UAS in (Inter)national Airspace: Resilience as a Lever in the Debate

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Abstract. This paper explores what a particular strategy from the resilience engineering "tool kit" – taking an alternative perspective – can do for "wicked" problems in which often numerous trade-offs have to be made. The Israeli Defence Forces have, as we will illustrate, successfully applied this strategy in their battle of Nablus in 2002. In this paper we attempt to transfer this strategy to the UAS integration debate. This is the debate around the safe introduction of unmanned systems in the current airspace structure along with its current (manned) "inhabitants." Many trade-offs have to be addressed in this debate, some of which will be neglected as long as certain angles to the issue are ignored. It appears that a social science approach – more specifically in this case the ethnicity literature – can strengthen dialogue and discussion. Also, it can provide a more adequate scientific understanding of some socio-technological issues underlying what superficially seems to be a simple case of managing trade-offs for the purpose of safety.

1 INTRODUCTION

How to safely integrate Unmanned Aircraft Systems (UASs) into the (inter)national airspace structure seems to be a "wicked" problem (e.g. Ramalingam, Kalawsky and Noonan, 2011) in which many trade-offs have to be successfully addressed. The debate about integration has some time depth but some issues, especially safety, have not yet been unresolved.

Historically, attempts to integrate UASs in the airspace have taken mainly engineering and technocratic approaches which focus on technological innovation (such as sense/detect-and-avoid technology) and on standardization, policy and regulation efforts (e.g. ICAO, Eurocontrol and EASE in UVS International, 2011; Loh,

Bian and Roe, 2009; Cork, Clothier, Gonzales and Walker, 2007). These "conventional" solutions, however, do not always seem to achieve the ends that one desires in these "wicked" cases. To pursue alternative strategies, approaching a topic from an unorthodox direction, can then be helpful. The Israeli Defence Forces (IDF) give us an example of this.

In April 2002 the IDF assaulted the city of Nablus while Palestinian armed organizations barricaded all entries to the old city. Streets and alleys were mined and entrances to buildings were booby-trapped, as were the interiors of strategically important structures. The IDF therefore chose to perform an unconventional manoeuver that they call "inverse geometry" or "walking through walls", part of their more broadly defined "lethal theory":

> *[In Nablus IDF] soldiers used none of the streets, roads, alleys, or courtyards that constitute the [usual] syntax of the city, and none of the external doors, internal stairwells, and windows that constitute the [normal] order of buildings. [They] rather moved horizontally through party walls, and vertically through holes blasted in ceilings and floors. In fact, after serving their original purpose, the openings forced through the walls [became] part of the [everyday] syntax of the city and [were] not reused for military purposes.* (Weizman, 2005)

Since Nablus this IDF manoeuver has been regarded as highly controversial (e.g. Gordon, 2002) but this is not the issue that will be addressed here. The advantage that this strategy gave the IDF in Nablus is taken here as an example of what an alternative viewpoint can achieve. In this paper this has been applied to the introduction of UASs into the national and international airspace structure.

Many trade-offs have to be addressed in this debate, most of them – if not all – affecting the larger system's safety. For some of these issues, standardized solutions are not sufficient. In these cases, unorthodox perspectives can perhaps provide a way in. What we propose here is a kind of a meta resilience engineering: the ability and resilience to deal with the many trade-offs and unknowns in a system before the system has even emerged yet. Like the IDF applied their "lethal theory" in Nablus we will suggest that the UAS integration debate can benefit from approaching this issue from the perspective of ethnicity literature. The issue, we believe, can benefit from this as it takes up the introduction of UAS as a sociological process of acculturation strategies rather than as a process in which it is assumed that "equivalent" levels of safety, for instance, can be arrived with by using or applying some supposed rational and universal standard.

