

What Happened to Suicide Bombings in Israel? Insights from a Terror Stock Model

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An analysis of three years of suicide bombing data in Israel reveals an increase in such attacks through March 2002 followed by a steep decline through the end of 2003. The authors propose a terror-stock model that treats the suicide bombing attack rate as a function of the number of terrorists available to plan and execute suicide bombings. The intent of Israeli tactics such as targeted killings and preemptive arrests is to reduce the capacity of terror organizations to commit attacks. When fit to the data, this model suggests that the targeted killing of terror suspects sparks estimated recruitment to the terror stock that increases rather than decreases the rate of suicide bombings. Surprisingly, only the deaths of suspected terrorists, and not Palestinian civilians, are associated with such estimated recruitment. Although Israeli actions have reduced the rate of suicide bombings over time, it is preventive arrests rather than targeted killings that seem more responsible for this outcome.

Received 20 August 2004; accepted 20 September 2004.

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Operational effectiveness of suicide-bomber-detector schemes: A best-case analysis

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Edited by Kenneth W. Wachter, University of California, Berkeley, CA, and approved May 2, 2005 (received for review January 22, 2005)

Standoff explosives-detection technologies allow, in principle, for the detection of pedestrian suicide bombers, although such sensors are not yet sufficiently affordable and reliable to justify widespread deployment. What if they were? Assuming the availability of cheap, perfectly sensitive and specific suicide-bomber-sensing devices, we analyze the operational effectiveness of sensor-based detector schemes in reducing casualties from random suicide-bombing attacks. We model the number of casualties resulting from pedestrian suicide bombings absent intervention, the reduction in casualties from alternative interventions, given timely detection of a suicide-bombing attack, and the probability of timely detection under best-case assumptions governing the performance of suicide-bomber-detector schemes in two different urban settings. Even under such optimistic assumptions, we find that the widespread deployment of suicide-bomber detectors will not reliably result in meaningful casualty reductions. Relaxing the best-case assumptions only makes matters worse. Investment in intelligence-gathering to prevent suicide bombers before they attack seems a wiser strategy than relying on sensor-based suicide-bomber-detector schemes.

mathematical modeling | sensor detectors | suicide bombings

Since 2001 (1) (www.mfa.gov.il/mfa/terrorism-%20obstacle%20to%20peace/palestinian%20terror%20since%202000/), and hundreds of civilians and soldiers have been killed by SBs in the current Iraqi insurgency (www.guardian.co.uk/Iraq/page/0,12438,1151021,00.html). Frequent suicide bombings in Israel prompted the *Jerusalem Post* to complain that Israel's weapons-manufacturing industry had yet to develop a technological solution including a "failure to invent an early detection device" (2). Citing similar concerns, the Defense Advanced Research Projects Agency recently commissioned the National Research Council (NRC) of the National Academies to examine standoff explosives detection, in part, to determine "the ability to detect a suicide bomber before the bomber is able to reach his or her target and detonate the explosive" (3).

As detailed in the NRC's comprehensive report (3), sensors employing x-ray or electromagnetic imaging in the infrared, terahertz, millimeter, or microwave spectral range can, in principle, detect SB explosive belts from standoff distances of at least 10 m, and novel approaches based on explosive vapor-plume imaging, anomalies in a SB's local atmospheric-ion background, or distributed biological sensors have theoretical potential to contribute to SB-detector systems. However, existing SB sensors are far from perfectly sensitive or specific, and some of the more promising sensors are bulky and expensive, for example, millimeter wave detectors weigh 650 pounds and cost hundreds of thousands of dollars per machine (3). Existing technologies are insufficiently affordable and reliable for widespread deployment.

But what if they were affordable and reliable? Highly sensitive and specific SB detectors deployed in portal screening/checkpoint environments at known targets (such as passenger screening at airports or visitor screening at entrances to government buildings, military installations, or sports events such as the Super Bowl) could

certainly prove useful. However, consider random, pedestrian suicide-bombing attacks, that is, attacks by individual SBs on foot at randomly chosen restaurants, shops, or other locations lacking effective checkpoint security and otherwise distinguished only by a crowd of potential victims. What is the operational potential of even perfect SB-detector schemes to reduce casualties from attacks of the sort experienced in Israel, Iraq, and elsewhere?

In the spirit of recent systems analyses modeling bioterror attacks, preparedness, and response (4–6), we report an analysis that models the number of casualties resulting from pedestrian suicide bombings absent intervention, the reduction in casualties from alternative interventions, given timely detection of a suicide-bombing attack, and the probability of timely detection under best-case assumptions governing the performance of SB-detector schemes in two different urban settings. We focus on best-case detection scenarios for the simple reason that, if such optimistic analysis fails to demonstrate meaningful casualty reductions because of SB-detector schemes, then no analysis will (7).

Models

We consider pedestrian SB attacks in two urban environments. The "grid model" (Fig. 1A) presumes a layout of 200-m $\times$ 200-m blocks separated by 10 m of street and 4 m of sidewalk width. A SB arrives at one of the intersections and walks at speed v along a blockface containing k shops. Absent detection, the SB attacks the first shop judged sufficiently attractive by entering and proceeding to its center before detonating. The probability that any shop is considered sufficiently attractive equals q . The target areas inside shops are modeled as circles with radius r m. Perfectly specific covert sensors detecting with certainty any SB who passes within r m are embedded in the center of a fraction f of the intersections in the grid, and, if the SB is detected, there is sufficient time to execute an intervention with the hope of reducing casualties (see *Appendix*).

The "plaza model" (Fig. 1B) portrays a large plaza or park (e.g., the Mall in Washington, DC, or New York's Central Park). Potential circular targets with radius r (e.g., crowd gatherings around performances, speakers, or outdoor cafes) are distributed within the plaza in accord with a spatial Poisson process. A SB arrives at a random location in the plaza (e.g., by car, motorcycle, or subway) and walks at speed v directly to the closest target located L m away. Perfectly specific covert sensors capable of detecting with certainty a SB who passes within r m are deployed in nonoverlapping fashion with density γ m⁻². Unlike the grid model, detection in the plaza model does not guarantee sufficient time to intervene, but the probability of timely detection [meaning at least 10 sec remain postdetection before the bomber explodes (3)] can be computed as a function of γ , r , and the expected SB travel distance, $E(L)$ (see *Appendix*).

Individuals within a target area are modeled as cylinders with height $h = 2h_0$ m and base width b m and are distributed over the

This paper was submitted directly (Track II) to the PNAS office.

Abbreviation: SB, suicide bomber.

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Counter-Terror "Fact and Fiction"

Duncan Graham-Rowe

July 2005

The continuing bomb threats in London have left most of us in no doubt that we are now living in the shadow of terrorism. By insisting that terrorists will not be allowed to affect our way of life and by using expressions like 'war on terror', politicians imply that we can somehow do something about this threat. But what exactly? TV series like *24* and *Spooks* may offer a glimpse into the inner workings of the counter-terrorism techniques used by the intelligence community, but how realistic are they? Can technology really help protect us?

Smart CCTV

Technology certainly has the potential to help protect us. Even before the collapse of the Twin Towers it had been widely recognised that certain public places, such as subway systems and airports, were prime targets for terrorist attacks and posed a particular challenge for protection teams. Consequently, technologies aimed at shielding such vulnerable hotspots from a range of threats have been under development for some years.

Much progress has been made in developing smart CCTV analysis software that can monitor camera feeds for 'unusual behaviour' that is statistically out of the ordinary. It can pick up anything from someone preparing to throw themselves in front of a train, to a fight breaking out, to someone leaving an item of luggage unattended at an airport.

One example of this technology is the Video Motion Anomaly Detection (VMAD) system developed by Roke Manor Research in Hampshire. Another system has been co-developed at Kingston University with technical partner Ipsotek and with research funded by the European Commission.

This system has in fact already been tested at Liverpool Street and Mile End Underground stations in London and is currently being trialed in Rome's Termini Underground station. But its emphasis is on monitoring crowd flow, and although it is able to spot intrusions into prohibited areas, unusual lingering and abandoned objects, it has a limited ability to spot suicide bombers.

With 1400 CCTV cameras on the London Underground network, this smart CCTV analysis software addresses the problem of having many cameras and not enough pairs of eyes to study the footage. But despite its potential for preventing suicides, fights and other petty crimes, it has very limited value in preventing a terrorist bomb attack of the sort we have recently witnessed. In this case, it is likely to prove useful only after the event. Since suicide bombers attack by blending in with the crowd, intelligent CCTV that spots unusual behaviour is unlikely to aid prevention.

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Study: Suicide Bomb Detectors Impractical

By THE ASSOCIATED PRESS

Published: July 4, 2005

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Filed at 5:56 p.m. ET

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WASHINGTON (AP) -- Setting up arrays of sensors in the hope of detecting suicide bombers in advance is unlikely to save many lives, according to a new study.

"Pedestrian suicide bombings might be better prevented by investing in intelligence leading to actions that prevent terrorists from prosecuting such attacks," Edward H. Kaplan and Moshe Kress report in Tuesday's issue of Proceedings of the National Academy of Sciences.

The detectors currently available are expensive and not sufficiently reliable for widespread use, they said.

If the technology were affordable and reliable it might be useful in preventing attacks at such known targets as airports, the entrances to government buildings or sporting events, they said.

But the sensors would be expected to be of little help in suicide attacks at such random locations as restaurants and shops.

"Widespread deployment of suicide bomber detectors would at best save a few lives," Kaplan, a Yale professor, said in a statement.

Kaplan and Kress, a professor at the Naval Postgraduate School, studied the effectiveness of detectors by analyzing pedestrian suicide bombing attacks on random crowds in urban settings.

They found that detecting attackers required a dense field of equipment capable of sensing bombs. In addition, to prevent casualties the response, such as fleeing or falling to the ground, must occur quickly.

