Security Through Design in the Public Environment

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The following thesis project is an investigation in the topic of security through design. The study sought a site and program susceptible to attack in the public environment in order to design an appropriate response to the inherent tension from those attributes. The work represents an architectural reaction to the engineered assessments and solutions that permeate the post 9/11 world. The seemingly indiscriminate deployment of bollards, planters, and jersey barriers choke the representation of openness and freedom as well as the perception of safety from contemporary cities and buildings.

My personal design approach attempts to re-present a constraint through the experience of a user to celebrate the inherent potential of that perceived limitation. The presented solution has embraced security and other ‘limiting’ considerations in the dialogue of design beyond base utilitarian functions. Acknowledging ‘security through design’ solutions in this context requires consideration of various building archetypes and particular sites as independent design variables. The vehicle for this research was found as an institute to counter terrorism located in the Washington D.C. region.
Dedication

From the bookends of my collegial career in memory of those lost, defense of the innocent, and the hope that my career bears fruit in the fight against terrorism, violence, destruction, and hate.

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"Therefore fortresses may or may not be useful according to the times; if they do good in one way, they do harm in another. The question may be discussed thus: a prince who fears his own people more than foreigners ought to build fortresses, but he who has greater fear of foreigners than of his own people ought to do without them... Therefore the best fortress is to be found in the love of the people, for although you may have fortresses they will not save you if you are hated by the people... I would therefore praise the one who erects fortresses and the one who does not, and would blame any one who, trusting in them, recks little of being hated by his people."

— Machiavelli

"Fixed fortifications are monuments to man’s stupidity"

— George S. Patton

"The inner condition of the formless is inscrutable, whereas that of those who have adopted a specific form is obvious. The inscrutable win, the obvious lose."

— Du Mu

"This is a matter of deceptively concealing your state. You should not let the opponent see what state you are in; for if the enemy sees your condition, he will surely have a response."

— Du Mu

“A skilled attack is one against which opponents do not know how to defend; a skilled defense is one which opponents do not know how to attack."

— Zhuge Liang

“So it is said that if you know others and know yourself, you will not be imperiled in a hundred battles; if you do not know others but know yourself, you win one and lose one; if you do not know others and do not know yourself, you will be imperiled in every single battle."

— Sun Tzu

“The difficulty of armed struggle is to make long distances near and make problems into advantages."

— Sun Tzu

Terror attacks while present throughout history have become the signature feature of asymmetric struggles in contemporary times. These tactics in many ways can be understood as a more complex instrument in the struggle for power and influence that has plagued mankind’s political, economic, and social institutions since their inception. Seeking to draw lessons from the past, research was conducted on defensive fortifications, martial & political philosophy, and incidents of terrorism. A selection of significant incidents of terrorism from this research appears as a timeline throughout the book.

Several conceptual design options were derived from additional topical research that was conducted of security through design, terrorism, and blast physics. This research uncovered a UN report, “Supporting Victims of Terrorism”, which provided the foundation of the building’s program.

FIGURE 1: Diagrammatic depiction of Maginot Line Fortification.

FIGURE 2: Michelangelo Buonarroti’s Florentian Fortifications.
Public Domain Image.

FIGURE 3: Great Wall of China.
Used under Fair Use, 2015

FIGURE 4: Supporting Victims of Terrorism UN report cover.
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ASSASSINATION ATTEMPT OF QIN SHI HUANGDI

- Poisoned dagger attack failed and two perpetrators were slain
- Attempted to save the state of Yan from perceived Qin aggression
- Yan regime overthrown the following year 222 BC
INITIAL CONCEPT SCHEMES
This scheme was born from research into the science of physical protection, in an attempt to better understand the physics of blast waves. A simple conceptual diagram of how these waves react to barriers raised the possibility of manifesting the phenomenon in physical form. In this way people could, in a manner, safely experience an explosion and help to understand its intangible properties. Translating the propagation of pressure waves as a topographic representation provides an immersive, physical environment that models blast behavior at a human scale.

This translation relates slope to blast pressure, with steeper inclines revealing areas of increased pressure. The resultant dynamic surface could make an intriguing green roof park, retaining some of the sites current use. The three arbitrary forms were introduced with different size, orientation, and distance relative to the ‘blast incident’. These easily translate into vertical circulation or light cannon elements. A regular structural grid conspicuously interacting with the surface provides a consistent measure that aids understanding.

This representation helps to provide a more understandable scale as well as experimentation with the introduction of additional elements playing through the surface.
The bridge scheme utilized a bridge as the launching point for the design. Bridges are often used as metaphors for relationships or life experiences and in that sense are appropriate for this scheme, investigating the experience of victims and attempts to effectively engage and reintegrate these individuals with society.

