**The Current State of the Practice:**
**A Look into the Protective Design Industry**

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## ABSTRACT

The protective design industry has to adapt to new threats and challenges facing the industry constantly. As a result, invested stakeholders within the industry must take a critical look at the current state of the practice. By assessing the current protective design industry, one can identify both challenges and opportunities within it and provide insight into how to improve the industry. This study aims to understand the current state of the protective design industry through an analysis of protective design literature and interviews with protective designers. Both academic literature (conference papers and journal articles) and design guidelines showcase the current trends and challenges within the industry. While understanding the protective designer's perception of their role help explain how protective designers engage within the design process with other design stakeholders. Together, both the literature and the people will dictate the current state of the protective design industry.  Lastly, this study has developed a database for protective design guidelines that both protective designers and other design stakeholders can utilize to search for a comprehensive database.

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## GENERAL AUDIENCE ABSTRACT

The 2001 September 11th attacks fundamentally changed the protective design industry. Not only did it take the lives of thousands of Americans, but it showcased a flaw in our national security. Designers and engineers had to rethink their perspectives on security and proceed to integrate more protective measures in both the private and commercial sectors of design. Now, nearly two decades later, there hasn't been a deadly attack to the scale of 9/11, but new threats are facing the protective design industry. Newer and more recurring threats such as mass shootings within the United States and vehicle attacks have become a significant threat. Because of these new threats facing the industry, it is appropriate to take a critical look at the challenges and trends in the protective design industry that need improvement. This study aims to understand the current state of the practice in the protective design industry by reviewing both the protective design literature and interviewing protective designers.

## ACKNOWLEDGEMENTS

This journey has not been easy, so it is only right that I thank all of the people who have helped me along the way. To start, I would like to thank my mother and my grandmother for pushing me every day to be the best person I can be. My mother and grandmother inspired me from a very young age to work hard, remain curious, and be a lifelong learner.

I am forever grateful for them!

I would also like to thank my graduate advisor, mentor, and friend Dr. Freddy Paige for the constant guidance and encouragement over the past six years since I have known him. Dr. Paige was one of the first people to introduce me to research as a freshman civil engineering major at Clemson University. Since then, he has continuously guided me along my research journey and provided me the necessary resources and motivation to be successful as a scholar and researcher.

This project would not have been possible without the assistance of Dr. Eric Jacques and Professor Kevin Jones. When I embarked on this journey, I was new to the protective design industry. Dr. Jacques provided me with the necessary resources to become a knowledgeable scholar of this industry and assisted with the interviews' advancement. Professor Jones constantly pushed me to become a better thinker, writer, and overall designer. His unique perspective as an architect provided the necessary balance within a committee full of engineers.

With that being said, this thesis's completion would not have been possible without their constant feedback and support.

I would also like to thank all the study participants for their time and effort in advancing the knowledge within the protective design industry. Their data helped shaped this thesis and added a valuable perspective of the industry.

Lastly, I would like to thank the rest of my family and friends who have always supported me in my endeavors. I love all of you, and I'm extremely grateful that you are in my life.

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# Chapter 1: Introduction

The protective design industry is tasked with evaluating and mitigating the risk that both natural and man-made threats impose upon products and services, infrastructures, and in the worst cases, human lives (FEMA 426 2003; McNamara, Fernandez, Nussbaum 2013; Nadel 1998). It is documented that before 1995, "minimum physical security standards did not exist for non-military federally owned or leased facilities (Department of Homeland Security 2020)." After the tragedy on September 11$^{th,}$ 2001, new security challenges surfaced regarding how the protective design industry would secure private and public infrastructure. The transition to securing private infrastructure required the protective design industry to develop new standards and guidelines for designing, educate new design stakeholders, and change traditional perceptions of the protective design industry. Now, nearly two decades since 9/11, the protective design industry is still not as widely established as wind or earthquake design, but it is still very critical that one understand the current state of the practice.

This thesis aims to answer two research questions: **1) What is the current state of the practice in the protective design industry,** and **2) How does the protective designer's role impact the design process?**

The thesis consists of seven chapters highlighting the current state of the practice in the protective design industry. After introducing the thesis, chapter 2 discusses the protective design industry and offers background knowledge on its design process. Chapter 3 describes the process for conducting the systematic literature review on both the academic and industry literature. Chapter 4 provides the framework for the creation of a comprehensive design database to house protective design guidelines and standards while also describing the process of visualizing the data using a network analysis. Chapter 5 will highlight how the literature dictates the current state of the practice for the industry through the use of a content analysis. The content analysis will highlight how the industry's progressed over the last 20 years, current trends, and challenges within the industry today. Chapter 6 contains a journal manuscript focusing on understanding the protective designers' perspective within the industry. The 14 protective designers interviewed for this study offered insight into how their role and engagement with stakeholders impact the design process. Chapter 1 and Chapter 7 consist of both the introduction and conclusion of the thesis.

# Chapter 2: What Is The Protective Design Industry?

## Introduction

The protective design industry has been increasingly changing since its integration into non-military federal facilities, state facilities, local facilities, private facilities after the Oklahoma City bombing and September 11th attacks. Before these events, federal military entities have been implementing protective measures throughout their facilities for decades. It is documented that before 1995, "minimum physical security standards did not exist for non-military federally owned or leased facilities (Department of Homeland Security 2020)." Then on April 19th, 1995, a terrorist truck bombed the Alfred P. Murrah Federal Building in Oklahoma City, Oklahoma, which signaled a change in the protective design industry. This event resulted in the creation of the Interagency Security Committee (ISC), a committee created to push for "government-wide security for federal facilities and offering guidance for protecting non-military federal facilities(Department of Homeland Security 2020)." Six years after the establishment of the ISC, the September 11th attacks signaled another expansion of the industry into the commercial and private sectors. Thus, significantly shifting the need for protective design incorporation in every sector of design.

The protective design industry was completely re-invented as a result of the September 11th attacks. Protective design professionals and concerned Americans identified the need for state, local, and private entities to redact sole responsibility for protecting their assets from the federal government. This extended the protective design field from strictly a military or federal practice but a societal effort in which all sectors take a level of responsibility for protecting themselves from terror. Before these attacks, terrorism was the federal government's responsibility, and there was little to no guidance/resources available to private entities (Bailes et al., 2004). The September 11th attacks highlight that threats can be unpredictable, and the federal government cannot ensure protection against all potential threats (Bailes et al. 2004). Therefore, both private, local, and state entities must work alongside the federal government, such as the ISC, in protecting assets from terror (Bailes et al., 2004). A statement released by The President's National Strategy for Homeland Security just four years after 9/11 stated that federal, state, and local levels must collaborate and partner with the private sector, since they control 85 percent of America's infrastructure (Busch and Givens 2012). With governmental support at all levels, the next step was to communicate protective design knowledge with the unfamiliar public-private sectors.

### What is Protective Design

Protective design can also be known as counter-terrorism design or anti-terrorism and security design. Depending on the setting, these three terms can be used interchangeably. They focus on securing assets within a building from potential threats. An asset is a valuable resource, tangible or intangible, that needs protection (FEMA 426, 2003). The U.S. Department of Homeland Security defines the protective design field as the ability to "assess threats/hazards, vulnerabilities, risks, and the design considerations needed to protect new and existing buildings and the people occupying them (FEMA 426, 2003: iii)." One central threat facing the protective design industry is explosions due to their destructive ability on a structure. Similar to explosions, other related threats that are of top priority within this field are weapons of mass destruction such as nuclear, biological, chemical, and radiological weapons (Bailes et al., 2004). As of late, active shootings within places of substantial congregation, such as movie theaters, schools, and nightclubs, have been a huge threat facing the industry (Lee 2013). The prevention of cyber-attacks continues to be a relevant issue related to the protection of intangible assets such as software and data (Longley 2019). However, these are only a few of the threats and tactics terrorists can use to target assets. In fact, there are several potential known and unknown threats that are available in a terrorist's arsenal. The stakeholders of the protective design process are responsible for identifying and containing these potential threats, knowing that it is not feasible to protect against all possible threats.

## Stakeholder Involvement

There are many direct and indirect stakeholders within the protective design process. To protect states, countries, and the world from terror involves collaboration between these two types of stakeholders. In most cases, the direct stakeholders make up a security planning team (Dalton, Gott, Parker, Moy, 2008). A security planning team consists of an owner/owners, security personnel and specialist, logistics, architects, and engineers [structural, civil, mechanical, electrical, and plumbing] (Coole et al. 2015; NAVFAC 1993). On the other hand, the list of potential indirect stakeholders is everyone else that works outside the protective design process or will interact with the project during its life cycle. This includes other working technical industries, end-users, and emergency users such as police officials, firefighters, and medics. The research team differentiates between direct and indirect stakeholders based on their involvement in the design process and the ability to make impactful decisions related to the project.

Because there are numerous indirect stakeholders, the direct stakeholders have difficulty accomplishing their task of mitigating security risk. The team of direct stakeholders has the responsibility "to consider how security fits into the total project's design (Dalton, Gott, Parker, Moy, 2008: 3–2)." Completing this task is far from easy due to the number of potential user constraints affecting a project. Identifying user constraints is part of the existing design process; however, end-users needs and wants change over time, thus creating uncertainty during initial assessments. In addition, it is a challenge to mitigate how security will impact all other aspects of a project unless there is an understanding of synergy for the necessary needs of particular indirect stakeholders.

## The Use of Protective Design Guidelines and Standards

In a collaborative effort, federal, state, local, and private entities created guidelines and standards to communicate the protective design knowledge attained by the U.S. military over the years. Due to national security concerns within federally-funded projects, more prescriptive protective measures are required than on private sector projects. The strict protective measures that exist when working on federally-funded projects help ensure that all federal projects have a baseline or standard of security. The creation of this standard of security has its benefits from a logistical point of view; however, it takes away some of the creativity from protective designers to create a more optimal solution.