In some cases, they said, response could even create even more

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Suicide bombers not easily foiled by technology

22:00 04 July 2005 by [Duncan Graham-Rowe](#)

When it comes to preventing suicide-bomb attacks technology cannot beat good old-fashioned detective work, a new study suggests.

The development of sensitive explosives sensors and terahertz scanners have in recent years raised the hope that technology could one day be used to detect suicide bombers.

The reality, however, is that even if the technology was affordable and reliable enough to justify widespread deployment in urban areas it would still fail to reduce casualties in any meaningful way, according to Edward Kaplan at Yale University, Connecticut, US.

Working with Moshe Kress at the Naval Postgraduate School in Monterey, California, US, Kaplan used mathematical models to predict how effective networks of sensors would be in early detection of pedestrian bombers, both in a city grid scenario and an open plaza environment. They did not consider car bombs.

They found that even if the sensors worked perfectly, to detect more than 80% of all attacks with sufficient time to respond would require between 70% and 80% sensor coverage of the area of a city. "It's not that there's nothing you can do, it's just that trying to rely on last-minute detection of random suicide bombers is the wrong way to go," says Kaplan.

Sensors are still likely to be effective in protecting specific target areas, such as sporting events or government buildings. But many suicide bomb attacks appear to be random, as illustrated in conflict-torn countries such as Iraq and Israel. And in these cases, investment in intelligence-gathering to prevent the bombers before they attack seems a wiser strategy, says Kaplan.

Journal reference: *Proceedings of the National Academy of Sciences* (DOI:10.1073/pnas.0500567102)



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SCIENCE JOURNAL

By SHARON BEGLEY



Why Just Detecting Hidden Explosives May Not Cut Deaths

July 8, 2005; Page B1

The explosions that ripped through three subways and a bus in central London yesterday underlined the urgency of determining what measures can reduce casualties from terrorist attacks. Although researchers have made strides in developing technologies to detect explosives at a distance, there is grave concern that such progress still falls short of protecting the public.

New research suggests that even perfect detection may not substantially lower the death toll from bombs set off in urban areas. And in some cases, terrorism experts now recognize a counterintuitive possibility: Warnings may lead to more fatalities.

Americans have an abiding belief in technological fixes, and that faith is now finding expression in the war on terror. The Pentagon's Defense Advanced Research Projects Agency recently commissioned the National Research Council to examine technologies able to detect suicide bombers before they reach their target. In its 2004 report, the NRC concluded that a number of sophisticated sensors, from millimeter-wave imagers to vapor-plume detectors, can detect hidden explosives more than 90 feet away, although none is perfectly specific (no false hits) or perfectly sensitive (no misses).

If, for example, a suicide bomber walked into a crowded plaza, "standoff" bomb detectors might well pick up an unambiguous signal. A terahertz imaging system could spy the telltale wires and explosives in 30 milliseconds, and ultraviolet-visible spectroscopy now in development could sniff out the trace vapors emitted by the ethylene glycol dinitrate in the plastique. Let's say the

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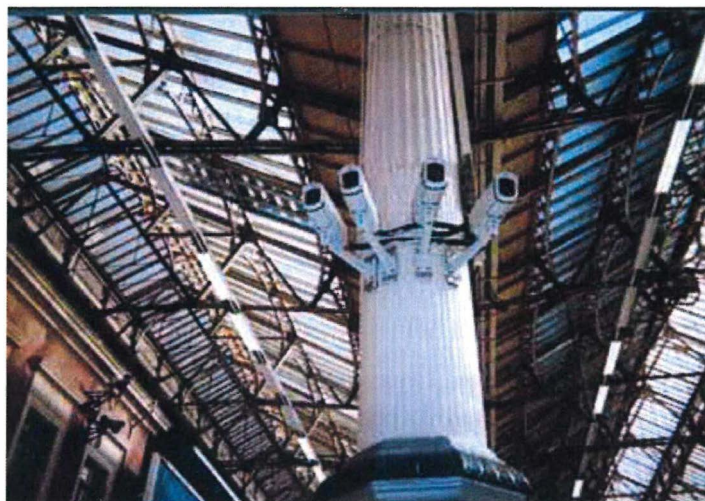
Politiker fordern mehr Überwachung zur Verhinderung von Terror

Florian Rötzer 11.07.2005

Größerer Schutz durch biometrische Ausweise, Überwachungskameras, Sensoren zur Sprengstofferkennung, Gen-Datei oder Speicherung der Verbindungsdaten?

Der Anschlag in London hat zu den üblichen Verurteilungen und Gesten der Einheit im Kampf gegen den Terrorismus sowie zu den erwartbaren Forderungen nach erhöhten Sicherheitsmaßnahmen und neuen Gesetzen geführt. Gerechtfertigt werden schon beschlossene Antiterror-Maßnahmen, beispielsweise in Deutschland oder Großbritannien die Einführung der Ausweise mit biometrischen Merkmalen. Aber die Bomben in London lehren vermutlich gerade, dass die meisten Sicherheits- und Überwachungsmaßnahmen entschlossene und einigermaßen intelligente Terroristen, auch wenn sie mit wenig ausgeklügelten Strategien und relativ primitiven Mitteln vorgehen, nicht daran hindern können, Anschläge im öffentlichen Raum von Städten auszuführen. Um das Risiko wirklich zu minimieren, wäre schon ein Überwachungsapparat Orwellscher Dimension oder ein Repressionsregime notwendig, wie man es etwa in Nordkorea findet.

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Wenn es denn stimmt, was der Independent [berichtet](#), dass die britische Polizei auch der Vermutung nachgeht, al-Qaida – wer immer das auch sein soll – könne "weiße Söldnerterroristen" für den Anschlag beauftragt haben, dann würde nicht einmal mehr das übliche Profil für die Täter zutreffen, nämlich dass die Täter jüngere männliche Muslime aus den arabischen Ländern oder Nachkommen von Einwanderern aus diesen Ländern sind. Möglicherweise, so die Spekulationen, habe man Muslime aus dem Balkan dafür ins Land gebracht, die bislang noch nie im terroristischen Kontext aufgefallen sind. Oder man habe gleich mit Geld kriminelle Banden damit beauftragt, schließlich handelte es sich offenbar nicht um Selbstmordanschläge.

Damit würde die Angst vor den muslimischen "Schläfern", die sich unauffällig in eine Gesellschaft eingemischt haben, übergehen in eine Angst, die sich gegen jeden richten kann, der gegen Geld bereit sein könnte, Anschläge auszuführen. Jedenfalls scheint man, auch wenn auf ausländische Terrorzellen [hingewiesen](#) wird, die auch hinter dem Madrider Attentat gestanden haben sollen, von unauffälligen Tätern ("cleanskins"), auszugehen, die durch keine Terrorliste mit oder ohne biometrische



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Study by Yale professor suggests best way to fight terror

By Doug Chandler

July 15, 2005 - NEW HAVEN-As he heard about the bombs ripping through parts of London's transit system last week, Edward H. Kaplan had "the same reaction as everyone else," he said. "It's a terrible thing."

But Kaplan, a professor at Yale and a member of the New Haven Jewish community, was also thinking of the study he and a colleague published only two days earlier in a journal of the National Academy of Sciences.

The study found that sensors or detectors deployed in urban areas to prevent suicide bombings are unlikely to save many lives, said Kaplan, a professor of management sciences and public health. In fact, Kaplan continued, the sensors could create even more casualties in some cases, as people close to the bomber flee the scene, enlarging the space in which bomb fragments can scatter.

"By reducing the crowd density, you're increasing the number of people who are going to get hurt," said Kaplan, who wrote the study with Moshe Kress, professor of operations research at the Naval Postgraduate School. The detection system "could backfire on you."

The researchers found that portal or checkpoint screening - detectors placed at airports, stadiums, government buildings and other known targets - could be useful in thwarting an attack. But the technology is simply ineffective in guarding against random attacks in such places as trains, restaurants and shops, they said.

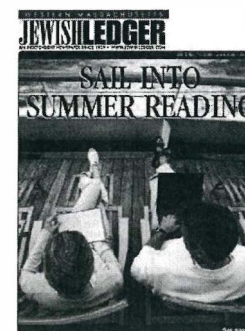
"You'd have to have an awful lot of sensors" to stop an attack, Kaplan said, noting that "cities are big places," and the response from law-enforcement officials would have to be "pretty quick," before the bomber has a chance to detonate the explosives. The study, published July 5, suggests that the most effective means of preventing suicide bombings is through intelligence work, followed by arrests of terror operatives and suspects - the method adopted by Israel.

"The Israelis have figured out how to counter this," Kaplan said in a phone interview this week. The groundwork laid by Israeli authorities has "led to the interdiction of these bombers before they even get started."

Rather than playing "last-minute defense," authorities should aim at pushing terrorists as far away as possible, said Kaplan, who studied Israel's success in a previous study, "What Happened to Suicide Bombings in Israel?" Effective intelligence work would include infiltrating terror cells and eavesdropping, according to the professor.

Discussing last week's attack in London, Kaplan said his study about sensors isn't directly relevant because it appears that most of the attackers weren't suicide bombers and the city doesn't use detectors in the transit system.

Cameras are spread throughout the city, but "no one who was monitoring these things saw anyone acting suspiciously," Kaplan said. Moreover, it is impossible to monitor all of the cameras simultaneously, which would require one person for each camera. He added, however, that the cameras' purpose lies more in investigating crimes than preventing them.



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על פי החוקרים, החיישנים הזמינים כיום נגד מחבלים מתאבדים יקרים ואינם מהימנים מספיק עבור פריסה מסחרית בכל המוקדים הציבוריים

א"י פי

הצבת חיישנים במטרה לאתר מראש מחבלים מתאבדים ופצצות לא צפויה להציל חיים רבים, על פי מחקר חדש שמתפרסם היום (ג').

