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DHS HS-STEM Final Report

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Throughout my HS-STEM internship, I worked on two different projects with a systems analysis group at Sandia National Laboratories in Livermore, California (SNL-CA). The first, and primary, project entailed building a conceptual model of health surveillance detection of a bioterror attack. The second project was much smaller in scope and looked at cost tradeoffs between volumetric and surface decontamination after the release of anthrax in a city. Both projects helped me to understand the challenges of planning for a bioterror attack and the importance of preparedness in the public health sector.

Description of Projects and Roles

My role in the conceptual model project entailed doing research on detection systems in place around the country and designing the conceptual model. This model acts as a framework for understanding and improving public health detection systems by providing a comprehensive analysis of timelines, capabilities, and utilization of detection systems. My focus was on detection systems that look for health-related data. This model primarily focused on detection in the absence of BioWatch and other environmental monitoring programs. The two types of surveillance my model focused on are syndromic surveillance and traditional surveillance through the laboratory notification system. Syndromic surveillance systems utilize pre-diagnosis and pre-clinical data to alert public health officials about potential outbreaks. Traditional surveillance via laboratory notification occurs after a doctor has made a diagnosis.

While the timeliness of laboratory notification is problematic, it is more reliable and disease specific than syndromic surveillance.

My first steps were to look at 3 different health departments in various geographic locations to explore a variety of specific systems. The health departments chosen were the New York City Department of Health and Mental Hygiene (NY), Public