Most existing standards and guidelines for protective design were created by and for the U.S. military; however, over time, the information was selectively adapted to non-military and private sector entities (Haynes et al., 2005). In 2003, the U.S. Department of Homeland Security created a series of Federal Emergency Management Agency (FEMA) anti-terrorism guidelines to provide guidance directly to the private sector (FEMA 426, 2003). Unlike the FEMA guidelines, the United Facilities Criteria (UFC) protective guidelines were created to influence federal projects specifically within the Department of the Defense (Dalton, Gott, Parker, Moy, 2008). Throughout both guidelines, the description of the design process and suggestive measures are very similar. In fact, information within the FEMA guidelines is directly referenced from standards established in the UFC guidelines. With that being said, in the FEMA guidelines (private sector guides), it is clearly stated that "the information contained in this document is: not mandatory," therefore, the private sector is not being forced to partake in these measures. On the other hand, the UFC standards (Federal sector guides) are mandatory and serve as the minimum requirement for Department of Defense projects (FEMA 426, 2003: ii).

## Protective Design Process

The process for protective design may vary slightly depending on whether the project is public or private. The military, federal, state, local, and private entities process are not exactly identical; however, four main components are central in all areas: assets, threats, level of protection, and constraints. Together these four components make up the basis for design or the design criteria (Dalton, Gott, Parker, Moy, 2008). The design criteria are used for "defining a protective system that mitigates vulnerabilities to assets (Dalton, Gott, Parker, Moy, 2008: 3-2)." The criteria identify and describe the assets associated with the project while also highlighting any potential threats to those assets. Next, in the process, a level of protection is established based upon the assets and potential threats while considering any constraints affecting the project (Dalton, Gott, Parker, Moy, 2008). The criteria are usually developed during the pre-stages of a project's design process alongside the clients and all the direct stakeholders. Once the criteria are set, they can change during the duration of the project. Protective designers use risk management and analysis to aid in the process of developing the design criteria (Dalton, Gott, Parker, Moy, 2008).

## Levels of Protection

Levels of protection are based on the value of an asset to its users and the degree needed to protect against potential threats (Dalton, Gott, Parker, Moy 2008). The owner is likely to select a level of protection, accounting for both their assets and threats. Then it is the design team's task to meet that standard by employing various protective measures throughout the project. It is important to note that the level of protection for a project may change based on the continuous variability of threats. For example, a design team can initially design for a low level of protection, and then additional security concerns unveil during the operation of the project. The owner may now decide to select a higher level of protection to satisfy the new threats. Table 1 highlights the four distinct levels of protection for a building according to the Protective Design Center.

| Table 1: Description of Levels of Protective Based on Structural Damage | |
|---|---|
| **Level of Protection** | **Description of Potential Structural Damage** (McCallister, Gott, Balkus, McAndrew 2018) |
| *Very Low* | Heavy Damage: Onset of structural collapse. Progressive collapse is unlikely. Space in and around the damaged area is unusable. |
| *Low* | Unrepairable Damage: Progressive collapse will not occur. Space in and around the damaged area is unusable |
| *Medium* | Repairable Damage: Space in and around the damaged area can be used and is fully functional after cleanup and repairs. |
| *High* | Superficial Damage: No permanent deformations. The facility is immediately operable. |

## Constraints

Constraints are a normal part of the design process, but at times they can be challenging to overcome. Some of the design objectives by direct stakeholders involved within the design process can compete with the security objectives established by the protective designer. Some of the main constraints stem from the struggle between competing interests, resources, and technical backgrounds.

Protective design, similar to other design fields, can become very expensive if it is not encouraged as early as possible within the project pre-design stages. In the UFC 4-010-01 manual, experts highlight the increasing linear relationship with time and cost when a client decides to wait to engage in protective design concerns in a project (McCallister, Gott, Balkus, McAndrew 2018; McNamara, Fernandez, Nussbaum 2013). Implementation of protective measures are least expensive when incorporated within early construction or at other times of change through a building's life cycle such as major renovation and restorations (McCallister, Gott, Balkus, McAndrew, 2018: 13). FEMA guidelines suggest the design criteria should be agreed upon "at the earliest stages of design, no later than preliminary design," because this is where protective measures will be the "least costly and most easily implemented (FEMA 426, 2003: 2-1)."

Outside of cost, other constraints exist within the backgrounds of sustainability, historical preservations, aesthetics, as well as overall function or operation of the project. For example, ideal fire safety evacuation procedures enable occupants to exit a building as quickly and safely as possible (Leonard et al., 2017). It also allows firefighters the ability to access a building easily and control the flame in the safest way possible (Leonard et al., 2017). Granted, this is not always the case for the firefighters due to protective design measures. These measures could undermine the ability of firefighters to gain access to a burning building effectively and undermine the ability of occupants to exit the building quickly and safely.

# Chapter 3: Comprehensive Review of the Protective Design Literature

The comprehensive review of the protective design industry was conducted to inquire how the literature has dictated the current state of practice. The comprehensive literature review used for this study mimicked a systematic literature review, with one of the main distinctions being that one sole investigator conducted the review. Typically, systematic literature reviews are conducted by a team of researchers to help make decisions regarding literature to include or exclude within the search (V.T.).

The literature review of both academic and industry design documents serves two purposes for this study. The first is to answer the research question: What is the current state of the practice in the protective design industry? Secondly, to offer additional knowledge to the investigators as they conduct expert interviews on protective designers in chapter 6 of the thesis.

## Data Collection

The research team conducted a comprehensive review of the protective design academic literature (journal articles and conference papers) using Engineering Village databases. Engineering Village contains over 12 academic databases providing enough breadth and depth of the protective design industry. The Engineering Village database was also selected because it organizes and compiles its literature so that the bibliometrics can be represented visually. For example, the Engineering Village databases can visualize a search conducted on published literature for a topic over time as a line graph.

The research team was able to locate the protective design literature on the databases by creating a list of keywords associated with the protective design industry and then locating the literature using the Engineering Village search feature. Throughout the entirety of the study, the list of keywords was iterated and optimized to ensure the articles generated from the search pertained strictly protective design knowledge. As of April 15, 2021, over 3000 conference papers and journal articles were collected using Compendex, Inspec, NTIS, and Knovel databases within Engineering Village. The keyword list was created based on the investigators' existing knowledge of the protective design industry and existing keywords represented in other prominent protective design literature. Table 2 represents the list of keywords used for the Engineering Village search with Boolean operators included.

All of the documents found were then stored in the management software, Zotero. Zotero allowed the investigators to store all of the relevant bibliometric data, which could be used to visualize the progression of the literature through time.

| Table 2: List of Keywords from Engineering Village Search Results | |
|---|---|
| Keyword Search String | "Terrorism Bombing" OR "Terror Attacks" OR "terrorist attacks" OR "terrorism" or "terrorist" or "terror" or "extremism" or "secure design" or "protective design" or "counterterrorism" or “progressive collapse” or "Anti-RAM" or "Vehicle Impact“ or “Vehicle Mitigation” or "AntiRam" or “Bollard” or “Bollards” or “Active Shooter” or “Force Entry” |

The industry-specific design documents and guidelines were collected using a multitude of online security databases such as the DoD, DHS, National Institute of Building Science, and Whole Building Design Guide. The team then selected 12 available design documents based on their experience within the industry to conduct the content analysis. Aside from their use of the content analysis, the design documents were also used to influence the interview process detailed within chapter 6 of the thesis. The documents were then stored within a managing software such as Zotero in preparation for analysis. Because the process of locating industry-specific documents and guidelines was more complicated than with the academic literature, the team decided to create a database so that protective design documents can be more easily accessible to everyone. Creating an industry design document database will allow protective designers and all interested stakeholders to easily find information related to the protective industry.

## Results

After gathering all the academic literature spanning from 1990- 2018, the investigators were able to showcase the study's significance through figure 1. Figure 1 highlights the role 9/11 had in the emergence of the modern protective design industry. The figure also shows the absence of an upward or downward trend in the last decade based on published academic literature. Since the published academic literature does not showcase a trend within the last decade, a thorough investigation of both the academic and industry governing literature would aid in identifying a trend.