"מוטב להשקיע כספים במודיעין כדי למנוע ממחבלים מתאבדים לבצע פיגועים", כתבו עורכי המחקר, אדוארד קפלן ומשה קרס, במחקר שפורסם בגיליון החדש של כתב העת [PNAS](#) מאת האקדמיה הלאומית למדעים בארה"ב.

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ניתוח הפגיעה האפשרית של מחבלים מתאבדים המתפוצצים בתוך קהל במוקדים עירוניים.

השניים גילו, כי איתור המתאבדים דורש הצבת מערך צפוף של חיישנים לאיתור פצצות. נוסף על כך, על מנת למנוע ריבוי

נפגעים, על הקהל להימלט מהמקום במהירות או למצוא מסתור - יכולות אנושיות שאינן בשליטת הטכנולוגיה. במקרים מסוימים, תגובה "שגויה" של הקהל עלולה להגדיל את מספר הנפגעים.

החיישנים עדיין לא מהימנים

על פי החוקרים, החיישנים הזמינים כיום יקרים ואינם מהימנים מספיק עבור פריסה מסחרית בכל המוקדים הציבוריים. אם הטכנולוגיה הייתה אמינה וזולה, ייתכן כי תתגלה כשימושית לצורך מניעת פיגועים ביעדים בעלי פוטנציאל סיכון גבוה, כמו שדות תעופה, מוסדות ממשלתיים או אירועי ספורט, הם קובעים.

עם זאת, הם מציינים במחקר כי חיישנים כאלה לא יהיו שימושיים

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אולי בעתיד
הרחוק
מי צריך את זה?
מספיק 32 ביט
על מה מדובר?
למה לא מספרים
לי כלום?

בחר אחד והצבע

תוצאות
ארכיון

חדשות

כלכלה



No high-tech solution to suicide bombings

RESEARCH conducted at Yale University by **Edward Kaplan** and Moshe Kress suggests that old-fashioned intelligence gathering is probably more effective in preventing deaths from random suicide bomb attacks than relying on sensors to detect explosives hidden in belts or backpacks.

Sensors using X-ray, electromagnetic or vapour-plume imaging can, in principle, detect suicide bombers from distances of about 10 metres, although they are far from perfectly sensitive or specific.

Although such detectors have proved useful in defending known targets, such as airports, government buildings or sports events, Kaplan and Kress set out to investigate whether sensors would help reduce deaths from random street attacks of the sort experienced in Iraq, Israel and elsewhere around the world.

Using mathematical techniques, they found that, even if a terrorist were detected before the attack, there would probably not be enough time to intervene - either to halt the bomber or to alert the population so that they could flee.

Their model also suggested that any intervention was unlikely to be successful.

Kaplan explains: "If people try to flee or fall to the ground and the bomber subsequently explodes, the number of casualties could, perversely, be higher than if no intervention had been launched.

"This has to do with the grisly physics of the situation. Persons closest to the bomber are most likely to be harmed but also serve, literally, as human shields for those further away."

It also seems unlikely that sensors would have any deterrent effect as, on a number of occasions, suicide bombers have demonstrated their willingness to attack overtly defended targets.

December 11, 2005

Preventing Suicide Bombing

By PAUL TOUGH

How do you stop a suicide bomber on his way to a target? Until recently, that wasn't an urgent question for scholars in the West. But it is now, and scientists, military strategists and security experts are scrambling, in different directions, to find an answer.

Last year, Darpa, the Pentagon's research arm, convened a panel of experts through the National Research Council to study methods to detect suicide bombers from a distance, before they strike. The panel's report presented some provocative ideas, including "detection by detonation." Under this plan, soldiers at a military checkpoint would fire radiation at each approaching car. If there were no explosives on board, the car would pass through the beam safely. But if the car carried suicide attackers, the radiation would cause their bombs to explode, killing everyone on board (and anyone unlucky enough to be nearby), but leaving the checkpoint unharmed. Another intriguing notion from the report: "distributed biological sensors" - bees, moths, butterflies or rats specially trained to pick up bomb vapors, buzzing or fluttering through a crowd, sniffing for fumes. (The rats, equipped with global-positioning-system chips, would work the sewers.)

Even if you manage to detect a suicide bomber, what do you do next? This question was taken up by Edward H. Kaplan, a professor of public health at Yale, in a paper he published in July, written with Moshe Kress of the Naval Postgraduate School in Monterey, Calif. Kaplan and Kress investigated the physics of a belt-bomb blast and reached some unexpected conclusions. It turns out that very few people are killed by the concussive force of a suicide explosion; the deadly weapon is in fact the shrapnel - the ball bearings, nails or pieces of metal that the attacker attaches to the outside of his bomb. The explosions, though, are usually not powerful enough to send these projectiles all the way through a human body, which means that if your view of a suicide bomber is entirely obscured by other people at the moment of detonation, you are much more likely to escape serious injury. Because of the geometry of crowds, Kaplan found, a belt bomb set off in a heavily populated room will actually yield fewer casualties than one set off in a more sparsely populated area; the unlucky few nearest to the bomb will absorb all of its force.

The authors used these calculations to question some assumptions about what authorities should do if they detect a bomber. The International Association of Chiefs of Police issued guidelines this year suggesting that police officers who find a bomber in a crowd should fire shots into the air to cause people near the bomber to scatter or hit the deck. But Kaplan's calculations demonstrate that in many cases, this would make things worse - as a packed crowd ran away from a bomber or dropped to the ground, the circle of potential victims around him would get wider and thus more populous, and more lives could be lost.

As Kaplan points out, these physics create an unusual moral dilemma. If you suddenly find yourself next to a suicide bomber about to set off his charge, there is what he calls "a huge conflict between what's best for you as an individual and what's best for the group." Soon after his paper was published, Kaplan came across one blogger who had read about his research and concluded that the heroic thing to do in that situation would be to approach the bomber and hug him or her, sacrificing yourself but saving the lives of many people behind you.

Not surprisingly, homeland security experts are still looking for other neutralization techniques, ones that don't involve hugging. And here there is another divide in the field. The association of police chiefs recommended this year that police on the scene simply shoot suspected bombers in the head - "specifically, at the tip of the nose when facing the bomber . . . or about one inch below the base of the skull from behind." The London officers who two weeks after the July bombings killed an innocent Brazilian man whom they suspected of being a suicide bomber were operating on similar instructions, a shoot-to-kill policy known as Operation Kratos.

There are other techniques to disarm a bomber, though, that don't involve guns. A company called International Security Defense Systems in Dallas offers antiterrorist advice to airlines and airports and employs several former high-ranking members of the Israeli security services. Chaim Koppel, one of I.S.D.S.'s trainers, explains that it is extremely difficult to shoot someone in the head perfectly, and adds that a shot to the head could in fact set off a suicide bomb. Koppel and his colleagues instead teach an array of moves based on Krav Maga, the self-defense martial art used by Israeli soldiers, that would disarm but not kill a potential bomber. If you're behind a bomber, according to Koppel, the best thing to do is grab him around the shins, lift up and push forward. The bomber will instinctively use his hands to block his fall. Once his hands are away from the trigger of his bomb, you grab them. If you are facing a bomber head-on, you use a different move, one that basically amounts to punching the bomber in the face and grabbing his hands. Violent, but certainly not deadly. And if you get the wrong person, as the London police did, you don't have a corpse on your hands. Instead, as Koppel's colleague Clive Miskin puts it, "you brush his coat off and say you're sorry."

Posted April 19, 2006

Operations Research & Management Science Today: News

Be a Hero, Hug a Terrorist

Researchers investigating physics of a belt-bomb blast reach some unexpected conclusions.

If you're a police officer armed with a handgun, what should you do if you confront a suicide bomber on a crowded street? Shoot to kill, preferably in the head, as the International Association of Police Chiefs recommended this year? Fire shots into the air to cause people near the bomber to scatter or hit the deck, as the association recommended last year? Point your gun at the bomber and tell the crowd to slowly back away, based on countless TV and movie scripts?

If you really want to be a hero, you'd give the bomber a big hug.

That's the advice one blogger suggested after reading a paper published last July by Ed Kaplan of Yale University and co-author Moseh Kress of the Naval Postgraduate School in Monterey, Calif. Kaplan and Kress investigated the physics of a belt-bomb blast and reached some unexpected conclusions. Their research also attracted the attention of Paul Tough, a reporter for the *New York Times Magazine*, who used it as the basis for an article in the magazine's "Year in Ideas" issue (Dec. 11, 2005).

Summing up Kaplan and Kress' work, Tough wrote: "It turns out that very few people are killed by the concussive force of a suicide explosion; the deadly weapon is in fact the shrapnel — the ball bearings, nails or pieces of metal that the attacker attaches to the outside of his bomb. The explosions, though, are usually not powerful enough to send these projectiles all the way through a human body, which means that if your view of a suicide bomber is entirely obscured by other people at the moment of detonation, you are much more likely to escape serious injury. Because of the geometry of crowds, Kaplan found, a belt bomb set off in a heavily populated room will actually yield fewer casualties than one set off in a more sparsely populated area; the unlucky few nearest to the bomb will absorb all of its force."

The calculations call into question some assumptions about what authorities should do — like using warning shots in an attempt to disperse the crowd — if they detect a bomber. "Kaplan's calculations demonstrate that in many cases, this would make things worse — as a packed crowd ran away from a bomber or dropped to the ground, the circle of potential victims around him would get wider and thus more populous, and more lives could be lost," Tough wrote.

The physics of the problem, Kaplan says, create an unusual moral dilemma. If you suddenly find yourself next to a suicide bomber about to set off his charge, there is what he calls "a huge conflict between what's best for you as an individual and what's best for the group."