The UN held a symposium in 2008 on supporting victims of terrorism and this scheme drew inspiration directly from the report documenting that event. The report highlighted, among other concerns, feelings of disenfranchisement and isolation from their community following their victimization. These were most effectively countered through conscious and conspicuous efforts from the community to engage these individuals. The bridge in this sense spans over time to reconnect those separated from their community/country by the schism of terrorist actions.

I was immediately drawn to cable stayed structures in diagramming such reconciliatory efforts. Numerous, light, supporting elements reaching out in tension from a consolidated strongly anchored tower struck me as a particularly apt expression.

This initial expression is a diagrammatic tool to start to adjust these ideas into architectural form. The concept is beginning to play with ideas of creating multiple experiences of space, molding of surfaces, and structural detailing that expresses alternate interpretations of connection and support.
The healing landscape scheme drew inspiration from an environment born out of the ruins of human construction. Often the response to a destructive attack is to clear the area and rebuild as if the event never took place. This mindset is emblematic of society’s tendency to ignore unpleasant history, which fails to acknowledge or ameliorate the lingering effects it has on victims. Retaining some scars acknowledges the place’s history and that of the community as a whole.

Thomas Cole’s ‘Course of the Empire’ series reveals the transformation of a fictitious settlement from a natural state, to its gradual suppression under human occupation, eventual destruction and slow natural healing that can be seen as cyclical rather than culminating steps in the series. This fifth work pictured is the launching point for the design. It is mirrored in much of the painter’s other work showing a symbiotic relationship between the ruins of manmade and natural environments.

These paintings reveal intrinsic characteristics of ruins that paradoxically relate more to a sublime impression than of degradation. This scheme attempts to translate this experience by utilizing these characteristics in a blending of landscape and building design elements. Initially these design vignettes have focused on the adaptive reuse natural and artificial environments makes of elements from the other.

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**Gunpowder Plot**

- Bombing plot targeting England’s Houses of Parliament attempting to kill Protestant King James I, his family, and aristocracy for the Emancipation of Catholics
- Planned 36 barrels (~1,800 lbs) of gunpowder in a coal cellar under the House of Lords
- Plot was discovered & all 13 conspirators & a priest who heard plot in confession were killed
- Emancipation of Catholics was not achieved until more than 200 years later
The site geometric scheme was derived directly from the interplay of site geometry and axial relationships carried through the site. Early diagrams assumed a direct relationship along Delaware Avenue between Constitution Avenue and the Capitol. The experience on the site, however, contradicts any direct relationship along this route. The grading and landscaping obscure the potential visual connection, the symbolic procession is sullied by the relegation of service functions to Delaware Avenue for intervening spaces, and even the route itself is blocked by vehicle checkpoints and guard booths.

With the site directly fronting Union Station and a perceived North-South Axis through the capitol grounds, a connection can be reintroduced between these institutions. The site is ideally situated to serve as a joint between these axes, salvaging the relationship between those anchors.

The body of the building program has been represented in the approximate form of the site itself with the redirected axes of connection cutting the building mass. This internal street provides orientation and direction from an urban standpoint, while siphoning public interaction and exposure to the program of the building. The expression of this redirection is celebrated in entry awnings that extend to draw visitors inside.
SITE ANALYSIS AND SECURITY CASE STUDIES
Research conducted into terrorism within the United States provided insights into the historical prevalence and lethality of various threat typologies. Figures published by the FBI covering 1980-2005 documented 320 incidents of terrorism.

This showed the most common form of terrorism attack in the US has been bombings. While the relative frequency of these attacks in relation to the number of overall incidents has decreased dramatically, bombings remain a consistent threat. Despite the reduced occurrences, bombings still represent by far the most dangerous terrorism threat faced in the US.

Assault on Harper’s Ferry

- Attempted to seize estimated 100,000 guns stored at a federal armory
- Abolitionist John Brown led assault to incite a slave rebellion by providing arms to slaves
- 10 conspirators were killed in the attempt and 5 were hung following its failure
- Slavery was abolished a few years later following the American Civil War
Wall height and depth provides a convenient seat for weary tourists. Minimal use of bollards, to span 'slip' in concentric ha ha's. If bollards are removable can provide emergency and service vehicular access.

Concentric pattern and width of walkways invite joggers. The walks also provide tourists unique panoramic perspective of the monument and its context.

Interior concentric pattern extends paths to allow gradual slope up to the elevated monument base and naturally tie into queuing line.

Entry at 'slip' in anti-ram perimeter wall. Traffic cone shows approximate drop in grade at south side of monument perimeter wall. Grass cover seamlessly flows in between wythes of the constructed wall and accepts the wall's retreat under its surface.

WASHINGTON MONUMENT - SITE DOCUMENTATION

The perimeter wall traces the circumference around the monument aside from the entry 'slips' and stepping around its tertiary building. The wall thickness is hinted at in the reveal of its interior wythe.

