Cost-effective Strategies to Address Urban Terrorism: A Risk Management Approach

CREATE Symposium
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The Keston Institute for Infrastructure
University of Southern California
Why are we here?

The post-9/11 world is viewed as inherently less safe
Objective of this presentation

To question whether static defensive measures are the best approach to addressing urban terrorism. As an alternative, basic risk management principles are suggested as a means to frame responses that balance actual threats, available resources, and a consensus level of risk tolerance.
Presentation Outline

- The nature of explosions
- Blast effects on buildings and people
- Countermeasures for vehicle bombs
- Using risk management in strategy development and decision making
Concern with terrorist vehicle bombs has dominated urban security.
Why the focus on vehicle bombs?

- **Availability:** 6 billion pounds of explosives legally manufactured annually in U.S.
- **Ability:** cookbooks readily available on internet and commercial sources
- **Delivery-capability:** medium and large trucks readily available for rental
- **Effectiveness:** an opportunity to make a big statement for a small (relatively) investment

"...bombings and explosion...the method that most commonly has been used by terrorists, and is most likely to result in the largest numbers of casualties and destruction of property "

E.R Frykberg, MD, FACS
The risk assessment process

In risk assessment, the analyst attempts to answer three questions:

✵ What can go wrong?
✵ What is the likelihood that it will?
✵ What are the consequences?

Kaplan and Garrick, 1981
What can go wrong?

Tokyo, 1995

Oklahoma City, 1995

New York, 2001

Madrid, 2004

Sharm El Shiek, 2005
What happens when a bomb explodes?

The detonation of a high explosive produces an enormous amount of energy in the form of heat, light, and physical work in a very short period of time.
What happens when a bomb explodes near a building?

1. Blast wave breaks windows
   Exterior walls blown in
   Columns may be damaged

2. Blast wave forces floors upward

3. Blast wave surrounds structure
   Downward pressure on roof
   Inward pressure on all sides
What happens to the building?

Glazing Failure

Glass Hazards to Occupants

Debris and Translation Hazard

Glass Hazards to Occupants

Debris and Translation Hazard

Structural Collapse
**What is the likelihood of an attack?**

\[ 0 \leq p \leq 1 \]

<table>
<thead>
<tr>
<th>Expression</th>
<th>Single-number probability Equivalent, % (median of responses)</th>
<th>Specified range, % (median upper and lower bounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almost certain</td>
<td>90</td>
<td>90-99.5</td>
</tr>
<tr>
<td>Very high chance</td>
<td>90</td>
<td>85-99</td>
</tr>
<tr>
<td>Very likely</td>
<td>85</td>
<td>75-90</td>
</tr>
<tr>
<td>High chance</td>
<td>80</td>
<td>80-92</td>
</tr>
<tr>
<td>Very probable</td>
<td>80</td>
<td>75-92</td>
</tr>
<tr>
<td>Very possible</td>
<td>80</td>
<td>70-87.5</td>
</tr>
<tr>
<td>Likely</td>
<td>70</td>
<td>65-85</td>
</tr>
<tr>
<td>Probable</td>
<td>70</td>
<td>65-85</td>
</tr>
<tr>
<td>Even chance</td>
<td>50</td>
<td>45-55</td>
</tr>
<tr>
<td>Medium chance</td>
<td>50</td>
<td>40-60</td>
</tr>
<tr>
<td>Possible</td>
<td>40</td>
<td>40-70</td>
</tr>
<tr>
<td>Low chance</td>
<td>20</td>
<td>10-20</td>
</tr>
<tr>
<td>Unlikely</td>
<td>15</td>
<td>10-25</td>
</tr>
<tr>
<td>Improbable</td>
<td>15</td>
<td>5-20</td>
</tr>
<tr>
<td>Very low chance</td>
<td>10</td>
<td>5-15</td>
</tr>
<tr>
<td>Very unlikely</td>
<td>10</td>
<td>2-15</td>
</tr>
<tr>
<td>Very improbable</td>
<td>5</td>
<td>1-15</td>
</tr>
<tr>
<td>Almost impossible</td>
<td>2</td>
<td>0-5</td>
</tr>
</tbody>
</table>

*Reagan, Mosteller, and Youtz. 1989*
What are the consequences?

- People injured and killed
- Buildings damaged and destroyed
- Businesses interrupted or terminated

In addition to the human suffering and social cost, this has a major financial impact!
Blast effects on people

**Primary**
- Caused by the direct effect of the blast wave
- Injury most severe in air filled structures: Lungs, GI tract, Sinuses, Ears

**Secondary**
- Injury from shrapnel or hurled debris
- Occurs from casualty being struck by fragments from the explosive device or by secondary missiles being energized by the blast

**Tertiary**
- Caused by the blast wind hurling casualty through air
- Occurs when the victim is thrown against the ground or solid objects
- Injuries are similar to blunt trauma or falls

**Quaternary**
- Crush, burns, toxic fumes

Courtesy: Battlefield Wounds, JR Mechtel, RN, MSN - DMRTI
Critical issues in protecting people from terrorist bombs

- Prevent glazing from fragmenting
- Keep the blast energy outside the building
- Protect the occupants from debris
- Prevent structural collapse
How to protect buildings and people from vehicle bomb attack?