2 RESILIENCE STRATEGY IN WICKED PROBLEMS

Walking through walls is not an obvious strategy. In the case of Nablus, one could say, it was a strategy that was born out of necessity; it provided a means for penetrating a previously "un-penetrable" city. However, choosing such an unorthodox strategy cannot be done without getting past one's current paradigms, here especially about the outside physical world:

> *This form of movement … sought to redefine inside as outside, and domestic interiors as thoroughfares. Rather than submit to the authority of conventional spatial boundaries and logic, movement became constitutive of space. … The IDF's strategy of "walking through walls" involved a conception of the city as not just the site, but the very medium of warfare.* (Weizman, 2005)

With this inverse geometry manoeuvre, the IDF truly crossed both physical and conceptual boundaries. The formulation of high level theories has been very important in the Israeli way of conducting a municipal war:

> *Theory is important for us in order to articulate the gap between the existing paradigm and where we want to go…. Without theory, we could not make sense of different events that happen around us and that would otherwise seem disconnected….* (Weizman, 2005)

The inverse geometry manoeuver is an example of what Weizman (2005) defined as "Lethal Theory". Although he does not define at length what Lethal Theory is, he seems to means the use of a particular theoretical discourse to aid the development of unorthodox tactics. The theoretical sources were found in poststructuralist schools which favour criticality (criticality attempts to critique and so transcend common assumptions of order, reality and society). The application of this unconventional strategy provided the IDF with a significant strategic advantage in the battle of Nablus.

In this particular case the IDF benefitted from avant-garde urban research conducted in architectural institutions. The point here is that, especially when numerous trade-offs have to be made, a tendency often exists to restrict oneself to a number of "everyday" choices. What the IDF case illustrates, however, is that in those "wicked" cases especially, a resilience engineering strategy (taking an alternative perspective) might be a better choice to provide a way in. Like with the assault of Nablus such a strategy can perhaps be helpful as well in the debate on the integration of UAS in the (inter)national airspace. Approaching the issue from a socio-technological rather than from an engineering or technocratic perspective, for instance, would allow us to look at the role social dynamics (a topic that so far has received little attention) can have in the UAS integration debate. Central to this debate, national and international, seem to be these two main premises:

1) UAS must meet the equivalent levels of safety (ELOS) as manned aircraft, and
2) UAS must be integrated seamlessly in the current air traffic management (ATM) structure

What these two premises imply is that the introduction of UAS integration in non-segregated (inter)national airspace implicitly (or explicitly) is supposed to rest on the capability of the UAS minority to act like the majority of the current airspace users i.e. manned aircraft. The worldwide UN-organization ICAO, in Circular 328 on UAS, expresses this this way: "The goal of ICAO in addressing unmanned aviation is … to underpin routine operation of UAS throughout the world in a safe, harmonized and seamless manner comparable to that of manned operations"

(ICAO, 2011). Framing the UAS integration issue like this has much in common with what Berry, a respected scholar in ethnicity research, terms “acculturation strategies”: the strategies that people seek in “the dual process of cultural and psychological change that takes place as a result of [prolonged] contact between two or more cultural groups and their individual members” (Berry, 2005).

Bringing acculturation theory to bear on UAS integration could have an effect like lethal theory in the battle of Nablus. Taking an alternative viewpoint, avoiding thereby current paradigms and resultant dead ends, could help clarify what is at stake in the UAS integration debate and result in an understanding and solutions that the current focus on engineering, policy and regulation has so far has not been able to provide. It allows us to look, for instance, at the role that social dynamics in general (a topic that so far has received little attention) can have in this debate. What current debates on UAS integration mask, it seems, is the notion of power.

3 ACCULTURATION IN THE DEBATE ON UAS INTEGRATION

3.1 Integration or Assimilation?

The aim of the various stakeholders in the UAS integration issue is to enable a safe *integration* of UASs in the airspace structure along with all the other users. The word integration, which is used in this debate by both members of the manned and the unmanned sector, deserves some exploration. Integration, for instance, is one of the eight key strategies that Berry identified in his bi-dimensional ethnic acculturation model (Fig 1).