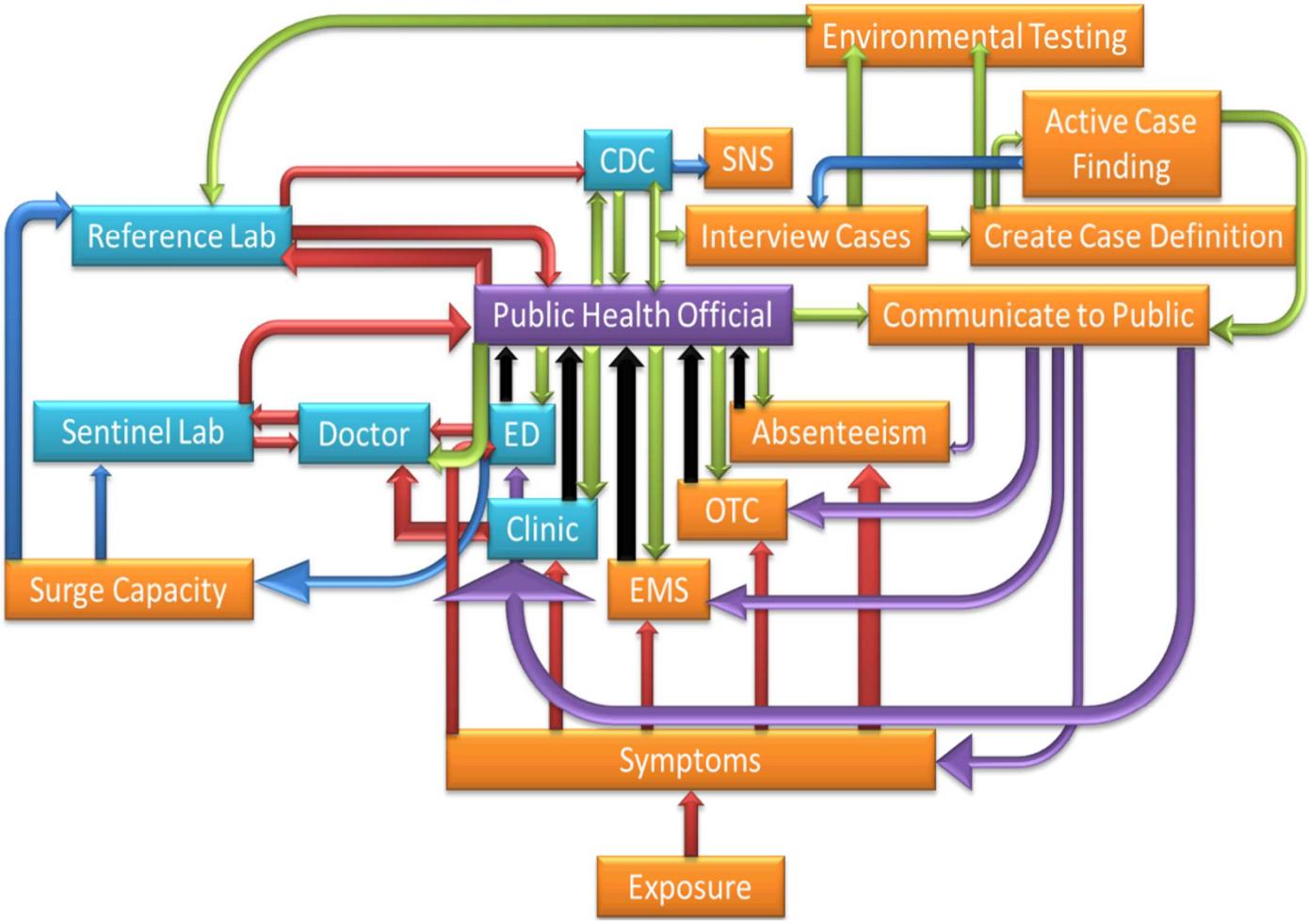

Figure 1: Conceptual Design of Public Health Detection Process

Health- Seattle & King County (WA), and the Tarrant County Public Health Department (TX). By picking these health departments, I incorporated a wide range of system types and capabilities. I researched laboratory capabilities, syndromic surveillance systems,

and preparedness plans. Once I understood the specific local systems, I examined more general data on public health preparedness as a whole. International and national organizations have examined the public health preparedness efforts in the United States in great detail. By using published studies, I was able to gather information on the number of public health jurisdictions with certain types of surveillance systems. Both of these steps were completed through literature reviews and database searches. I then compiled my data into a report. After organizing this information in my report, I started designing the model. This proved troublesome at first but after several different designs, I was able to create a model that sufficiently explained the different information inputs and response outputs to a public health official during a bioterror event. Figure 1 shows the resulting flowchart, demonstrating data pathways. This was done using PowerPoint. Not included in this figure are elements of timeliness and capabilities of healthcare facilities and public health departments. There is much variability in both timeliness and