- Limit the size of the bomb
- Keep it as far from potential targets as possible
- Provide robust construction materials and methods

(Hinman, E., 1998)
A traditional way of achieving the first two objectives has been to provide

**Standoff**

*Standoff is the distance between a bomb and its target*
The quest for adequate standoff is not a new phenomenon
Standoff is now enforced in many ways
Research has identified many options to provide more robust construction

- Enhanced glazing materials to reduce the production of shards
- Improved column design to resist shattering of concrete and shearing of steel members
- Polymer coatings to reduce wall and slab failure
- Extra reinforcing and multiple connections to prevent progressive collapse

These are all effective but come with a cost!
But what if the threat and countermeasures don't intersect?

The Maginot Line

"If you entrench yourself behind strong fortifications, you compel the enemy to seek a solution elsewhere."

Clausewitz
The risk management process

In risk assessment, the analyst attempts to answer three questions:
✧ What can go wrong?
✧ What is the likelihood that it will?
✧ What are the consequences?

Kaplan and Garrick, 1981

Risk management builds on the risk-assessment process by seeking answers to a second set of questions:
✧ What can be done and what options are available?
✧ What are the associated trade-offs in terms of costs, benefits, and risks?
✧ What are the impacts of current decisions on future options?

Haines, 2002
## A framework for assessing risk management options

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Consequence</th>
<th>Risk Level</th>
<th>Action Indicated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certain A</td>
<td>Catastrophic 1</td>
<td>1A,1B,1C,2A,2B,3A</td>
<td>These are unacceptable risks. Action must be taken to eliminate or reduce them.</td>
</tr>
<tr>
<td></td>
<td>Very serious 2</td>
<td>2A,2B,3B,3C</td>
<td>These may be unacceptable risks. These risks may be acceptable as part of a comprehensive risk management strategy.</td>
</tr>
<tr>
<td></td>
<td>Serious 3</td>
<td>3A,3B,3C</td>
<td>These risks are usually acceptable as part of a comprehensive risk management strategy.</td>
</tr>
<tr>
<td></td>
<td>Not serious 4</td>
<td>4A,4B,4C,4D</td>
<td></td>
</tr>
<tr>
<td>Highly probable B</td>
<td>Catastrophic 1</td>
<td>1A,1B,1C,2A,2B,3A</td>
<td>These are unacceptable risks. Action must be taken to eliminate or reduce them.</td>
</tr>
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<td></td>
<td>Not serious 4</td>
<td>4A,4B,4C,4D</td>
<td></td>
</tr>
<tr>
<td>Probable C</td>
<td>Catastrophic 1</td>
<td>1A,1B,1C,2A,2B,3A</td>
<td>These are unacceptable risks. Action must be taken to eliminate or reduce them.</td>
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<td>3A,3B,3C</td>
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</tr>
<tr>
<td></td>
<td>Not serious 4</td>
<td>4A,4B,4C,4D</td>
<td></td>
</tr>
<tr>
<td>Improbable D</td>
<td>Catastrophic 1</td>
<td>1A,1B,1C,2A,2B,3A</td>
<td>These are unacceptable risks. Action must be taken to eliminate or reduce them.</td>
</tr>
<tr>
<td></td>
<td>Very serious 2</td>
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</tr>
<tr>
<td></td>
<td>Not serious 4</td>
<td>4A,4B,4C,4D</td>
<td></td>
</tr>
</tbody>
</table>
What can be done and what options are available?

- Avoid the risk by locating somewhere else (This is not always an option for many place-based industries or iconic structures.)
- Reduce the risk by taking countermeasures (the focus of this paper)
- Spread the risk by choosing multiple redundant locations for certain activities (The New York Stock Exchange and many businesses in New York and elsewhere have taken this approach.)
- Transfer the risk by buying insurance (The viability of this option will depend on reauthorization of the Terrorism Risk Insurance Act of 2002 and the willingness of the insurance industry to underwrite terrorism risk at rates the real estate industry is able and willing to pay.)
- Retain the risk (In light of the preceding points, building owners may have no choice but to accept a portion of the consequences of terrorist acts.)
What are the trade-offs that must be considered in this decision?

