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A systems engineering approach to counter terrorism

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Terrorism as creativity

Terrorism is "the systematic use of violence to create a general climate of fear in a population and thereby to bring about a particular political objective" (Encyclopaedia Britannica, 2005). Terrorism has a long history, and it affects almost every nation on earth: the terrorist activities of 11 September 2001 (abbreviated here as "9/11") brought this home with particular force. Terrorist actions such as 9/11 have two properties that are of particular interest for the present discussion: they must surprise the people against whom they are directed (otherwise the intended targets will implement appropriate prevention or avoidance measures), and they must be effective. If they do not have any concrete effect (such as killing people), they are a failure and may even lead to loss of resources for no gain, "gain" being understood in terms of dealing out death and destruction. This means that in order to cause a climate of fear the malevolent products of terrorists must satisfy the two basic criteria of creativity (novelty and effectiveness). Thus, they are an example of the dark side of creativity, indeed since they deliberately seek to cause harm, of malevolent creativity.

Unlike most people and organizations that generate effective novelty, terrorists function more or less outside the conventional moral system. In terms of Sternberg's position (this volume), they do not concern themselves with the common good (although terrorists often claim that they are pursuing a higher order common good, even in the societies they claim to be defending their work is often rejected or condemned), so that they are not affected by moral considerations. Even in war, nations usually pay at least lip service to "the rules of

war" and seek through "rules of engagement" to avoid harming innocent bystanders, although there are notable exceptions such as the allied bombing of the German civilian populace in the second world war. This means that the creativity of terrorists represents a special form of malevolent creativity: one that is free of moral constraints.

Creative products

Terrorists are continually changing their ways and means in, unpalatable as it is to say it, a very creative manner, as 9/11 shows. Thus, a deep understanding of creativity is required to understand the way they are creating the next threat, and to block their activities. Since the effects their malevolent creativity achieves (i.e. its products) are crucial for success or failure (from the point of view of the terrorists), understanding the creativity of terrorists requires an extended understanding of creative *products*. Cropley and Cropley (2005) have proposed an appropriate model of creative products founded on the concept of creativity in engineering, basing it on the idea of "functional" creativity. A bridge built by civil engineers must, for instance, not only be original and surprising in design (novel), but it must also successfully solve the problem of how to transport vehicles across a river (effectiveness). A non-functional product that is novel but ineffective is at best aesthetic. A product that is effective but not novel is routine. There may well be a place for both in creativity theory, but a terrorist product that does not cause death and destruction is useless (from the terrorists' point of view), no matter how novel it is, while terrorists who stick to a single product become predictable, no matter how effective it is, and are likely to have a short career.

The concept of functional creativity goes beyond mere novelty and effectiveness to incorporate two further principles which are used in this chapter to analyze the malevolent creativity of terrorists. These are elegance and genesis (Cropley and Cropley originally referred to the latter as "generalizability"). In the present context, an elegant product is one that achieves its effective surprise in a smooth, neat and (of particular importance for anti-

terrorist agencies) economical way. A generic product is one that draws attention to previously unnoticed weaknesses (seminality), suggests new ways of solving old problems (germinality), or transfers directly to different situations (Cropley & Cropley, 2005). While novelty and effectiveness are sufficient for a solution to be creative, in business settings elegance and genesis add value to a new solution, for instance by making it difficult for rivals to emulate or nullify it, or by subtracting value from rival solutions, for instance by making a whole class of competing solutions obsolete. To take a simple example, the development of the transistor not only added effective novelty to the area of portable radio construction, but ultimately revolutionized communications technology (Genesis) and subtracted value from the vacuum tube, despite the fact that vacuum tubes continued to be capable of doing the job they were developed for, although no longer used.

Cropley, Kaufman and Cropley (2008) drew attention to a further property of functional solutions. They are highly susceptible to the effects of time, because the passage of time usually means loss of novelty and, where effectiveness depends on surprise, loss of novelty frequently leads to loss of effectiveness. Cropley, Kaufman and Cropley (2008) called this effect “decay” of novelty/effectiveness. D. H. Cropley (this volume) gives the example of the thwarting of the 9/11 terrorists’ planned use of the flight UANNN to attack either the White House or the Pentagon. Once the passengers on that flight heard about the World Trade Center attacks, i.e. once novelty had seriously decayed, they were in a position successfully to oppose the planned further attack, albeit at the cost of their own lives.