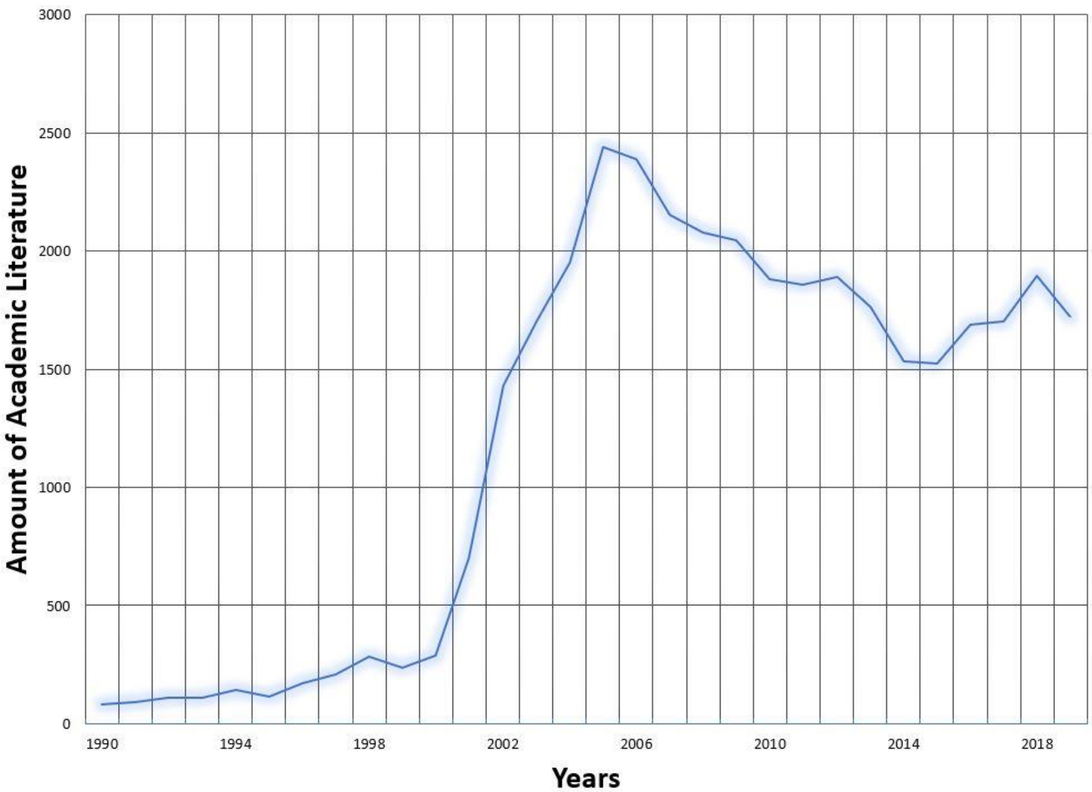


Figure 1: Published Protective Design Academic Literature (1990-2018)

# Chapter 4: Network Analysis & Database Development

A network analysis was conducted within this study to model relationships among the protective design documents and guidelines compiled in the database. Network analyses are useful tools to model relationships, summarize data, and represent constructs and concepts visually (Chu et al. 2013). This tool has been used effectively within a variety of fields ranging from healthcare research to social media networks on platforms such as Twitter, Facebook, and LinkedIn. Commonly known academic search databases such as SCOPUS use network analysis techniques for collecting bibliometrics data on its literature, i.e., citation count, citation impact factor, and citation mapping. Bibliometrics data can be useful for researchers and academics conducting comprehensive literature analyses by making the relevant information about the literature easily accessible. The bibliometric data collected for the design documents, guidelines, standards, and manuals are established below.

- Citations
- Purpose
- Publisher
- Published Year
- Code Name
- Country
- Availability of Document
- Design Area

The research team used their existing knowledge of the protective design industry and other academic databases such as SCOPUS to decide what data would be useful in creating the database. Currently, the existing database of protective design documents has amassed over 300 documents and counting. As the study continues to add and update the existing database, the research team must find an accessible location to house the database for all design stakeholders to use. The research team used the design documents collected in the database to track and map the most heavily cited documents from the data set. The network analysis used the bibliometric data gathered within the database to create an existing literature network.

Suppose the research team could gather all of the governing design documents within the industry, then they could conclude the most significant documents in the industry based on characteristics from the network analysis. One hypothesis that the research team inquired about was that the most heavily cited design documents would be the most significant document in the industry. As a sample for this study, the research team created a network analysis of the 12 documents selected for the content analysis.

The research team selected to use Gephi software version 8.2 to complete the network analysis. This tool was selected due to its ability to visually extract useful knowledge within a complex network while having an easy-to-use interface (Chu et al. 2013). Using the Gephi tool, the investigators differentiated between various documents using graphical properties such as size and color gradients (Bastian et al. 2009). Gephi's interface does not require any coding experience to input the necessary input data to establish the documents' relationships. The team compiled each design document and its relationships within two separate Excel CSV files, which were later inputted directly into the Gephi software. Gephi is also easily accessible to use. It is an open-source network analysis software compatible with Windows and Mac computers (Chu et al. 2013).

## Collection and Compilation Process

**There are two excel files used to create the network analysis: Nodes and Edges.**

The nodes file focused on tabulating the protective design documents and guidelines as they were found using the online resources. The following details below represented the nine columns for each design document within the nodes files and the database.

| Table 3: Bibliometric Data Compiled in the Protective Databases and Nodes File | |
|---|---|
| Document ID | Unique ID to each reference, literature found online. |
| Label | Name of the reference as published. |
| Publisher | Name of the entity which produced the document. |
| Publisher Year | Year of the original publication |
| Code Name | Shorten name for a specific document |
| Availability | Is the document available to the public? |
| Country | What country were the document publications in? |
| Design Area | The specific design area of protective design |
| Purpose | Why was the document created? |

**Process for creating the Nodes File:**

- Locate the document within Zotero (This study only focused on 12 documents for the content analysis.
- Go to the reference list of the document and locate if the references in the document are already a part of the NODES excel file or the original 12 documents.
    - If not, add the reference to the excel file, with all the details required, ensuring a document I.D. is allocated to it. If, in any case, there are missing details, make a note of them in the excel file.
    - If yes, make sure the details in the excel file are completed and are correct.

**Process for creating the Edges File:**

- The document I.D. column detailed in the Nodes file was extrapolated to the Edges file.
- There are two columns that make up the Edges File, "Source" and "Target."
- The Edges file only identifies each document by its document I.D. number.
- When going through the references of a document, add the referred document I.D. to the Target column. after adding them to the Node excel file
    - For e.g., While going through the document, if a new document that was not a part of the Node file was found, it will be given a new I.D. number (for e.g., 45). In this

scenario, if you are reviewing document I.D. #3 and a new reference appears, add 3 to the source column and 45 (or the next available number in the list) in the target column.

Table 4: The 12 Documents Selected for the Network Analysis

| | Guidelines | Publisher | Year |
|---|---|---|---|
| 1 | Reference Manual to Mitigate Potential Terrorist Attacks Against Buildings | US Department of Homeland Security (DHS) & Federal Emergency Management Agency (FEMA) | 2003 |
| 2 | Primer for Design of Commercial Building to Mitigate Terrorist Attacks | US Department of Homeland Security (DHS) & Federal Emergency Management Agency (FEMA) | 2003 |
| 3 | Site and Urban Design for Security: Guidance Against Potential Terrorist Attacks Against Buildings | US Department of Homeland Security (DHS) & Federal Emergency Management Agency (FEMA) | 2007 |
| 4 | DoD Minimum Antiterrorism Standards for Buildings | U.S. DEPARTMENT OF DEFENSE, UNIFIED FACILITIES CRITERIA PROGRAM | 2002 |
| 5 | Blast Protection of Buildings | American Society of Civil Engineers | 2011 |
| 6 | Risk Assessment: A How-To Guide to Mitigate Potential Terrorist Attacks Against Buildings | US Department of Homeland Security (DHS) & Federal Emergency Management Agency (FEMA) | 2005 |
| 7 | Incremental Protection for Existing Commercial Buildings from Terrorist Attack | US Department of Homeland Security (DHS) & Federal Emergency Management Agency (FEMA) | 2008 |
| 8 | GSA Alternate Path Analysis and Design Guidelines for Progressive Collapse Resistance | General Services Administration (GSA) | 2013 |
| 9 | Security Engineering: Physical Security Measures for High-Risk Personnel | U.S. DEPARTMENT OF DEFENSE, UNIFIED FACILITIES CRITERIA PROGRAM | 2011 |
| 10 | Chemical, Biological, Radiological Incident Handbook | Central Intelligence Agency | 1998 |
| 11 | DoD Security Engineering Facilities Planning Manual | U.S. DEPARTMENT OF DEFENSE, UNIFIED FACILITIES CRITERIA PROGRAM | 2008 |
| 12 | Guidance for Protecting Building Environments from Airborne Chemical, Biological, or Radiological Attacks | Centers for Disease Control and Prevention/National Institute for Occupational Safety and Health | 2002 |

## Results

The research team used modularity to measure how densely connected each cluster of documents were connected within the total system. Outside of simply referencing each document to each other, quantitatively measuring how flea connected to the documents would allow the investigators to justify their visual conclusions.

Modularity is simply a way to measure how densely connected a cluster or compartment is within a system (Kharrazi 2019). Typically, highly connected systems would result in a lower level of modularity. This concept and framework can be utilized in many industries dealing with vulnerable systems that develop a network. Based on these 12 documents analyzed, the system resulted in a modularity of .565 out of the 57 communities registered in the Gephi software.

Understanding the degree of connectedness as well as how each document is reference helps interested design stakeholders navigate protect design information.

Figure 2 showcases the complete network analysis for the 12 documents used within the study. Each number above the nodes coincides with the document I.D. referenced on the table aches above. Each cluster's colors result from the degree of modularity and its impact on the total system.

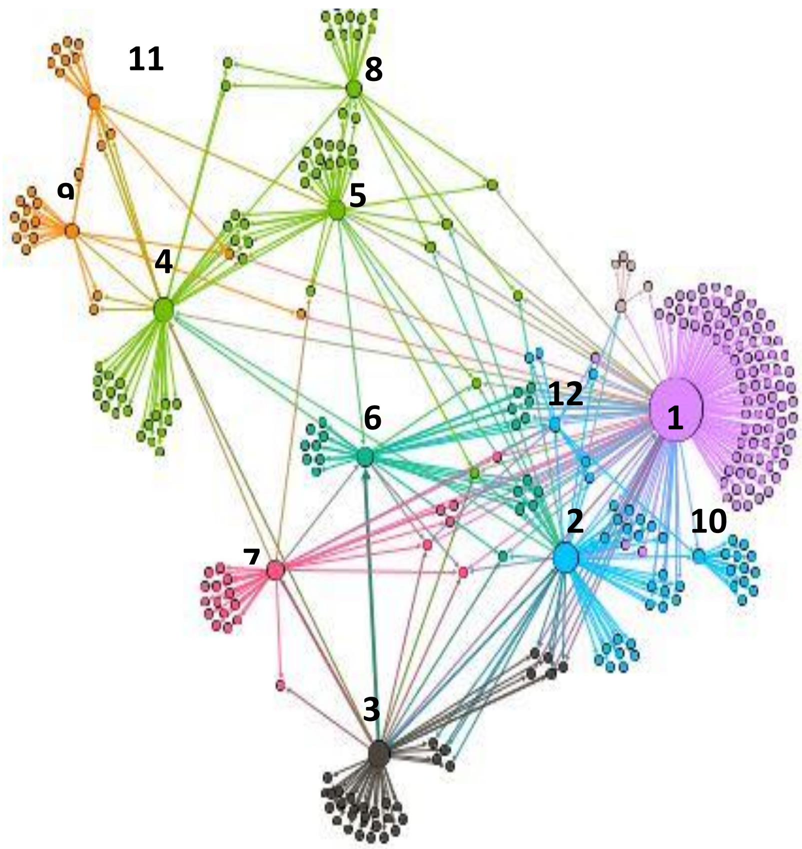


Figure 2: Network Analysis of Protective Design Governing Documents

# Chapter 5: Content Analysis

The content analysis provides critical insight from academic literature and industry design documents related to understanding the current state of the practice in the protective design industry.