- The building owner is responsible for ensuring the reasonable safety of occupants and visitors.
- The building owner has a fiduciary responsibility for the integrity of the structure.
- The business owner has a responsibility for the continuity of business operations.
The cost of providing building protection

- $15 - $20 per square foot for blast resistant features (glazing, façade, structural features)
- $75 per square foot for land
- 300,000 square foot office building with a 25-foot setback (~ 0.5 acre)

= ~ $7 million per building
The cost of casualties

<table>
<thead>
<tr>
<th>Type of Casualty</th>
<th>Cost per Person</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatality</td>
<td>$5,000,000</td>
</tr>
<tr>
<td>Injury</td>
<td>$125,000</td>
</tr>
</tbody>
</table>
# Categories of Building Damage

<table>
<thead>
<tr>
<th>Damage Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>No damage</td>
</tr>
<tr>
<td>Slight</td>
<td>Isolated nonstructural damage; repair costs less than 5 percent of market value of the building</td>
</tr>
<tr>
<td>Moderate</td>
<td>Considerable nonstructural and slight structural damage; repair costs less than 25 percent of market value</td>
</tr>
<tr>
<td>Severe</td>
<td>Considerable structural and extensive nonstructural damage; repair costs less than 50 percent of market value</td>
</tr>
<tr>
<td>Total</td>
<td>More economical to demolish than repair</td>
</tr>
<tr>
<td>Collapse</td>
<td>Structural collapse</td>
</tr>
</tbody>
</table>
## Assumed Consequences of Event Categories

<table>
<thead>
<tr>
<th>Category of Event</th>
<th>Consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catastrophic</td>
<td>≥50 lives lost&lt;br&gt;≥200 seriously injured&lt;br&gt;≥$250 million in damage</td>
</tr>
<tr>
<td>Very Serious</td>
<td>10&lt; lives lost&lt;50&lt;br&gt;50&lt; seriously injured&lt;200&lt;br&gt;$100&lt; million in damage&lt;$250</td>
</tr>
<tr>
<td>Serious</td>
<td>5&lt;lives lost&lt;10&lt;br&gt;25&lt; seriously injured&lt;50&lt;br&gt;$25&lt;million in damage&lt;$100</td>
</tr>
<tr>
<td>Not Serious</td>
<td>&lt;5 lives lost&lt;br&gt;&lt;25 seriously injured&lt;br&gt;&lt;$25 million in damage</td>
</tr>
</tbody>
</table>
## Expected values of consequences to be avoided ($10^6$)*

<table>
<thead>
<tr>
<th>Category of Event</th>
<th>Catastrophic</th>
<th>Very Serious</th>
<th>Serious</th>
<th>Not Serious</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certain P = 0.95</td>
<td>$594$</td>
<td>$167.4 - 594$</td>
<td>$60 - 167.4$</td>
<td>&lt; $60$</td>
</tr>
<tr>
<td>Highly Probable P = 0.8</td>
<td>$500$</td>
<td>$141 - 500$</td>
<td>$50.5 - 141$</td>
<td>&lt; $50.5$</td>
</tr>
<tr>
<td>Probable P = 0.7</td>
<td>$437.5$</td>
<td>$123 - 437.5$</td>
<td>$44 - 123$</td>
<td>&lt; $44$</td>
</tr>
<tr>
<td>Improbable P = 0.15</td>
<td>$94$</td>
<td>$26.4 - 94$</td>
<td>$9.5 - 26.4$</td>
<td>&lt; $9.5$</td>
</tr>
</tbody>
</table>

* All values contained in this table are hypothetical
Estimated Cost of a Life Saved

Assume:

- $7.0 million per building
- 50 potential targets
- 50 deaths avoided

\[ \therefore \]

\[
\$350,000,000/8.75 \text{ (PWF, 2.5\%, 10 years)}/50 \text{ lives} = \$800,000 \text{ per life per year}
\]
# Comparative Costs of Risk-reducing Regulation

<table>
<thead>
<tr>
<th>Regulatory Action</th>
<th>Cost per Life Saved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steering column protection</td>
<td>$0.2 million</td>
</tr>
<tr>
<td>Passive auto restraints</td>
<td>$0.5 million</td>
</tr>
<tr>
<td>Head impact protection</td>
<td>$0.7 million</td>
</tr>
<tr>
<td>Blast vulnerability reduction</td>
<td>$0.8 million</td>
</tr>
<tr>
<td>Aircraft seat cushion flammability</td>
<td>$1.0 million</td>
</tr>
<tr>
<td>Children’s sleepware flammability</td>
<td>$2.2 million</td>
</tr>
<tr>
<td>Asbestos protection for workers</td>
<td>$5.5 million</td>
</tr>
</tbody>
</table>
What are the long-term consequences?

This is not inevitable!
(But may be if we’re not vigilant!)

