SURVEY AND DESIGN OF ALTERNATE CARE SITES FOR DISASTER AND PANDEMIC RELIEF

An Undergraduate Research Scholars Thesis

by

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UNDERGRADUATE RESEARCH SCHOLAR

Approved by
Faculty Research Advisor: George J. Mann, AIA

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Majors: Environmental Design and Architectural Studies[1, 2, 3, 4]

RESEARCH COMPLIANCE CERTIFICATION

Research activities involving the use of human subjects, vertebrate animals, and/or biohazards must be reviewed and approved by the appropriate Texas A&M University regulatory research committee (i.e., IRB, IACUC, IBC) before the activity can commence. This requirement applies to activities conducted at Texas A&M and to activities conducted at non-Texas A&M facilities or institutions. In both cases, students are responsible for working with the relevant Texas A&M research compliance program to ensure and document that all Texas A&M compliance obligations are met before the study begins.

We, Alanna Burnett[1], Nallely Chavarria[2], Virgilio Duarte[3], and Madison Lesmeister[4], certify that all research compliance requirements related to this Undergraduate Research Scholars thesis have been addressed with my Research Faculty Advisor prior to the collection of any data used in this final thesis submission.

This project did not require approval from the Texas A&M University Research Compliance & Biosafety office.

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ABSTRACT

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The coronavirus, or COVID-19, is a highly contagious respiratory virus caused by SARS-CoV-2 that has plagued our world for over a year now. The virus brought to light the many ways we were unprepared for the initial outbreak as well as all the devastating deaths, job losses, shutdowns, and food shortages that followed. In a world where natural disasters, global pandemics, and unforeseen dangers are increasingly becoming more apparent, the role of architects has come into prominence. Oftentimes, as uncalculated disasters occur, they tend to have a series of destructive capabilities: communities are displaced, mass casualty incidents arise, and buildings are demolished.

Amid the COVID-19 pandemic, hospitals experienced an influx of patients and a lack of adequate space to effectively provide shelter and medical treatment for critically ill individuals. With healthcare facilities exceeding their servicing capabilities, and large volumes of people around the globe progressively becoming exposed and infected with the coronavirus, there has been an increasing demand for rapidly built alternate care sites to care for those in need. Thus,

with the implications of COVID-19, architecture, as both a discipline and profession, has been brought to the forefront of global attention as a potential solution for "surge capacity."

The goal of this study was to research the most effective ways of creating and transforming architecture to be adapted as an alternate care facility for a surge, or rapid influx, of patients in need of medical attention and currently lacking a place to receive it. Through real world scenarios and prospective architecture, this study, a survey of existing and successful alternate care sites, aims to propose future solutions for alternate care sites through research and design-based studio projects. Alternate care sites, or "surge facilities," are made from pre-existing or newly built spaces that allow for necessary hospital operations when hospitals are unable to provide care for the overflow of incoming patients. Surge facilities can be converted or built in a rapid period of time in order to meet the medical needs of the community in the event of a pandemic or natural disaster.

Designing for a future that responds to unpredictable and unforeseen challenges is crucial. In the event of surge capacity within a hospital, it is important to be able to quickly flex other existing buildings into an alternate care site. Particularly, this transition and turnover can be made easier if the original design of the structure already has this flex predetermined. Ultimately as architects progress in their future designs, it is important for outcome-based care to translate to outcome-based design, and alternate care sites need to think about how technology, wayfinding, and workflow efficiency can streamline processes, making facility spaces more dynamic. As architects and designers, we are accountable to establish sustainable and resilient infrastructures that demonstrate how the built environment can positively impact health in a justifiable and measurable way.

DEDICATION

To our friends, families, instructors, and peers who supported us throughout the research process, and to those who have suffered hardship, experienced job loss, and lost loved ones because of the coronavirus pandemic.

ACKNOWLEDGEMENTS

Contributors

As a team, we would like to thank our faculty advisor, Professor George J. Mann, as well as Ronald L. Skaggs, Joseph G. Sprague, and Brian Briscoe from HKS Architects, and William R. Eide, for their guidance and wisdom throughout the course of this research. Thanks also go to Associate Director of the Center for Health Systems and Design Dr. Zhipeng Lu for beneficial feedback, and Judy Pruitt and Julie Wilson for administrative support.

We would also like to give thanks to our friends, colleagues, and the Department of Architecture faculty and staff for making our time in the College of Architecture at Texas A&M University a great experience.

The research and materials analyzed and used for our thesis "Survey and Design of Alternate Care Sites for Disaster and Pandemic Relief", were provided by our advising firm HKS Architects, our professor George J. Mann, and our classmates Desiree Allen, Valerie Andrade, Mariana Cardenas, Nallely Chavarria, Virgilio Duarte, Andrea Hartley, Melanie Guerrero, Jonathan Latta, Madison Lesmeister, Gustavo Marin, Stefany Rodriguez, Victoria Saracco, Rylan Severance, Guanqi Shuang, and Ethan Vickers. The analyses depicted in the thesis "Survey and Design of Alternate Care Sites for Disaster and Pandemic Relief" were conducted in part by The College of Architecture, Alanna Burnett, Nallely Chavarria, Virgilio Duarte, and Madison Lesmeister and is currently unpublished. All other work conducted for the thesis was completed by the students independently.

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1. AESTHETIC MOTIVATION AND RESEARCH QUESTION

In March of 2020, humans were brought face to face with the fact that our world was unprepared for an aggressive virus that would infect hundreds of thousands of people. In just a few months, life as we knew it came to a halt; businesses closed their doors, communities were asked to self-isolate, grocery stores had rolling food shortages, the infection rates were skyrocketing, and medical surges overran hospitals. A medical "surge" occurs when patient numbers and volumes contest or surpass a hospital or healthcare facility's medical servicing capacity. Furthermore, the term "surge capacity" describes a particular healthcare facility's capability to provide sufficient and satisfactory medical care during an unpredictable mass casualty event (COVID-19 for example) where patient needs, and the use of necessary medical equipment exceed the normal limits of the infrastructure.

Thankfully, architects and engineers were quick to act when the issue of significant overcrowding arose in hospitals. As a team, we have spent the past year surveying and analyzing a multitude of alternate care sites that were successful at housing infectious patients when the servicing capacity of healthcare facilities were overloaded. This thesis discusses alternate care sites, or surge facilities, during the COVID-19 pandemic, and showcases student research and design projects from Fall of 2020 which attempt to solve the prevalent issue of surge capacity for future disasters.

Diseases and illnesses have existed and plagued humanity since the earliest days and although outbreaks have occurred constantly throughout history, not all of them have been as catastrophic as the current COVID-19 pandemic. The unexpected impacts that followed the initial outbreak of the coronavirus has prompted the design community to reevaluate their work for a future that might never be "normal" again. Infrastructures that promote large gatherings such as airports, academic buildings, and corporate offices must be reimaged, and this is where architects must come up with new, advanced ideas in response to the pandemic. There is an increased demand for construction elements suitable for public spaces that apply health standards, like decreasing the number of flat surfaces for germs to collect or providing negative air pressure systems to regulate clean airflow. With the new design standards that followed as a result of COVID-19, designated areas within existing hospitals may no longer meet healthcare criteria such as newly implemented social distancing regulations in large waiting rooms. Thus, we were motivated to conduct research over surge facilities, because it is important that we, as designers and innovators, think about how designing common public spaces like hotels, museums, and dorms, with regards to social distancing and attention to health standards, will protect the health of humanity from future disasters.

Our guiding research question was "how can we as architects design more efficiently to prepare for future pandemics and natural disasters?" During the COVID-19 pandemic, there has been an influx of patients needing immediate care which has caused patient care rooms in hospitals rooms to reach maximum capacity. As a result, hospitals and communities are in need of more efficient solutions for surge capacity. By participating in this research study, we are striving to discern how hospitals can be prepared with additional available space for patients infected with coronavirus and observing how structures can be converted into an alternative care facility if hospitals reach maximum capacity. With unforeseen natural disasters, unpredictable pandemics, and healthcare facilities reaching maximum capacity, it is necessary to design for a future in which alternate care sites can be readily available and implemented quickly. Our research initiative aims to present architects, healthcare industries, and communities with potential solutions for surge capacity in hospitals as a response to unpredictable emergencies.

Furthermore, it is important that we look at what is currently working well, what needs to be implemented more efficiently, and how we need to adapt to be better prepared for future pandemics or disasters. The coronavirus pandemic has taught us valuable lessons about how prepared we are when handling disasters, and what areas need improvement. Our goal is to provide our audience with case studies of different options for care facilities, explore those different methods used to respond to such emergencies, and use them to guide our decision making for proposed designs of surge facilities that seek to efficiently support healthcare workers and provide care for patients.

Healthcare facilities acknowledge the importance of designing medical spaces that not only function impeccably but facilitate an atmosphere that significantly contributes to a patient's wellness and recovery time. Since hospitals and medical centers are essential service facilities, it is important that these buildings are able to withstand natural disasters and unpredictable misadventures in order to provide and administer impertinent care to a community during such an event. Along with natural disasters, healthcare facilities also need to withstand the servicing capabilities and the challenges that result from a pandemic. Whether it is by designing more efficient homes or communities, it is the job of architects to perceive the needs that have been brought as a result of the pandemic and propose creative solutions. Architects have been tasked with improving the lifestyles of society through health, safety, and welfare.

In Professor George J. Mann's research and design studio during the Fall semester of 2020, eight student teams selected an urban context of their choice, conducted research over surge facilities, and designed their own solutions to the issue of surge capacity. By stepping up to the challenges that the pandemic has presented to designers, we responded to its concerns by designing a community center that could be transformed into a surge facility in the event of a future wave of COVID-19, or natural disaster. As teams, we worked tirelessly to come up with multiple design solutions and strived to improve the wellbeing of cities that were greatly affected by coronavirus. Each team project addresses the issue of surge capacity within various urban contexts and attempts to prepare these communities for a future pandemic or natural disaster. Our design solutions are intended to be used for their original function daily and converted into their secondary functions for emergency disaster relief (Figure 1.1).

ARCH 305.934

Instructor: **George J. Mann,** *Architect, AIA, The Ronald Skaggs FAIA Endowed Professor of Health Facilities Design*

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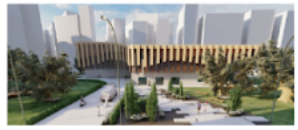
Beirut Museum of Fine Arts
Earthquake Sheltering and War Refugees
Beirut, Lebanon



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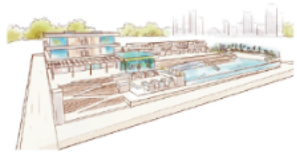

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Seu Museu e Santuário (Her Museum and Sanctuary)
"Women's Museum Converted into SURGE Sanctuary"
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"SURGE" Hospital
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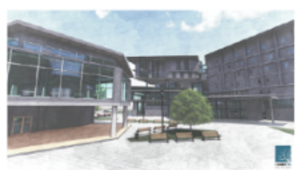

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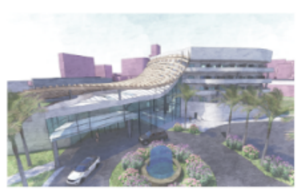

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"SURGE" Facilities in an Urban Context

At the start of 2020, the world was brutally introduced to an unexpected deathly virus, accompanied by an unprecedented pandemic, now globally recognized as COVID-19. Health facilities and hospitals were met at maximum capacity and nations became in desperate need of 'SURGE' spaces to keep up with the increasing infected patient rates.

Our project brief focuses on the research and design development for 'SURGE' health facility conversions from common buildings.

Our studio will present the diverse propositions of 8 teams with strategic primary design functions at various locations around the world in an urban context setting.

With Special Thanks To Our Collaborative Team of Advisors,

William R. Eide, *CHSD Jr. Architect Emeritus*

Ronald L. Skaggs, *Chairman Emeritus AIA, FACHA, FHFI, LEED AP*

Joseph G. Sprague, *AIA, FACHA, FHFI, Senior President (Ret.)*

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Figure 1.1: Research and Design of SURGE Capacity and Alternate Care Sites in an Urban Context

2. HISTORICAL CONTEXT, DISCIPLINARY PARADIGMS, AND AESTHETIC STANDARDS

With about 2.7 million COVID-19 deaths and 131.81 million cases reported throughout the world as of the year 2021, it is safe to say that the novel coronavirus has claimed its spot on the list of the deadliest pandemics throughout history. Though new vaccines have been able to circulate throughout parts of the world, the daily number of confirmed COVID-19 cases have remained near the apex throughout the entire year and continue to increase daily. When referencing history and prior global pandemics, there have been notable occurrences such as the Spanish Flu in 1918 which devastated around a third of the population and had a death count that surpassed the damage done by the COVID-19 pandemic. However, neither the Spanish Flu nor the coronavirus have come anywhere near the death toll reached by the Bubonic Plague, or Black Death, with a total of 200 million lives lost.

In regards to the Spanish Flu, World War I and the lack of proper hygiene and social distancing, were large contributors to the spread and infection of millions of people. Soldiers were living in compact spaces and deployed to many different countries bringing the Spanish Flu with them everywhere they travelled. Similarly, to the coronavirus, the Spanish Flu was a novel virus meaning it was new to the world and there were no vaccines or built-up immunities to these new viruses. Time has proven that though we have an inordinate amount of resources now as compared to a 100 years ago, the public is still susceptible to a worldwide pandemic of this sort. This phenomenon changes the way in which both the public and architects must think, act, and respond in the present as well as in the future for a pandemic of this scale. After conducting a substantial amount of research over the history of pandemics and disease outbreaks, we found that there have always been new viruses circulating through the public and COVID-19 is not the first nor the last virus to spread at a global scale. Perhaps through architecture and strategic design, we can learn from previous disasters and implement innovative design solutions to mitigate the level of devastation and destruction that future disasters might cause.