Entry 'slip' through perimeter wall. Grass cover extends to edge, mimicking traditional ha-ha's.

The redesign of the Washington Monument was investigated as an excellent case study for strategies of addressing the tension between security and access. Easily one of the most iconic monuments and significant tourist attractions in DC, it required security solutions that would not impede public access, nor detract from its symbolism as a monument to freedom. The redesign achieved an effective defense against vehicle-borne improvised explosive devices through a series of restrained and well-designed security elements.

The design employed lessons from landscape design, including simple grade adjustments and traditional ha-ha's to minimize the visual impact of security features.

ASSASSINATION OF TSAR ALEXANDER II

- BOMBING, IRONICALLY ON THE DAY ALEXANDER SIGNED A DOCUMENT GRANTING THE FIRST CONSTITUTION OF THE PEOPLE.
- THEORIZED TO HAVE BEEN ATTEMPTED IN RESPONSE TO RUSSIFICATION POLICIES AGAINST POLISH LANGUAGE; ALTHOUGH NUMEROUS GROUPS HAD PREVIOUSLY MADE ASSASSINATION ATTEMPTS
- INITIAL ATTACK INJURED SEVERAL OF ALEXANDER'S GUARDS, WHEN HE WENT TO CHECK ON THEM ANOTHER ATTACK SUCCEEDED IN KILLING ALEXANDER.

BOMBING
1 KILLED
SEVERAL WOUNDED
WASHINGTON DC - PERIMETER SECURITY DOCUMENTATION

Washinton DC is known for its range of contemporary strategies and approaches to perimeter security. These case studies were evaluated primarily in relation to the level of security achieved and its impact on the overall design of its immediate surroundings. Some of the more effective solutions reveal consideration of these security feature's ability to blend in the design, and opportunity to serve additional functions in the overall design.

The study as a whole reveals varying degrees of success in implementing security solutions in the public environment. The range of these solutions presently deployed speaks to the evolution of this consideration in the design process.
The site selection process evolved with the program selection and began with a series of diagrams of Washington DC. Along with an analysis of underdeveloped sites throughout the city, two diagrams in particular guided the selection of potential sites.

The first diagrammed DC institutions with a higher perceived terrorism threat. These included seats of government both domestic and foreign, monuments, memorials, tourist attractions, and stadiums.

The second conveyed a diagram of the city’s transportation network, emphasizing gateways, points of arrival, and axes of organization.

Seven sites were selected from these underlays representing a range of threats and urban conditions. Following site visits the list was then narrowed down to three for further investigation.

**Potential Sites**

**LOS ANGELES TIMES BOMBING**

- Bombings at an office building and two residences
- Perpetrated in retaliation for unfavorable reporting against organized labor
- Seriously hurt the position of the AFL and unions, particularly in LA

![Diagram of DC Institutions with higher perceived terrorist threat overlaid with visited potential sites](image_url)
The three prospective sites were studied, diagrammed, and evaluated primarily on the impact of each site on three criteria:

- The mission’s public & legislative outreach
- Symbolic presence
- Connection/access to the city’s transportation infrastructure

From this analysis the Lower Senate Park site was selected.

**Potential Sites**

**Assassination of Archduke Franz Ferdinand**

- Shooting and bombing ambush
- Perpetrated to advance Serbian nationalist agenda over Austro-Hungarian rule
- Event sparked World War I which claimed more than 37,000,000 casualties
A portion of Lower Senate Park is unzoned and the rest is zoned C-2-A. The limiting building height in this zone is 50’ and has minimal setbacks which will more than be accommodated for blast setback. For the purposes of this study the unzoned portion is assumed to have an approved variance for development or included in the C-2-A zoning.

The site has major vehicular routes to its north and west in Columbus Circle and Louisiana Avenue, respectively. The building location on the site will therefore seek to maximize the physical setback from those roads without detracting from its visual presence. There is minimal grade variation across the site with just a slight rise to the northeast.

The context around the site is dominated by its proximity and visual connection to both Union Station and the Capitol. Its immediate surroundings are undeveloped with office/commercial development further to the west and residential further to the east. The closest surrounding buildings were studied for opportunities to pick up on contextual connections and view corridors were diagrammed to and from the site.

Wall Street Bombing

- Bombing delivered by horse drawn cart filled with 100 lbs of dynamite
- Remains uncertain who perpetrated the attack but anarchists were suspected
- Failed to halt the economic rise of the city or its institutions
Despite the parklike nature of Lower Senate Park, the Taft Carillon, and Capitol underground parking garage restrict development on the south blocks of Lower Senate Park. Locating at the existing surface parking lots would necessitate the provision of significant new & replaced parking.

The greatest advantage of the site is in the strength of the visual axis along Delaware Avenue with its unique relationship connecting the Capitol building and Union Station. These considerations drove the siting within Lower Senate Park on the Blocks along Columbus Circle.