Police Concede Slain Suspect Not a Bomber

Security Efforts Turning the Capital Into an Armed Camp

We aren’t wired to respond rationally to terrorism.

Scaring Us Senseless

human nature, all related to the judgement and perception of un
usual events. The first and key among these has been observed over
the last two decades by neurobiolo-
gists and behavioral scientists, who
have debunked a great fallacy that
has marred Western thinking since
 Arsène and most acutely since the
Enlightenment.

That is to say that as much as we
think of ourselves as rational ani-

mals, we aren’t.

Like an extremely naive statistician,
be an extremely naïve statistician,
because it was built for a primitive
environment with simple dangers.
That might work fine for you the next
time you run into a snake or a tiger.
But because the emotional system is
impressionable and prefers shallow,
social and anecdotal information to
abstract data, it hinders our ability
to cope with the more sophisticated
risks that afflict modern life.

For example, the death of an ac-
anist acquaintance in a motorcycle accident would be more likely to deter you
from riding a motorcycle than would
a dispassionate, and undoubtedly far
more representative, statistical analysis of motorcycles’ dangers.
You might avoid Central Park on the
basis of a single comment at a cock-
tail party, rather than bothering to
read the freely available crime sta-

tics that have the power to amplify such
usual disturbances, particularly
their use of images that go directly
the emotional brain.

Consider this: Osama bin L
continued killing Americans
Western Europeans in the after
of Sept. 11, though indirectly. No
large number of travelers who
drive rather than fly, and this is
a corresponding rise in cases
from automobile accidents.
Frontal risk of death exceeds that
from terrorism.

Yet these automobile acci-
dents are not news stories — they
have become routine. We have picked
up those killed by bombs, not
those killed on the road. As Stalin su-

nedly said, “One death is a tragedy;
million is a statistic.”

New York Times, 7/24/05

New York Times, 2/22/04
The potential consequences of security without context

“New Defense Department building security standards, adopted without public input and scheduled to take effect in 2009, would require much greater distances between buildings and curbs. At the moment, virtually none of the department’s office buildings comply with those standards, and many or most stand little chance of doing so by 2009. If Defense sticks with them, the result could be an exodus of Defense workers and offices, as well as defense contractors who service them, from the metropolitan core to far-flung military bases or leafy exurban sites. That would injure the region’s economy -- and the notion that security requirements can coexist with smart urban planning.”

Washington Post, Monday, November 15, 2004; Page A24
“Given the high cost of implementing an effective urban physical security strategy, the participation and knowledge of all affected parties, including policymakers, law-enforcement officials, building owners and occupants, planners, architects, engineers, and security specialists will be required. Questions of this import are not for engineers alone to answer.”

Little, 2004
A real debate on security has yet to occur

“Despite the creation of a vast new Department of Homeland Security and despite the billions of dollars the government has poured into homeland security over the last three years, there has been little hard discussion in Congress, in the media or elsewhere about just what the nation's long-term homeland security priorities should be.”

Washington Post, Sunday, October 17, 2004; Page B06
Conclusions

- Blast-effects, vehicle bombs, and the effectiveness of countermeasures are reasonably well understood (The \textit{physics} problem)

- Terrorist attack is not inevitable; we need to manage the risk of attack, not just our vulnerability to it (The \textit{risk management} problem)

- Static physical countermeasures are expensive and not the only solution; rational strategies must be worked out based on tradeoffs among threats, resources, and risk tolerance (The \textit{socio-political} problem)
A “To Do” list for enhanced urban security

- Understand urban security issues given the increasing complexity of threats, vulnerability, and risk
- Clarify and define the problem of protecting urban areas (people, buildings, and infrastructure) and establish meaningful, achievable objectives
- Organize, empower, and fund the appropriate organizational entities
- Work with all stakeholders (owners, law enforcement, public) on how best to address threats, vulnerabilities, and possible consequences
- Develop adequately trained professionals who understand the holistic nature of planning for security
Some Final Thoughts
Threats and countermeasures must be congruent.
We need to focus on risk and threats, not just vulnerabilities.

vulnerability* ≠ threat** ≠ risk***

* Openness to attack or damage
** The intention to inflict injury or damage
*** The probability of an event multiplied by the consequences of the event (R=P x C). Apparently simple, but quite complex in practice!
Effective urban security needs to balance likelihood with costs/benefits and equity.
We need to move from this

The Physics Problem

The Risk Management Problem

The Socio-political Problem
If we make security an end unto itself, we may not like where it leads us.

“The City (London) should be turned into a medieval-style walled enclave to prevent terrorist attacks... In private there is talk about a ‘walled city’ approach to security with access through a number of small ‘gates’ and controlled by security discs...”

“The Times, April 27, 1993

“I miss the security of a walled city.”
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