For my study, I have selected to use a qualitative content analysis with similarities to that of the summative approach. I will not be explicitly counting any elements of the text but rather comparing design documents to one another. For the 5-10 heavily cited documents from my network analysis, I will extract specific design elements for my content analysis. Bowen (2009) elaborates on how a document or content analysis provides a "systematic procedure" to review and evaluate various forms of documents (Bowen 2009 p. 27). These design elements that I will extract will aid in the process of establishing the current state of the art in the industry.

For my study, I have selected to conduct a content analysis to understand the social and technical realities which frame the current state of the art in the industry by navigating selected design text through the design documents. A content analysis is a communication tool and research method for "making replicable and valid inferences from data to their context" text is the main source of data for content analysis ranging from verbal communication, written documents, and visuals (Krippendorff 1989; Krippendorff 1998 p. 403). Researchers use this method with the intended goal "to provide knowledge and understanding" to a particular topic being investigated (Hsieh and Shannon 2005 p. 1278). In the context of this study, the topic being investigated is the current state of the art in the protective design industry.

There are two different types of content analysis:

1. **Quantitative Content Analysis**- An "empirical method for systematic analysis of well-defined, audio, textual, visual and/or audiovisual media content (Bock et al. 2020)."
2. **Qualitative Content Analysis-** "A method for systematically describing the meaning of qualitative data by assigning successive parts of the material to the categories of a coding frame (Schreier 2020)."

A qualitative content analysis will highlight the unique social and technical qualities which make up the protective design industry, therefore being an ideal technique rather than conducting a quantitative content analysis. In addition, based on a qualitative content analysis ability to be systematic yet flexible and reduce data makes it ideal for analyzing the complete dataset (Schreier, 2014). The qualitative content analysis's flexibility and its ability to reduce data allow me to focus on selected aspects of the entire dataset.

There are three different approaches to qualitative content analysis based on coding schemes and the origins of codes (Hsieh and Shannon, 2005):

1. **Conventional Approach**- A conventional approach towards a qualitative content analysis means the coding categories are derived directly from the data.

2. **Directed Approach**- A directed approach towards a qualitative content analysis means the analysis process begins with prior theory or research findings, and they serve as guidance for initial codes.

3. **Summative Approach-** A summative approach towards a qualitative content analysis means the analysis process involves "counting and comparison" of content similar to that of a quantitative content analysis; however, in a summative approach, the process ends with the interpretation of the underlying context.

The content analysis is a significant piece of the study because it will allow the research team to understand how protective design information is being cited from one document to another and offer a microscopic view of the current and emergent trends within the industry. The process to conduct the content analysis was very similar to that of the conventional approach described with Hsieh and Shannon (2005) method above. The research team analyzed each document by highlighting relevant trends and themes from the documents using a qualitative coding software.

## Results

The protective design industry is a reaction-based industry. The comprehensive literature review conducted on the published literature showcased a huge surge in publications and academic research in industry post 9/11, shown in Figure 1. This trend was not only found in the comprehensive literature review, but it was also relevant as to how the document discussed the event of 9/11.

**Federal Emergency Management Agency Statement (FEMA 426 2003)**

> *Since September 11, 2001, terrorism has become a dominant domestic concern. Security can no longer be viewed as a standalone capability that can be purchased as an afterthought and then put in place. Life, safety, and security issues must become a design goal from the beginning.*

**American Society Civil Engineering Statement (American Society of Civil Engineers 2011)**

> *This is the first edition of this standard. Its need had been identified in advance of the events of September 11, 2001... In the months following SEI's announcement that a committee would be formed to prepare this standard, numerous experts stepped forward to volunteer for the effort. Hence, this standard represents approximately ten years of dedicated work by a knowledgeable committee.*

The protective design industry being reaction-based is a very common trait for many industries, especially after a catastrophic event. However, in the most recent decade, the protective design industry has not shown any significant trend or pattern since the 9/11 surge. Even though there have not been any significant events to the scale of 9/11 since 2001, other significant events have happened across the nation, and the impact on the industry isn't clear. Some of the preliminary results from the content analysis help shed light on the current state of the practice in the protective design industry.

Even though more work is needed to complete the content analysis on the 12 documents, the preliminary findings speak to the current trends in the industry. The themes showcase that active shootings, vehicle mitigation, and accidental explosions have been recent trends within the protective design industry, and they are areas of interest moving into the future. Particularly when it comes to active shooters in the United States, finding ways to protective civilians has been a significant issue within the past two decades. This research shows that the protective design industry is taking steps to address the issue of active shootings in the US and what type of guidance is needed.

The results from the study have showcased some of the trends that help answer, what's the current state of the practice in the protective design industry. As the database continues to build and more documents are added to the network analysis, the research team will be able to dissect the information that's being cited from one document to another and track the evolution of protective design over the next decade.

# Chapter 6

## Opportunities and Challenges Impacting the Design Process:

### *Investigating the Role of a Protective Designer*

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## Abstract

This paper provides pragmatic evidence on the role protective designers fulfill in mitigating and evaluating security risks. Protective designers are a highly specialized group of design professionals who must be better understood in the design community. Similar to other specialized design service providers, the effectiveness of a protective designer is limited by their ability to communicate their specialized design knowledge, collaborate with design stakeholders, and facilitate both the creation and implementation of a design solution. Due to the growing need for protective designers post 9/11, it is important to increase awareness of how the protective designer's role impacts the design process to minimize the negative impact of fictitious perceptions. By analyzing interviews with expert protective designers, opportunities and challenges have been identified, impacting the design process. The findings from this exploratory analysis connect back to issues faced by other design professionals. Protective designers will benefit from better processes to aid in developing a shared understanding among design stakeholders, overcome restrictions to knowledge sharing, and incentivize early collaboration to minimize the impact of competing design objectives.

**Highlights**

- Protective designers perceive that the role of a "protective designer" within the design process is misinterpreted.
- The protective design industry's environment restricts knowledge sharing within design sectors and among design stakeholders
- Early involvement and collaboration by protective designers can minimize competing design objectives and benefit all design stakeholders

## Introduction

**The protective designer is expected to be able to evaluate and mitigate the risk that threats impose upon products and services, infrastructure, and human lives** (FEMA 426 2003; McNamara, Fernandez, Nussbaum 2013; Nadel 1998). As a part of a protective designers' role, they use their knowledge of engineering design paired with physical, technological, and operational security measures to create effective solutions to deter, detect, deny, and devalue potential threats (FEMA 426 2003; Grosskopf 2006). In many cases, protective designers engage with ill-defined problems which require solutions for threats that have a relatively small probability of occurrence. The occurrence of low probability events that leave a path of death and destruction has influenced life and safety standards to protect from the unexpected. The Oklahoma City Bombings of 1995 and the September 11th Attacks of 2001 are man-made tragedies that have drastically changed the approach to designing the built environment. Both events signaled the need for additional design guidance and processes for the protection of public and private infrastructure (McNamara, Fernandez, Nussbaum 2013).

**Protective design is a performance-based, co-creation design industry**. Outside of the minimum life safety and building codes required for all projects, the building owners or client specifies their additional security and safety needs (Nadel 2003; Stevens et al. 2011; Thompson and Bank 2007). There are no mandatory security codes specifically for protective design, but there are recommended best practices within protective design guidelines and standards. Protective designers have the flexibility to negotiate various design objectives to achieve the owner's ideal level of protection. Selecting a level of protection can be very challenging for design stakeholders because many security design objectives can compete with other objectives such as sustainability, functionality, accessibility, and the cost of the project (Oberle et al. 2005). Depending on design stakeholders' perceptions of protective designers or their need for protective measures will dictate the outcome of the design solution.

Protective designers use a vast array of agency standards, guidelines, recommendations, and best practices to govern their design processes (FEMA 426 2003). Typically, protective designers have a background in site and layout design, building design, building envelope systems or operational security. Protective designers evaluate and mitigate risk by identifying threats and the potential consequences during the design process (Coole et al. 2015; McCallister, Gott, Balkus, McAndrew 2018). Some of the prominent measures that protective designers focus on are planning and coordination, information control, access control, site layout, and structural hardening (U.S. Department of Transportation 2017). The protective designers use these protective measures in collaboration with other design stakeholders to create what they perceive to be a holistic solution. However, this is not a straightforward task because the protective designer's perceptions of a holistic design solution may differ from that of the client, architect, or any other design stakeholder involved in the design process; therefore, having a shared understanding among design stakeholders is critical.