The blogger who read about Kaplan's research concluded that "the heroic thing to do in that situation would be to approach the bomber and hug him or her, sacrificing yourself but saving the lives of many people behind you."

Not surprisingly, Tough writes, "homeland security experts are still looking for other neutralization techniques, ones that don't involve hugging."

Tactical Prevention of Suicide Bombings in Israel

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Suicide bombings are the leading cause of death from terrorism in Israel. Counterterror tactics, such as the targeted killings or preemptive arrests of terror leaders or suspects, are meant to prevent such attacks. To investigate whether these tactics are successful, we estimated via maximum likelihood a family of shot-noise models from monthly data covering 2001 through 2003 to see whether we could predict the rate of suicide-bombing attacks as a function of prevention tactics over time. Although preventive arrests appear to lower the rate of suicide-bombing attacks, targeted killings seem to be followed by an increase in the number of suicide bombings. In addition, limited evidence suggests that the probability of intercepting a suicide bomber en route to an attack increases with the expected number of suicide-bombing attacks. Such an endogenous relationship could imply an upper limit on the rate of successful suicide bombings.

Key words: military: tactics and strategy; probability: applications.

History: This paper was refereed.

Suicide terrorism has become a strategy of terrorists worldwide, who have conducted suicide attacks in Afghanistan, Egypt, England, India, Indonesia, Iraq, Israel, Lebanon, Pakistan, Russia, Spain, Sri Lanka, Saudi Arabia, Turkey, the United States (9/11), and Yemen (ICT, http://www.ict.org.il/inter_ter/intnl_attacksearch_frame.htm). A growing number of studies address suicide bombing. Atran (2003, p. 1534) defines *suicide terrorism* as “the targeted use of self-destructing humans against noncombatant—typically civilian—populations to effect political change” and claims that the primary use of suicide terrorism is “as a weapon of psychological warfare intended to affect a larger public audience.” Berman and Laitin (2006, p. 8) claimed that suicide attacks around the world “were most often marked by a religious difference between the attackers and the victims.” Merari (1990) and Pedahzur et al. (2003) examined the characteristics of suicide bombers and their motivations. In a lead article in the *American Political Science Review*, Pape (2003, p. 1) argued that suicide terrorism follows a strategic logic, “one specifically designed to

coerce modern liberal democracies to make significant territorial concessions.” Pape also wrote that, over the past two decades, suicide terrorism has been rising “largely because terrorists have learned that it pays,” although this has been questioned (Abrahms 2004).

Countertactics used by governments around the world to fight suicide terrorism include nonlethal preventive measures (for example, intelligence-driven arrests of terror suspects) and lethal offensive measures (for example, targeted killings, or hits, of terrorist operatives or leaders). Ganor (2005) postulated that targeted killings can lead to a boomerang effect, causing the number of attacks to increase following such hits. In Ganor’s view, targeted killings increase suicide bombers’ motivation while reducing terrorist organizations’ operational capabilities.

Kaplan et al. (2005) developed a terror-stock model of suicide bombings based on theory proposed by Keohane and Zeckhauser (2003). In that model, suicide bombings derive from the number of terrorists actively involved in planning and conducting suicide bombings (the terror stock), and the intent of

המרכז לחקר טרור ביולוגי

מתכבדים להזמין למפגש
הפורום לחקר טרור ביולוגי

הרצאה:

Prof. Edward H. Kaplan

Yale University, USA

Deadly Games: Suicide Bombings and Targeted Killings in the Israeli-Palestinian Conflict

Game theory models to examine suicide bombings and targeted killings in the Israeli-Palestinian conflict

דיון

Relevance for Bioterrorism

המפגש יתקיים ביום שני, 29 במאי 2006 משעה 14:00 עד 15:00

בחדר 105 קומה 1, בניין סאקלר

הפקולטה לרפואה ע"ש סאקלר, אוניברסיטת ת"א

2006

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**** JOINT OR/IE/ISE SEMINAR ****

**Speaker: Ed Kaplan,
Yale University**

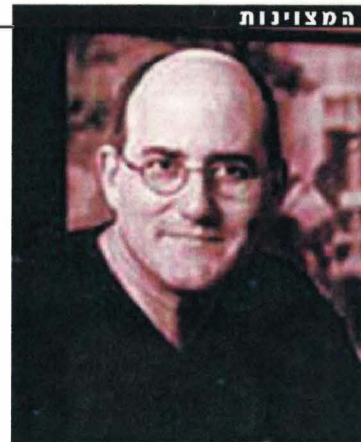
Suicide Bombings and Targeted Killings in the Israeli-Palestinian Conflict

Terrorist organizations deploying suicide bombers have murdered hundreds of Israeli civilians during the past six years. Israeli countertactics range from intelligence-driven operations meant to interdict suicide bombers before they strike, to targeted killings (or "hits") of "ticking bombs" or other terror operatives (and have also resulted in civilian casualties), to last-minute interceptions at checkpoints, roadblocks, or as the result of search and pursuit. We develop a family of game theory models to examine suicide bombings and targeted killings in the Israeli-Palestinian conflict, and generate several results that aid in understanding the associated "cycle of violence."

Joint work with Dan Jacobson

ההרצאה תתקיים ביום שלישי 30.05.2006

בשעה 13:00 בחדר 527 בנין בלומפילד



משחקים קטלניים

פרופסור אד קפלן, חבר אקדמי בקורטוריון הנוכחין וחבר בוועדה האקדמית המייעצת לפקולטה להנדסת תעשייה וניהול, נשא הרצאה במסגרת סמינר מערכות מידע בפקולטה. נושא ההרצאה: "משחקים קטלניים: פיגועי התאבדות וחיסולים ממזיקים בסכסוך הישראלי-פלסטיני". פרופסור קפלן הינו חבר סגל באוניברסיטת ייל המשתייך ל-3 יחידות אקדמיות - בית הספר לניהול, חטיבת ההנדסה ובית הספר לרפואה. את כל תארייו המתקדמים רכש פרופסור קפלן ב-MIT. מחקריו בעבר עסקו במגוון עצום של נושאים הנוגעים בסטטיסטיקה יישומית, למשל טיפול מונע כנגד איידס ו-HIV, קונפליקטים פוליטיים, ניכוי תוצאות של משחקי כדורסל, וניכוי תוצאות בחירות לנשיאות בארה"ב. פרופסור קפלן גדל בקנדה, וזוהי חבר בתנועת "היהודה הצעיר". בשנת 1966 הגיע לראשונה לישראל, עם הוריו, ומאז ביקר כאן פעמים רבות כילד וכמבוגר. אחד הביקורים התקיים ב-1988, כאשר להקת ריקודי העם שבה היה חבר השתתפה בפסטיבל המחולות בכרמיאל. גם את אשתו, הוא מספר, פגש בחוג ריקודי עם. בשנות התשעים ביקר פרופסור קפלן בישראל מספר פעמים - בין השאר כדי ללמוד עברית באולפן - ולאחר מכן שהה בשנת שבתון

בפקולטה לרפואה באוניברסיטה העברית שבמסגרתה הרצה במחלקה לסטטיסטיקה באוניברסיטה העברית. פרופסור קפלן וזינו חבר באקדמיה הלאומית להנדסה בארה"ב וכן באקדמיה הלאומית לרפואה. בסוף שנות ה-90 הצטרף פרופסור קפלן לאגודה הישראלית לחקר ביצועים ומאז הוא משתתף באופן מתמשך בפעילויות האגודה וכינוסיה.

הרומן עם הטכניון

"ב-1997 ביקרתי לראשונה בטכניון, במסגרת ביקורי באוניברסיטאות השונות בישראל", מספר פרופסור קפלן. "ב-1998 כבר העברתי קורס בסמסטר הקיץ של תוכנית ה-MBA בפקולטה להנדסת תעשייה וניהול. הקשר עם הטכניון, ובפרט עם כמה אנשים ספציפיים כאן, נשמר ואף התחזק, עד שלפני כשנתיים 'גויסתי' לקורטוריון הטכניון. עבורי זו גאוה גדולה - אני יודע שזהו מוסד חשוב מאוד ברמה העולמית, וגאה לתרום לו ככל יכולתי".

"במשך שנים רבות חקרתי יישומים של חקר ביצועים ברפואה הציבורית, בעיקר בנושא של תוכניות לטיפול בחולי איידס. חלק מהמודלים שלי אומצו בארה"ב, קנדה, אוסטרליה ועוד. בחלק מהמדינות מופיעים ציטוטים מהמחקרים שלי בחוקי המדינה עצמם. "בעקבות ארועי ה-11 בספטמבר 2001 קיבלתי שיחת טלפון ממשהו מרשויות הבריאות של ארה"ב, שהזמין אותי לפגישה בנושא טרור ביולוגי. היו שם כלכלנים, אנשי רפואה, אנשי צבא ו-CIA, מדענים ועוד. אותי הזמינו כמומחה בתחום של מתודולוגיות בעקבות הפגישה ההיא כתבתי עבודה על תגובות חירום אפשריות למתקפה ביולוגית (אבעבועות שחורות). באופן כללי ניתן לומר שבשעה שהרופאים שאלו מה עלולה המחלה לעשות לאנשים, אני ביקשתי לשאול מה יכולים האנשים לעשות למחלה. עסקנו גם באפשרויות של מתקפת אנתרקס, שעמדה אז באוויר, וסביב הנושא הזה הגעתי גם לתל השומר.

"באחרונה התחלתי מחקר משותף עם פרופסור בועז גולני ופרופסור אוריאל רוטבליט (הפקולטה להנדסת תעשייה וניהול) ופרופסור אבי מרמור (הפקולטה להנדסה כימית); ראש המרכז לחקר בטחוני עתידי בטכניון) בנושא הקצאת משאבים למלחמה בטרור".