Hospitals and emergency care facilities are the number one focus when it comes to managing illnesses and making sure the public is kept safe and protected from rapid and widespread contamination. If hospitals are overrun and reach severe overcrowding, then infected individuals will continue to expose and contaminate others, thus creating an exponential increase in the amount of cases that persist throughout the world. In order to mitigate the spread of COVID-19, architects have had to quickly respond to the chaotic and unpredictable pandemic with proposals for alternate care sites that are able to provide care to those that are infected but are unable to receive care at a traditional hospital. With non-traditional healthcare facilities being built, alternate care sites, or surge facilities, are able to reduce the number of coronavirus cases by providing infected patients with additional medical facilities where positive COVID-19 cases are controlled, isolated, and treated as opposed to an overcrowded hospital.

Providing solutions and responses to current and future disasters, this thesis presents research, precedent case studies, and analysis from active professionals in the field of medicine and architecture, regarding current temporary hospitals and alternate care facilities (built in response to the COVID-19 pandemic). These temporary hospitals offer the medical care needed for COVID-19 patients all around the world and can be completed in a matter of weeks depending on the scale of the project; these design solutions are effective and quickly constructed.

Our research has been conducted to inform the public about the progress and advancements that architects and construction workers have made in the field when it comes to responding to the negative outcomes of COVID-19 as well as designing for a future that is responsive to unpredictable disasters and mass casualty incidents. As a result of the unstable and destructive nature of the current pandemic and pandemics in the past, it is of utmost importance to investigate all possible design solutions that utilize a holistic approach in order to provide the best care for patients.

The research acquired in this section serves to represent the broad nature of alternate care facilities and their functionality as it relates to geographical regions where COVID-19 cases have skyrocketed and continue to multiply. In order to progress in responsive and adaptable architectural design, it is important to reference, carefully analyze, and learn from recent architectural advancements that design for health. Accompanying the extensive and investigative research regarding the use and benefits of alternate care facilities, this section also provides firsthand experience and research presented by active professionals who have either worked on or conducted their own research over. In addition, these active professionals and healthcare designers/specialists have provided us with additional information, statistics, and strategies regarding the COVID-19 pandemic, its impact with the hospital setting, and how it can be mitigated and isolated through architecture.

In the section following directly after this one, we discuss multiple different case studies that we have researched over the past year and used as precedents for designing our own alternate care sites. Each case study is an example of how to convert a specific type of infrastructure into a suitable surge facility that is able to provide medical care as well as shelter during natural disasters and the current coronavirus pandemic. Whether they are design proposals or existing buildings, these case studies show the diverse range of solutions that architects and engineers around the world have conceptualized or executed successfully. By looking back and contemplating the past, our world has faced many natural disasters and pandemics of various extremes and even though the bulk of this thesis focuses on COVID-19, it is a continuation of the ongoing conversation regarding surge facilities and how architects can design to protect their communities from future catastrophic events.

2.1 Precedent Studies: Alternative Care Facilities

Hospitals have faced a crisis-level shortage of beds as COVID-19 has surged across the globe, and as a result, architects, engineers, and officials respond by configuring different possibilities to open additional space for patients needing care from healthcare providers. Different approaches to solve the lack of available space in hospitals from the past year are examined as precedent studies, which are past influences. This form of research allows one to learn about the design processes and strategies that were implemented by active professionals, which methods presented strong solutions and which ones presented weak results, in order to provide support towards an idea that will be applied in the future. Since hospitals are facing new challenges from the pandemic, designers are having to provide original solutions in order to accommodate the needs of both patients and healthcare providers. In one year, there have been a multitude of unique design solutions to combat the issue of COVID-19, varying from small-scale architectural innovations such as modular units that are easily transported and assembled onsite, to vehicle conversions, to large-scale solutions such as flipping hotels and convention centers into alternative care facilities.

2.1.1 Prefabricated Structures

Prefabrication is the act of assembling structural components off-site and then transporting them to their destination to be completed. As modular construction is trending, it is beneficial to use in a pandemic, because of the reduced labor, cost-effectiveness, and time savings. Prefabricated structures are creatively designed in order to meet those benefits and to see more productivity. Depending on the structure, the components may not even involve an expert to quickly set them up, thus promoting communities to come together for a good cause.

2.1.1.1 Tents and Field Hospitals

A field hospital is a temporary hospital or mobile medical unit that administers medical treatment to casualties on-site before those ill or injured individuals can be safely transported to more permanent healthcare facilities. Typically, a field hospital is equipped with a medical staff, various medical supplies, and a spacious tent-like or inflatable structure. Field hospitals are efficient, easily deployable, and can be readily built near the source of casualties. This term was initially used in military medicine (such as the Mobile Army Surgical Hospital or MASH), but it is inherited to be used in civil situations such as disasters and major incidents.

With the effects of COVID-19, the Samaritan's Purse Emergency Field Hospital in Central Park, New York (Figure 2.1) was established to administer care for those suffering from the global pandemic. Since the initial opening, the Samaritan's Purse field hospitals have worked diligently to both admit and treat critically ill patients. Ultimately designed as a direct response to the coronavirus outbreak, the Samaritan's Purse Emergency Field Hospital, a mobile medical facility, is equipped with a "14-tent and 68-bed respiratory care unit, 10 ICU beds, and ventilators" (Figure 2.2).[8]

Figure 2.1: Samaritan's Purse Emergency Field Hospital in Central Park, New York (Exterior)

Figure 2.2: Samaritan's Purse Emergency Field Hospital in Central Park, New York (Interior)

2.1.1.2 Transportable Health Units

Transportable health units are mobile alternate care facilities that are able to stand as their own entity and travel to medically underserved areas to provide necessary care to patients,

patients who would have otherwise not had medical treatment available. VHL Architecture and Da Nang Architecture University have partnered together to design alternative healthcare facilities (Figure 2.3) that can be deployed around the world to lower economic areas that are facing numerous challenges from the COVID-19 pandemic such as the shortage of patient beds, medical personnel, ventilators, etc. In rural areas, where cases of the virus are increasing every day and medical care is unavailable, transportable and mobile health units can be extremely beneficial to provide healthcare to the community. The transportable health units by VHL Architecture and Da Nang Architecture University have been designed as containers that are "20 feet long and can be split into four parts for transportation purposes."[21] Each room size is 2x2.4 meters, holding one bed and sufficient space for medical examinations and treatment processes. Ultimately, the health models can easily be transported to any location, and installed on-site on any flat land, to provide the surrounding community with immediate and effective care.

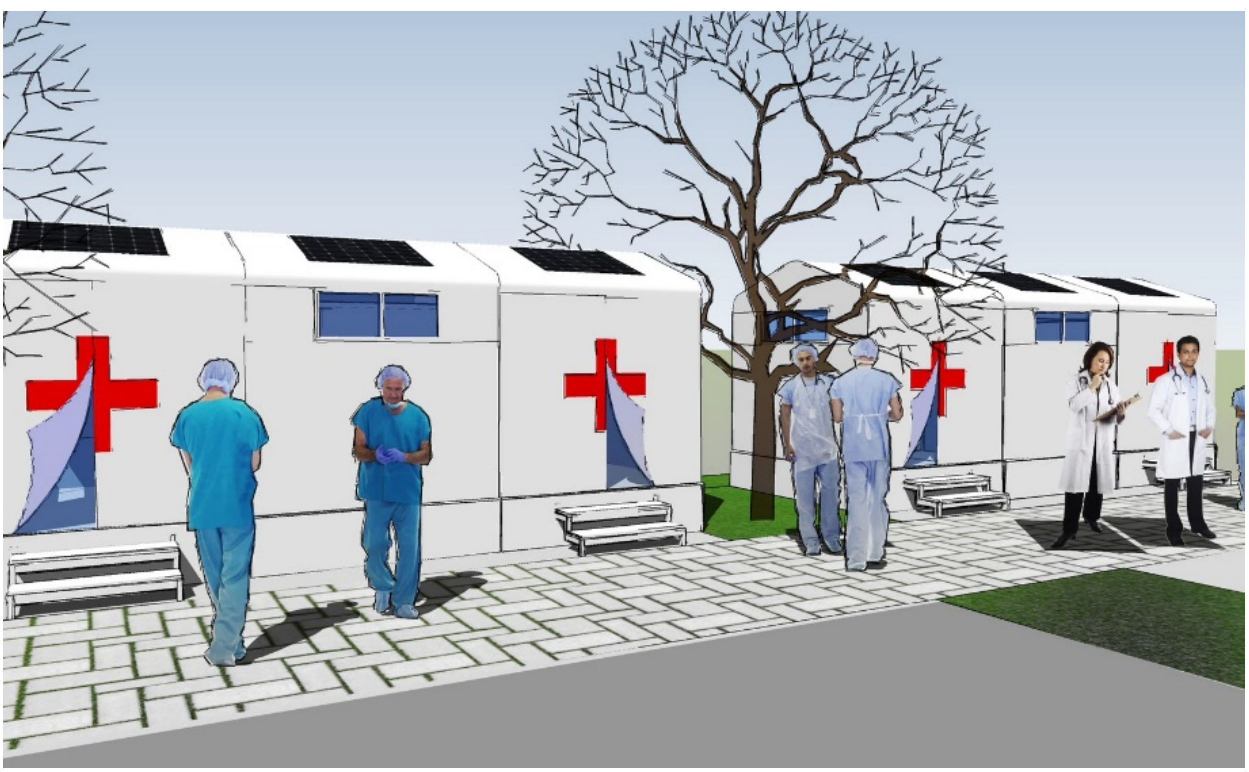

Figure 2.3: Transportable Health Unit by VHL Architecture and Da Nang Architecture University

As another effort to face the lack of beds in healthcare systems, JUPE HEALTH created a sequence of mobile units (Figure 2.4) that include rest and recovery units, as well as mobile ICUs. The JUPE Health units are "1/30th the cost of a hospital room", are "designed by leading healthcare professionals and mobile shelter experts" and are ready to be shipped anywhere needed.[1] The best part of these mobile units is the convenience of its deployment (Figure 2.5). Interestingly, the JUPE Health unit can deploy up to "24 health units with a single 40' flatbed and heavy-duty pickup truck to both rural and urban areas" and "up to 500,000 can deploy on a single cargo ship."[1]

Figure 2.4: Transportable Health Units by JUPE HEALTH

Figure 2.5: Transportable Health Units – A tent-like structure that is easy to assemble, disassemble, and transport.

2.1.1.3 Modular Units

Modular health units are an ideal solution for emergency response, because modular units can be rapidly deployed, have the ability to quickly expand capacity, and can easily be demobilized after the mass casualty incident has receded. Architect and engineer Carlo Ratti teamed up with a group of international experts to design and develop intensive care pods referred to as Connected Units for Respiratory Ailments (CURA). As a design, the CURA Pods (Figure 2.6) are shipping containers that have been converted into modular, mobile, deployable alternate care sites for coronavirus patients. When observing the careful design of the CURA Pods, "each pod is intended to function independently of the next and will be retrofitted to include the medical equipment—beds, IV stands, and ventilators—necessary to treat two COVID-19 patients."[17] With two patient beds in one pod (Figure 2.7), it is important for medical staff to be able to maneuver around both the patients' bed as well as the necessary medical equipment. The floor plan provided demonstrates how CURA Pods have been spatially organized to assist in the medical staff's measures of patient care (Figure 2.8).

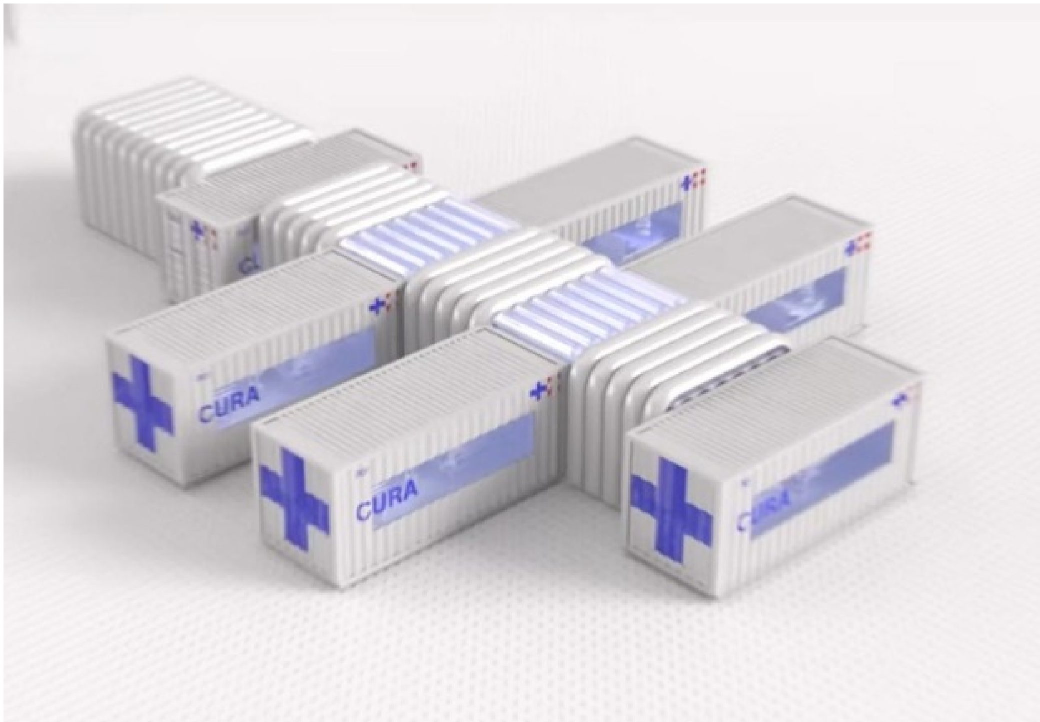

Figure 2.6: CURA Pods by Italian Architect, Carlo Ratti – modular arrangement of an alternate care site