**This paper aims to identify opportunities and challenges in how the protective designer's role impacts the design process and offer recommendations to the broader design community.** Because the protective design industry is a niche profession, the role of a protective designer is susceptible to being misunderstood (Björklund et al. 2020). An increased understanding of protective designers' role will help other design stakeholders when working with protective designers. To better understand a protective designer's role and its impact on the design process, the research team conducted a series of semi-structured interviews with protective designers. The interviews explored the protective designer's perceptions of their role within the design process and engagement with design stakeholders. For data analysis, the team developed a two-cycle coding process to highlight salient themes showcasing potential challenges or opportunities in the design process. The themes emerged from the interview data and were linked to engineering design theories on high-performing teams and stakeholders' engagement in the design process. This study's findings are targeted recommendations for the protective design industry and protective designers, but any design stakeholder seeking to incorporate protective measures on their projects will find value in this study.

## Roles of Designer: Collaboration, Communication, Facilitation

Designers use characteristics of design thinking to develop their solutions. Luka (2014), Johansson and Woodilla (2009) describes design thinking as a way of reasoning or the way designers think. In a later study, Baeck A., & Gremett P. (2012) extracted nine distinct design thinking characteristics which designers experience when designing: ambiguity, collaboration, constructiveness, curiosity, empathy, holism, iteration, non-judgmental way, and openness. Designers use a combination of these characteristics to approach a problem when engaging in the design process. How designers think and approach problems within a given industry can influence their roles as a designer in the design process.

A designer's role is to solve problems by effectively communicating, collaborating, and facilitating their design knowledge and ability to stakeholders on the design team. Designers work alongside a team of multi-disciplinary stakeholders and clients to negotiate design decisions (Dym et al. 2005). The role of a designer requires an individual to be an effective communicator that can transfer their knowledge to design stakeholders clearly and concisely (Howard and Melles 2011). Being an effective communicator goes both ways because the designer must communicate their knowledge to design stakeholders on the team while also listening to the other design stakeholders' expertise. Effective communication is the foundation for collaboration among a design team. Ideally, a design team with effective communication and collaboration will reach a shared understanding to achieve a more holistic design solution (Dong 2005). To bring the team's vision to life, the designers facilitate their design resources and implement their solutions throughout the project.

The ability to effectively share knowledge between design stakeholders can impact the design team's performance. Designers and other design stakeholders rely on knowledge to fuel decision-making in the design process. Ahmed-Kristensen et al (2005) explain that knowledge is generated through observations and experiences, interpretations of data and information, or a combination of various pieces of knowledge. In the context of engineering design, knowledge can be classified as explicit knowledge or tacit knowledge (Skyrme, David J. 1997). Regardless of how knowledge is generated, exchanging knowledge between design stakeholders improves their ability to develop a shared understanding of the problem and address it.

A designer's role is to lead the collaborative effort on the design team by constructing an environment that promotes productive negotiations and discussions related to the design. Collaboration occurs when the design stakeholders are "thinking together" rather than just exchanging knowledge (Larsson 2003 p. 159). Collaboration is based on the establishment of a shared understanding within the design team (Larsson 2003). Previous literature has highlighted that developing a shared understanding or vision for a design team can increase knowledge sharing amongst design stakeholders and promote an environment for asking questions, which is a prerequisite for healthy collaboration (Cash et al. 2020; Stempfle and Badke-Schaub 2002). The design team's ability to collaborate indicates the team's level of communication and overall team success.

Facilitation allows for the successful integration of the various expertise on a design team (Aguirre et al. 2017). Due to the complexity of engineering design problems, they require many disciplines to collaborate and share their knowledge to achieve a sought-after solution. Traditionally, the designer is skilled in the art of designing generally or for a specific discipline; however, they are responsible for ensuring their expertise is implemented into the right aspects of the design (Golsby-Smith 2007). Through facilitation, the designer is to aid in the collaborative effort to effectively communicate with design stakeholders in an environment open for sharing (Howard and Melles 2011).

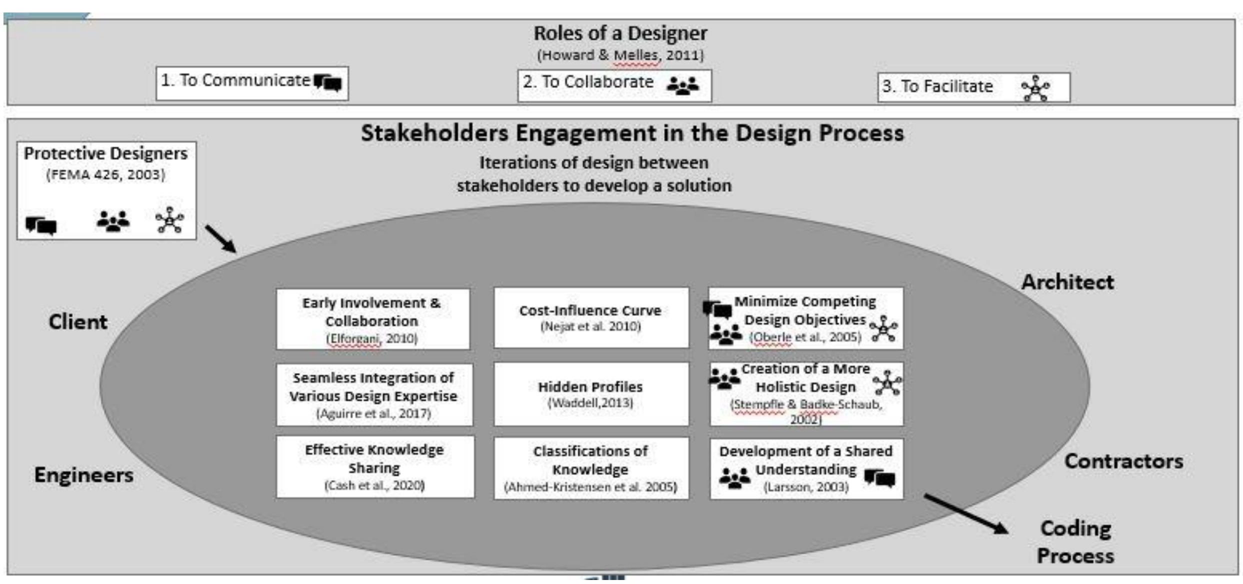

*Figure 3: The Impact of a Protective Designer's Role on the Design Process*

## Designing in the Protective Design Industry

Variability in the protective design process requires effective communication to transfer knowledge between stakeholders. Effective communication is an important role for all designers, but in the protective design process, the protective designer must use the aspect of their role to identify the owner's needs appropriately during the assessment process. The protective designers derive the necessary parameters for a particular project by undertaking asset, threat, vulnerability, and risk assessments. These assessments help achieve a sought-after level of protection through implementing protective measures (FEMA 426 2003; McCallister, Gott, Balkus, McAndrew 2018). The protective designer relies on the client's perceived value of their assets to agree on an acceptable risk level. A protective designer must effectively transfer all of this information to design stakeholders, so the client can make a rational and informed decision for a proposed solution (Nadel 2003).

Collaboration between protective designers and design stakeholders helps to mitigate competing design objectives in the design process and the development of an optimal solution. Most projects will have competing design objectives, which will require a level of collaboration to implement the necessary negotiations to achieve a sought-after balance. Because the protective design industry is not as widely established as wind or earthquake design, some design stakeholders may not be familiar with the specific design objectives, elements, or necessary negotiations that are needed within the industry. Through collaboration, the design team has an open learning environment to constructively share ideas to better the design.

Designing within the protective design industry requires the protective designer to facilitate the implementation of the protective design guidelines and measures throughout the design process. Protective designers facilitate the implementation of the protective design guidelines to ensure the design team uses the most recent and best available resources. Using the governance from protective design guidelines, protective designers can effectively communicate their expertise and collaborate with the rest of the design team (Dalton, Gott, Parker, Moy 2008). The protective designers also facilitate the implementation and construction of protective measures into the project to ensure all measures are constructed in their intended design.

## Methods

Interviews were selected to understand protective designers' perceptions of their role within the design process. The interview data collected were transcribed and coded to highlight opportunities and challenges based on the protective designers' role. The in vivo and focused coding methods were used for data analysis to showcase the protective designers' words and thoughts, explaining their perceptions and highlighting significant themes related to engineering design theory. Data analysis was not done alone; to maintain credibility within the codes, the research team participated in an interrater reliability process. The following section will provide a detailed description of these techniques.

### Semi-Structured Interviews

Semi-structured interviews were performed to explore the protective designer's perceptions of their role within the design process and engagement with design stakeholders. The investigators selected semi-structured interviews to maintain control over the interview process while allowing flexibility within the participants' responses (Given 2008). William Adams, an experienced qualitative researcher, highlights that semi-structured interviews are advantageous for examining underexplored areas that may contain potential problems or issues which need addressing (Adams, 2015). He also explains that semi-structured interviews give the participants maximum freedom to identify useful leads and discuss them (Adams 2015). Furthermore, semi-structured interviews can complement other methods and approaches, such as comprehensive and systematic literature reviews. On the other hand, Adams identifies the process of conducting semi-structured interviews as "time-consuming" and "labor-intensive" because of the huge task of coding and analyzing transcripts (Adams 2015 p. 494). For this study, semi-structured interviews explore the protective designers' perceptions of their role on the design process and the protective design industry.