הסכסוך הישראלי-פלסטיני

"הביקורים שלי בישראל הלכו ותכפנו, ולאט לאט התחלתי להרגיש שאני עוסק באפשרויות וירטואליות (מתקפות ביולוגיות), בשעה שבישראל מתרחשת אינתיפאדה ממשיכה לגמרי. ידעתי שהמתודולוגיות שפיתחתי עשויות לשפוך אור על הסכסוך הישראלי-פלסטיני. "כמו בשאר המחקרים שלי, גם כאן הגישה שלי היא סטטיסטית, והשאלה שלי - איך מחליטים אילו טקטיקות אנטי-טרוריסטיות הן יעילות. כל הנתונים קיימים - תאריכים, זהות והמתאבדים, מספר ההרוגים הישראליים, התגובה הישראלית, מספר ההרוגים הפלסטינאים, המקום בו התרחש הארוע, וכיו"ב. והשאלה היא איך לנתח את זה נכון. כולם מדברים על 'מעגל האלימות', אבל אני חיפשתי את הקשר, את הרצף, את הסיבתיות ההדדית של הפעולות הפלסטיניות והישראליות. "בהנחה ששני הצדדים רציונליים, כפי שאנחנו תמיד מניחים בתורת המשחקים, אנחנו מבינים שכל אחד מהצדדים אומד את הרווח וההפסד והצפויים לו, ולא יפעל אם ההפסד גדול מהרווח. הקושי הוא להעריך כיצד מתבצע האומדן הזה, כשלא תמיד ידוע כיצד יגיב הצד השני. זה מה שעשיתי במחקר שעליו הרציתי כאן בטכניון".

מבט לעתיד

"פתרון כולל הוא משימה מאוד יומרנית כיום. אני חושב שהגישה הישראלית נכונה - למזער נזקים כהיעדרו של פרטנר; להשיג עמדה טובה למו"מ עתידי; לשמור על רמה מירבית של התחשבות הומניטרית; להמשיך לחתור לאסטרטגיה בת הגנה. בסך הכל אני אופטימי - אני מאמין שצריך סבלנות והזמן יעשה את שלו".

Terror Queues

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This article presents the first models developed specifically for understanding the infiltration and interdiction of ongoing terror plots by undercover intelligence agents, and does so via novel application of ideas from queueing theory and Markov population processes. The resulting “terror queue” models predict the number of undetected terror threats in an area from agent activity/utilization data, and also estimate the rate with which such threats can be detected and interdicted. The models treat terror plots as customers and intelligence agents as servers. Agents spend all of their time either detecting and infiltrating new terror plots (in which case they are “available”), or interdicting already detected terror plots (in which case they are “busy”). Initially we examine a Markov model assuming that intelligence agents, while unable to detect all plots, never err by falsely detecting fake plots. While this model can be solved numerically, a simpler Ornstein-Uhlenbeck diffusion approximation yields some results in closed form while providing nearly identical numerical performance. The transient behavior of the terror queue model is discussed briefly along with a sample sensitivity analysis to study how model predictions compare to simulated results when using estimated versus known terror plot arrival rates. The diffusion model is then extended to allow for the false detection of fake plots. Such false detection is a real feature of counterterror intelligence given that intelligence agents or informants can make mistakes, as well as the proclivity of terrorists to deliberately broadcast false information. The false detection model is illustrated using suicide bombing data from Israel.

Subject classifications: intelligence; counterterrorism; informants; Markov models; diffusion models; queues; suicide bombings.

Area of review: Stochastic Models.

History: Received June 2009; revisions received December 2009, March 2010; accepted March 2010. Published online in *Articles in Advance* June 3, 2010.

1. Introduction

Intelligence operations protect society against the threat of terrorism. Guiora (2007, p. 218) argues that “Without intelligence, governments cannot protect their citizens. Without knowing who the terrorist is, governments cannot know where he is. Without knowing where the suicide bomber is, governments cannot prevent planned suicide bombing attacks,” and in a subsequent book states succinctly that “Intelligence is the heart and soul of operational counterterrorism” (Guiora 2008, p. 80).

In Israel, human intelligence operations (HUMINT) have been credited in large measure with bringing the wave of suicide bombing attacks on Israeli civilians that accompanied the Second Intifada under control (Kaplan and Kress 2005, Kaplan et al. 2006). Undercover counterterror intelligence operations have a long history in Israel, where units known in Hebrew as “mistaravim” (agents disguised as Arabs) have immersed themselves culturally and physically in Israeli Arab and Palestinian populations for the purpose of infiltrating and interdicting terror cells before they can attack (Deflem 2010). Indeed, in a candid response to a question asking whether Israeli intelligence had infiltrated the Hamas (which was responsible for the majority of suicide bombing attacks inside Israel), the former head of the Palestinian Authority’s General Intelligence Tawfiq al Tirawi responded that *all* Palestinian organizations had been penetrated by the Israelis (Andraeus 2009).

The importance of infiltrating terror plots is also reflected in the national intelligence strategy of the United States. The first of six mission objectives stated in this strategy document is “Combat Violent Extremism,” and within this mission objective, the intelligence community is urged to “...penetrate and support the disruption of terrorist organizations...” (Blair 2009). A recent United States example of the importance of such HUMINT infiltrations can be found in the discovery and interruption of a plot to bomb two synagogues and shoot down a military aircraft with a surface-to-air missile; as reported in the *New York Times*, “The investigation... began with the work of a confidential informant, who portrayed himself as an agent of a Pakistani terror organization, and who became a critical member of the men’s plot” (Wilson 2009). Other recent terror threats in the United States that were penetrated and disrupted by undercover intelligence operatives include the interdiction of Najibullah Zazi, charged with plotting bomb attacks (Johnston and Shane 2009), and the arrest of Hosam Maher Husein Smadi, charged with attempting to bomb a Dallas skyscraper (Associated Press 2009).

Beyond the penetration and disruption of individual terror plots, data gleaned from intelligence operations offer the potential to infer the magnitude of current terror threats. For example, in May 2007, Britain’s Security Service (the MI5, <http://www.mi5.gov.uk>) reported that it was monitoring about 2,000 people believed to be “...actively involved in supporting Al Qaeda” (Gardner 2007). However, the

Suicide Bombings and Targeted Killings in (Counter-) Terror Games

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This article develops sequential game models for key operational terrorist (how often to attack) and government (how often to execute targeted killings) decisions taken during a (counter-) terror campaign such as the second intifada. Key results include the following: The government initiates targeted killings when the marginal number of Israeli civilian lives saved from prevented terror attacks exceeds the marginal number of Palestinian civilian lives lost in such "hits"; targeted killings are not employed if they are either ineffective or extremely effective at thwarting terror (since terrorists will not induce their use); even after accounting for downstream terror attacks motivated by prior targeted killings, a civilian casualty-minimizing government can optimally order targeted killings over time; and low-level cycles of violence can occur when the government is more patient than the terrorists, but higher, stable levels of violence result when the terrorists are the more patient players in the game.

Keywords: *suicide bombings; targeted killings; game theory; operational decision making; terrorism; counterterrorism; Israeli-Palestinian conflict*

The second intifada pitting Palestinian terrorists against the State of Israel witnessed waves of suicide bombing attacks on Israeli civilians and targeted killings of terrorist operatives and leaders by the Israeli military that also resulted in Palestinian civilian casualties. This article models that conflict as an alternating sequence of actions taken by the terrorists and the government, with the optimal strategies given each side's motivations determined from a game-theoretic perspective. In particular, we focus on the terrorists' use of suicide bombing attacks and the government's targeted killings of suspected terrorists by way of helicopter gunfire, fighter aircraft, and other means.

Israeli decisions to order targeted killings (or "hits") are not taken lightly. The judge advocate general of the Israel Defense Forces (IDF) has listed the conditions

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A Check Against Terrorism

Realtor Daniel Rose's gift for joint research by the Technion and Yale sprang from a desire to see justice done.



Boaz Golany, above, a professor of industrial engineering at Technion Institute, will lead seminars addressing homeland security issues with Prof. Edward H. Kaplan of Yale.

by Doug Chandler
Special to the Jewish Week

The motivation behind large gifts to schools, hospitals and other institutions varies from donor to donor, who might wish to honor a relative, advance a favorite cause or to aid an organization that once helped his or her own family.

For Daniel Rose, the chairman of one of New York's oldest real-estate firms and a member of one its best-known philanthropic families, the driving force behind his latest gift couldn't be clearer.

The \$1.3 million gift, made to the Technion-Israel Institute of Technology and the Yale School of Management, has established a three-year partnership between the two schools to conduct homeland-security and counterterrorism research. And it stems from the decision several years ago by a British academic union to boycott Israeli universities, according to Rose.

Sitting in a conference room of Rose Associates, the three-generation firm founded by Rose's uncle, David, and his father, Samuel, the 78-year-old businessman said the union's action alone proved "disheartening enough." But what he found especially dispiriting was "the lack of outrage" by the rest of the world, he recalled. And then, he added with a wry laugh, he learned that the couple who launched the boycott, Steven and Hilary Rose, shared his last name.

The academic union eventually revoked the boycott, saying that it could be illegal under British law and, therefore, couldn't be implemented. But the episode "galvanized" Rose to do something, he said, calling himself an "activist by nature."

Two questions followed that sense of resolution, Rose said: "What could we do to show the world that major institutions are not only not boycotting [Israeli universities], but are, in fact, reaching out [to them]?" And how can that desire translate into an effective, meaningful project?