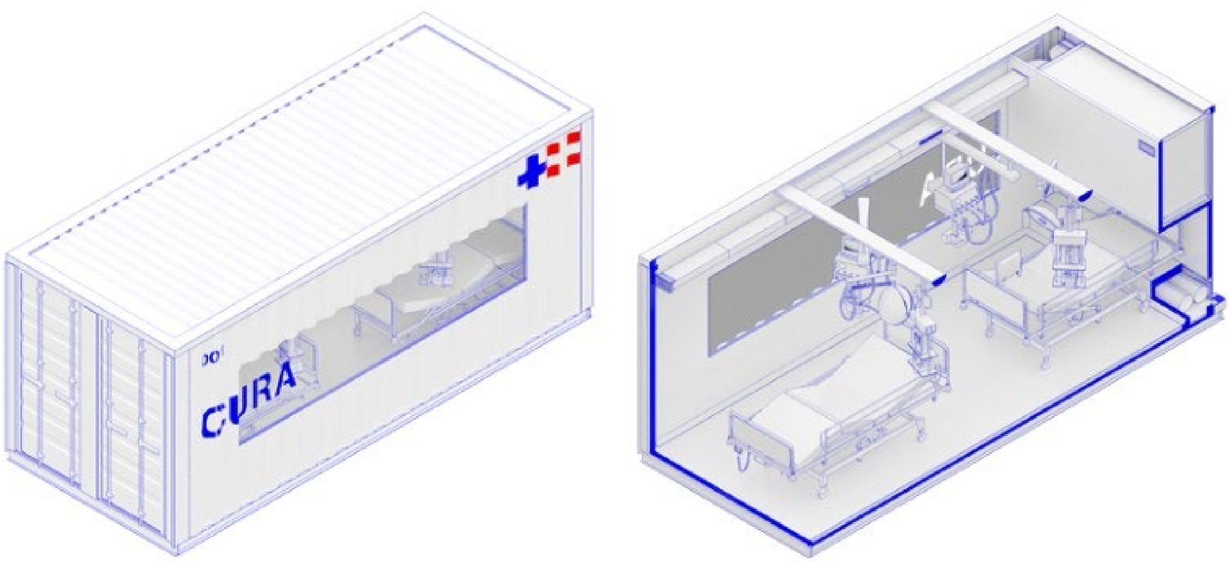

Figure 2.7: CURA Pods by Italian Architect, Carlo Ratti – exterior (left) and interior (right) view of container

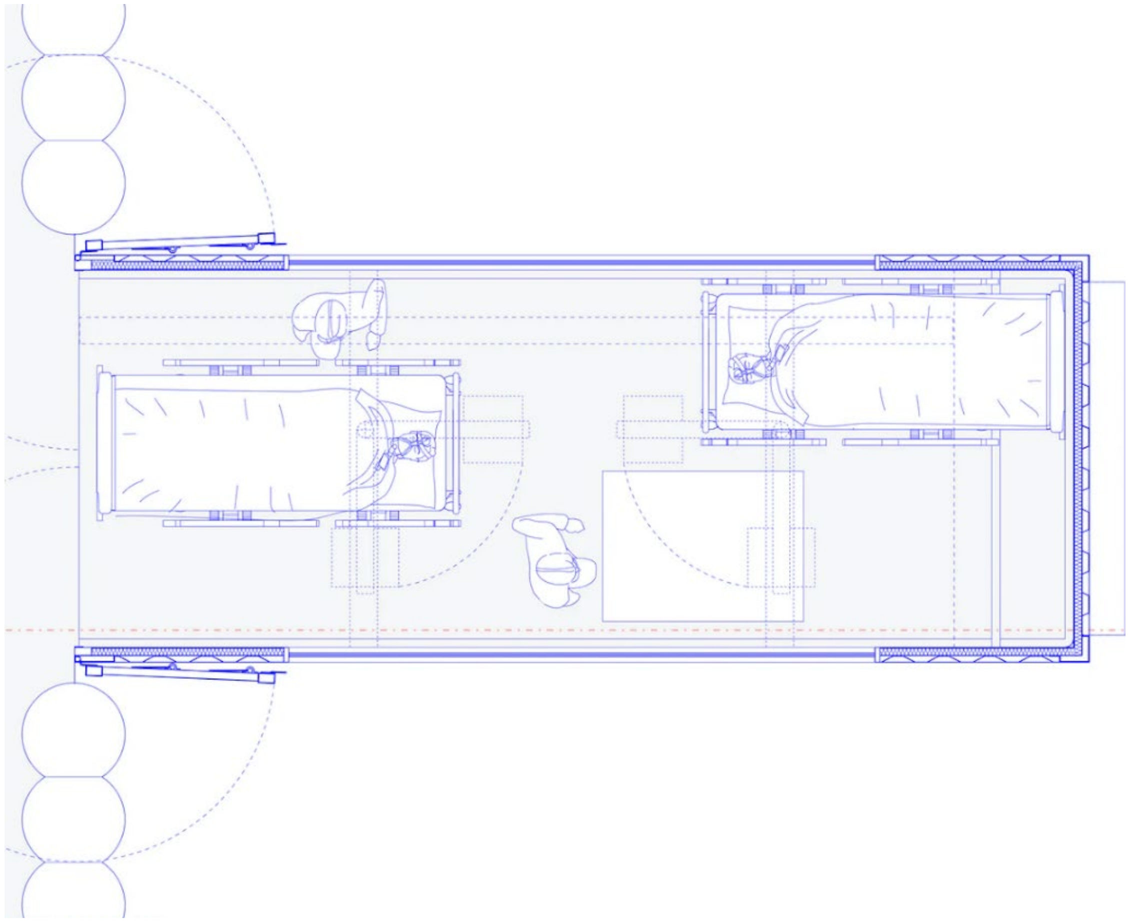

Figure 2.8: CURA Pods by Italian Architect, Carlo Ratti – medical shipping container floor plan

Similarly, to the CURA Pod design, MMW Architects have created an alternate care site design solution (Figure 2.9) that is an “efficient, flexible and affordable modular hospital” that will be utilized to “increase intensive care capacity on a national- and international level.”[11] The innovative construction of the modular solution is “based on the use of recycled shipping containers and inflatable fabrics” in order to “meet the strict requirements of air contamination in hospitals.”[11] Based on the needs and circumstances of the mass casualty incident, the shipping containers can accommodate both large patient rooms as well as intensive or isolated care rooms. Ultimately, “the system is intended to be a contingency hospital that will function as a satellite hospital physically close to a larger hospital” (Figure 2.10).[11]

Figure 2.9: Modular Unit by MMW Architects (Exterior Perspective)

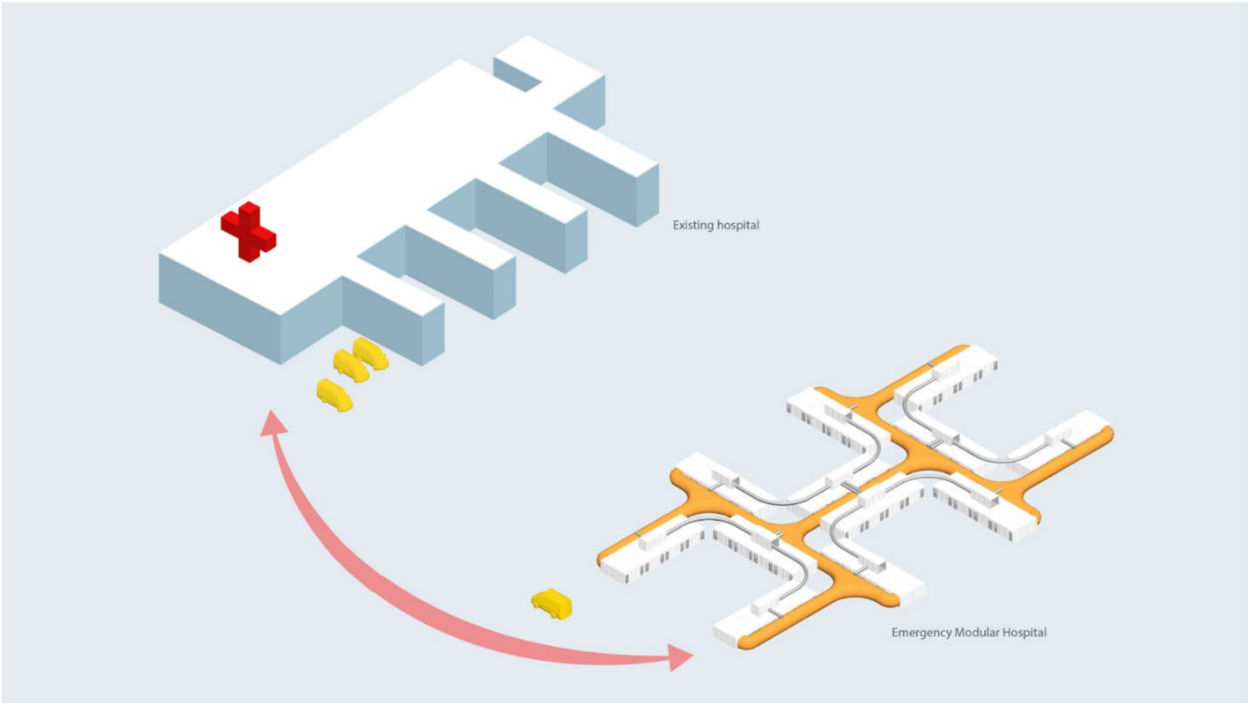

Figure 2.10: Modular Unit by MMW Architects – alternate care site in relation to existing hospital

2.1.1.4 Shipping Containers

In an effort to combat the coronavirus outbreak, Rapid Deployment (Rad) Hospitals are working to design and build emergency hospitals out of shipping containers (Figure 2.11). The RaD prototype uses "decommissioned shipping containers and repurposes them into ICU/Isolation Units" for positive COVID-19 patients.[22] Currently, RaD is "coordinating with the Department of Health to build these makeshift facilities as few private hospitals have announced that they have reached maximum capacity and can no longer accept more COVID-19 patients."[22] Providing both sufficient circulation for healthcare providers and practitioners, the floorplan and layout of the modular shipping containers have been arranged in a strategic manner (Figure 2.12).

Figure 2.11: Shipping Container Alternate Care Facility (Exterior Perspective)

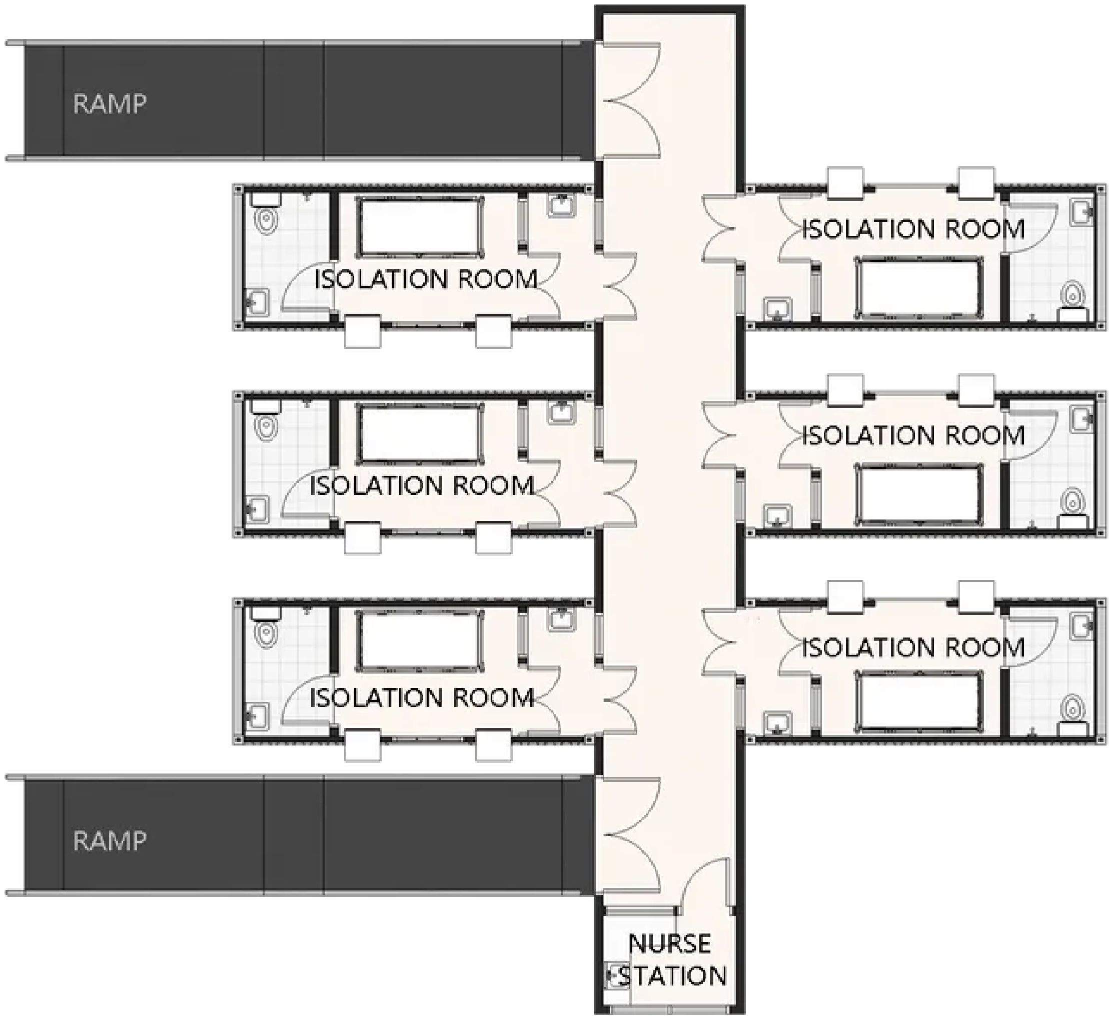

Figure 2.12: Shipping Container Alternate Care Facility (Floorplan)

The Field Rescue Center (FRC), developed by the HAHA Architects Group located in Poland, sought to establish an alternative care site that would conceptually serve as a "mobile diagnose and treatment facility."[11] Essentially, the Field Rescue Center (Figure 2.13) was developed to be utilized in times of future unforeseeable crisis such as: "epidemic, pandemic, natural disaster, refugee crisis or on humanitarian missions, when it is crucial to quickly provide medical help to a vast number of people."[11] Furthermore, as a self-sustainable solution, this alternate care site is fully equipped to operate as a "functional temporary hospital, while a proper medical facility is under construction" (Figure 2.14)[11]. Through the use of Twenty-foot Equivalent Unit (TEU) containers, the Field Rescue Center is deemed a mobile structure that is relatively easy to transport and assemble. With a simple deployment and assembly, the only tasks required consist of "placing the containers in the right place, connecting the FRC to power, running water, gas, etc., and moving in the medical equipment."[11]