## Pilot Study

A pilot study was performed to strengthen and modify the initial interview protocol to solidify the direction of the study. Castillo-Montoya and Majid et al. (2016; 2017) elaborates on how piloting interview questions helps identify potential flaws or limitations located within the interview protocol. Van Teijlingen and Hundley (2002) suggest that piloting interviews can address practical issues or liabilities within the study, resulting in a complete study redesign. The first set of interview questions were created using existing literature related to form vs. function in building design, design education and approaches, and governing protective design industry documents. Because these questions would be piloted, they were created to remain very broad and explorative. **The initial interview protocol is available in Appendix A.**

For the pilot study, the investigators were sampled and selected to interview four protective designers. The investigators used the four participants to help solidify how participants would be sampled and selected moving forward. The interviews were conducted using videoconferencing software to record the participants' responses. All interviews were held to a 30-45-minute time limit unless all parties agreed to continue the interview after time expired. Each interview recorded was then transcribed and compiled within a team drive for analysis. After completing and transcribing the four interviews, the investigators coded the data for themes using the process established for the main portion of the study (Majid et al. 2017). In addition, when searching for themes, the investigators looked for ways to improve upon the existing protocol. This study followed the outlined steps within Majid et al. (2017) to pilot the interview questions on the first four participants, as shown in Figure 2.

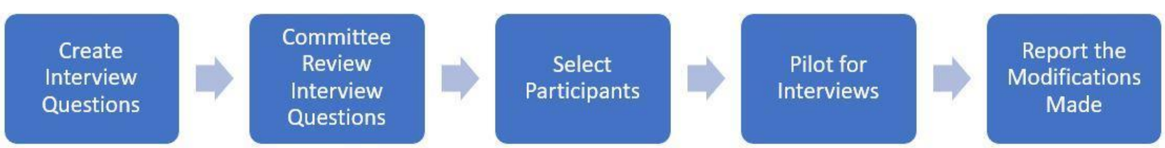


*Figure 4: Process map for Pilot Study*

## Main Study

The pilot study results were used to refine the interview protocol by adding demographic interview questions, clarifying existing questions, and a regrouping of the interview questions in conversational order. Demographic interview questions were added to the interview protocol to see if the protective designers' characteristics established any patterns with their perceptions of their role. The demographic questions provided additional context to participants' responses related to the participants' experience level, roles, responsibilities, and projects they have worked on. Additionally, the investigators added supplemental interview questions to provide clarity on certain questions that needed more explanation. Lastly, the investigators regrouped the interview questions into two categories: "The Current State of the Practice" and "Protective Design Education." These categories were created based on the pilot data collected and the natural conversation order of the interviews. **The existing modified interview protocol can be viewed within Appendix B.**

Purposeful, convenient, and snowball sampling techniques were used to selecting participants for the main study(MacNealy 1999).

1. Purposeful Sampling is identifying a portion of the population that has characteristics imperative to answer questions related to one's research question/s or the topic of study.
2. Convenient Sampling is identifying a portion of the population that is easily accessible by being in public locations and platforms.
3. Snowball Sampling is identifying a portion of the population that may or may not be in the "population of interest," but can identify an individual who possesses the characteristics of people who are in the "population of interest" (MacNealy 1999 p. 157).

All three sampling techniques together maximize the amount and the rate the investigators receive qualified interview participants. Purposeful sampling was used to observe a population of individuals with the needed skill set and characteristics required to address the research questions. Each interview participant needed to have experience working within the protective design industry as an engineer, architect, or designer. After identifying and verifying the study's attributes, convenient sampling was used to locate public platforms where most, if not all, the population contained the necessary attributes for the study. The investigators located public social media platforms that included individuals with the required attributes for the study. Lastly, snowball sampling was used by asking all interview participants if they would recommend anyone they may know with relevant attributes to participate in this study. These interviews used the same procedures as the pilot study to record and transcribe the participants' responses.

## Data Analysis: Coding

The interview transcripts were coded to highlight themes related to challenges and opportunities in the design process represented in the data (Hruschka et al. 2004). Saldana (2016) showcases that many coding methods can be used depending on how the researcher would like to address their research question/s. Many established methods and forms of coding can be used within both qualitative and quantitative research studies. This study's approach suggests that inductive coding techniques be applied to the interview data because themes and constructs are derived directly from the data (Hsieh and Shannon 2005). Typically, a study may contain two rounds of coding, and in most cases, the second round will complement the first. This study encompassed two rounds of coding; the first uses in vivo coding method, and the second using the focused coding method (Saldana 2016). Codes and categories will become themes based on repeatedly being present or significantly absent in the interview data (Corbin and Strauss 1990). Following, the research design for the first and second cycle coding will aid in the synthesis of relevant themes through the data.

## Coding Process

In vivo coding was selected for the first round of coding because it can describe social qualities related to the protective designers' perceptions using their exact words and phrases. In vivo coding refers to or showcases the actual spoken words and phrases from a participant in a dataset (Manning 2017; Saldana 2016). Saldana (2016) elaborates on how in vivo coding enhances one's understanding of culture, society, and worldview by coding the participants' actual words. Also, Manning and Kunkel (2014) explain how in vivo coding can form social context through language and social interactions. Understanding the social context of how the protective designers see the impact of their role on the design process will provide a clearer illustration of the data. Based on the data collected from the protective designers, in vivo coding will provide additional perspective on the protective designer's impact on the design process. Analytic memos will serve as research journal entries to document the coding process.

Focused coding was selected for the second round of coding because it identifies "the most frequent or significant codes to develop the most salient categories," making it a suitable form of coding to follow in vivo coding (Saldana 2016 p. 240). The goal of focused coding is to develop categories from the codes established in the first round of coding to connect to broader themes. In this study, all the in vivo codes were categorized and connected back to the protective designers' role as focus codes.

## Interrater Reliability

Interrater reliability was used in this study to help ensure codes, categories, and themes derived from the data were consistent by achieving similar results between multiple researchers. The process of interrater reliability attempts to reduce "error and bias" generated during qualitative data analyses and provide credibility amongst findings (Hruschka et al. 2004 p. 309). Understanding there will always remain a level of subjectivity within a study, the research team created additional credibility in the study by assessing the degree of similarity of codes among researchers. Two of the investigators worked together to develop codes throughout both rounds of coding, and together, the two investigators systematically derive codes from the interview data and then measured their codebooks' reliability. The investigators referred to both Saldana (2016) and Hruschka et al (2004) as a guide to completing the process, as shown in Figure 5.

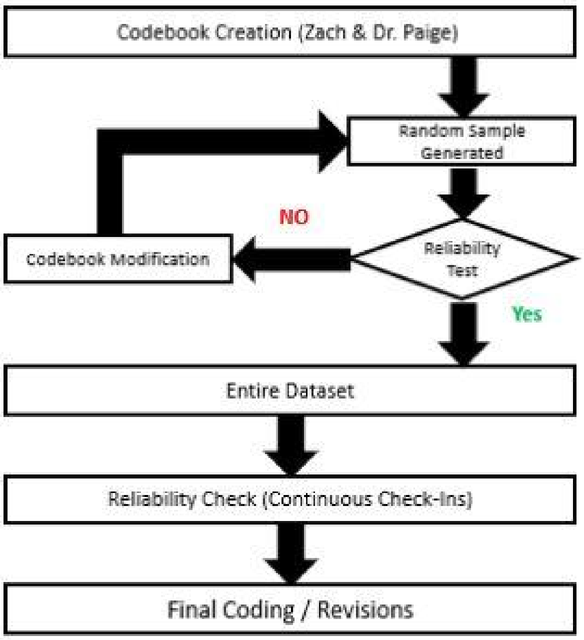


*Figure 5: System for Intercoder Reliability*

## Results and Discussions

The 14 participants selected for this study had various work and years of experience in the protective design industry. Even though 4 out of the 14 were interviewed in the pilot study, all 14 interview transcripts were incorporated into the data analysis process. The 14 protective designers interviewed represent eight companies that cater to both domestic and international sectors of protective design. All eight companies had a background in either architectural, engineering, construction, or security fields. For years of experience, 57% of the participants have been practicing protective design for between 10-20 years (57%), with a much smaller percentage of participants having less than 10 years of experience (14%) and more than 20 years of experience (29%). The majority of them have worked on over 30 protective design projects.

### Misalignment in Stakeholders' Perceptions Lead to Lack of Shared Understanding

The in vivo coding process used the protective designers' own descriptions and words to highlight a misalignment between protective designers and other design stakeholders related to the protective designer's role in the design process. Table 5 provides a reflection of a protective designer role based on how other design stakeholders view them. The overall theme across the participants was that the protective designers **perceived that they were aiding the design process based on their established role**. Protective designers describe the impact of their role as helpful, complementing, and aiding the design process. In contrast, other design stakeholders, such as the owner, architects, and engineers, perceive just the opposite. The protective designers described their impact as **"basically complementing"** the existing design and made it a point to state their intentions were **"not to wreck somebody else's design."** The research team extracted each finding by connecting the in vivo codes back to high-performing teams and stakeholder engagement theory as focused codes in Table 2 (Howard and Melles 2011; Mesmer-Magnus and DeChurch 2009; Waddell et al. 2013).

The protective designers believe that other stakeholders in the design process misinterpret their role in the design process. When asked how other design fields and design stakeholders perceive the impact of their role on a project, the protective designers responded that other design stakeholders **"are afraid of what [the protective designer] is going to say."** One participant even stated other design stakeholders viewed protective designers **"as a pain in the you know what."** Three participants cited that other design stakeholders **"don't understand**" either why or the need for protective design measures. Two other participants noted that other stakeholders perceived the protective designer as a "**burden**" to the design process. It is important to note that these are all the perceptions that the protective designers are making on behalf of other design stakeholders involved in the design process. Even though the perceptions are only from the protective designers' point of view, it does not minimize the potential effects their perceptions may have on how protective designers conduct their role in the design process.

The protective designers interviewed do not believe other design stakeholders understand a protective designer’s role within the design process. Based on the statements given by the protective designers above showcased a clear disconnect between both parties. If other designers don't understand the protective designer's role, other designer stakeholders may not understand the purpose behind the protective design industry.