The problem for the users of malevolent creativity is that they do not wish to conceal their novelty from public knowledge: On the contrary, they often wish it to become as widely known as possible, for instance to achieve the general climate of fear referred to in the opening paragraph. This means that, as in the UANNN example just cited, the novelty of their actions often decays very rapidly. Terrorists must thus constantly generate further effective

novelty. The same is true of countermeasures: their life cycle is very short. They must involve fast, effective, adaptive solutions to deal with continuously changing conditions. Organizations seeking to engineer anti-terror solutions have to be very creative to remain effective as terrorists continuously change their methods. Thus the malevolent creativity of terrorists can be regarded as a process of extremely flexible, rapidly changing generation of effective novelty in the face of competition from a rival (anti-terrorism agencies). The terrorists, however, are not constrained by working from a highly stable, immobile infrastructure such as extensive physical plant, a body of career managers, control by government or other regulators, or the demands of shareholders, as traditional businesses are. Terrorist organisations use this freedom to plan and perform their operations.

Opposing terrorists' malevolent creativity

Thinking of terrorism as malevolent creativity sheds light on creative ways of combating it. Counter-terrorist agencies need to see their activities in the context of competing functional creativity. Terrorists and counter-terrorists are two creative agencies competing with each other to develop functionally creative products which outperform their opponents' products, add value to their own products, or subtract value from their opponents'. This applies to products that are physical engineering devices and objects (e.g. metal-detectors) as well as products that are systems, services and processes. The concept of functional creativity dictates that counter-terrorism must, as a minimum, continuously generate effective novelty in order to stay ahead of the competition (the terrorist). Furthermore, by understanding the terrorist product in terms of the characteristics of functional creativity it is possible to tailor counter-terrorist solutions to maximize their effectiveness and even to subtract value from the terrorist product.

Many counter-terrorist approaches focus only on problem solving. Creativity theory, however, emphasizes creative problem *finding*. This includes re-examination of the nature of

the problem and asking whether the right problem is being addressed. This is akin to the difference between verification and validation in engineering. Verification asks, “Are we solving the problem right?” whereas validation asks, “Are we solving the right problem?” A problem finding approach makes it possible to see combating terrorism in a new light. The following example from Tibi (2003) demonstrates this.

Passengers, airport operators and aviation companies are all forced to invest substantial resources and time in order to prevent hijackings. But is the problem of terrorists hijacking passenger aircraft really one of preventing them from getting guns onto the aircraft? Or is it really a problem of negating the danger posed by a terrorist who has succeeded in getting a gun onto an aircraft? The former focuses attention on things like metal detectors, and security screening, while the latter might focus attention on arming other passengers as a means of negating the effect of an armed terrorist. In the event of a hijacking the “auto immune” concept is based upon enlisting the passengers to foil the event, rather than trying to prevent the hijacking in the first place. Both approaches are directed at solving the underlying problem of hijacking, yet they generate radically different solutions, some of which (like metal detectors) have already experienced very substantial decay of novelty and are not 100% effective, in any case, so that they are easy for terrorists to counteract. The metal-detector also gives potential terrorists ample opportunity to study their competitors and devise their own creative ways of subtracting value from (nullifying) their competitor’s efforts.

A solution to the newly defined problem might, for example, involve providing non lethal weapons to all passengers. While radical, it is certainly original and surprising (not least for the terrorist). Arguably this “auto-immune” aircraft solution would have stopped the 9/11 events within seconds of the first terrorist brandishing his box cutter, and saved many lives. The purpose of this example is not to suggest an actual solution, but to illustrate the kinds of thinking and analysis, based on concepts of creativity, that would yield other real, workable

solutions. Such solutions, realistically, may only work once, because of novelty decay. It is no longer so much the case that the price of peace is eternal vigilance; rather it is now the case that the price of survival is eternal creativity.