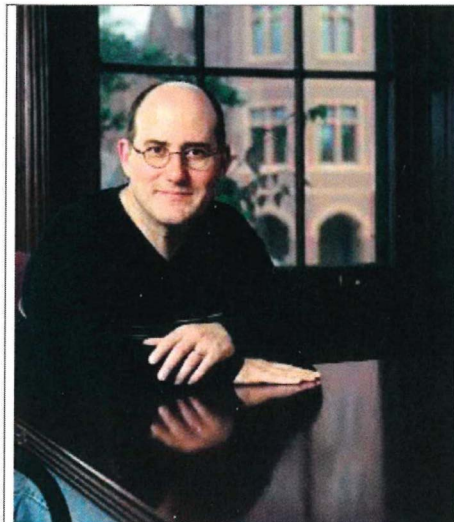
The questions, and the thinking behind them, provide a glimpse into Rose himself. Somewhat of a Renaissance man, he served as an intelligence-analyst and Russian-language specialist for the Air Force during the Korean War. Ever since, he has pursued an interest in foreign affairs as a leading member of the Foreign Policy Association, the Council on Foreign Relations and the International Institute for

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Bullets and Band-aids

Monday, 05 January 2009 | Ali Weiner



The counterterrorism models of Professor Edward Kaplan have gained the attention of both U.S. and Israel defense agencies (Courtesy Kaplan).

Professor Edward H. Kaplan is a round-faced man whose piercing gaze radiates from behind bespectacled eyes. His workspace is a caricature of a professor's desk, piled with open books, family photos, loose papers, and legal pads with formulas scribbled in pencil. But this Yale School of Management (SOM) professor does not live and work in a world of abstract, academic theory. His work is nothing if not practical.

"We have to learn to think like terrorists," Kaplan explained, when asked about the underlying focus of his recent work. "Which targets are terrorists most likely to go after? How can you estimate the size of a terror threat? What can you do to make it harder for the other side to succeed?"

A professor of management, engineering, and public health at Yale SOM, Kaplan has teamed up with Boaz Golany, dean of Industrial Engineering and Management at Israel's Technion Institute. Brought together through a grant from real estate giant and philanthropist Daniel Rose, Kaplan and Golany are using mathematical models to analyze counterterrorism operations. Their research partnership is unique in its funding and its methodology. Many in academia and counterterrorism circles hope the results will play an unprecedented role in protecting key targets from the threat of attack.

Small Pox and Suicide Bombers

Mathematical modeling—using complex formulas to analyze a system—is familiar territory for Kaplan, whose breakthrough models for HIV prevention and smallpox vaccinations are widely acclaimed. Counterterrorism, on the other hand, is a relatively new area of expertise.

"I got into this [field] because I was asked to get into it," recalled Kaplan. As the U.S. government scrambled to secure the nation after September 11, national security agencies took interest in Kaplan's revolutionary models of the HIV epidemic. In 2002, he was invited to Washington to meet with several government agencies, including the National Institute of Health (NIH), the Central Intelligence Agency, the department of defense, and the President's Council of Economic Advisors. The NIH asked him to create a mathematical model for the Center for Disease Control's proposed smallpox containment plan. The model proved the relative effectiveness of mass vaccination against a smallpox outbreak and led the federal government to increase the number of people vaccinated against smallpox from a few thousand to half a million. For Kaplan, this exercise in prevention was also the start of a new focus.

Since then, Kaplan has taken an original but effective approach to counterterrorism. "The majority of academic research on terrorism is either on the sociological or political economy side of it—the root causes of terrorism, the macro policy work, what things a given country is doing that are encouraging terrorism," Kaplan explained. "We deal at the operational level. We want to prevent people from launching a successful attack."

One of Kaplan's recent models, for instance, evaluated the effectiveness of installing suicide bomber detection systems in public areas. Though these sensors were technologically feasible, Kaplan's modeling deemed them wasteful. "By the time you detect the bomber, they'll set off their bomb before you can catch them," he concluded. Kaplan recommended that the money instead be spent improving preemptive intelligence collection capabilities.

The Catalyst

Kaplan's work was indirectly propelled forward by an international dispute. In May 2007, the Palestinian Campaign for the Academic and Cultural Boycott of Israel persuaded the influential University and College



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Flying is safer than you think

By EDWARD H. KAPLAN AND BOAZ GOLANY

27/01/2010 22:20

In spite of the Christmas near-miss over Detroit, the real risk of flying is truly tiny, with or without the added terror scare.

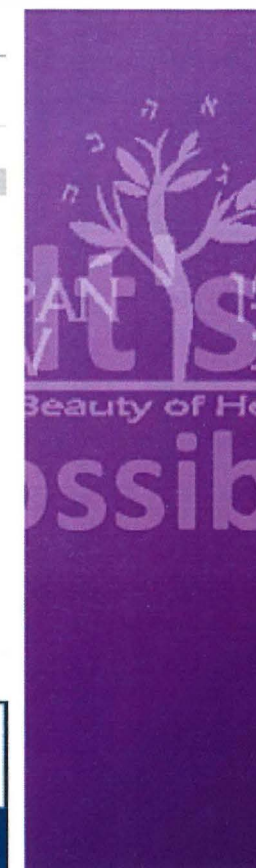
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Umar Farouk Abdulmutallab nearly succeeded in downing a Northwest passenger jet over Detroit on [Christmas Day](#). [President Barack Obama](#) has laid the blame for this egregious [security](#) breach on the inability of US intelligence services to sew together individual pieces of information that, viewed collectively, would surely have raised an alarm. Others have suggested that Israeli airport security practices as exemplified by El Al need to be implemented to prevent such violations. But in spite of Abdulmutallab's attempted briefs bombing, we think that flying remains safe.

Consider Israeli passenger screening, which certainly is different from the typical US

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Journal Highlights

Queueing theory vs. terror plots

By Barry List

Synopses of selected research recently published in INFORMS' scholarly journals:

"Terror Queues" by Edward H. Kaplan, Operations Research, Vol. 58, No. 4

In the new book "Son of Hamas," former terrorist Mosab Hassan Yousef reveals how he informed on Hamas for Israel's Shin Bet security service over a period of 10 years. Yousef's story illustrates the importance of confidential informants and undercover agents more broadly in operational counterterrorism. In the United States, many terror plots have been interdicted thanks to evidence procured by undercover agents and informants.

Beyond disrupting individual plots, information gathered by intelligence agents should relate to the extent of a terror threat. For example, in May 2007, Britain's MI5 security service reported that it was monitoring 2,000 Al Qaeda sympathizers. While one can argue whether 2,000 is a large or a small number, one wonders how many such sympathizers would have been detected had the MI5 doubled (or halved) the size of its force.

In this study, Ed Kaplan provides the first operations research model developed specifically for understanding the infiltration and interdiction of ongoing terror plots by undercover agents, and does so via an unlikely methodology: queueing theory. In an unusual adaptation of marketplace terminology to the work of intelligence and detection, he writes that terror plots are analogous to customers arriving to a service facility, the detection of such plots is analogous to providing "service" to these customers, and successful terror attacks are analogous to customers who drop out of queue before completing service.

In "Terror Queues," by first using a Markov model and then a simpler diffusion process, Kaplan models the joint distribution of the numbers of undetected and detected terror plots, along with the conditional distribution of undetected plots given the known number of detected plots. He then takes into consideration the occurrence of detection errors that lead intelligence agents to pursue "fake plots." Such false detection is a real feature of counterterror

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Parshat Vayeshev- Unclear and Present Danger

06/12/2012 · by Tzvi Silver

ויאמר אלהם ראובן, אל-תשפכו-דם-השליכו אותו אל-הבור הנה אֶשָׁר בְּיָדְךָ ... לְמַעַן, הַצִּיל
”אתו מִיָּדָם” (ל”ו: כ”ב)

This week’s begins with the incidents of jealousy between יוסף and his brothers, culminating in the sale of יוסף. Throughout this story, the brothers seem very united in their hatred of יוסף- the תורה doesn’t distinguish between them during most of the sale of יוסף, just referring to them as “אחים- *the brothers*.” However, mid-way through the story, one of the brothers is singled out for having a different motive than the rest- *Reuven heard and he saved him (Yosef) from their hands... in order to save him and return him to his father.*” Reuven, unlike the other brothers, had no intention to hurt Yosef, and successfully stopped his brothers from trying to kill יוסף. Instead he advises them to throw יוסף into a pit, a *בור ריק אין בו מים- An empty pit without water,*” which רש”י interprets as a pit without water... but full of scorpions and snakes (see Joseph and the Amazing Technicolor Dreamcoat). Though this pit is very lethal and dangerous (the גמרא teaches that a pit of scorpions is so dangerous that if a man is seen falling into a pit like this, his wife can remarry without any עדים testifying that he is actually dead), ראובן is nevertheless praised for saving יוסף’s life.

The brothers then sit down to eat bread, when, suddenly, a caravan of passes by. יהודה, realizing that they could make some easy money off of יוסף instead of letting him rot in a scorpion-filled pit, says *מה בצע כ”* *What do we gain from killing our brother?*” The brothers, by יהודה’s advice, decide to sell יוסף to the ישמאעלים, which quite possibly saved his life. Nevertheless, יהודה is portrayed as a bad guy as seen at the beginning of the next פרק, where רש”י teaches that as the brothers saw יוסף’s misery at his loss of יוסף, they blamed it on יהודה, the one who caused יוסף to be sold away, and as a result *Yehuda was lowered [in the eyes of his brothers].*”

Why is ראובן praised for trying to save יוסף’s life when in reality, he put him in an extremely dangerous, life-threatening situation, while יהודה, who saved יוסף’s life by selling him into slavery, is shunned by his brothers?

Rav Chaim of Volozhin רמ”ל, a תלמיד of the Vilna Gaon, brings a very interesting answer with shocking implications. He teaches that ראובן is praised for saving יוסף’s life because, a man is safer in a pit filled with scorpions in ארץ ישראל than living in physical safety in the Diaspora, he continues, because a person’s spirit is safer in Israel than outside of it, no matter how much safer it seems there. He concludes (verbatim): “In the Diaspora, even if a Jew is privileged to rise to greatness, he is closer to death than life.” By putting יוסף in the pit, ראובן might’ve put יוסף into temporary physical danger, but it was an attempt to save him from the seemingly-eternal spiritual danger that יוסף would face living in Egypt, even as he rose to power. Even though Rav Chaim passed away in 1918, he understood an idea which is an integral part of the modern State of Israel, an idea which is almost taken for granted by the

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PERSPECTIVE

How dangerous is America?