Site visits throughout the year revealed the strength of the visual connection between the site’s existing landmark institutions varies with the seasons. The connection is strongest in the fall and winter without the leaves on the trees. The link wanes in the spring and summer months as the view corridor is obscured. However the perpendicular axis to the Capitol over its underground parking was discovered as an underutilized view corridor which the projects development sought to act as a fulcrum connection.
During site investigations, considerable effort was made to direct the design’s development with respect for existing conditions. The site could primarily be described as park-like in nature. 16 flag poles on each of the sites blocks participate in the sequence of flags from all 50 US states, territories, and the District of Columbia along Columbus Circle. 14 different species of trees were found on the site, identified from their common and scientific names by plaques mounted on the trees throughout the site.

A plaque revealed the historic nature of a number of these trees as “The President’s Trees;” a gift from the Maryland Society of the Daughters of the American Revolution in 1934. While research failed to unearth which trees numbered among the 31 dedicated in this manner, it was hypothesized the Northern Red and Scarlet Oaks spaced along the site’s perimeter represented these trees. The age of growth and planting pattern of these trees relates closest to the quantity of 31 trees identified by the corresponding plaque on site.

The variety and historic nature of the plantings on the site necessitated a concern to develop a delicate footprint on the site to limit the disturbance to these existing conditions. These concerns pushed the available footprint for the building to the southeast of the site which recorded the lowest quantity and least mature trees on site.
SITE AND BUILDING DESIGN
The tree planting design was derived from two influences from the existing context of the site. The first was from the “President’s Trees” dedicated by the Maryland Society of the Daughters of the American Revolution in 1934. While a number of these trees have been cut down it appears that these were planted along the perimeter of the block bounded by Columbus Circle, Louisiana Avenue, D Street, and Delaware Avenue. The building was sited to minimize the new constructions impact on the surviving historic trees and the site plan includes new Presidents trees to be inaugurated for all 43 Presidents (44 if you count each of Grover Cleveland’s non-consecutive terms). The design also depicts future presidents trees demonstrating the intended patterning of these trees on the site over time. The second element in the site’s planting design was taken from Olmstead’s Plan for the Capitol grounds. The tree planting clearly clusters trees along the major sight lines to and from the site as well as slightly more sparsely along the circulation paths within the site and sparingly throughout the interior.
The perimeter security is achieved through a detail which was derived from a tiger pit trap. The vehicular standoff line is achieved through a continuous anthram wall which is "buried" below grade. The tiger pit "cover" is contiguous with grade and supports the weight of pedestrians allowing them to traverse unimpeded. However the supports of the pit "cover" will "fail" under the weight of a vehicle dropping the level of ground into the pit and arresting the vehicles intrusion at the anthram wall. The wall's effectiveness is increased by the earth it retains from its protected side. The trap can be further augmented with recessed bollards in the wall and activated by pneumatic pressure tied to the supports of the pit "cover" or remotely controlled from a security office.
The building program integrating public access with secure private operations necessitated particular concern be given to circulation in, through, and around the building. Pedestrian circulation for visitors to the site, transiting the site, as well as users of both the public and private functions of the building were analyzed in a number of diagrams. The building was sited to become a gateway rather than a reinforcement of the path along Delaware Avenue. This arrangement clarified a separation of building uses, connected across the site axis.

Circulation patterns were diagrammed at both the scale of the site as well as that of nodal connections at the building entry, exit, and joint between private and public building areas. Ultimately these diagrams were critical in minimizing redundant circulation paths, increasing the efficiency of the building and allowing a greater mixing of building users.

Zoning considerations and respect for the plantings on the site, limiting both the building height above grade and its footprint pushed the massing of the building below grade.
The buildings siting, straddling the axis connecting Union Station and the Capitol Building, imbued significant prominence to the intersection of the building and this contextual axis. This area was developed as the keystone of the project’s organization. This area needed to defer to the existing vistas across the site, celebrate and tap into the pedestrian route transiting the site, define separation of building uses while simultaneously bridging the programmatic masses.

A series of studies were developed for the massing of this joint above grade with particular consideration for the view to Union Station, view to the Capitol, and the building entry(ies). The need for a separation between the public and private masses below grade required special treatment at the lowest level of excavation to prevent unauthorized access. This was resolved by the provision of a pool at the lowest level, simultaneously providing physical separation, visual interest, and taps into the imagery of bridging societal gaps between institutions and people.
There are two basic types of explosions, deflagrations and detonations. Deflagrations release their energy relatively more slowly and tend to therefore result in reduced pressure loads than a comparable detonation would. These are useful in propellants and are therefore more common in the munitions and projectile realms.