Another conclusion could be that protective designers do not fully understand their role in the design process, which is why protective designers think other design stakeholders view them negatively. To better understand whether other design stakeholders view protective designers the way the participants from this study stated, an additional study is needed investigating clients, architects, engineers, and contractors' perceptions of protective designers. In the meantime, having targeted protective design education for protective designers and other design stakeholders as certification programs or post-secondary courses could help address the lack of a shared understanding between all parties.

It is a part of a protective designer's role to actively work with other design stakeholders to develop a shared understanding based on a project's need. Previous literature has showcased that establishing a shared understanding or common ground amongst the design team is the basis for better communication and collaboration in the design process. Kleinsmann and Valkenburg (2008) defines shared understanding as the "similarity in the individual perceptions of [stakeholders] about either how the design content is conceptualized or how the [process] works." Kleinsmann and Valkenburg (2008) drew a direct link between stakeholders' perceptions/interpretations in the design process with the development of shared understanding. In addition, other studies have highlighted that teams with a greater shared understanding produce higher quality, quantity, and timely products with fewer unnecessary iterations within the process (Valkenburg and Dorst 1998). Therefore, it is critical to understand how other design stakeholders perceive the protective designers' role because it could be leading to less optimal solutions within the design process.

| Table 5: Reflection of A Protective Designer's Role | |
|---|---|
| **In Vivo Codes** | |
| How Protective Designers **View** Themselves | How Protective Designers **Think** Other Design Stakeholders View Them |
| Participant #7: So they [other design objectives] are definitely in our mind as we need to make sure it **kind of meshes with those things** [overall design].<br><br>**Focus Codes: 1, 2, 5,6** | Participant #6: They [other design stakeholders] think we're going to make this massive fortress with no windows or anything. **They're a little reluctant to hear what we have to say.**<br><br>**Focus Codes: 2, 3,5, 6** |
| We tell clients all the time, the **earlier you can get us on board, the better it's going to be for everyone.**<br><br>**Focus Codes: 3, 4** | Participant #7: **Not a good understanding**…They [other design stakeholders] give us information, we come back and give them something else and they don't know where it comes from.<br><br>**Focus Codes:1, 3, 5** |

| | |
|---|---|
| Participant #9: You want to do things elegantly, with the minimum, **and this kind of goes into the cost, but solutions that deliver the most value for the least amount of dollars.**<br><br>**Focus Codes: 1, 2, 4, 6** | Participant #9: we are kind of a pain to them [other design stakeholders]. They don't really like it, **because it just makes their jobs harder.**<br><br>**Focus Codes: 1, 2, 6** |

| Table 6: Explanation of Focus Connection to Engineering Design | |
|---|---|
| **Focus Codes** | **Definition of Focus Codes** |
| **1) Shared Understanding Among Stakeholders** (Larsson, 2003) | Are design stakeholders working together towards or against a common goal or objective? |
| **2) Priorities & Design Objectives** (Oberle et al., 2005) | What are the clear objectives for a design as it relates to a stakeholder's role? |
| **3) Stakeholder Engagement in the Design Process** (Elforgani, 2010) | How are stakeholders engaging with each other in the design process? |
| **4) Cost-Influence on Design** (Nejat et al. 2010) | What is the relationship between cost and the ability to influence a design? |
| **5) Knowledge Sharing** (Cash et al., 2020) | How are stakeholders sharing their design knowledge with each other? |
| **6) Integration of Various Design Expertise** (Aguirre et al., 2017) | How is various design expertise being integrated into the design process? |

## Lack of Knowledge Sharing Impacts the Role a Protective Designer has on the Design Process

A protective designer's ability to share their knowledge in the design process is an aspect of their role to communicate and collaborate. **However, it is not always easy to either verbally or visually share knowledge, depending on how it is classified and articulated. In engineering design, knowledge can be classified as explicit knowledge or tacit knowledge.** Explicit knowledge can be articulated, easily codified, and can be shown as words or figures (Skyrme, David J. 1997). On the other hand, tacit knowledge cannot be articulated because it is the designer's intuition or feeling within the design process. Tacit knowledge is generated through various forms of "observations, conversation, and on-the-job learning," thus making the process of sharing tacit knowledge with other design stakeholders who are not in the protective design industry difficult (Skyrme, David J. 1997).

Specifically, in the private sector, protective designers struggle to share knowledge because many private sector stakeholders have varying levels of knowledge regarding protective design. The ability to share knowledge can vary widely within the protective design industry because protective design measures are more common in governmental and public sectors. One of the participants elaborates on their ability to transfer knowledge working with government and military entities because most of the design stakeholders are familiar with protective design.

> Participant #12*: **If you're talking to the government and military… that a totally different deal**. They've got their own experts, and you talk to their experts. Together both you guys develop what you're going to do and then you fold that into the design.*

In government, military, and most public sector facilities, most stakeholders are familiar and well versed with protective design knowledge, unnecessary iterations, and time explaining their designing process. Because the origins of the protective design industry began within the military, government agencies such as the Department of Homeland Security helped lead the effort for a more secure and safe environment. Many of the standards and guidelines today have used the military and other federal agencies' resources to gain the much needed resources to be extremely competent within the industry.

With that being said, sharing knowledge in the private sector is not only time-consuming but generally not a smooth process. Participants describe the process of transferring knowledge in the private sector as **"very slow"** and **"it takes time."** They also highlight how significant costs influence the private sector clients.

> Participant #12*: Now, whenever you get into the civilian on the industrial, commercial side, not so much, **they're looking at the bottom dollar**. **And so they gotta make money and that then drives the decision-making**. So some of the things that you won't have done, that you say have to get done, may not because they're the ultimate decision-maker, right?*

The participants spoke to the importance of collaboration that takes place early in the design process to "**help get everybody on the same page**" and establish a shared understanding. Two participants mentioned how private sector clients and design members could be completely ignorant of protective design practices.

> Participant #7*: **They give us information, we come back and give them something else and they don't know where it comes from**… And there are also some things in blast that are not intuitive. Some items in blast are not intuitive and it's harder to explain that way.*

> Participant #3*: I think that's something harder to explain, but I just don't think there's a lot of understanding of the general concepts of blast engineering, because it's rare and on a project where it's not required by government criteria… **on a private project, it's like, "I don't really want to do this and I don't understand why." So then it's harder to even convince them to do it.***

Outside of the examples within the data, there are other possible reasons why design stakeholders struggle with "*getting on the same page*" with protective designers. One reason is that there is much uncertainty within the protective design industry. Protective designers are designing for highly unpredictable situations, and their solutions may not be as straightforward as other design industries. For example, a structural engineer selecting steel members for a project will know for certain the max load on a structure and can select the best steel member for that situation. However, protective designers will always have a level of uncertainty in their design process because the threats they may be protecting against can change after creating the design. Another reason why design stakeholders may struggle could be due to the additional cost associated with typical protective design solutions. Protective design solutions can be expensive therefore creating tension between the project's budget and the addition of protective measures needed. This intense environment restricts the ability to openly share knowledge between design stakeholders with the project's budget is governing the design.

The protective design environment restricts knowledge sharing and it can be seen within the guidelines which they use. Table 7 defines the levels of protection by the amount of damage a structure can take in case of a terror event. The use of technical language such as "progressive collapse" and "permanent deformations" may be common used among protective designers; however, this is not the best way to share what levels of protection are with other design stakeholders. Instead, Table 7 could have catered design objectives that other design stakeholders are most comfortable with such as cost or functionality. This example presents an opportunity for protective designers to create a foundation for how knowledge can be effectively shared to minimize competing design objectives.

**Table 7: Description of Levels of Protection Based on Structural Damage**

| **Level of Protection** | **Description of Potential Structural Damage** (McCallister, Gott, Balkus, McAndrew 2018) |
|---|---|
| *Very Low* | Heavy Damage: Onset of structural collapse. Progressive collapse is unlikely. Space in and around the damaged area is unusable. |
| *Low* | Unrepairable Damage: Progressive collapse will not occur. Space in and around the damaged area is unusable |
| *Medium* | Repairable Damage: Space in and around the damaged area can be used and is fully functional after cleanup and repairs. |
| *High* | Superficial Damage: No permanent deformations. The facility is immediately operable. |

In order to increase knowledge sharing within the protective design industry, protective designers need to understand how to share knowledge depending on its classification. Even though tacit knowledge is more difficult to share and communicate than explicit knowledge, there are some effective strategies protective designers can use to better share all three classifications of knowledge. Table 8 highlights some effective strategies to share knowledge, especially within the private design sector where protective design is not as common. Having protective designers understand how knowledge is generated and how to effectively share the various classifications of knowledge with design stakeholders can mitigate competing design objectives in the design process and foster a community for communication and collaboration.

| Table 8: Recommendations for Sharing Each Classification of Knowledge Effectively | | |
|---|---|---|
| | Definition | Examples |
| **Explicit Knowledge** | Knowledge that is easily codified and articulated (Skyrme, David J. 1997). | Figures, sketches, charts, and other traditional design communication tools.<br><br>Can be more effective with the addition of innovative technology such as BIM. |
| **Tacit Knowledge** | Knowledge that is derived from personal experiences and is not easily articulated (Nonaka et al 2000)<br><br>Typically requires trust and collaboration between parties to share tacit knowledge. (Foos, 2006) | Face-to-Face interactions aid in the sharing of tacit knowledge (Nonaka and Takeuchi 1995)<br><br>Establishing a trusting environment with open communication |