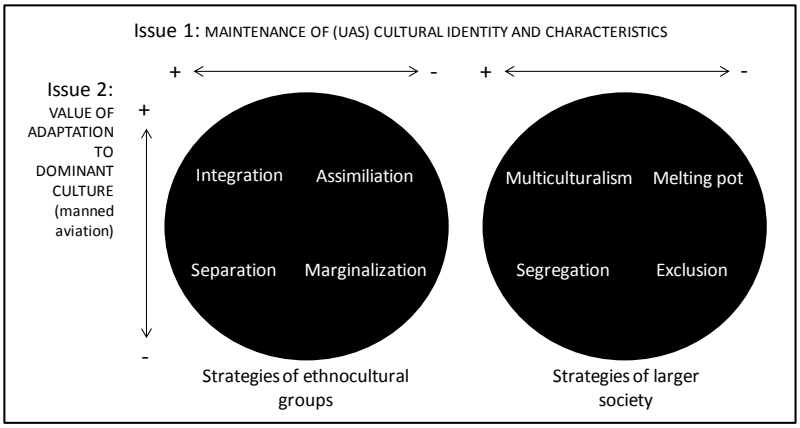

Fig. 1. Berry’s acculturation model (Berry, 2005)To integrate, viewed through Berry’s model, is a strategy of *non*-dominants to try to maintain the own habits and characteristics while at the same time to seek interaction and exchange with members of the dominant group. The corresponding attitude towards newcomers by *dominants* would be called in Berry’s terms multiculturalism. Dominance, by the

way, is recognized in most acculturation models but the question of how this dominance is arrived at (except by sheer number) is, also by Berry, seldom directly addressed. Translated to the UASs, nonetheless, integration would thus mean an end-state in which both manned aircraft and UAS can operate in close (even collaborative) conjunction with each other in the same airspace structure while at the same time retaining differences in say technical characteristics and in concepts of operations. This, in no way, however, coincides with the pathway that the various stakeholders seem to have embraced on this issue. After all, the two premises mentioned earlier rather seem to assume and encourage UAS to act exactly like manned aircraft. This resembles the characteristics of a melting pot (~ assimilation) strategy rather than those of integration or multiculturalism. There seems then to be a divide when it comes to the introduction of UASs in the airspace between the intention that is articulated (integration/multiculturalism) and the actions performed or intended (directed towards assimilation/melting pot).

3.2 Or should we consider Fusion?

This belief, that for a safe integration of UASs they should act like manned aircraft, corresponds to what Woods refers to as the “substitution myth”. Woods applied this term to engineers’ apparent belief that human activities can be substituted by automation activities “without otherwise affecting the operation of the system” (Woods and Christofferson , 2002, p. 3). Such a “substitution”, however, actually adds another actor to the system and this is invariably accompanied by a whole rearrangement of tasks, roles, duties and also of responsibilities. What seems to be a simple substitution of one item for another can thus instead, to a greater or lesser extent, impact the system as a whole, resulting at times in a complete different system. Not recognizing this, can weaken discussions on system safety.

The introduction in aviation of a collision avoidance system in aviation at the end of the past century is an example in which this substitution myth was not recognized and had a tragic effect. This Traffic Collision Avoidance System (TCAS) is an on-board system and generates automated air traffic coordination messages. However, it does this within the existing air traffic management (ATM) structure provided by human air traffic controllers on the ground. The introduction of TCAS can thus produce a potential source of ambiguity and thereby can it inadvertently limit or weaken the system as a whole. Indeed in 2002, five years after the introduction of TCAS and just before the aviation industry was ready to call the TCAS system “mature", a Bashkerian Airlines passenger plane collided in the air with a DHL cargo aircraft. In this accident, the directions of the on-board TCAS system conflicted with the air traffic instructions from the ground. The result was to extend the development phase of the TCAS system.

Similarly, the impact that the substitution myth can have in the UAS integration debate has gone so far unnoticed. In this debate it is believed that as long as UASs act as any other (piloted) aircraft in the airspace structure, i.e. as long as a melting pot strategy is pursued, it will be safe for UASs to share the airspace structure. It can, however, be argued that UASs can be made to act similarly to manned aircraft,

but never exactly alike. In other words, with the introduction of a substantial amount of UASs in the airspace structure, it is inescapable that the airspace system will change as a whole and the operations within it as well. This possibility exceeds, however, Berry's acculturation model which does not seem to allow for an altered system to develop.

A more recent and more applicable acculturation model, therefore, is perhaps the fusion model. In this model the newcomers and the host society are believed to mutually influence each other in such ways that their aggregated acculturation process results in a new society with characteristics that set it apart from the previous one. In the fusion model, the acculturation processes of the two groups *together* thus ultimately creates a whole new structure (e.g. Hermans and Kempen, 1998; for other references for this fusion model, see Coleman, 1995; Padilla, 1995; LaFromboise et al., 1993). When applied to the introduction of UAS in the (inter)national airspace, the fusion model allows a new structure to emerge from the dominants' (conventional aircraft) and the non-dominants' (UAS) behaviour(s). This model therefore seems to fit the issue. Still, the aviation community claims to pursue the *integration* of UAS in the aviation sector. There thus seems to be a gap between the strategy pursued in the UAS debate and that what can be argued reflects the actual situation. The fusion model in particular would therefore perhaps be a better framework for the introduction of UAS in the (inter)national airspace than other models such as the integration model that is currently used.