There are two basic types of explosions, deflagrations and detonations. Detonations release all their energy at once resulting in an immediate rise in pressure that quickly depletes gas propellants away from the source. These are typically the intended reaction from terrorists and are the focus of the study in the blast walk. Blast effects can be computed with a high degree of accuracy when appropriately scaled and thus smaller controlled blasts can be utilized to predict the effects of larger explosions. The physics behind blasts has been extensively studied and a realistic computation of its effects requires significant adjustments for the variables of the site and its surroundings. Often the amount of effort necessary to run those calculations is unnecessary and there are some simple approaches that provide a rough approximation to determine if more precise calculations are appropriate or required. The blast walk has utilized one such basic approach for two blasts of different charge weights to provide an experiential representation of blast speed, duration, and pressure. Blasts are typically expressed in units of equivalent pounds of TNT regardless of the source material.

**Blast Walk**

**Assassination of Aldo Moro**

- Shooting assault to take Italian politician Aldo Moro hostage
- Perpetrated to achieve leverage to secure the release of prisoners & bring attention to their cause
- Killed 5 in the kidnapping and after 2 months killed Moro
- Failed to secure the release of any prisoners and the subsequent crackdown essentially dismantled the group

**KIDNAPPING**

- 6 KILLED

**41**

**42**
The Blast Walk’s ‘Experiential Pressure Zone’ has the markers from each explosion’s marked locations (each 0.1 of a second) encroach into the walk to represent the overpressure at that location/time of the blast. That marker reduces the typical walking surface area at that location which relates the pressure experienced by the human body at that location. These distance values have been derived from a formula relating distance remaining (in inches) and pressure (in psi) from 4 set points relating compression at the scale of the human body and the comparable impacts to humans at various pressures. 2 psi is a common measure for blasts as glass windows will fail at this blast pressure and while certainly felt, the pressure will not typically cause significant harm to humans. Comparably 30” is more than sufficient for humans to traverse but not without feeling somewhat constricted or at least feel the encroachment in their personal space. At blast pressures as low as 5 psi, the ear can sustain damage or rupture. Accordingly while 16” is less than an average person’s body width with an opening of that size would still be passable. At blast pressures of 40 psi a person sustains significant damage and their lungs collapse, while an 8” opening is nearly insufficient to traverse in any manner. Finally blast pressures of 100 psi are typically fatal and 3” is completely impassable. These set values were related in the scatterplot at left and a best fit logarithmic equation provided the relationships for all other pressure and distance values.

- **Blast Walk**

- **AIREY NEAVE ASSASSINATION**
  - Car bombing, placed on victim’s car and detonated as he drove away from outside the English House of Parliament.
  - Despite a terrorist group claiming responsibility and reinforced by the failure to prosecute anyone, theories abound as to who perpetrated the act and to what end, as responsibility was never confirmed.
February 26, 1993
World Trade Center Truck Bomb
~ Equivalent to 1,000 lb of TNT

Blast arrives in 0.1 second
Peak overpressure of 3.5 psi
Positive pressure phase duration of 3.9 milliseconds (0.0039 sec)

Blast arrives in 0.2 second
Peak overpressure of 1.8 psi
Positive pressure phase duration of 3.6 milliseconds (0.0036 sec)

Blast arrives in 0.3 second
Peak overpressure of 0.65 psi
Positive pressure phase duration of 4.4 milliseconds (0.0044 sec)

Blast arrives in 0.4 second
Peak overpressure of 0.35 psi
Positive pressure phase duration of 5.1 milliseconds (0.0051 sec)

Blast arrives in 0.5 second
Peak overpressure of 0.22 psi
Positive pressure phase duration of 5.6 milliseconds (0.0056 sec)

Blast arrives in 0.6 second
Peak overpressure of 0.15 psi
Positive pressure phase duration of 5.9 milliseconds (0.0059 sec)

Blast arrives in 0.7 second
Peak overpressure of 0.13 psi
Positive pressure phase duration of 6.0 milliseconds (0.0060 sec)

Blast arrives in 0.8 second
Peak overpressure of 0.10 psi
Positive pressure phase duration of 6.0 milliseconds (0.0060 sec)

Blast arrives in 0.9 second
Peak overpressure of 0.08 psi
Positive pressure phase duration of 6.0 milliseconds (0.0060 sec)

Blast arrives in 1 second
Peak overpressure of 0.06 psi
Positive pressure phase duration of 6.0 milliseconds (0.0060 sec)

August 6, 1945
"Little Boy" Atomic Bombing of Hiroshima
~ Equivalent to 30,000,000 lb of TNT

Blast arrives in 0.2 second
Peak overpressure of 105 psi
Positive pressure phase duration of 1.8 milliseconds (0.0018 sec)

Blast arrives in 0.3 second
Peak overpressure of 60 psi
Positive pressure phase duration of 1.75 milliseconds (0.00175 sec)