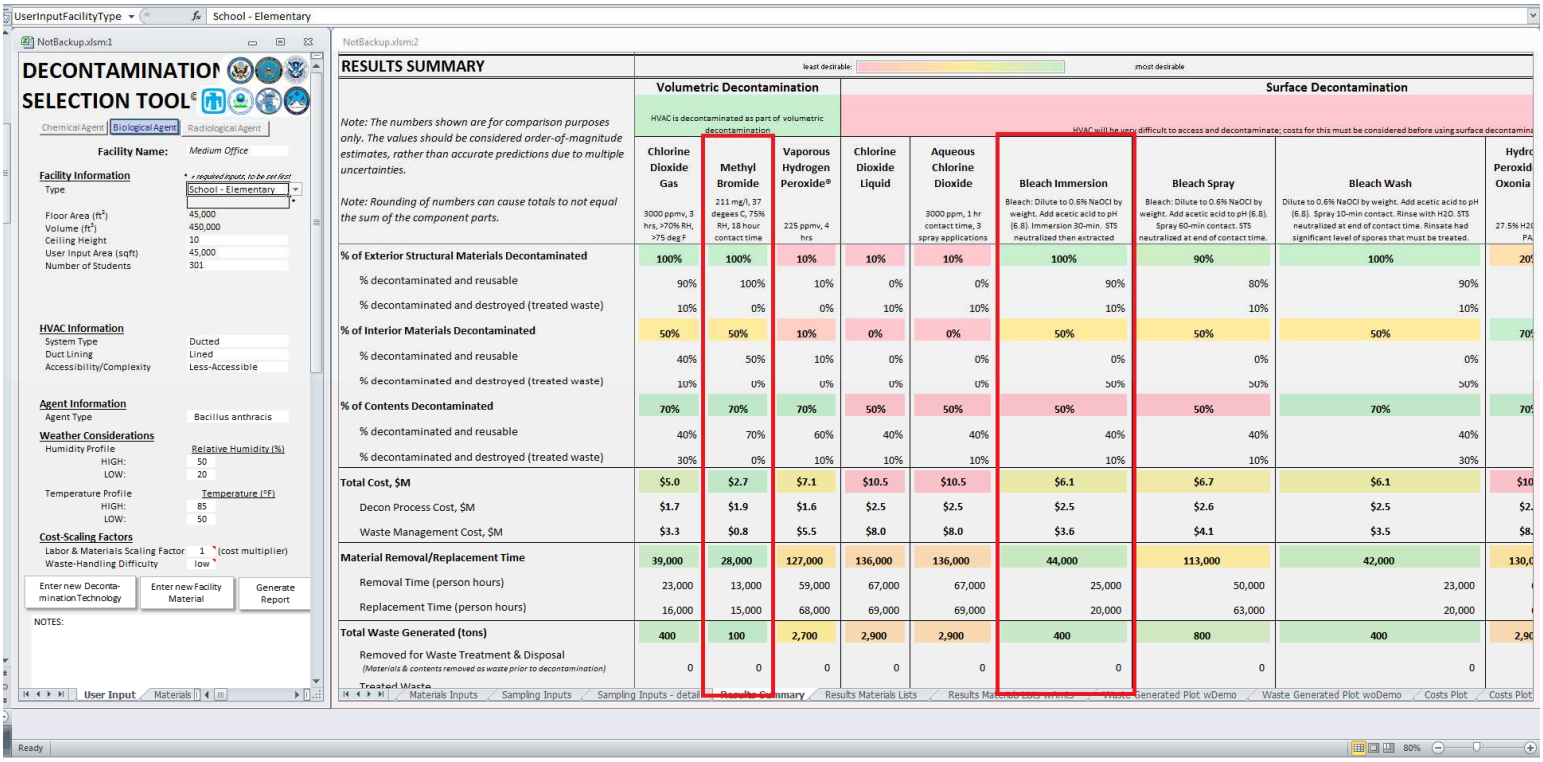

Figure 2: Inputs and Outputs of Decontamination of an Elementary School

capabilities and they were shown in a table (not pictured).

My second project utilized a tool created by SNL researchers in 2013 for use by the Environmental Protection Agency (EPA) after a bioterror attack. The tool compares different methods of decontamination based on costs, size and type of building, HVAC systems, and weather considerations (Figure 2). The two primary types of decontamination (not including demolition) are volumetric (methyl bromide) and surface (bleach). The total cost of decontamination is a combination of the actual decontamination process and the waste created from materials that were destroyed in the process. The volumetric decontamination process is more expensive and there are a limited number of decontamination machines in case of a bioterror attack. However, volumetric decontamination produces less waste and is thus cheaper overall. Surface decontamination produces more waste and is more expensive, but bleach is widely available and is thus a better alternative in the case of a large-scale bioterror attack. Because methyl bromide is always cheaper for decontamination, the tool always recommended methyl bromide at the default size settings. For availability reasons, decontamination of everything using methyl bromide is not practical. My project was to figure out the size cutoff points where bleach would become cheaper than methyl bromide. At first, this seemed like a simple task. However, it became quite challenging as, for many building types, bleach was never cheaper (or it was only cheaper when the size was lower than 400 sq. ft., which was not practical). The movie theater was the only building where bleach was cheaper at a reasonable square footage. After dwelling on this conundrum with my advisor, she recommended that I calculate the percentage of different materials in each building type to examine whether the movie theater was

unique in its composition. After calculating percentages, the project became even more puzzling. It was quickly discovered that the driving force of the costs was the exterior materials because the weight (related to the cost of waste) of the exterior materials was far greater than the interior materials. However, the exterior composition of the movie theater (which was on one cost extreme) and the hospital (which was on the other cost extreme) were exactly the same. This was an unexpected result as the cost for similar building structures should have been relatively similar. Due to time constraints and scheduling conflicts, at the time of this writing, the problem has not been resolved.