3.3 Framing

Another issue that we would like to discuss here is the one that brought us to bring ethnicity theory to bear at the introduction of UAS in the airspace to begin with: framing. Safety is a key issue in the debate. No concessions to safety are allowed, no trade-offs for safety. "Thoroughness" (Hollnagel, 2009), so to speak, dominates the discussion. The discussion has, however, been framed such that one of the parties, UAS so it seems, has to argue – or rather to negotiate – in the terms and references of the majority group (manned aircraft). Under the rhetoric of being equal – the basic premise of integration – the arguments pro and con UAS status are thus already "tilted" in the direction of manned aviation. This leads us to challenge whether it is pure safety that is adhered to in the discussions or something else.

4 DISCUSSION

Historically, the aviation sector has been seen by itself and others as a safety conscious domain. It can be argued then that the UAS integration debate has a firm base in safety as well. After all, many of the arguments in the debate – if not all – in the end seem to boil down to arguments after safety. The first premise in the debate, that UASs must meet an equivalent level of safety in the air and for people on the ground as manned aircraft, is perhaps the most obvious one. Inherently to

the debate are the many trade-offs that the different stakeholders will have to make in conjunction with each other. These social dynamics (and process) allows a social science or, even better, a socio-technological perspective on the issue.

Like lethal theory for the IDF in Nablus, acculturation theory seems to be able to provide a useful theoretical perspective on the UAS integration issue. It can perhaps bring to the surface some important, but not yet widely acknowledged, issues related to the safe introduction of UAS in the (inter)national airspace structure. The lack of congruence, for instance, between the stakeholders' positions and the acculturation model that seems to interpret actual practice best – the fusion model – can result in both discussions and solutions being less nuanced than they perhaps should be. From a resilience perspective, it is therefore necessary in this debate to consider the acculturation strategies which stakeholders embrace, and to analyse whether they have the potential to improve airspace safety. Neglecting these issues could in fact jeopardize safety in ways that otherwise could be difficult to pinpoint.

What current integration UAS debates mask, for instance, is the notion of power. Rhetorically, the arguments pro and con UAS status are already "tilted", so it seems, in the direction of the dominant party, manned aviation. Perhaps if we can shift the terms away from this notion of integration, we can begin to deal with some of the more difficult but important issues that so far have not surfaced in the UAS airspace debate. What lies behind what seems to be an academic or policy debate about equality seems to be one in which self-interest is at work right across the spectrum from (inter)national concerns to market interests to those at a more micro level (self-interest ranging from (individual) firms, actors and their respective careers and successes).

This paper has focused specifically on the safe introduction of UASs in the current (inter)national airspace. We have proposed to take an alternative perspective on the issue since it appears that taking such an unorthodox approach can be useful in providing empirical data which could help clarify neglected but important safety issues in this debate. Further research from a social science perspective should be performed, however, to find out whether this can also reveal obstacles in a more general sense as well in debates on issues of safety that strictly engineering, management, and policy may not be able to identify or address. Under uncertainty specifically, unorthodoxy seems to have at least the potential to serve as a source of meta resilience in systems engineering in general.

5 CONCLUSION

What we have argued for in this paper is that, especially when numerous trade-offs are to be made, such as in the debate around the introduction of UAS in the airspace structure, a tendency often exists to restrict oneself to the choices already formulated (which often reflect the basic premises in a debate). It is in these instances in particular, it seems, that a specific resilience engineering strategy (taking again an alternative perspective), can provide a way in. Bringing, for

instance, acculturation theory to bear on UAS integration, can help clarify what is actually at stake in this debate. While safety is said to prevail at all times (no trade-offs for safety), discussions have been framed such that the minority group (UAS) by definition will be at a disadvantage, regardless how safe they are, since they are forced implicitly to express themselves in the language of safety of the majority manned aviation sector. What this paper does, therefore, is that it acknowledges and illustrates how bringing in an alternative perspective can lay bare hidden assumptions and bias regarding trade-offs, for instance, that otherwise would not be brought to the table.

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