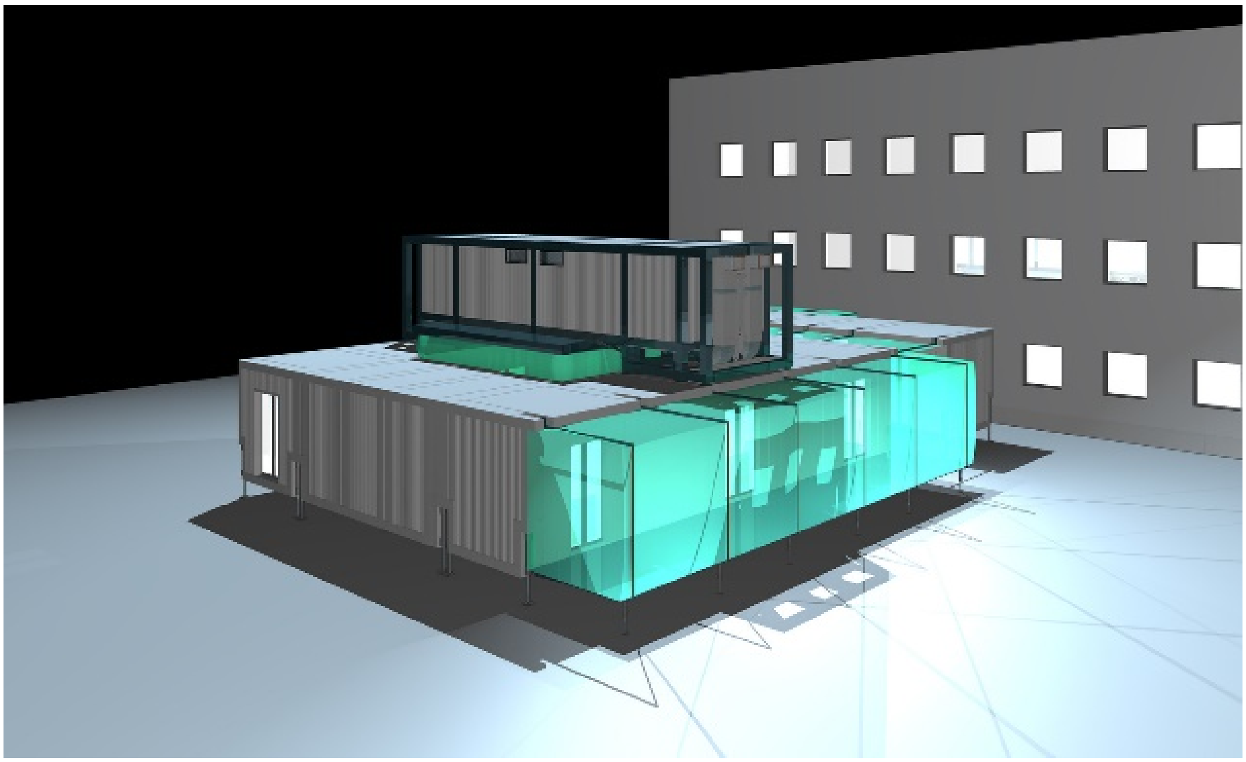

Figure 2.13: Shipping Container SURGE Conversion - Field and Rescue Center (Exterior Perspective)

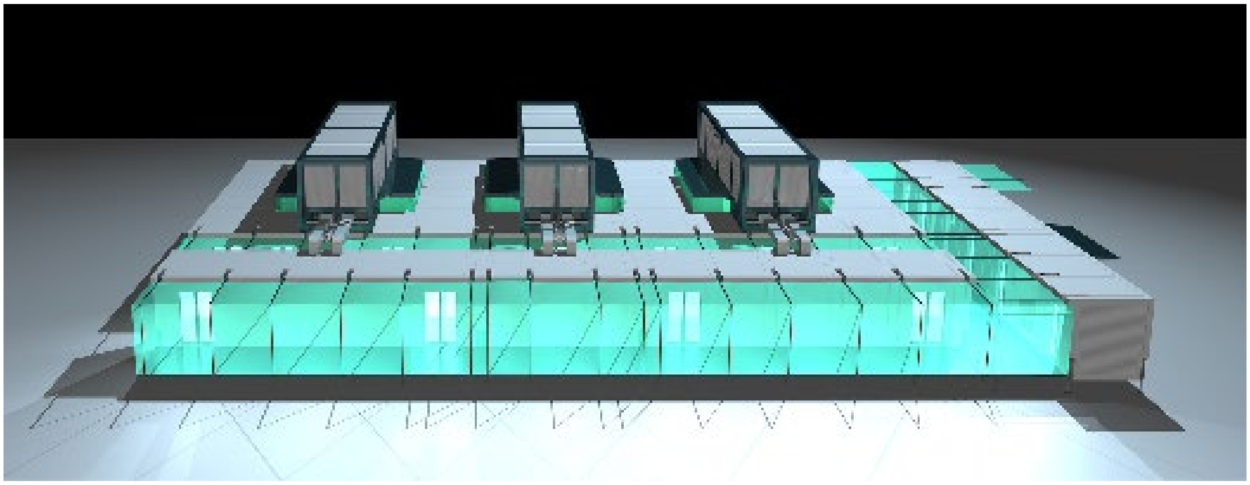

Figure 2.14: Shipping Container SURGE Conversion - Field and Rescue Center – temporary hospital arrangement

2.1.2 Existing Building Conversions

When designing alternate care sites, existing facilities are beneficial medical conversion opportunities, because they offer essential transitional design spaces that can be equipped to accommodate the needs of patients and healthcare providers. A few of the transitional spaces that are offered with existing buildings include large open gathering spaces, kitchens and dining areas, private rooms for staff, drive-up entries for emergency vehicles, and layouts that divide the flow of incoming patients, discharged patients, and medical staff. Examples of existing infrastructures that can flex into an alternate care site include schools, convention centers, hotels, and parking garages. As the existing facility transitions into an alternate care site, careful and detailed planning must go into areas of conversion to ensure that health standards are being met and that patients are receiving the utmost care.

2.1.2.1 Schools

As an alternate care site, educational facilities provide access to large and open spaces which are essential when considering design solutions for housing increased quantities of patients seeking medical care. Some of the large spaces within educational facilities that lend themselves to housing high quantities of patients include gymnasiums, cafeterias, and atriums. Additionally, the long-widened corridors and individual classrooms inside the school complex allow for conversion opportunities such as patient care rooms and wayfinding/circulation considerations. In an effort to provide a solution to school conversions, HKS, a renowned architectural firm in the U.S, has researched ways in which a school alternative care conversion could be most effective when utilizing the variety of spaces that schools provide. Through research, design, and practice, HKS has devised an overview of the most efficient spaces that can be allocated or easily transformed into surge functions within an educational facility (Table 2.1).

Table 2.1: School SURGE Conversion Considerations Outlined by HKS Architects

High School to Patient Care: Potential Room – Use Conversions	
High School Conversion	Patient Care Use
Classrooms	Patient ward, command center, office spaces, meeting rooms, staff sleeping
Science Labs	Stat lab, point-of-care testing, pharmacy, patient care
Cafeteria	Break room, meal prep for patients and staff
Library	Command center, office space, meeting room
Gymnasium	Larger patient ward
Locker Rooms	Staff/patient showers
Bathrooms	Multi-stall toilets
Laundry	Washing frequently used items
Dock	Loading/off-loading supplies
Drop off / Bus lanes	Ambulance staging, drive through testing and flexible site flow

Existing educational facilities, and their open floor plans, allow schools to be advantageous structures in the event of a medical surge or mass casualty incident. School conversion spaces offer a duality between large COVID-19 Wards and privatized Airborne Isolation Infection Rooms (AIIR) for critically ill or infected patients. Taking advantage of some of the flexible open spaces within a school, the Health Education Campus in Cleveland utilizes an atrium as a potential alternate care facility (Figure 2.15). Easily capable of transforming in the event of a surge capacity, the 80-foot-tall central atrium gives access to upwards of 150 beds in a single space. Ultimately, the Cleveland Health Education Campus will be able to house approximately 1000 beds when each lecture room, lab, and office is occupied to full capacity (Figure 2.16).

Figure 2.15: Cleveland Health Education Campus (Primary Function as School)

Figure 2.16: Cleveland Health Education Campus (Secondary Function as SURGE Facility)

2.1.2.2 Hotels

With access to both large open spaces and private rooms, hotel structures offer a fast and easy alternative medical facility conversion for local hospitals that are overrun and need to have patients relocated. Built within each unique hotel design, private guest suites and bathrooms serve as opportunities for conversion into isolated patient wards in the event of an unpredictable disaster. In order to transition a hotel guest bedroom into a patient care room, the design components and interior features of a single guest room have to be altered to meet health guidelines. Design considerations for a typical hotel room conversion into a patient room could include carpet replacement, non-essential furniture removal, waterproof bed protection, as well as sufficient air that is not recirculated within staff rooms (Figure 2.17).

While it is important to understand how a simple guest room will be able to accommodate patients, it is also necessary to strategize design considerations for massive spaces such as ballrooms that can accommodate a large subset of patients seeking medical care. Recently, HKS conducted extensive research on how a hotel ballroom might satisfy a successful medical ward in the event of a disaster like the COVID-19 pandemic. The ballroom is an advantageous conversion space because it is a flexible open room, relatively centralized within a hotel, and has strengthened floors and ceilings. In addition to hotel ballroom conversion methods, HKS strategizes how an entire hotel structure could be organized into hospital treatment zones with access to a point of care lab, medication/ supply storage, and control center (Figure 2.18).