Achievements

I gave several presentations while at Sandia to various audiences. Half way through my internship, I briefed several members of my department on the progress of my model. I also gave a presentation to a general Sandia audience at the Student Intern Symposium. At the symposium, I gave an overview of the work I was doing to an audience that consisted of interns and technical staff. In my last week of this internship, I gave an exit presentation to my group and several other technical staff.

The results of this work culminated in a 20-page report of my conceptual model and information used to create the model. This model will help researchers understand tradeoffs between different technological interventions and provide recommendations to the public health community that will improve the public health ability to detect a bioterror attack.

New Skills and Knowledge

Before this internship, I had little knowledge of bioterrorism or bioterror detection systems. The first few weeks, there was a steep learning curve as I was suddenly plunged into the world of health surveillance systems. Very few of the systems have been modeled and even fewer have been tested in real-life outbreaks. Furthermore, there has only been one bioterror attack on the US which means that there is very little data to create the model.

I also learned a lot of new skills this summer. First and foremost was conceptual modeling. At the beginning of making the model, I struggled with how to clearly represent all the data I had collected. After talking with my mentor and drawing the design of the model out on paper, I was able to present my model in both written and visual forms.

I learned how to design questions for informational interviews with experts. I vetted my model with two different scientists at Sandia with whom I was not directly working. Getting their feedback was extremely beneficial in designing a model. However, to elicit the most useful information, I had to structure and design my questions based on my model.

Academic and Career Planning

I found Sandia's Intern program to be extremely helpful in career planning. Sandia not only hosts DHS interns but also has their own internship program for high school, undergraduate, and graduate level students. As such, they had many events throughout the summer focused on career planning.

Such events included:

- Interview Techniques and Resume Writing Workshop
- Psychology of Persuasion
- Networking: Your Network is Your Net Worth
- How to Negotiate an Offer
- How to Get a Job at Sandia
- How to Get into Grad School

The presenters ranged from members of the Sandia Talent Acquisition Team to the director of the Student Diversity Program at UC Berkeley. We were also able to tour different parts of the lab and Lawrence Livermore National Laboratory's National Ignition Facility which was a great way to see other intern projects and be exposed to different fields related to the national laboratory mission.

Working in a national laboratory, especially one as big as Sandia, gave me an appreciation for the research and development done to keep our nation safe. I met several different people who were willing to talk about their careers and how they ended up at Sandia. These kinds of conversations, while not coordinated events by Sandia, helped focus my career and academic goals by learning about the various job types related to homeland security.

Suggestions for Improvement

One problem that I became aware of during my internship was the lack of collaborative communication between the Department of Homeland Security, the national labs, and the public health community. While the goals of all organizations are to prevent a bioterror event and, if an attack did occur, to respond efficiently and

effectively to save lives, the DHS, the national labs, and the public health community all have different ways of talking and planning for such an event. The DHS and the labs tend to focus on low-probability, high-impact events. The public health community, on a daily basis, works on high-probability, lower-impact events, such as foodborne outbreaks and chronic diseases. The day-to-day mission and foci cause a difference in perspective and resource availability even when all parties can agree that bioterrorism prevention and response plans are needed. Positive collaboration is absolutely necessary to prevent and respond to a bioterror attack. More research and efforts by all parties needs to be made to make sure that in the event of an attack, communication by the federal, state, and local actors will be clear and productive.

Overall Summer Summary

The DHS HS-STEM Internship was an educational experience that taught me so much about national security and all the efforts made to keep America safe. I am very grateful for this experience and the opportunity to work with amazing scientists at Sandia National labs.