Counter-terrorists also face an interesting variant of the moral issues previously discussed, in order to avoid their own creativity becoming dark. Western cultures generally are not prepared to compromise fundamental values such as freedom of transportation, freedom of communication (the right to know), legal systems founded on the presumption of innocence and trial by jury, the right to meet, and the right to privacy, especially in business and financial issues. Public opinion in the West still protests and opposes any attempt to compromise these values in order to prevent terror. Examples include objections to activities such as building security fences to segregate populations, preventative searches of people and property without due cause, pre-emptive investigations, profiling and preventive arrests. It may well, of course, be right to oppose such measures, but that does not alter the facts of the uneven playing field on which the two organizations compete.Thus, the creativity of counter terrorists is restricted by constraints that the malevolently creative can ignore.

A systems engineering-oriented approach to finding solutions

The efforts of the international systems engineering (SE) organization, INCOSE, to modify the SE processes to develop anti-terror solutions are very impressive (INCOSE, 2002, 2003, 2004, 2005). However, cases have arisen where an anti-terror solution development team simply refused to use the SE guidelines as required by the SE standards and handbooks, because of the urgency of the problems. They claimed that standard SE processes do not meet the special characteristics of anti-terror solutions development outlined above, and especially that they do not display the required urgency. Comments such as: "…We have to save lives here, there is no time for the 26 standard views of DODAF documents…" were encountered. (DODAF is the United States of America Department of Defense Architecture Framework)

(DODAF 2004). Responding to this problem, Hari and Weiss (1996) proposed a 10-step approach to designing solutions that they called the *Integrated Customer Driven Design Method* (ICDM). This integrates creativity-fostering techniques such as brainstorming (Gordon, 1961; Osborn, 1957) or TRIZ (Altshuler, 1984).

In the past, novel products and systems were frequently designed by a single person, who possessed all the know-how needed. With the information explosion, the possibility of a single person designing a novel complex system alone has been practically eliminated, and an IPT – Integrated Product Development Team— is needed (Clausing, 1994). The tools developed by the design theory and methodology community and by ICDM are aimed at assisting and coordinating the activities of an IPT in the development of a new product or a new system. In counter-terrorism a methodology is required that will generate rapid and constantly changing solutions. A telling factor is the need for continuous creativity aimed at solving the "right" problem. Such approaches are referred to in SE as "agile."

According to The American Heritage Dictionary of the English Language "agile" is defined as an ability to move in a quick and easy fashion; active (Houghton Mifflin 1976). Key practices of agile SE were published by Wilson and Mooz (2003), who defined it as:

> "rapid user and stakeholder requirements management, including concept selection, architecture development, system integration, verification, and validation in a development environment characterized by swift adaptation to changes, non-hierarchical baseline management, and a notable absence of low-value bureaucracy."

The features that distinguish agile SE from traditional SE are speed and adaptability. A deep discussion on agility is found in (Dove 2001). He discusses agility from the broader enterprise and organizational view, including a set of tools for analyzing, measuring, and designing

change proficient business practices and strategies. The seven key practices of agile SE can be summarized by Wilson and Mooz (2003) as:

1. The project team understands, respects and works (behaves) within a defined systems engineering process;
2. The project is executed as fast as possible with minimum down time or staff diversion to other priorities during the project;
3. All key players are physically or virtually co-located. Other contributors are available online;
4. There is a strong bias for automatically generated electronic documentation. Engineers rely on their tools and their "Electronic Engineering Notebooks" to record decision rationale. Artifacts and documentation for operations and replication is done only if necessary, not to support an existing bureaucracy or policy;
5. Baseline management and change control by formal, oral agreement based on "make a promise, keep a promise" discipline, players hold each other accountable. Control gates are settled with a handshake;
6. Opportunity exploration and risk reduction are accomplished by expert consultation and rapid model verification, coupled with close customer collaboration. Software development is done in a rapid development environment, while hardware is developed in a multi-disciplined model shop;
7. A culture of constructive confrontation pervades the project organization. Issues are actively sought. Anyone can identify an issue and pass it on to the most likely solver. No issue is left unresolved (the team takes ownership for success; it is never "someone else's responsibility").