Blast arrives in 0.4 second
Peak overpressure of 43 psi
Positive pressure phase duration of 1.7 milliseconds (0.0017 sec)

Blast arrives in 0.5 second
Peak overpressure of 36 psi
Positive pressure phase duration of 1.75 milliseconds (0.00175 sec)

Blast arrives in 0.6 second
Peak overpressure of 29 psi
Positive pressure phase duration of 1.85 milliseconds (0.00185 sec)

Blast arrives in 0.7 second
Peak overpressure of 24 psi
Positive pressure phase duration of 2.0 milliseconds (0.002 sec)

Blast arrives in 0.8 second
Peak overpressure of 19 psi
Positive pressure phase duration of 2.1 milliseconds (0.0021 sec)

Blast arrives in 1 second
Peak overpressure of 15 psi
Positive pressure phase duration of 2.3 milliseconds (0.0023 sec)

The blast markers set in the ground plane are indicated at intervals of 0.1 seconds from ground zero, set at the center point of Columbus Circle at the entrance of Union Station, the point of arrival for many visitors. In addition to the arrival time of the blast wave, the markers relate the distance from the blast origin, the peak overpressure, and the time lapse duration of the positive pressure wave at that location. The radius of these hypothetical explosions are marked along the nearly half mile path between Union Station and the Capitol.

The blast walk provides an experiential representation of two large explosions: the 1993 truck bombing of the World Trade Center and the 1945 atomic bombing of Hiroshima. These examples portray relative effects of blasts with a charge weight of 1,000 lbs and 30,000,000 lbs of TNT, respectively. Both representations are approximations to a relative charge weight, which neglect the effects of reflection off the ground plane, the characteristics of the surrounding environment, and nuclear blast physics (in the case of the Hiroshima bombing). However, this representation should provide a clear representation of the critical effect distance from the explosion has on the amount of damage a given blast can inflict.

Iranian Embassy to Britain Hostage Situation

- Shooting/Hostage Situation lasting a week
- Perpetrated to achieve leverage to seek political sovereignty and secure the release of prisoners
- Terrorists failed to achieve any of their goals
- Situation was covered heavily by the media, including live feed of the police storming of the embassy securing the hostages release. This is still studied for questions of the role of the media and police response to acts of terrorism.

Hostage Situation
1 killed
25 hostages taken
Security Detail

Mechanical equipment includes sensors and filters to detect and protect against chemical, biological, or radiological threats from entering through the mechanical outside air intake.

See Secure Skylight Detail for additional information on the security features of this element. This can also be utilized as a mechanical shaft.

Emergency Egress Stairs provides a separate means of escape should a forced-entry attempt be made through the security checkpoint.

Security Checkpoint shall be sized for a person-borne improvised explosive device (5-40 lb). Use of pressure opening louvers dampers will reduce effective blast loading.

Security Hardline

The building’s hardline contains the institute’s office functions in the building’s east wing. The bridge connection between the building’s wings serves as the security checkpoint. This space provides the sole access to the secure space and functions to screen its entrants. The checkpoint is designed to withstand a person-borne explosion, largely limiting its impact to this area.

The building is protected from chemical, biological, or radiological threats from its mechanical systems. The outside air intake system contains sensors to detect air-borne threats and filters to remediate their effect.

The fire egress stairs also serve as an emergency escape route should a forced entry attempt be made through the checkpoint.

The fire egress stairs also serve as an emergency escape route should a forced entry attempt be made through the checkpoint.

Hyde Park and Regent’s Park Bombings

- Two 10 lb gelignite bombs packed with nails
- Regent’s Park bomb was placed under the grandstand of a free military band concert
- Hyde Park car bomb was timed to detonate at the passing of the guards en route to the changing of the guard ceremony at Buckingham Palace

BOMBING 11 KILLED 50 INJURED
The skylight detail sought to maximize the amount and depth of natural light penetration into the building, while denying access from person-borne improvised explosive devices. The windows on the ground plane are directly accessible and therefore represented a potential security vulnerability that needed to be addressed.

The skylights provide a vertical shaft for light to penetrate directly into the building while pushing the horizontal closure of the buildings hardline below the level of public access. The detail was developed as a hypothetical approach to counter a backpack, briefcase, handheld explosive bombing through the skylights. The effects of an explosion are amplified in an enclosed space and therefore a means of absorbing or releasing the explosion was needed beyond simply redirecting it from occupied spaces. This detail served to illustrate a few theories in utilizing water to reduce the relative impact of an explosion. The free movement of the water reacting to the blast will convert some of the blast energy into harmless water projectiles. It was theorized that the strength of the blast wave is diminished when transiting between states of matter and additional energy would be absorbed in the explosion converting water to a gas state.