Estimating the number of hidden terror plots reveals an answer you might not expect.

By Edward H. Kaplan

PHOTOGRAPH BY

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It's not breaking news that the United States began to feel like a more dangerous place after 9/11. The Gallup Poll has reported that roughly 9 in 10 Americans have worried about future terror attacks on US soil ever since. For many people, that general sense of dread got even more intense after the Boston Marathon bombings. In late April, Gallup said 51 percent of Americans surveyed believed another attack could happen soon, up from 38 percent about a year and a half earlier. Yet the reality is that we're far safer than we often feel.

In late 2012, I published a study in the journal *Studies in Conflict & Terrorism* that set out to estimate how many jihadi plots are in the works and how long it takes would-be terrorists to plan them. I knew that in the anxious weeks and months after a terrorist attack, it could feel as if we were under siege — as if there were bombs waiting to go off around every corner and under every subway seat. But the results of my analysis suggest otherwise: On average, at any one time there are fewer than three hidden terror plots being planned across the country.

How is it possible to count hidden terror plots? First, I reviewed hundreds of pages of indictments, criminal complaints, the testimony of FBI special agents and informants, and other court documents and reports associated with terror plots since 9/11. I then analyzed them through the lens of queueing theory, which is often used to assess the efficiency of customer-service call centers. Comparing terrorism to call centers isn't as odd as it might sound. In my research, the plots were the "customers" and the local police, FBI, or even National Security Agency (NSA) were providing the "service" of foiling them. I treated a successful plot the same way someone studying a call center would treat a customer hanging up before being helped.

For some, three terror plots will sound like a lot — any death from a terrorist attack is tragic. But I would guess that many might feel a measure of relief from the number; I know I did.

That Gallup Poll from April indicated that 40 percent of Americans worry that they or a family member could fall victim to a terrorist attack, and yet the chance is so much smaller than that. Recently, the former coordinator of the UN team that monitors Al Qaeda and the Taliban said that, between 2007 and 2011, your chances of being killed in a terrorist attack were about 1 in 20 million. You have about a 1-in-126,000 lifetime risk of being killed by lightning.



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Mass Casualty Potential of Qassam Rockets

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In spite of the bombardment of southern Israel by thousands of Qassam rockets fired from the Gaza Strip, comparatively few people have been injured or killed. This has led some observers to dismiss Qassams as more of a symbolic than lethal threat. However, southern Israeli towns feature robust civil defense systems that include safe rooms, bomb shelters, early detection alarms, and missile defense. How many casualties would occur were such systems not in place? This article applies shrapnel-casualty and spatial allocation models to the population of the southern Israeli town of Sderot to estimate casualties per randomly aimed rocket fired into the unprepared town; that is, in the absence of civil defense (technical details appear in the Appendix). Assuming an injury radius of only 5 meters from impact, the modeled expected casualties per rocket are between three (best-case) and nine (worst-case) times higher than Sderot's observed casualties-to-rocket ratio, suggesting that Qassam-like terror attacks on unprotected urban locations could prove much more serious than what one would expect based solely on the observed number of casualties in Sderot.

Despite concerns about terror organizations possibly acquiring and utilizing biological, chemical, or nuclear weapons of mass destruction,¹ terror attacks since 11 September 2001 continue to feature the use of explosives in the form of pedestrian or vehicular suicide bombs,² improvised explosive devices,³ and low grade rockets and missiles.⁴ Dating back to October 2001, Hamas and other Gaza-based terrorist organizations have engineered, manufactured, and launched thousands of Qassam rockets into southern Israel.⁵ The range of successive generations of Qassams has increased from 3 to 17 kilometers, while their explosive payloads have increased from 0.5 to about 15 kg of TNT equivalent in addition to packed shrapnel.⁶ The small Israeli town of Sderot (population 20,700), located only

Received 23 August 2013; accepted 15 October 2013.

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IIASA NETWORK / SYSTEMS ANALYSIS

Modeling terrorism

Posted on January 7, 2014 by KATHERINE LEITZELL

On October 15, 2012, a young man from Bangladesh named Quazi Mohammad Rezwatul Ahsan Nafis parked next to New York Federal Reserve Bank in a van with what he believed was a 1000-pound bomb, walked a few blocks away, and then attempted to detonate the bomb by mobile phone.

In fact, the bomb was a fake, supplied by undercover agents for the United States FBI. The agents, posing as radical jihadists, had led Nafis along for months, allowing him to believe they were fellow terrorists and gathering information about his plot. The cover was maintained until the moment when his bomb failed to detonate, and Nafis was arrested. Disaster averted.

Researchers at IIASA study many risks to society, from floods, hurricanes, and natural disasters, to the impacts of climate change on future generations. They use models that can help disentangle the costs and benefits of different policies that could help prevent damage or deaths, or mitigate the impacts of global problems like climate change and air pollution. Could the same techniques apply to the dangers of terrorism and jihadists attacks? Could systems analysis help inform intelligence agencies in order to stop more terrorist attacks?

Yale University Professor Ed Kaplan has done just that in work that he presented at IIASA in late December 2013. His research, which has intersected with IIASA in the past through collaborations with former IIASA Directors Howard Raiffa and Detlof von Winterfeldt, uses operations research to find ways to improve intelligence operations so as to catch more terrorists, before an attack can take place.



Kaplan, an expert

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"המ'גון בשדרות מנע עשרות הרוגים"

איתמר אייכנר

מחקר מדעי שנערך באוניברסיטת ייל שבארצות הברית קובע: אלמלא אמצעי ההגנה האזרחית שמפעילה ישראל נגד רקטות הקסאם מעזה – מספר הנפגעים היה עלול לגדול פי 3 עד 9.

המחקר – "פוטנציאל נפגעים המוני מרקטות קסאם" – שערך ד"ר אדוארד קפלן וליאן צוקר, התמודד עם הטענה שבשל העובדה שיש יחסית מעט מאוד נפגעים מירי קסאם – בהשוואה למספר הרקטות הרב שנורה מרצועת עזה – יש לראות בקסאם נשק סימבולי ולא נשק קטלני. "הטיעון הזה מתעלם מתשתית ההגנה האזרחית המעולה שמפעילה ישראל – מקלטים, חדרי ביטחון, התרעה מוקדמת וכיפת ברזל", הסביר ד"ר קפלן.

החוקרים לקחו את העיר שדרות כמקרה מבחן והשתמשו במודל מתמטי ופיזיקלי ולפיו מכל נפילת קסאם יכולים להיפגע בין 3 (התרחיש הקל) ל-9 בני אדם (התרחיש הגרוע ביותר) בטווח של 5 מטרים ממקום הנפילה.

בשדרות מתגוררים 20,700 תושבים, והיא ספגה 5,000 רקטות בשנים 2001–2010. במשך השנים האלה נהרגו 10 אנשים, וכ-500 איש נפצעו. על פי החוקרים, ללא מערך ההגנה היו עלולים להיהרג בין 27 ל-92 איש.

פוטנציאל פגיעת רקטות

פוטנציאל פגיעת רקטות > ציוד לשעת חירום > מפרם - ראשי

רקטות קסאם הן רקטות פשוטות ביחס לרקטות אחרות. למעשה, הן מורכבות מצינורות מתכת פשוטים המלאים חומר נפץ, והדלק שמניע אותן ניתן לייצור באמצעים ביתיים. למעשה, את כל תהליך ייצור הרקטה ניתן לבצע באופן ביתי, זול וללא מאמץ מיוחד. טווח הרקטה מוגבל יחסית, והדיוק שלה אינו גבוה. למרות המספר העצום של הרקטות מסוג זה אשר נורו מרצועת עזה לעבר יישובי החוף הדרומי של מדינת ישראל, ישנם מעט מאוד נפגעים כתוצאה מהרקטות. לכן, יש הטוענים כי רקטות הקסאם פותחו על ידי ארגון "חמאס" כנשק סמלי בלבד המשמש להרתעה וללחמה פסיכולוגית נטו, ולא נועדו להיות נשק קטלני.

ומה אומרים מחקרים?

אך האם אכן ניתן לייחס את מספר הנפגעים הנמוך לאיכותן הירודה של הרקטות? מחקר חדש מוכיח כי הדבר אינו נכון, ושמיעוט הנפגעים נובע דווקא מטיב מערכות המיגון שמפעילה ישראל. שם המחקר הוא "פוטנציאל נפגעים המוני מרקטות קסאם". המחקר, שנערך באוניברסיטת ייל בארה"ב ע"י החוקרים ד"ר אדוארד קפלן וליאן צוקר, קובע כי כל קסאם שנופל בסביבה עירונית עלול לפגוע בשלושה עד תשעה בני אדם, המצויים ברדיוס של חמישה מטרים ממקום הנפילה. על מנת להגיע למסקנה זו, השתמשו החוקרים בעיר שדרות כדוגמא, ועליה יישמו מודל פיזיקלי ומתמטי המדמה את פגיעת הקסאם.

המחקר הוכיח שאמצעי ההגנה האזרחית- ביניהם כיפת ברזל, מקלטים ומרחבים מוגנים, וכן מערכת התרעה מוקדמת- הם אלה שהפחיתו באופן דרסטי את מספר ההרוגים. לא פחות מ-5000 רקטות קסאם נורו מרצועת עזה לעבר העיר שדרות בשנים 2010-2001, ומניין הנפגעים כתוצאה מרקטות הגיע לעשרה הרוגים ו-500 פצועים. על פי תוצאות המחקר, אם מדינת ישראל לא הייתה מפעילה את אמצעי ההגנה האזרחית בעיר, מספר ההרוגים עלול היה להאמיר ל-92-27 בני אדם, ומספר הפצועים- לאלפי בני אדם.