The anti-terror solution workshop

The desire to satisfy these requirements while complying with SE standards and processes motivated the development of a special five-day workshop. The participants included some of the most creative experts in a wide range of areas. The focus of the workshop was on an immediate, painful and relevant problem. Israel experienced a series of terror attacks with many civilian casualties during the years 2003- 2004. In one of them a suicide bomber had just blown up a bus in Haifa, Israel, and 14 people, most of them children, had been murdered; one of them was the son of a colleague. The urgency of the problem created a feeling of a mission, excitement, devotion, and persistence.

The effort started with preparatory meetings. The first one included decisions on the methodology, the problems to focus on, the time frame and general instructions, boundaries and constraints of the expected solutions. A half day "awareness day" was then carried out. During this, the representative of the customers described the needs and the challenges, the organizers described the methodology and the president of the organization gave the motivation and declared the management commitment for the process. The participants were arranged in four teams – a team for each terror problem which was to be solved. In a second meeting the team structure was finalized and customer representatives were allocated to each of the teams. In this preparation meeting background material was also selected and sent to the team members. Logistic preparation, budgets and some other formal arrangements were also finalized.

The workshop meetings took place in the organization's training facility, which includes a plenum hall, four syndicate rooms and other facilities. The team meetings were scheduled for five consecutive Tuesdays. This allowed the team members to continue with

their regular jobs. The workshop structure also allowed team members to go through some reading and internet search activities between the meetings. Each day was opened with a short session of methodological and general instructions, then the teams dispersed to the syndicate rooms for the team sessions. Towards the end of the day they returned to the plenum hall to present their outcomes to the other teams' members, for discussion, and for decision-making for the next meeting as well as conclusions.

The workshops were accompanied and supported by an organizational consultant, who observed the whole process, interviewed the team members and the customer representatives, and helped the facilitators with advice and lessons learned. The process was structured but flexible. Methodology was tailored to the special requirements of the process and each team's unique characteristics. For example two teams found that their solutions were mutually linked and these teams initiated additional joint sessions.

A series of terror events in Israel encouraged organising another workshop to solve other terror problems in 2004.

The workshops yielded several conceptual and technological solutions to the major problems. Some examples for such concepts are:

- Auto immune concept for airplane hijacking.
- Self-checking at the bus door.
- A fence with no fence.
- Real-time intelligence for terror events.

As a results of the lessons learnt in the previous workshops, a research was initiated to develop, study and formalize the counter terror agile system engineering process.

In all, 30 teams of experienced engineers were assigned to develop creative anti-terror solutions; 19 of them served as research groups and 11 served as control groups. All 30 teams applied the10 steps of ICDM step by step. The teams met 14 times once a week for 3 hours of

training, consulting and sharing their progress, and continued applying the process during the days between these meetings. Data were measured and collected on several aspects of their work such as: time investment, performance, effectiveness, novelty, elegance, generalizability, design quality and levels of ICDM methodology performance. The research teams and the control teams performed their tasks at the same time but did not know about each other. The subjects of the projects include: ports protection, bus protection, border pass systems, portable police barriers, containers protection, water reservoirs protection and terror-intent forensic incrimination.

Results indicated that:

1. Using agile SE processes two–three month from a need identification to implementation of a solution is more then enough time.
2. In order to achieve reasonably good results a team should invest 100–170 hours per team member. To achieve very good results the team needs to invest more then 200 hours per person, which is questionable from an economic point of view.
3. The creative activities of ICDM encourage the teams to be very creative and to create many ideas and concepts.
4. The screening tools of ICDM help to reduce the number of ideas and concepts to a manageable number. As a result the screening tools of ICDM help to identify the best ideas and concepts rapidly and efficiently.
5. Incentives help the teams to create more ideas and more primary concepts.
6. Final concepts exhibit a high level of novelty and effectiveness.
7. Final concepts also achieve a high level of elegance.
8. The generic quality of products is low.

An enormous amount of efforts are invested to initiate rapid, creative and effective methods of combating terrorist malevolent creativity. One of these efforts was the establishment of workshops that offered a semi-structured environment for the creation of new ideas & conceptual solutions by highly motivated teams. This chapter presented such a process and discussed the special ingredients and features of agile Systems Engineering as applied to anti-terror solutions and the application of the model of functional creativity in the context of combating terrorism.

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