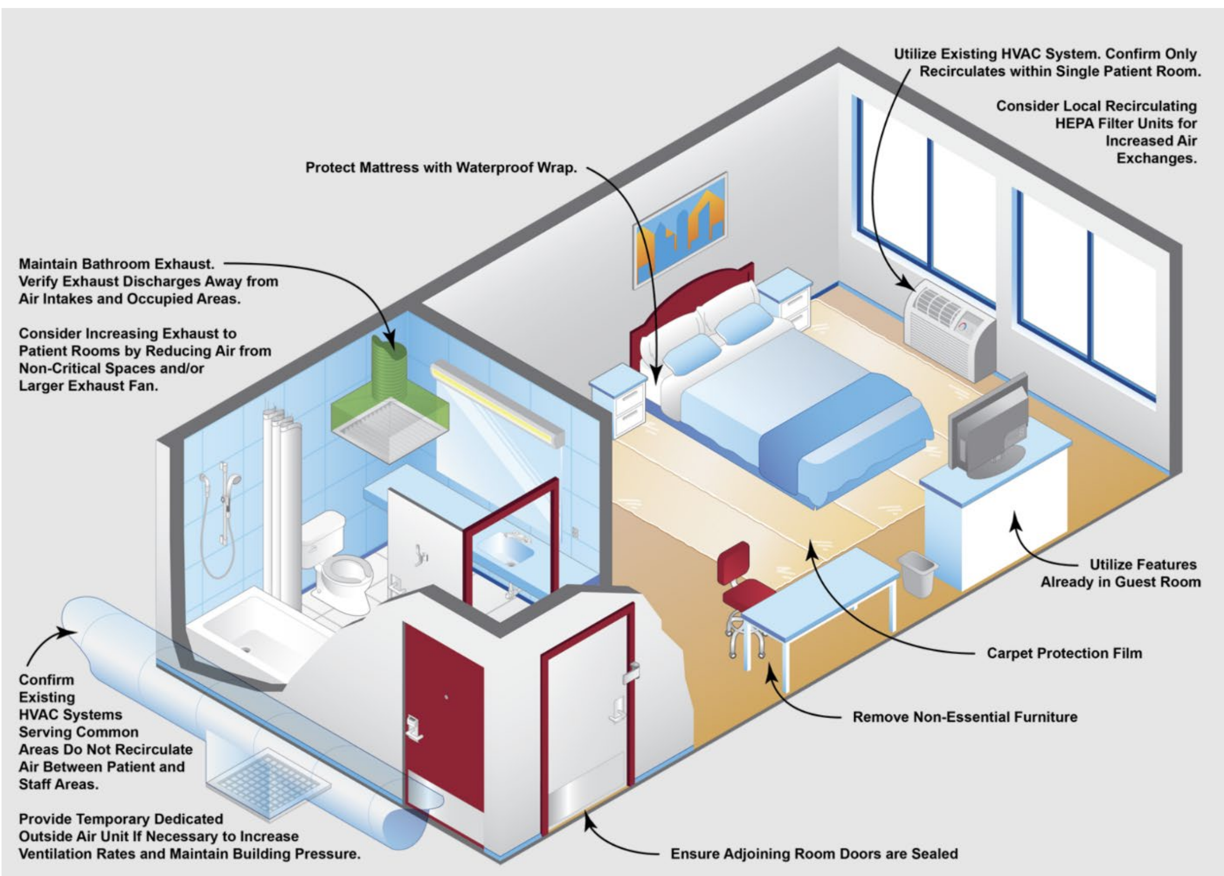

Figure 2.17: Hotel SURGE Conversion – Hotel Room to Patient Room

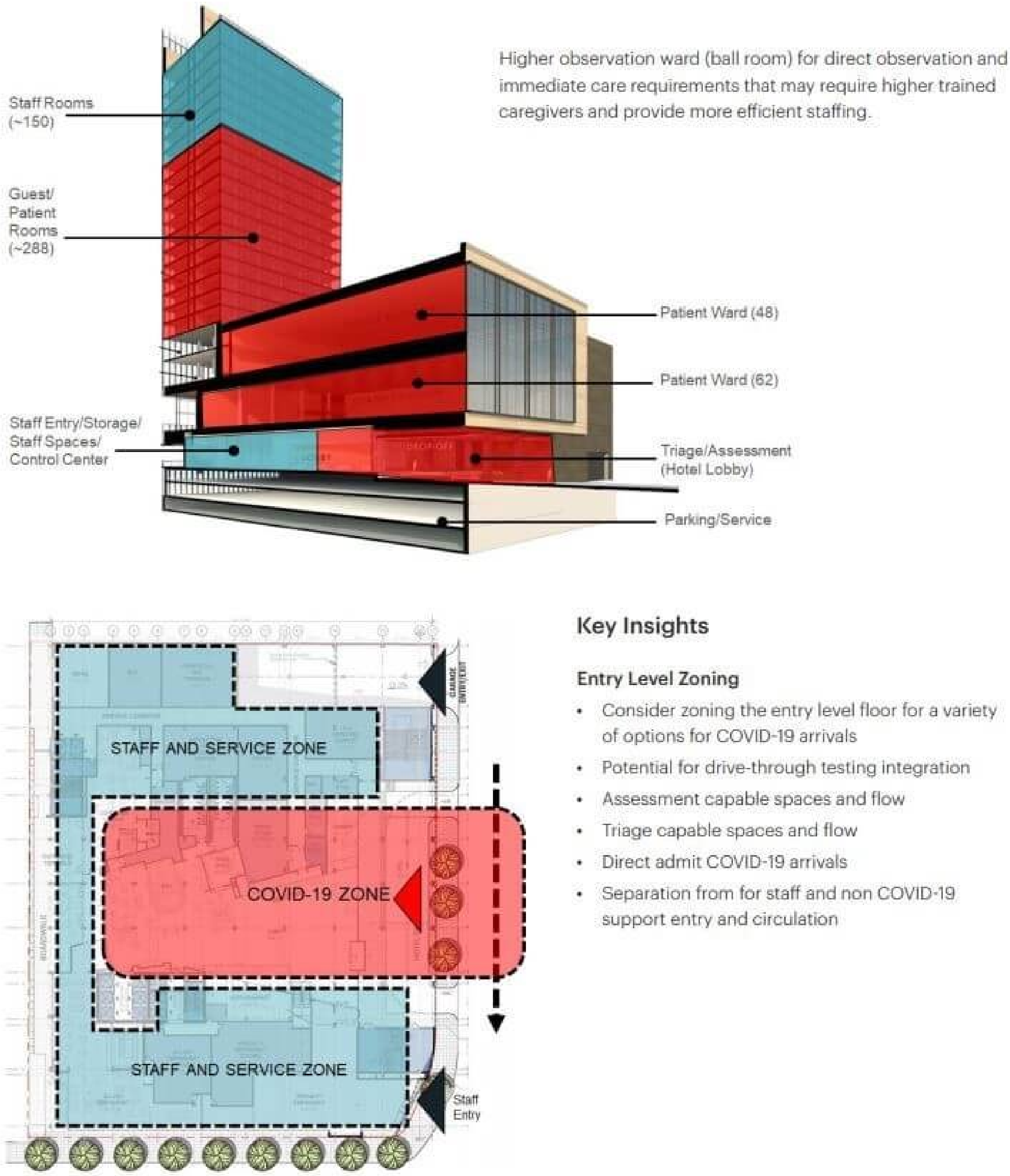

Figure 2.18: Hotel SURGE Conversion – HKS Zoning Diagram

2.1.2.3 Parking Garages

A non-profit hospital network called "Renown Health" has begun to experiment with how to effectively flex a parking garage structure into an alternate care facility (Figure 2.19). Overall, the project took 10 days to complete with ample HVAC and electrical systems that run along the top of each floor. A single partitioned staff area splits each floor to allow for the most efficient access to each floor. Although there are no partition walls between each patient, the area is kept clean and is supplied with all necessary medical equipment. One large factor that contributes to the success of this parking garage surge conversion is the accessibility to the hospital which is located adjacent to the parking garage. Ultimately, Renown Health's surge conversion plan was enacted to ensure that if there was a large medical surge in the nearby hospital facility, patients could be easily relocated to the nearby parking garage to receive medical care.

Figure 2.19: Parking Garage SURGE Conversion – Renown Health

2.1.2.4 Convention Centers

When it comes to the necessity for large alternate care sites, convention centers offer a massive and efficient space for containment and patient treatment. The boundless space each convention center provides gives easy access to large swaths of patients that overrun their local hospitals. Although there is slight variation between how each convention center operates, most of the ones that have been converted since the COVID-19 pandemic have all maintained a similar level of organization along with providing necessary medical equipment for treatment. Ventilator systems, beds and ICU units are placed in each of the ‘pods' that are set up in rows to allow for the most efficient way of utilizing and maximizing the large convention center space. The Washington Convention Center (Figure 2.20), a strong example of a convention center conversion, serves to represent a massive space that can be used to house hundreds of patients in the event of a natural disaster or pandemic. At a macro level, these pods can be assembled and organized at a relatively efficient speed from the conception of the project. At a micro level, each isolation room has been equipped with ICU beds and necessary medical supplies (Figure 2.21).

Figure 2.20: Washington Convention Center SURGE Conversion

Figure 2.21: Washington Convention Center Individual Care Room

2.1.3 Existing Mobile Conversions

When observing alternate care solutions, creating additional space for patients to receive medical treatment does not necessarily mean that the facility must remain as a stationary structure in a designated location. Utilizing mobile or vehicular alternate care designs is a strategic way to serve a variety of patients, especially patients that might not have access to a traditional healthcare setting. Since vehicular structures are able to transport, these care modules are not limited by a geographical location and can provide medical services to both rural and urban areas. In other words, mobile alternate care sites can be located in critical access points (suburban and rural areas), providing multi-specialty care in a location that might otherwise not have access to the nearest medical facility.

2.1.3.1 Hospital Ships

In an attempt to encourage a global response, Weston Williamson, an award-winning architecture and urban design practice, proposes hospital ships as a potential alternate care site (Figure 2.22). As a potential solution, Weston Williamson is utilizing shipping containers on marine vessels, as the shipping container module is ideal for intensive care patient rooms and medical equipment (Figure 2.23). With the hospital ship proposal, approximately 3,500 shipping containers could be placed per vessel, and "patients would only remain on the ship in circumstances where there is no place to deploy them" (Figure 2.24)[11] As an effective design solution, the shipping containers have been "adapted by removing one of the steel doors and nailing a Perspex panel in place."[11] The Perspex panel is an important design consideration because the "hit and miss panel for natural ventilation and a built-in air conditioning unit," which is extremely beneficial for the patients on board.[11]

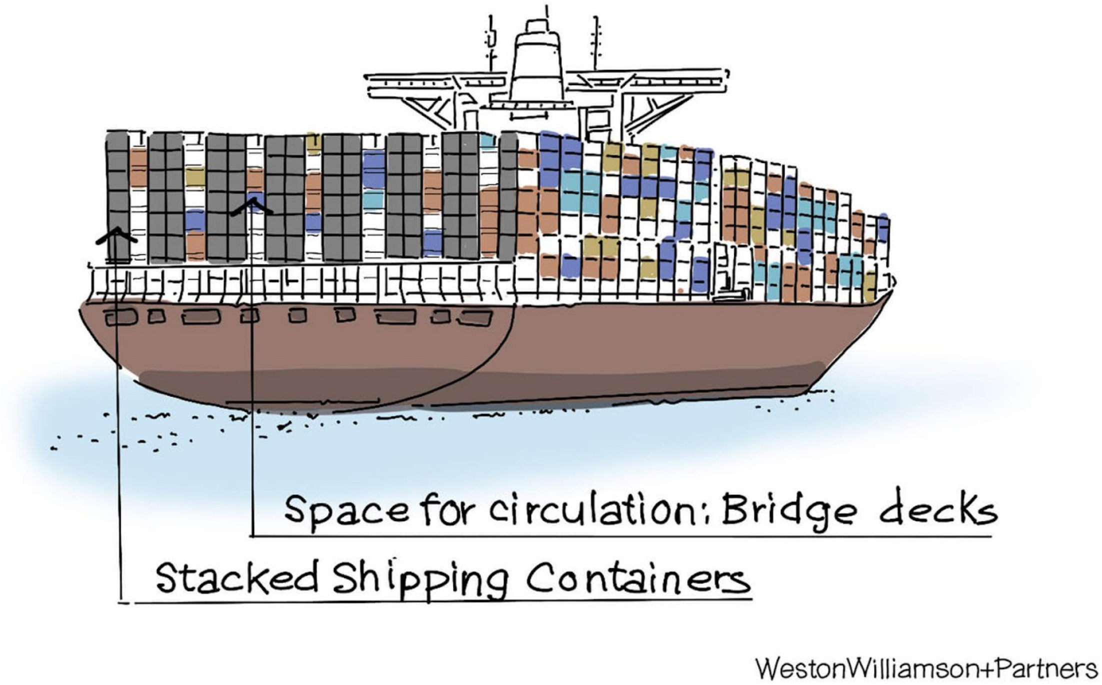

Figure 2.22: Weston Williamson Hospital Ship SURGE Conversion

Figure 2.23: Weston Williamson Medical Shipping Container Module

Figure 2.24: Weston Williamson Rapidly Deployable Medical Shipping Container via Hospital Ship

2.1.3.2 School Busses and Public Transit

Designing for a mobile alternate care facility, Perkins and Will transformed an old school bus into a mobile COVID-19 testing clinic. Overall, the design of the clinical school bus includes an outdoor covered area, which serves as a fold out protective tent where patients can arrive to get tested for coronavirus (Figure 2.25). The interior of the bus is primarily utilized by nurse practitioners administering the COVID-19 tests. With the layout of the mobile unit, healthcare providers are able to administer necessary exams, test samples and specimens in an on-site lab, and have access to ample storage space for necessary medical supplies and equipment (Figure 2.26).

Figure 2.25: School Bus SURGE Conversion – Perkins and Will

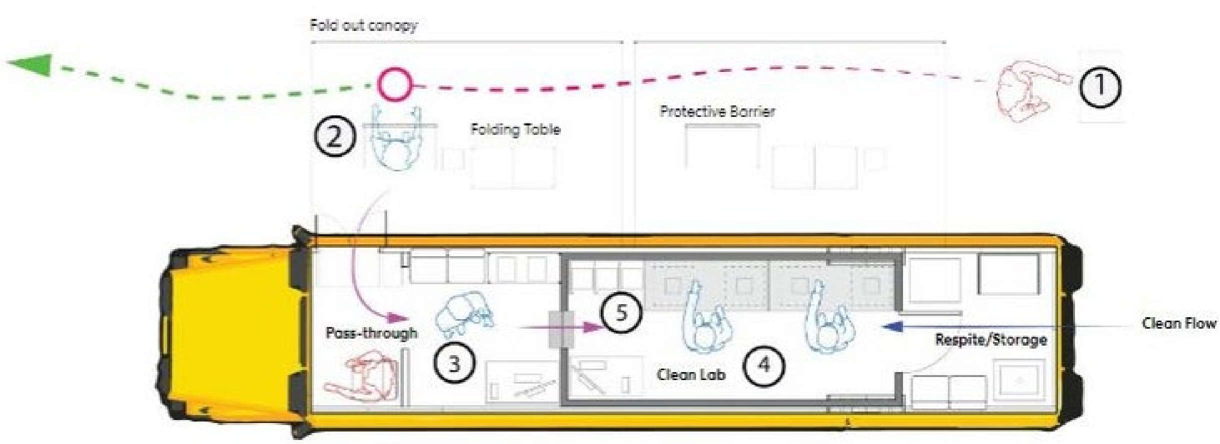

Figure 2.26: School Bus SURGE Conversion – Perkins and Will interior layout and floorplan

Similar to the concepts presented by Perkins and Will, Hospitainer has designed a shipping container mobile laboratory to perform viral disease tests in affected areas (Figure 2.27). Hospitainer believes that this modular and mobile design solution could "contribute to combating infectious diseases like Ebola, Zika and Corona."[14] As a mobile solution, the Hospitainer Laboratory Trailer provides several advantages such as "better climate control with AC/heating and insulation, better protection of staff because of pressurization systems, HEPA filtering and (eye) shower, better and safer work environment for staff, and containers are usable under all climatological circumstances."[14] With these healthcare design solutions implemented on a mobile unit, the Laboratory Trailer can be driven to critical access points, providing both easy access to the consumer and multi-specialty care.

Figure 2.27: Mobile SURGE Conversion – Hospitainer Mobile Medical Unit

HOK Group, a global design, architecture, and engineering firm, teamed with Germfree Laboratories Inc. to design a mobile testing lab to "address the needs of large institutions including universities, companies with large campuses, manufacturing facilities, or government agencies" (Figure 2.28)[12] The collaborative design is a self-contained biocontainment facility that "provides advanced, on-site capabilities for any setting" and can be considered as a "rapidly deployable solution for testing active or suspected cases of COVID-19."[12] When looking at the design itself, the mobile medical modules contain labs that "accommodate up to nine staff workers as well as one or two high-throughput diagnostic machines capable of testing 80 samples at a time, resulting in up to 1,120 tests per day."[12] Thus, the mobile COVID-19 testing labs, created by HOK and Germfree Laboratories Inc., provide the consumer with access to quick and reliable testing and medical care during the COVID-19 crisis (Figure 2.29).