## Early and Often Collaboration Helps Mitigate Competing Design Objectives

Protective designers' early involvement in the design process increases their ability to establish a shared understanding between stakeholders, increase knowledge sharing, and assists in mitigating competing design objectives. In most projects that require protective design elements, the client is the most influential stakeholder. The participants made it clear that the client isn't always the owner or the buyer of the project, but their client could also be another member of the design process, such as the architect. Whoever is the acting client helps establish the design criteria needed to help protective designers reach a solution. Within the design criteria, the design objectives are broadly discussed, but as the design continues to develop through the conceptual stages, it can be common to have competing design objectives that arise. Some of the common design objectives that compete with the security design objective are the project's cost, functionality, aesthetic, accessibility, and sustainability (Oberle et al. 2005)

Based on the interview data and the literature survey, the project's cost is the driving design factor. Protective design measures can become very expensive if they are not encouraged early within a project's pre-design stages (McCallister, Gott, Balkus, McAndrew 2018). In the U.S. Department of Defense United Facility Criterion 4-010-01 manual, experts highlight a correlation that time and cost increase when a client decides to wait to engage within the protective design process (McCallister, Gott, Balkus, McAndrew 2018; McNamara, Fernandez, Nussbaum 2013). Protective design tends to follow the cost–influence curve, whereas a stakeholder's involvement earlier within a project results in greater cost reduction and influence over the design (Nejat et al. 2010). However, a lack of stakeholders' involvement early within a project results in a lower cost reduction and influence. The cost–influence curve is a common governing design concept within design literature and has a critical role in the protective design process. The protective designers that were interviewed understood how the cost–influence curve affected their projects. **The participants expressed their frustrations when clients brought them on a project in later phases in the design process. The participants suggested that being brought on to a project as early as the conceptual design phase has proven to be the most cost-effective.**

> *Interviewer: At what stage in a project's life cycle is it best for protective designers/security experts to start working on a project?*
>
> *Participant #12: "The security is **more effective** and it's much **more cost-effective to include it at the very, very beginning of the conceptual design** me. When you try to bolt it on at the end, it's cumbersome, it's ineffective, and it's really expensive. And then they're all usually out of budget"*

Even with cost being a driving component, clients and other members of the design process, such as the architect, contractors, and engineers, have design demands that can serve as competing security objectives. In the quote below, one of the participants explains how certain stakeholders approach aesthetics and functionality within projects.

> *Participant #7:[Architects] want to put out **a cutting-edge, distinguishable building** that the people who use it are going to say, "**This is great.**"*
>
> *Participant #7:Civil engineers [and] landscape architects **creat[e] open, inviting, usable spaces** [which are] another big facet of what we need to work with and work to[wards] as physical security designers.*

The data uncovered that protective designers are maybe more cost-effective in their role if they are brought onto a project earlier. This finding aligns with the existing engineering design theory and understanding of the cost-influence curve; however, the participants explained that even though they have stated to clients coming onto projects earlier is their preference, clients still bring them on at the latter stages of a project (Nejat et al 2010). Understanding this scenario is not ideal for both parties because there will be fewer protective options to choose from since some protective measures cannot be implemented effectively or at all. Based on the data sample, this challenge within the design process cannot be generalized across the entire protective design industry; therefore, additional investigation is needed.

## Conclusion & Implications

*How can protective designers fix this misalignment in stakeholders' perceptions and increase knowledge sharing in the design process?*

Currently, the solution seems to point toward a need for targeted education or re-education related to how the protective designer engage with stakeholders in the design process. The push for additional stakeholder engagement education should target design stakeholders who work alongside security professionals and protective designers. This could be one conclusion drawn from the data; however, the challenge may reside with protective designers not fully understanding their role within the design process. By investigating a national certification program for protective designers is one form of targeted education that can aid in the educational process for protective designers. Organizations such as the American Society for Industrial Security (ASIS) have internationally recognized certification programs for security professionals, and they can use their resources to lead the effort.

The knowledge and the application of knowledge that a protective designer has are not currently being taught at universities and colleges around the country, nor is it easily accessible to other design stakeholders. Multiple participants mentioned how their respective companies have workshops, courses, and events catered to educating clients and others interested in the industry; however, this void still exists. Therefore, protective designers must develop creative and innovative ways to effectively share their knowledge with the rest of the design team.

Within the data, the participants mentioned some of the ways they communicate their design knowledge to other stakeholders through the use of engineering design such as sketches, presentations, interactive physical and virtual workshops etc. The current methods protective designer use to engage within the design process is not aiding in achieving a shared understanding amongst the design team. Protective designers must continue to be innovative and creative in how they effectively communicate their knowledge with design stakeholders in a more collaborative way.

This study's findings were based on data collected by semi-structured interviews with protective designers' which excluded other design stakeholders from the data sample. It was mentioned early within the manuscript that the protective designers were asked, "how do other design stakeholders perceive their role within the design process." Further investigation is needed to verify if these findings based on the protective designers' perceptions are congruent with data collected on other design stakeholders, such as architects, contractors, engineers, and owners. A more in-depth study related to other designer stakeholder's perceptions of protective designers would ensure that all perspectives are heard and properly analyzed.

# Chapter 7: Conclusion

Chapter 1-5 highlights the current trends and challenges that exist within the protective design industry today. With the rise of active shootings in the United States, accidental explosions and vehicle rammings have been shown to be very important elements in the protective design industry. These are just a few of the challenges that exist; however, these only highlight present-day challenges. Within the protective design industry, protective designers must be ahead of the threats of tomorrow because, if not, they may not be able to mitigate the aftermath of a terrorist incident. These chapters also showcase the usefulness of a comprehensive protective design database for the entire design community in conjunction with a complete network analysis of industry governing documents.

Chapter 6 of this thesis highlights how protective designers role while engaging with other stakeholders in the design process. The result from this study showcases that protective designers perceive that other design stakeholders within the design process are misinterpreting their role. Two potential conclusions were drawn as to why this misinterpretation exist are:

1. Protective designers don't fully understand their role in the design process
2. Design stakeholders are misinterpreting the protective designer's role in the process

Only the perceptions of the protective designers were considered within this study; therefore, additional interviews of other design stakeholders are needed to verify that this misinterpretation exists within the protective design industry. This chapter also highlights how the protective design environment restricts knowledge-sharing between other design stakeholders who may be less informed about the protective design industry. Lastly, this chapter reiterates the importance of early collaboration and involvement by the protective designer to minimize competing design objectives within the design process. This is not a new finding within the design field; however, it was a significant thing that was showcased within the data.

One of the next steps for this research study is to continue developing the protective design database to be a fully functional tool for protective designers and other design stakeholders interested in the industry. There is also a need for additional interviews with both protective designers and other design stakeholders involved in the design process to address the misinterpretation appropriately. If additional education is needed, then it can be targeted at either the protective designers or other design stakeholders.

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# Appendix A

**Initial Interview Protocol**

1. Please define what physical security means to you and/or your company? How does usability/functionality of the building fit within your definition of physical security?

2. Do you feel that your clients have the background knowledge and the understanding of physical security to take an active role in the design process?

3. How do you communicate your technical advice/solutions (design suggestions) to clients?

4. With as much detail as possible, will you please elaborate on the process of interacting with a new client in the private sector?

5. From your experience, in what ways have physical security elements impact the usability of a structure? Please provide any examples.

6. My next question concerns the topic of level of protection and intended use and occupancy. How do you describe levels of protection to clients?

7. Throughout the design process, what steps do you follow to balance the physical security of a building while maintaining the usability of the building?

8. What standards/codes do you follow to ensure the proper measures are being taken?

9. Generally speaking, there are a number of different blast-resistant window strategies. For example: Security window film, laminated glass, and blast curtains/catcher systems. Based on your experience, can you please rank and discuss each by their robustness in terms of level of protection?

# Appendix B

**Final Interview Protocol**

**Background Information:**

- How long have you been working in the protective/secure design space?
- What is your current job title, and how long have you been in this position?
- Tell me about your role/roles (tasks, duties, or responsibilities) within your present position?
- Could you provide an estimate on how many protective design projects you have work on?

**Section A. Current State of the Protective Design Field**

1. From your perspective, what are the main design objectives of the protective design field?
2. Are there any design objective/s which you pay the most attention to during a protective design project?
3. Has there been a significant shift in design objectives within the protective design field since you have been involved?
4. Can you inform me of the guiding documents, for example: guidelines, standards, code manuals, which you use to inform your protective design process?
    a. Are these guidelines, standards, and codes applied differently depending on the sector, public or private?
5. Based on your experience, how do protective design practices differ between the private and public sectors?
    a. Are there any differences in working with clients in the private and public sectors of protective design?
    b. Are there similarities across sectors that you find beneficial to your practice of design?
6. Who are the stakeholders that make up the protective design process?
    a. In as much detail as possible, could you explain (Insert names) roles?

**Section B. Design Objectives and Constraints**

7. Are there project delivery methods that you prefer over the others when working in the protective design field?
8. At what stage in a project's life cycle is it best for protective designers/security experts to start working on a project?
9. Which stakeholder/s decides when the design has reached maximum efficiency or optimization based on metrics established by influential stakeholders?
10. How do other design fields and stakeholders perceive your role within a project?
11. How has your experience been working with other design fields outside of protective design?
    a. Are there any challenges or benefits you have experienced?

**Section C. Protective Design Education**

12. Where (college/university, military, industry, etc.) and how (workshops, classes, internships, etc.) did you acquire your knowledge base of protective/secure design?
13. Can you describe to me the background knowledge or understanding of protective design that clients typically bring to a protective design project?
14. How do you communicate with your clients the technical advice and solutions you suggest? For example, how would you describe levels of protection to a client?
15. Can you describe to me the process of transferring knowledge to other project stakeholders or teams outside of the protective design field (if applicable)?

16. Do you or your company have any trainings or workshops that you all offer to your employees, clients, or anyone interested in learning more about protective design?