Recognizing these effects won’t balance that of the blast, the reservoir’s floor is designed to fail first, directing the blast away from occupied space and structural building supports. The skylight reservoirs also serve as storage tanks for hot water, rain water catchment, and site irrigation.
The upper roof not only provides shade and weather protection for the grade level but reinforces the unity of the overall building. The building’s west (public) wing is organized rectilinearly while the east (private) wing is organized along the radials of the hypothetical blast walk’s ground zero at Union Station. This perspective shift reflects the experience of those impacted by incidents of terrorism. The order and regularity of individual’s and society’s lives can be distorted by such events; so their routines, perspectives, and hopes can be reshaped by that singular event. The building seeks to bridge the gap between these systems with sensitivity to the unique needs of individuals impacted by terrorism, maintaining civilizations’ order and values, and helping to reintegrate society as a whole. The roof is formed in plan with the organizing geometries of both systems, with a discontinuity which, defers to the axial connection from Union Station to the Capitol. In section however the continuity of the roof’s form is conspicuously revealed emphasizing the marriage of the buildings disparate systems.

The Green roof is intended to be occupied and supports functions ranging from the informality of a park setting or viewing platform to the formality of amphitheater performances or use as an exterior ballroom.

Rangoon Bombing

- 1 of 3 bombs detonated in a failed assassination attempt on South Korean President Chun Do Hwan
- Perpetrated by North Korean agents at the tomb of assassinated Burmese leader Thanin Aung Sang, who negotiated the country’s independence following nonviolent means.
The ground level primarily remains as exterior public space, interrupted by a series of pavilions marking the building below, and acting to provide entry for light, air, and people. The public wing is buried less deeply, participating in the landscape, announcing its presence, and providing access. While the private wing is fully submerged, minimally revealed through its skylights disguised under small reflecting pools, egress pavilion, and in the geometry of the canopy structure.

The main entrance is located at grade level, directly off the blast walk pedestrian thoroughfare. The western entrance is on the Promenade level, 1/2 level down from grade and accessed by monumental stairs. This creates another small amphitheater space which can be utilized for small exterior performances, talks, or even overflow retail space.

The Promenade level connects the buildings entries across a bridge walkway overlooking the exhibition spaces and tiers below. The Institute/Museum’s gift shop is located on this level, tapping into the circulation flows horizontally between the buildings entries and vertical terminus from the public wing.

Brighton Bombing

- Semtex bombing of the Conservative Party conference at the Brighton Grand Hotel
- Perpetrated in an attempt to assassinate Prime Minister Margaret Thatcher and her government, in response to the presence of British troops in Northern Ireland.
- Active British operations remained in Northern Ireland until 2007 well after the 1998 Good Friday Agreement

BOMBING 5 KILLED 34 INJURED
The open tier spaces on the public side of levels B2-B4 serve as the exhibition floors of the museum. These spaces visible from above invite visitors deeper into the building for a more immersive experience of the exhibitions on display. The open exhibit spaces also serve to expand the pre-function space available at the Institute’s formal public outreach components: auditorium, conference center, and classroom/training spaces. The auditorium’s stadium seating descends from the B2 to the B3 levels, reflecting the tiers opening to the building’s center. The area behind the auditorium provides the public wing’s mechanical room.

The B2 level provides the sole link between the building’s public and private wings. This level also houses the Institute’s reception, offices, and conference rooms. The B3 level provides open collaboration/multi-purpose space.
On the public wing the class/training room and double height conference center are accessed on the B4 level, with utility/storage occupying the remaining area under the auditorium. As with the upper levels, the tier space is given to exhibition space.

The B4 level in the private wing houses the Institute’s library, archives, and research spaces. It is envisioned the Institute would employ a mix of full time employees and offer fellowships/grants for prominent researchers, whose published work would then be housed in the library and archives.

The pool level serves as an aesthetic element for the building’s atrium as well as fire suppression reservoir tank and catchment from the skylight reservoirs and could be partitioned as supplemental storage tanks for hot water, rain water catchment, or site irrigation.
Sectionally each tier opens up to the central atrium with programmatic elements contained in the area below each tier. The open spaces are easily understood as public, the enclosed double-height spaces as semi-private, and other enclosed areas entirely private.
While clearly related the organization of the building’s two wings reveal slight differences emphasizing their respective public or private character. These can be seen in the detailing of the railing (visually open/solid), interaction with the ground plane, and relative closure of the tier spaces.