Figure 2.28: Mobile SURGE Conversion – HOK and Germfree Laboratories Inc. (Exterior Perspective)

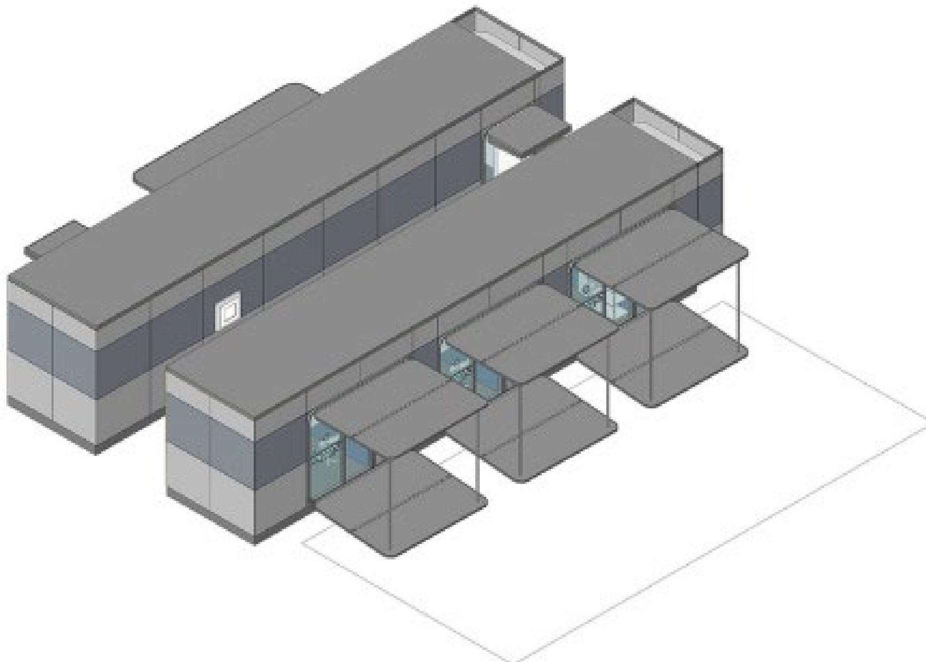

Figure 2.29: HOK and Germfree Laboratories Inc. Mobile Testing Lab

2.1.3.3 Helicopters and Airplanes

As coronavirus cases continue to increase around the globe, the Air Force has decided to train medical professionals how to correctly operate an isolation system; an isolation system that can be utilized to transport critically ill or infected patients on military aircraft. The Transport Isolation System (TIS) is "an infectious disease containment unit that can be secured inside aircraft to minimize the risk of contagion to the aircrew while at the same time allowing for medical care" (Figure 2.30).[18]

The Transportation Isolation System was first utilized after the Ebola outbreak in 2014, when the TIS was predicted to have a low volume of patients. However, with the outbreak of the coronavirus pandemic, TIS must respond and "adapt to higher volume transport."[18] The TIS module “consists of one antechamber module and two isolation modules so that two patients can be comfortably accommodated into one unit, and fits on C-130H, C-130J, and C-17 aircraft” (Figure 2.31 & 2.32).[18] While the isolation modules are for individual patient care, the antechamber module “provides an area for medical workers to safely decontaminate and remove personal protective equipment.”[18]

Figure 2.30: Aircraft SURGE Conversion -Transportation Isolation System

Figure 2.31: TIS interior isolation module and antechamber

Figure 2.32: TIS Steel Shipping Container

2.2 Research: Texas A&M University "Architecture for Health" Lecture Series

2.2.1 "SURGE" Capacity: Healthcare Preparedness for all Hazards Response

This lecture series serves to provide information concerning healthcare and the importance of health safety from multiple accounts from architects and members in the field of construction science. The lecture series as a whole takes from different perspectives in the field to address concerns within the healthcare system as it relates to the growing pandemic. Each lecture contributes to a different problem or solution that is meant to educate the public on how to appropriately view surge capacity along with the adoption of surge facilities to be put as an alternative to hospitals.

2.2.1.1 The Case for Clean Air: Long Term Architectural Implications

"The Case for Clean Air" lecture gives an overview of health safety along with building safety and building management within hospitals. The lecture is presented by Dr. P.K. Carlton, former Surgeon General of the United States Air Force, and Allan R. Parr, the chief executive partner of REES architecture, planning, and interior design firm, with the intention to inform the public about COVID-19 itself and the steps buildings can take to adhere to a safer environment. Initially, Dr Carlton explains that COVID-19 is spread through respiratory droplets whilst surface interaction does not constitute vast spreading of the virus. There are ways in which to detect the illness which can be done through the use of multi factor health screening. The importance of understanding how it is spread is used to help figure out the most effective ways in which to counteract the spread in facilities. ASHRAE gives insight on how we could clean the air around the building by ensuring that there are at least twenty air changes per hour. The HEPA filter proves to be the most efficient filter that can diffuse particles whilst the air can be treated by Hydrogen Peroxide gas generation units. Personal protective equipment or PPE is vital for the protection of oneself and others and lowers the risk of the virus. One last aspect that this lecture covers is the consideration for touchless bottle filters and drinking fountains which lower the surface interaction as an extra precaution.

2.2.1.2 Construction / Design / Engineering Firms Turn Operating Penitentiary into COVID-19 Hospital

This lecture, presented by Clark Construction, serves to inform the public on projects that have been undertaken for the sake of converting pre-existing buildings into surge capacity alternate care sites. The representatives from Clark Construction, Patrick C. Suermann, Hernan Guerra Santos, Terry Edmondson, and Mark Corwin, took on a variety of jobs responsible for the conversion of existing buildings into alternate care facilities which include that of Hagerstown Correctional Facility. The project itself had to be completed within three to six weeks and had to be converted into a 192-bed, non-acute COVID-19 Alternative Care Facility. With the project as a non-acute healthcare facility, Clark Construction had to focus on the initial design along with the pricing, negotiation, construction and turnover within a short period of time. The most important aspect of the project was figuring out more of the electrical systems and mechanical systems to ensure a clean environment. One of the main concerns within the project was the lack of cooling and AC within the rooms. In order to counteract this, there had to be a distribution of cooling through the roof and corridors to ensure positive pressure ventilation so that negative pressure could exist within the patient rooms. In order for the project to be successful, there had to be field assessment along with controlled access points and a sterilized work environment. In all, construction lasted for two and a half weeks with the total project duration being forty days.

2.2.1.3 Guidelines & Standards for "SURGE" Health & Hospital Facilities

This presentation by Jeffrey Henne, Safety and Emergency manager of Penn Medicine, reflects on the guidelines for an appropriate surge hospital facility. Henne is also president of the American Society for Healthcare Engineering (ASHE) which is a key partner in national leadership of architecture. The lecture serves to give insight on the Pennsylvania hospital which is considered a very congested hospital that contains around five to seven thousand patients a day through the outpatient center. The idea was that there was going to be a new addition of a patient pavilion tower in which rooms could be easily converted into ICU rooms along with the necessary addition of a new outpatient center and ICS center. The question of this lecture revolves around the idea of making sure there is management at all ends for creating the most efficient operations while still always maintaining appropriate health and safety precautions. For one, there needs to be a diverse group of leadership that ranges from the Surge Council along with Health systems directors to control any medicine issues, negative pressure supplies and whatnot. There is a major importance for the use of PPE and ICU's, wards, as well as single and double occupancy patient rooms. Communications are a key component of maintaining such a large operation, and this is why the knowledge center is so important in keeping track of the information reported to the state along with all the staff that is located in each section of the hospital. With that, there is the necessity that all of the tasks taken to ensure appropriate guidelines and standards should be met in compliance with ASHE.

2.2.1.4 "SURGE" Spaces: The Epidemiology of Refugee Distress and Architectural Implications for Spaces Designated for Healthcare

This lecture was presented by Dr. Dale Moshe Sumbuerur over the origins of COVID-19 and pandemics in general, along with salutogenics and surge now. Sumbueru has his bachelor's degree in biochemistry and nutrition and is a Doctor of Public Health in epidemiology. The lecture serves to give the public an overview of the pandemic itself by presenting it as an unexpected increase in disease cases in a given geographical area. Extreme examples of this include the schistosomiasis disease in Spokane, Washington. Sumbueru then begins to explain what the epidemic curve starts to look like by presenting the point of impact and how epidemics and pandemics have fluctuated over periods in history. There is this notion that when you design buildings, you must always consider the potential of creating surge space beforehand which includes an embedded design that can perform the tasks of a surge facility. A key takeaway from this lecture was that we as humans need to take time to observe the facts of these occurrences instead of relying on the media to give us the information.

2.2.1.5 "Alternative Care Facilities" for the United States Army Corps of Engineers Emergency Response to COVID-19

Jim Whitaker, director of Government & Alternative Project Delivery at HKS design firm, gave a presentation on projects that were completed by the combined work of the Corps of Engineers, architects, and other professionals in the spring of 2020 on buildings that were converted to meet the needs of serving and caring for COVID-19 patients. Each project that was presented gave an overview of the timeline of the conversion, the square footage, the number of hospital beds that were accommodated, the total cost, and the unexpected challenges that were faced along the way. The first job that was completed by the teams was the Suburban Collection Showplace, which is a convention center in Novi, Michigan. The 250,000 square feet venue held 200 beds and cost 15 million dollars of work. Initially, the plan was to finish the conversion in 15 days, but it was finished after 11 days in a constantly evolving process. Whitaker said that the plans were updated every hour, but lessons were learned from this experience and from the other jobs that were completed. For example, teamwork on multiple levels is essential to carrying out such a task, because "senior leadership cannot abandon project delivery teams to problem solve alone." Leadership also matters and is fundamental to any successful endeavor. Other lessons were pointed out, but the overall presentation not only gave the viewers an understanding of the realistic process of a conversion, but also the importance of hard and soft skills that contribute to an efficient project.

2.2.1.6 How to Plan for Disasters Before Beginning the Process of Designing Responses

This presentation by Luis Martinez and Michael R. Cook, partners of the Innova Group, focused on the understanding of the language around pandemics, the pandemic triage and treatment planning, and lessons learned from these experiences. The presentation started off with explaining some ways that diseases can be passed from person to person, such as in direct, indirect, and vector paths. Pandemic preparedness was then elaborated on through the Pandemic Planning tool, a tool that uses epidemiologic, operational, and facility assumptions to estimate the number of staff, space, staff equipment, and patient equipment needed over a wave of demand. This certain tool gives estimates on popular triage, consult and education, vaccination areas, visitor centers, and many more functions or activities for services. The services include hospitals, campuses, and communities. Some questions that arose from previous work on these services were: Is concentration of care more important than the ease of access to care for the patient? Where is your patient population residing in relationship to your sites of care or the sites of testing? These questions allowed them to reflect on their planning and analyze the factors that play an important role in pandemic preparedness. Lastly, the Innova Group gave some suggestions when thinking about the design process. These suggestions included arrivals and site circulation, physical distancing, and medical equipment in order to remember when future services in a pandemic must be carried out.

2.2.1.7 SURGE Hospitals: Bed Maximization Study for Yale New Haven Health System and COVID-19 Surge Solutions Task Force of HAIO (Healthcare Associated Infections Organization)

The lecture given by Cathleen Lang, Scott Mueller, and Gerard Georges from Shepley Bulfinch Architects, and James Labrie from Turner Construction introduced topics on a hospital maximation study and the task force. The Bed Maximization study concentrated on understanding the different types of patient areas at each campus. Those types that were identified were categorized into four tiers, each tier ranging from existing hospital beds to underground spaces. They described how the Greenwich Hospital turned an 86-bed floor into a 150-bed floor, which was accomplished by fitting two patients in each room while still being able to designate space for necessary medical equipment. Another operational change occurred in the McGivney Surgery Center, which was transformed into a COVID-19 treatment facility by utilizing spaces such as recovery rooms and operating rooms to transform 41 beds for patients with the virus. HEPA filtration, or High-Efficiency Particulate Air, was emphasized for its critical need in these spaces in order to mitigate infection spread. The goal for HAIO, or Hospital Acquired Infections Organization taskforce, is to develop surge capacity solutions for post-acute patients, providers and building industries. There are some considerations to take in when converting existing healthcare facilities, such as building assessment, operational qualities, time, costs, and engineering considerations. More topics were covered on converting hotels and dorms, and on-site appropriateness that overall covered crucial elements involved in maximizing bed space and developing spaces.

2.2.1.8 Designing for Surge: Taikang Ningbo Hospital Fever Clinic

Kevin Kim and Tan Zheng from Gresham Smith presented on the response to the infectious disease through hospital design in China and began with a few facts about their healthcare design. Their hospitals have more beds than those in the United States, and they also prioritize the control of infectious disease. As a result, they design fever clinics, which are secluded from the hospital and contain a layout which ensures that the circulation paths of patients and medical staff do not intersect. It operates cleverly by a system that assigns color-coded QR codes, which indicate the health status of the patient, and then follows by three passes that they need to go through, where they end up in a consulting room with a doctor. Kim and Zheng gave an overview of the design layout of the BOE Chengdu Hospital located in Chengdu, Sichuan, designed by Gresham Smith, which is a very large hospital that contains six centers of excellence, and 2000 beds. They also control the condition of the soil or trash to prevent spread, so that they do not contaminate other parts of the hospital. Other departments that locate fever and infectious clinics are separated by hard walls to ensure spread is limited. The Cilin Hospital and Taikang YongYuan CCRC + Hospital are two other designs by Gresham Smith that serve to have flexibility for surge and isolation. The careful planning in these hospitals is vital to the large, dense population of China so that infectious diseases are handled early in order to prevent massive spreading.

2.2.1.9 Through Their Eyes: Facility Challenges and Opportunities from the User's Perspective

A look into the impacts on space and design was given by guest speakers Dan Thomas, Dr. Velma Jackman, and Patrick M. Casey from CallisonRTKL firm. Their purpose was to identify major issues and key lessons learned to gain an understanding of how COVID-19 has affected the community. Changes to consider in the future of healthcare design are continued use of telehealth, centralization of materials management, keeping more supplies on hand, and continued monitoring of building access. In preparing for a surge, screening and entries must have protective energy barriers. Separating the front and back of hospitals is effective, as well as having different stages of patients, such as virtual waiting rooms and social distancing taking place in waiting rooms. Patient care areas should consider universal patient rooms, moving equipment from patient rooms into the hallways, and other advantages that the space gives. Staff areas provide safe academic integration, and support spaces provide opportunities for personal protective equipment (PPE) storage. Looking towards the future, some of their propositions are to design smaller, more agile hospital footprints, shift in care to the environment, and look to non-healthcare trends, such as curbside delivery, for inspiration.