מצב ההיערכות לפגיעת רקטות

ואכן, מדינת ישראל פועלת באופן מאסיבי ומשקיעה תקציבים ומאמצים רבים עבור **ציוד לשעת חירום** על מנת להבטיח את שלומם של תושבי הדרום, הנמצאים תחת איום מתמיד של ירי רקטות מהרצועה. סוללת כיפת ברזל, לדוגמא, מצליחה ליירט 75% מהרקטות בתחום שלה בעודן באוויר, ובמהלך מבצע עמוד ענן, אחוז ההצלחה עמד על 84%. מערכת "צבע אדום", מערכת להתראה מוקדמת על ירי רקטות, מתריעה 15-30 שניות לפני הנפילה ובכך מודיעה מראש שיש לתפוס מחסה מפני הרקטות. מאז מלחמת המפרץ, כל בנייה חדשה בישראל מחייבת בניית מרחב מוגן דירתי. אין פלא אפוא, שמערכות המיגון הצליחו להפחית את מספר ההרוגים בשיעור כה גבוה.



Pourquoi les roquettes font-elles peu de victimes?



Une étude révèle que sans le système de défense israélien, le nombre de victimes serait 7 fois plus élevé



En l'absence de systèmes de défense civils performants contre les tirs de roquettes depuis Gaza, le taux de victimes dans le sud d'Israël serait sept fois plus élevé, a rapporté mardi le Jerusalem Post.

Cette étude a été menée par le spécialiste Edward H. Kaplan, professeur en ingénierie de la santé à l'université de Yale aux Etats-Unis, et son ancien élève, Lian Zucker.

Kaplan et Zucker ont construit leur recherche sur un modèle qu'ils ont créé en calculant le nombre de roquettes qui se sont abattues sur Sderot (sud d'Israël) ces dix dernières années et en le recoupant avec la trajectoire de la pluie et les débris et leur impact.

Les deux chercheurs disent avoir eu l'idée de cette étude après avoir entendu beaucoup de personnes "qualifier les tirs de roquettes de symboliques et non de menaces mortelles".

Interrogé par le Jerusalem Post, Kaplan a expliqué que "les critiques faites à l'encontre d'Israël concernent le fait que même si des milliers de roquettes sont tirées vers l'Etat hébreu, le nombre de victimes est très faible".

Les systèmes de défense civile actuellement en place sur le territoire israélien comprennent les systèmes anti-missiles "Dôme de Fer", mis au point par Israël et financés par les Etats-Unis, les sirènes d'alerte, les abris dans les maisons, les bâtiments publics ainsi que dans les rues et les parcs.

Dix personnes sont mortes entre 2001 et 2010 suite aux tirs de 5.000 roquettes sur Sderot.

"Ces attaques terroristes sur des zones urbaines non protégées pourraient s'avérer beaucoup plus graves que ce qu'on laisse entendre", a déclaré Kaplan au Jerusalem Post.

"Le taux de victimes est faible car Israël protège ses citoyens, pas parce que ces attaques sont symboliques", a conclu le spécialiste.



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07:42am

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Why do Gaza rockets result in few casualties?

New study finds that without Iron Dome, sirens, shelters, casualties fwould be seven times higher

A new study has found that without Israel's effective civil defense systems against rockets fired from Gaza, the rate of casualties would be an average of seven times as high as it is, the Jerusalem Post reported on Tuesday.

Yale School of Management's engineering and public health specialist Professor Edward H. Kaplan and his former student Lian Zucker published their findings in the paper "Mass Casualty potential of Qassam Rockets".

According to the abstract of the paper, they were inspired towards this research after observing people "dismiss Qassams as more of a symbolic than lethal threat."

Speaking to the Jerusalem Post, Kaplan elaborated, saying "many critics of Israel point out that while there have been thousands of Qassams fired into Israel, the resulting number of casualties is very small. There has been a concerted attempt by many to portray Qassam rockets as essentially harmless, symbolic weapons."

Kaplan and Zucker's paper applies "shrapnel-casualty and spatial allocation models" to the town of Sderot "to estimate casualties per randomly aimed rocket fired into the unprepared town."

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Diplomacy & defense



THE JERUSALEM POST

Israel's best-selling English daily and most-read English website



Photo by: Ben Hartman

Study: Civil defenses cut 86% of deaths from Gaza rockets

By YAAKOV LAPPIN

18/03/2014

Iron Dome, bomb shelters and warning systems are reason Hamas rockets are seen as 'harmless,' says report.

The thousands of Palestinian [rockets fired at southern Israeli towns](#) from the Gaza Strip over the years would have caused an average of seven times more casualties had Israel not developed a set of effective, life-saving civil defenses, a new study has found.

The study's authors, Prof. Edward H. Kaplan, a specialist in engineering and public health from the Yale School of Management, and his former student Lian Zucker, began the research after encountering several instances in which international media dismissed the threat of Gazan rockets.

"Many critics of Israel point out that while there have been thousands of Kassams fired into Israel, the resulting number of casualties is very small," Kaplan told The Jerusalem Post this week. "There has been a concerted attempt by many to portray Kassam rockets as essentially harmless, symbolic weapons.

"Having seen this repeated so often caused me to think for a moment – why is it the case that with thousands of rockets, there have been so few casualties?" he asked. "Is it really because Kassams are harmless, or is there another reason? After all, simple physics suggests that explosive-propelled shrapnel is lethal if one is hit - that's how suicide bombs kill people.

"Of course, there is another obvious reason – Israel has invested large sums of money in civil defense infrastructure in southern Israel. Safe rooms, bomb shelters, the Red Dawn early warning system and most recently the Iron Dome collectively shield civilians from Kassams," he said.

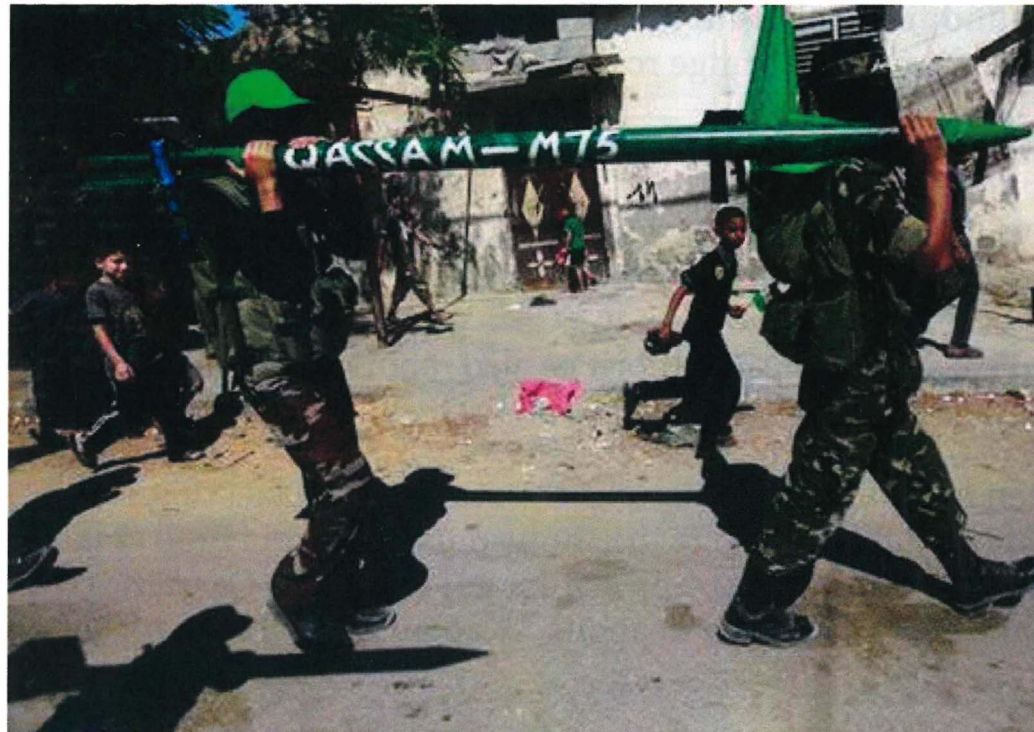
Rocket attacks on unprotected urban locations, they argued, "could prove much more serious than what one would expect based solely on the observed number of casualties in Sderot."

Taking Sderot as a case study, Kaplan and Zucker applied shrapnel/casualty and spatial allocation models to the population of the town to estimate casualties per randomly aimed rocket fired in the absence of civil defenses.

With civil defense measures in place, Sderot sustained 5,000 rockets between 2004 and 2010, and 20

Duck and Cover

Study: Effective civil defenses in Israel town have greatly reduced deaths via terrorist rocket attacks



Hamas members hold up a replica of a Qassam missile in a demonstration / AP

BY: [Abraham Rabinovich](#)

March 19, 2014
9:56 am

JERUSALEM—An effective civil defense system has cut casualties in Israeli towns near the Gaza Strip by 86 percent, according to a study led by professor Edward Kaplan of Yale University's School of

Management.

Taking as a case study the town of Sderot, only a mile from the Gaza Strip, Kaplan and one of his former students, Lian Zucker, calculated that it had been hit by 5,000 Qassam rockets between 2001 and 2010. Ninety percent of residents reported a rocket landing on their street or one adjacent. There were 10 fatalities in the town during this period.

Kaplan told the *Jerusalem Post* this week that a scenario based on shrapnel dispersal and “spatial allocation models” projected a median death toll of 75 for these randomly fired rockets during the decade. A “best case” scenario showed three times as many fatalities as Sderot suffered and a “worst case” scenario would