Assassination of Juvenal Habyarimana/ Genocide in Rwanda

- Missile attack on Rwandan Presidential Plane killed 12
- Perpetrators remain unknown
- The response from the government and Hutu Majority was genocidal
- Action against the country’s minority Tutsi’s
- Within 13 weeks at least 500,000 & perhaps over 1,000,000 were killed

Genocidal Campaign
At least 500,000 killed
The building’s form opens up along the axial connection between Union Station and the Capitol, in deference to these landmarks. The blast walk serves as an item of interest for tourists and joggers; providing a connection to these institutions thatcelebrates rather than detracts from their prominence. The grade level features of the building were designed to evoke garden pavilions. These elements provide viewing platforms, places to host formal events, and moments of retreat in between. With intensive green roof covering the majority of the building the building grows out the landscape. The building participates in the landscape blending natural and built components. Grade changes and hills are blended with ramps, stairs, amphitheaters, and platforms blurring the line between built and natural environments.
The building circulation is organized along the north and east edges of the building footprint. By providing a single loaded circulation system, the building footprint can be narrowed while maintaining large undivided programmatic areas. This also energizes the spaces directly off the circulation routes more effectively by keeping the attention of visitors undivided. Building users are constantly arriving at new programmatic areas rather than passing between them.

The building’s main entrance is off the blast walk on the ground level and serves both wings of the building. From the main entrance public visitors proceed straight across the promenade walk affording a view of the tiers descending below and connecting to the gift shop. The promenade also connects to the building’s secondary entrance which reorients visitors to the fulcrum connection from Union Station to the Capitol through Upper Senate Park. Circulation through the west wing processes along the northern edge of the building descending at the edge of each successive platform level. Circulation to the east wing descends to the B2 level and crosses the bridge connection to the private wing. Both wings are served by elevators providing handicap accessibility as well as emergency egress stairs.

<table>
<thead>
<tr>
<th>9-11</th>
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<tbody>
<tr>
<td><strong>Plane Hijackings</strong> and pilotless crashes along the US Eastern Seaboard</td>
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<tr>
<td>- Perpetrated in response to US support of Israeli &amp; presence of US troops abroad</td>
</tr>
<tr>
<td>- Planes were crashed into the Pentagon, the North World Trade Center Tower, the South WTC Tower, &amp; a rural Pennsylvania field</td>
</tr>
<tr>
<td>- US response initiated a global war on terror &amp; toppled Afghanistans governement</td>
</tr>
</tbody>
</table>

3,000 killed, 6,000 injured
Building below grade introduces additional challenges in introducing natural light and providing sufficient ventilation. These challenges compound as the building area becomes less square and the deeper the building penetrates below grade.

The design sought to maximize the efficiency of slab penetrates by routing building circulation, natural lighting, and ventilation together as much as possible. These paired openings were organized along the north and east edges of the building footprint. This orientation maximizes the penetration of natural light washing down the building through the vertical voids required for circulation.

Additional skylights were provided in the center of the building above spaces that aren’t fully enclosed. This brightens the central open space, lends the building more of a light and open feeling, and allows greater light penetration throughout the building. An additional row of skylights were provided along the south edge of the building to provide natural light to the fully enclosed conference center.

The mechanical spaces were located towards the bottom and backs of the tiers, which would receive the least amount of natural light, yet still can have louvered access to the skylights as open air shafts.

Moscow Theater Hostage Crisis

- Hostage situation using mines, suicide vests, and guns at the House of Culture in Moscow, lasting for 3 days
- Perpetrated to demand the withdrawal of Russian troops from Chechnya
- The rescue attempted to use an anesthetic gas which, while it had a limited effect during the rescue, actually killed 120 of the rescued hostages itself.

Hostage Situation
125 Killed
900 Hostages Taken

January
February
March
April
May
June
July
August
September
October
November
December

67
68
The structural system of the building was developed observing construction techniques for excavation in urban centers around Washington DC. The predominant method observed utilized tieback excavation techniques, which maximizes available space in the excavated area. The structural design focused on resisting the lateral loads introduced by building below grade. Structural redundancy was introduced in the retaining walls by both maintaining the tie-back anchors as well as using the building floorplates themselves as cross bracing between the exterior walls. The columnar supports, particularly those around the perimeter aid in distributing the lateral load along the vertical depth of the building.

The lateral loads are reduced by the introduction of a double exterior wall system focused on relieving hydrostatic pressure. The outer wall is not treated to resist water penetration and allows the water through to the void between the exterior wythes. The penetrating water then can be treated and collected in the pool at the building’s lowest level or sloped to drain away from the building back into the earth.
APPENDIX: SELECTED PROCESS WORK
Full size installation built for the thesis defense of a "Blast Walk" representing the effects of a suitcase bombing
PARTIAL LISTING OF PROJECT RESEARCH REFERENCES:

BOOKS

INTERNET
LIST OF FIGURES

All figures not created by the Author have been used for educational purposes and are cited below. All other images have been created by the Author:

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FIGURE 2: Michelangelo Buonarroti’s Florentian Fortifications
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FIGURE 5: Inspirational suspension bridge image
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FIGURE 17: Deflagration Pressure Chart
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FIGURE 19: Blast Parameters for TNT Surface Bursts
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FIGURE 21: Adapted use/natural organic growth pattern simulating an elevated ground plane
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