2.2.1.10 COVID 19, Health Care, and the Disadvantaged Citizens

For all who have suffered from the pandemic, we know that it has treated each of us in different ways. Guest speaker William Raymond Manning, president of Manning Architects, relates this to the topic of his presentation by expressing, “Just because COVID-19 has affected all of us in the same way, doesn’t mean it has affected all of us equally.” He opens the topic of disadvantaged citizens in health crises by providing some statistics from the pandemic when it first began, and certain links that were discovered. When people from all over the country and world attended Mardi Gras, there were many cases that arose quickly, and it was found that there were large numbers of African American people affected. Manning’s eighty-nine-year-old mother had contracted the virus and passed away four days later. African American people had only made up 3% of all known COVID-19 cases, and people of color made up 65.3% of the known cases. Many patients admitted into the New Orleans East Hospital are admitted with one or more comorbidities, including cancer, heart conditions, and sickle cell disease. To begin to understand why many people of color are vulnerable, one needs to look at social determinants of health outcomes, like race, ethnicity, culture, and education. How do we create healthcare equity? Manning defines this on the basic principle that all people despite race, gender, age, religion, geographic location, or sexual orientation have the equal opportunity to lead healthy lives. Lastly, he shares the recipe for healthcare equity: R for research, E for education, C for collaboration, I for initiative and implementation, P for public health policy with passion and purpose, and E for empathy and evaluation to empower.

2.2.1.11 COVID 19 Surge and Disaster Preparedness Delivered in Four Unique Ways

This presentation offers some insight on disaster preparedness through certain case studies such as the Rush University Medical Center as well as the Sherman Alternate Care facility. The presentation was given by representatives Jean Mah, Jerry Johnson, Chisako Fukase, Clark Miller, Javid Aboutorabi, Jenny Riddle, Elizabeth Rack, Chuck Siconolfi, and Brad Hinthorne from Perkins and Will, a firm specializing in healthcare design. The Rush University Medical Center was designed as the largest academic medical center in Chicago and had to undergo a surge transition throughout this pandemic. The main transition that proved to be successful was the adaption of making all the pods transferable to negative pressure rooms which ultimately led to the success of the operation. The alternate care facility that accompanied the medical center had to be heavily renovated in order to withhold the appropriate safety measures. Everyone had to adapt to a new flow of construction with the Army Corps of Engineers as the main source of leadership within the operation. Since the operation had to finish within four weeks, there were a lot of questions that had to be asked, like being able to understand how to best communicate with everyone or how everyone can be working as efficiently as possible within their respective units. Though the main systems were operational, which proved to be a key component to the success of the project, there were still many organizational factors that were difficult to attend for to ensure that it was the healthiest environment it could be. Clark Construction was a key component which was split up into the respective pods to ensure the maximum efficiency of the project.

2.2.1.12 The Story of the Conversion of the Integris Baptist Medical Center, Portland Campus Conversion for a COVID 19 SURGE Facility, Oklahoma City, Oklahoma

This lecture, presented by two HKS architects, Brent Wilson and Mike Purcell, discussed HKS's advancements in designing for health and alternate care facilities. The Integris Baptist Medical Center was a large project that HKS had to take part in converting it to an alternate care facility in which the scope consisted of a 110-bed conversion with 278 existing beds. The project proved to be difficult with the 12-day period they had to design, construct and manage the operation in accordance with the Manhattan project. The first problem that was encountered with an operation of this scale was managing the air pressurization of the units. The firm had to be creative and find places with beds with no room previously. The electrical components of the building had to be one of the first things to work out before other aspects were taken care of. At one point in the project, HKS had an instance in which they had to convert an entire floor of the building into a negative pressure area where gauges are placed to represent the room as a positive or negative pressure area. Also, each room had to have a camera that ran back into the nurse station room so that these rooms could be sufficiently monitored.

2.2.1.13 Beyond Pandemic Planning

This lecture was presented by Crandle Davis and Betsy Berg through HDR architects and focused on the healthcare initiatives and what is beyond the pandemic. There are many questions that have to be asked when focusing on the longevity of the practice when seeing how the pandemic is affecting our lives. For one, how are the site design groups going to be best oriented for success and with it, how can there be the most efficient organization when working on projects that offer new, challenging problems. A main focus with HDR is understanding how a project will adapt to the site especially when noting all of the different aspects of hospital design. With this comes the knowledge that outdoor spaces are the safest option for the pandemic due to how ultraviolet light and air particles diffuse most of the COVID-19 air particles that are released from a patient. HDR asks an important question that revolves around how they can take humanized outdoor spaces and somehow figure out a way to provide that same phenomenon indoors. There are a bevy of ways to try to consider how to effectively create an alternate care site. There are drive-in clinics, shipping containers, pods etc. that could test a person from either the safety of their car or with minimal construction. Another concern that arises is a housing crisis in which health workers need to quarantine before they can return home to their loved ones. One amenity that could be provided is a temporary home to quarantine before returning back to their own house.

3. EXPLANATION OF EXHIBIT

As a team, we presented three original design solutions of a surge conversion health facility at the virtual LAUNCH Undergraduate Research Symposium. The symposium was a week-long asynchronous event that displayed various presentations via ForagerOne Symposium Platform, and allowed participants to observe, actively engage with, and comment on presentations from other undergraduate research scholars. The research scholars, as well as Texas A&M campus members, like professors and classmates, were invited to participate in the Undergraduate Research Symposium and encouraged to exchange comments and feedback with the presenters.

The three designs that we chose to present were each executed as a video presentation of the design proposals along with a detailed slideshow of the material. The content that was displayed in each of our virtual presentations included research over alternate care sites and 2D images representing our design solutions for surge capacity, which were created using Adobe programs, Autodesk, Revit, and Rhino. When designing our individual surge facilities, Revit and Rhino were used to model and detail our projects within the surrounding context of the urban landscape in which we were proposing to place our buildings. Revit and Rhino were instrumental in enabling us, as aspiring architects, to visually understand how our proposed buildings would interact and respond to the existing site conditions and urban context. In order to graphically conceptualize the surge facility solutions that were being presented, 3D perspective views of each project were selectively chosen and converted into a flat and legible drawing representation for the audience. Once the perspective views of each project were selected, Adobe Illustrator was utilized to create a more refined image to carefully interpret and present detailed drawings.

Through the use of varying line weights, colors, and textures, Adobe Illustrator allowed us to emphasize important elements of the design, allowing our content and material to be cohesive and easily understood by the viewer. To create a photorealistic image of our models, we used 3D rendering software's such as Lumion and Enscape which allowed the model to be shown realistically in the urban landscapes that we selected at the beginning of the design process. Lastly, when constructing the final presentation, PowerPoint and Adobe InDesign were utilized to organize the images, text, and references on pages or slides, enabling us to present each design project fluidly. Although there was not a great deal of equipment needed to produce our exhibit, the virtual presentation could not have been possible without the use of the programs mentioned above and the use of Zoom to produce the video recordings of each presentation.

As most schools transitioned to a virtual platform during the COVID-19 pandemic, we felt that it was appropriate for us to display our work virtually in order to follow the pandemic guidelines and avoid large public gatherings. Utilizing a virtual presentation platform also extended the opportunity for invited attendees to both access multiple presentations from any geographical location and permit them to take their time to review the material that was being presented. Furthermore, with the sheer volume of drawings and renderings that were produced in our creative artifacts specifically, it was imperative to have a platform that would be able to accurately represent all of the work and research that was accomplished instead of having to curate drawings that would be required to fit on a poster or physical presentation. The creative artifacts that we presented at the LAUNCH Undergraduate Research Symposium are all distinctive from one another; each presentation represents a design approach revealing how a surge conversion can be effectively executed. In pursuant to the volume of drawings and renderings that had to be produced, the virtual platform allowed each of the creative artifacts to be autonomous from one another while still communicating the same central idea that exists within the surge conversion presented.

The creative artifacts that were showcased through architectural drawings and diagrams included the designs of a museum, a hotel, and a dorm complex that were each capable of converting to a surge health facility. Strategically, the creative artifacts graphically reflect our ideas from the developing schemes to the proposal in order to best communicate our ideas and concepts. Prior to revealing the design process of a surge facility, we present both precedent case studies and an urban analysis (context of surrounding environment as well as social, economic, and geographical factors) to provide the viewer with a background regarding existing conversion projects that assisted us in formulating our own alternate care site ideas. Before looking at how the final form of the building was made, we included diagrams and sketches of how the masses were originally created, and the steps that were taken to achieve the final form. A few of the important architectural drawings that were incorporated into the presentation included zoning diagrams, circulation diagrams, detailed floor plans, elevation and section drawings, and concept sketches. These drawings were crucial in relaying how infrastructures could be designed in response to unpredictable disasters or easily converted into an alternate care facility. With providing a variety of different building typologies and functions as creative artifacts, each project presents a unique and different analysis of the ways in which an existing building can transition into a surge facility

In a virtual platform scenario, it is critical for the speaker to engage with the audience so that viewers are able to remain actively engaged, absorb the information being presented, and learn from the presentation. By including both a video recording of us presenting our design proposals and an accompanying slideshow of the presented material, the viewer is able to see and connect with us as presenters and graphically observe our design approach being explained through images and architectural drawings. Ultimately, the virtual platform was appropriate to effectively represent all the work that was produced, given how much information had to be relayed to the audience. Considering the significance of the urban context, as well as the conception of the building and its argument in accordance with the site, the virtual platform was able to fluidly communicate each design idea as it related to each consecutive PowerPoint slide and show the process from its conception to its completion. Overall, the virtual platform gave a consecutive account of the urban study of the exhibition: 1) the initial design concepts and main ideas that drove the project, 2) exhibiting the primary use of the building and the secondary use as a surge facility, 3) exploring the buildings relation and response to the urban context.

4. REFLECTION

In the wake of unexpected circumstances, we must always be prepared for any adversity that will be placed along our path. In the case of COVID-19, the fickle nature of this disease alone makes it extremely difficult to combat and recognize its carnage, especially when it is so aggressive and quick to act. Within half a year, this disease has infiltrated every aspect of our lives and has caused hospitals from around the world to become overrun with infected and critically ill patients in a matter of days. The research that was conducted for this thesis was a direct result of the COVID-19 phenomenon and was developed and continually updated as time progressed as new pandemic relief facilities were created. When reflecting on the process of the research, there was a considerable number of changes that happened in the world as the research was managed in a real time crisis. As a general scope, the research is a response to the COVID-19 pandemic on all levels in a broader sense but has a direct correlation with how architecture could be a key component in mitigating the spread of the disease and creating safer environments. Although the research may inherently connect with architects and designers that can understand more of the design-based topics produced within creating an alternate care facility, the main basis of the research is to inform everyone about the crisis that persists throughout the world within facets people may not have known about. Many of the topics listed within our research have exploited the fact that we have to use a certain amount of cognitive intelligence to conform an existing resource into something that provides a completely different use (i.e., transforming an existing facility into an alternate care site).

When studying alternate care sites and methods of facility conversions, we understand that each aspect of recuperation requires a substantial amount of money, time, and energy put forth by the ongoing community. COVID-19 has challenged the world to unite in the face of a common enemy, one that has no remorse or judgement, but the insatiable desire to infect our planet. There are certain lessons to be learned by this pandemic, one being the simple fact that we can never take what we have for granted. Ultimately, COVID-19 has made us realize how vital it is to remain cautious yet still proactive.

The creative artifact that was pursued within this research was a study on the proactive nature that had to ensue when creating a surge alternate care facility as a result of unpredictable disasters that we continue to endure. As mentioned previously within the report, the creative artifact was supposed to enhance one's knowledge on how an alternate care facility might operate and what systems and design decisions have to be made in order to efficiently create a hospital-like environment in a non-traditional healthcare setting. The research itself gives way to a large variety of buildings that are viable for an alternate care or surge conversion which directly correlates to how the creative artifact was thought about and constructed. With that idea in mind, our creative artifacts resembled a swath of different building typologies that were realized from their primary function as a building as well as in the surge setting to showcase various conversion topics organized in the research. The public presentation, presented at the LAUNCH Undergraduate Research Symposium, followed a chronological format of surge facility design that showed the process of the design operations from its conception on the site following its primary use and the main changes to the building that reflected the research done in the report in order to create the most efficient space for a hospital-like setting.

In the celebration of our creative artifacts, there are a variety of things that could be changed if the project were to be recreated and if each creative artifact had a different criticism that could help enhance the overall design. After presenting at the LAUNCH Undergraduate

Research Symposium, there were several things to learn from the individual presentation themselves and how both the creative artifact and the research could have been enhanced for audience clarity. If the creative artifact were to be recreated and with more time available, refinements could be made in order to make the conversion from a building's primary function into a surge facility more efficient. One aspect of the project that we could consider refining would be the adaptation of the surge context within the primary function of the building; the transition from the primary function to the secondary function as an alternate care site could always use more modifications for a seamless and effective surge conversion. Furthermore, when thinking about how to strengthen our public presentations, we could consider prioritizing diagrams and drawings that would be more beneficial for explaining the detailed aspects of a surge conversion. In addition to generating more detailed architectural drawings, our creative artifacts and research could have been enhanced with detailed mechanical and electrical diagrams, comparing the operative methods of the original building and its functions as an alternate care site. Electrical and mechanical drawings are important because a surge facility for coronavirus patients has to emulate the air quality of a hospital in order to prevent the virus from spreading further. Through electrical and mechanical drawings, we would be able to convey how converted facilities like alternate care sites must be effective in creating both negative and positive pressure zones to mitigate the spread of COVID-19. Throughout the presentations we were able to explain the concept and outcomes of implementing negative and positive pressure zones, but we would need ample time in order to produce images that would explain these systems more efficiently.

Since we have already experimented with the existence of convertible alternate care sites, architects are able to examine and learn from conversion examples that have been extremely effective as well as examples that have proven to be unsuccessful or have faced design challenges. The COVID-19 pandemic has aggregated a large number of negative aspects to our society, but it has also taught architects and designers valuable lessons that we can learn from and implement into our future designs. As we progress and begin to build new structures, it is important for architects, urban planners, project managers, and construction workers to design for a future that responds to unforeseen disasters.

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APPENDIX: CREATIVE ARTIFACT

Research and Design of "SURGE" Health Facilities in an Urban Context

Dormitory SURGE Conversion: Madison Dorm Complex

Within the Heart of the University of Wisconsin Madison lies the Madison Dorm Complex (Figure A.1) which serves as a medium between on campus living and community within the entire campus. Though the primary function of this complex is used to meet the needs of students and their accommodations, this project can also be adapted as a surge facility. The complex itself encompasses the efficient space and circulation within each structure to be efficiently utilized into a surge facility.

Figure A.1: Madison Dorm Complex by Jonathan Latta and Virgilio Duarte

To begin to understand the program and plan of this project, it is first necessary to begin to analyze the context to which this complex was placed in relation to the rest of the buildings on campus and the social life that exists outside of the campus. We knew that this complex had the opportunity to mediate between the public life outside of campus while also having the amenities to satisfy the population within the campus. The three buildings act as a primary, secondary and tertiary space in which the dorm tower represents the primary space for the students to live whilst the dining hall and game room act as a more public space that accommodates those on campus and those who wish to participate in a more social environment. When analyzing the dorm tower, there are a variety of different amenities that it provides both as its primary function as a dorm facility and as a flex building (Figure A.2). The first floor consists of the appropriate reception desk, conference rooms, study areas, coffee shop/ lounge area, loading dock, mechanical core, elevators, mail room, and offices whereas the floors above it accommodate more of the private living quarters that the students live in. The second-floor acts as an interesting intermediary space which combines one half of the building as a privatized dorm and the other half as a lounge space/ computer lab area. Each of the floors that supersede the 2nd floor are predominantly dorm rooms apart from the 5th and 6th floors which contain additional space to the south wing to accommodate more dorms and dining space. In all, the Dorm tower consists of 75 dorm rooms with half of them as double occupancy rooms. The surge function of the dorm tower considers the same plans of the dorm tower with a few exceptions to the first floor with the addition of walk-in testing through the coffee shop and the renovation of the south end dining area into a testing lab for the people doing the walk in testing. Other notable differences that can be seen throughout the flex plans represented in black are the morgue on the south end of the second floor replacing the computer labs, and the lounge space conversion to a storage area. Each of the dorm rooms had to be carefully converted in order to contain hospital beds and the necessary space to house hospital equipment such as IV's and respirators. The privatized bathrooms within each of the dorm rooms makes it possible for there to be an ante room which allows for the existence of a negative pressure area and air to be filtered to the outside.

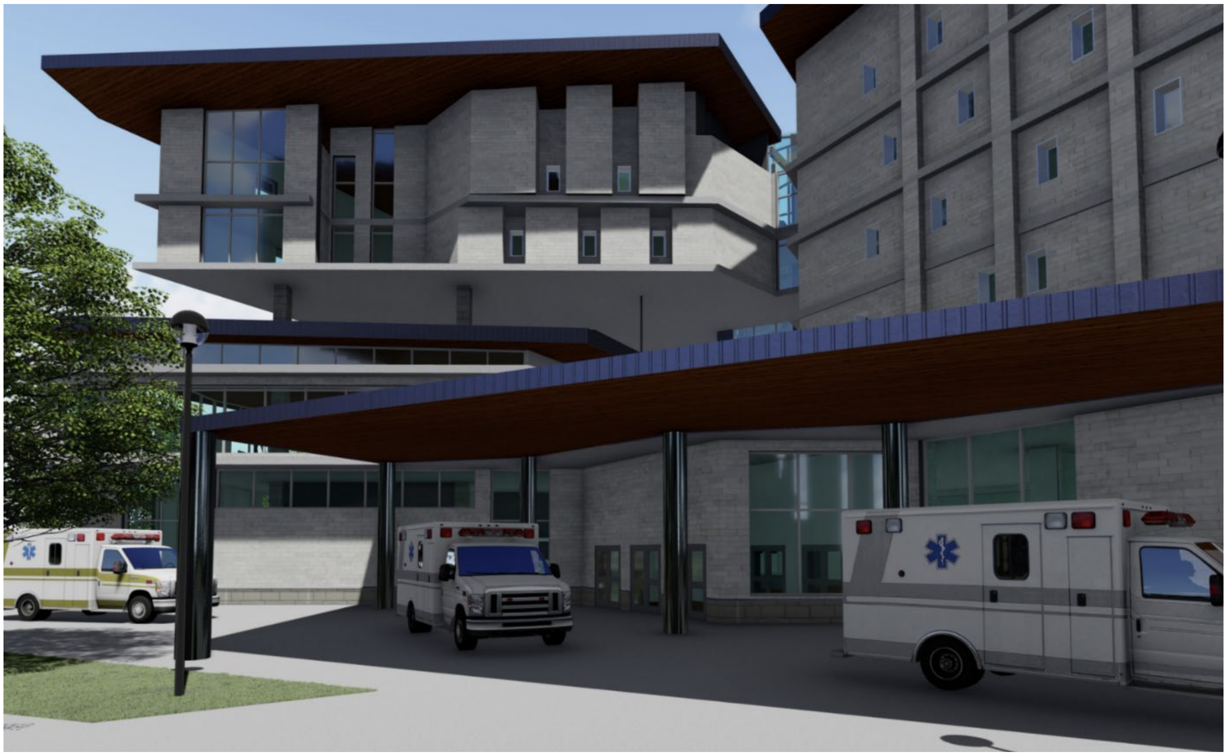

Figure A.2: Madison Dorm Complex – Emergency entrance/exit when converted into a surge facility

The tertiary space that exists on the North side of the complex is the Game area that is able to be accessed through to the public and contains games such as pool tables, ping pong tables, lounge areas and a stage for live performances (Figure A.3). Though the interior space is overall a single space interior, there is a second story balcony that extends the lounge area for leisure and to experience the lush courtyard that exists in between the other two buildings. The surge function of this building acts as a chapel for loved ones to pray for their relatives or friends that are admitted into the dorm tower/hospital (Figure A.4).

Figure A.3: Madison Dorm Complex – interior perspective of the game room (primary function as dorm complex)

Figure A.4: Madison Dorm Complex – interior perspective of the chapel (secondary function as surge facility)

The Dining area is the secondary building within this complex and serves to provide students and the public with two restaurants on the first floor with an outside dining area facing the courtyard. The second-floor acts as a large space that includes the necessary booths and tables for the community to enjoy their food. The main surge function for this building exists on the second floor and is predominately used as a means for providing extra space for storage that is received at the Dorm tower and transported to the dining hall when there is an overrun of storage that needs to be kept in close proximity.

Hospitality SURGE Conversion: Moana Resort

The Moana Resort (Figure A.5), which is located in Honolulu, Hawaii, is a proposed boutique hotel that can be converted into a surge hospital for a local or global emergency. Its existing layout of public and private areas such as the ballroom, gym, and guest rooms allow for a quick and easy conversion. The hotel focuses on accommodating citizens in the event of a crisis, while incorporating sustainability in Hawaii from the choice of materials and access to natural lighting, overall creating a restful environment.

Figure A.5: Moana Resort by Nallely Chavarria and Ethan Vickers

The site chosen for the design in Honolulu, Hawaii was suitable because it is located on a few acres that were in close proximity to the Waikiki Beach and shops, hotels, and restaurants. Any guest staying here would be able to walk to the beach or for shopping and dining. Honolulu is vulnerable to a few natural disasters, which include earthquakes, tsunamis, floods and coastal hazards. Since most of these hazards are water-related, it was appropriate for the site to be located away from the beach and with a built structure to sustain these disasters, and affected people around the area would be able to access the hotel and be given the care needed in an event. Hawaii is an island state of the U.S., and there is less accessibility to having all types of goods and materials delivered there, so it was important to think of local materials to use for the construction of the building. Some of the local materials that were chosen include cross-laminated timber, cork, concrete with fly ash, and bamboo. The use of them promotes sustainability since it demands less transportation, and some of them are recyclable. For the form generation of the hotel, the curvature was similar to the flow of the corner of the site that is connected to the four-way street. It becomes inviting to any person while driving past the corner as the hotel opens up to them. The entrance is also prominent from a perspective view, with the entrance lane guiding one up to the roundabout in front of the main entrance, encircling a large water fountain and native plants.

The program of the interior of the resort is divided into three categories: public, private, and support services. On the ground floor there is a covered area for the entrance that allows people to drive up and drop off luggage without risk of exposure to any weather that may occur. Walking into the lobby, which is a large atrium to provide plenty of space for seating while pouring in natural lighting from the skylights, there is a reception desk with an office, the breakfast buffet, restaurant, and kitchen. The right side of the ground floor consists of a shop, computer lab, restrooms, elevators, mechanical room, and a large ballroom that can be separated into two rooms by a partition wall. The second floor has a gym, break room, laundry room, and a storage room. Floors three through five contain the guest rooms which are a mix of standard rooms and suites as well as a storage closet for housekeeping and a vending machine room. In total there are 36 guest rooms, 24 that are standard and 12 of which are suites. Each guest room is designed with light colors (Figure A.6) and contains windows for natural light to pour in while giving guests views around the site. About half of the guest rooms have balcony access, with views to the surrounding landscape on the site and buildings. The sixth floor is for the mechanical components of the hotel. Outside in the back of the hotel there is seating for outdoor eating behind the restaurant, access to the roof of the atrium through ramps, and outdoor bar, a swimming pool, a hot-tub, and a garden with plenty of local flowers. The walkable rooftop is covered with a large, remarkable pergola made up of cross-laminated timber. It casts light shade to users on the roof as well as those dining outside and highlights the existing curvature in the building as it flows with the form. A section drawing of the hotel (Figure A.7) visually sets out the program of the hotel, showing larger spaces designated for the public and smaller spaces that are guest rooms.

Figure A.6: Moana Resort – floor plan of guest suite (primary function as resort)

Figure A.7: Moana Resort – section drawing (primary function as resort)

When converting to the surge hospital, the programming was split up into public spaces, private spaces, and staff areas. In a perspective view of the front parking lot (Figure A.8) there are parking spots reserved for emergency vehicles, though they have easy access to the roundabout which leads to the front entrance of the hotel. The six entrances on the ground floor became designated for specific reasons that are separated, as annotated in the ground floor plan. The front entrance is for patient entry and the back is for patient discharge, the kitchen door is for staff entry and the restaurant is for the staff exit. When entering the vestibule, patients will be screened and enter the lobby where there is less furniture placed to minimize the spread of infections. The check-in will take place at the reception where patients will be directed to the ballroom where central care will be provided by nurses. There is also space in the ballroom for beds to be placed, and the existing restaurant will be for staff only. The front elevators will be divided so that the ones on the left are for patients only and the ones on the right are for staff to use. On the second-floor plan, the gym converts into a room with a partition wall to divide up the space for critical care and sterile equipment storage. There are also rooms for clean personal protective equipment and dirty personal protective equipment. Sufficient room is made available for storing furniture, gym equipment and other items. The third and fourth floors, which are represented by a typical floor plan, are reserved for patients to occupy the existing guest rooms, with two rooms on each floor reserved for a nurse station, eye and hand wash, nurse call, and medical storage. The fifth floor will be occupied only for staff, with the penthouse being converted to a staff break room and existing guest rooms for traveling staff. Once there is no longer a need for the surge facility, the transition back to a resort is simple. The medical equipment is removed from the building and the furniture that was placed in storage is moved back into the guest rooms, gym, and lobby. The Moana Resort provides many amenities for its guests to take advantage of, is located in a heavy tourist area, and can easily be converted into a surge facility if ever needed.

Figure A.8: Moana Resort – emergency vehicle parking (secondary function as surge facility)

Museum SURGE Conversion: Seu Museu e Santuario

Seu Museu e Santuário, known as "Her Museum and Sanctuary" (Figure A.9), located in the urban context of Brasilia, Brazil, demonstrates the dichotomy between designing for a museum structure and designing for a surge facility. Ultimately, Seu Museu e Santuário has been developed as a female art museum in its primary function. Moreover, in its secondary function, the museum is easily equipped to convert into an efficacious and strong alternate care facility in the event of a surge.

Figure A.9: Seu Museu e Santuário by Alanna Burnett and Madison Lesmeister

When understanding the plan of the building, the ground level of Seu Museu e Santuário operates nearly identically in both its primary function as a museum and its secondary function as a surge facility. Upon entry into the lobby, visitors are greeted by a receptionist to direct flow of traffic and assist with wayfinding. As the main entry to the building, the lobby serves as the primary circulation for either museum visitors or patients arriving for medical care (Figure

A.10). The dining hall on the other hand, serves as the secondary circulation on the ground floor. In both the museum and surge function, the dining hall is utilized to provide necessary meals and beverages to either museum guests and employees or to medical personnel and hospitalized patients. The third and final zone of the ground level, the control center, is one of the more critical designated areas and receives the tertiary circulation; the circulation that is performed by either museum staff employees or essential medical personnel. Primarily in the museum function, the control center operates as a workstation for museum employees and is equipped with private individual desks, group meeting/conference rooms, and collaborative worktables. Conversely, the control center for the sanctuary function of the building aims to focus on hospital-level flow and efficiency, such as maximizing bed capacity or reducing patient boarding times. The surge facility command center also strives to improve patient outcomes through centralized quality control and coordination of patient care. Overall, the surge command center provides a centralized medical task force station, individual desks, ample storage for necessary on hand medical supplies, a laboratory, and designated x-ray room.

Figure A.10: Seu Museu e Santuário – emergency vehicle entrance/driveway (secondary function as surge facility)

In its primary function, the second floor of Seu Museu e Santuário serves as exhibition spaces that feature several pieces of artwork created by famous female artists (Figure A.11). As a result of the building's unique form, the exhibition spaces adhere to a continuous circulation, allowing for ease of wayfinding. In other words, a visitor is able to seamlessly transition from one exhibit to the next. Overall, the second floor of the museum consists of a large exhibition hall, small intimate art galleries, and a vast display of sculptures. Once flexed into a surge facility, the second floor of Seu Museu e Santuário transitions into a medical surge. Divided into zones, the second floor consists of both a trauma center and intensive care suites. When designing for a medical surge it is necessary for healthcare facilities to include architectural elements that take into account patient workflow processes, work to keep patients safe and close to the medical supplies that they need and recognize that efficiency in design helps to decrease wait times and allow for quicker room turnover. Maximizing the space of what once was a large exhibit hall, the trauma center has been designed to provide empty beds and immediate care to patients seeking shelter and medical attention. Within the trauma center, there is a central nurses station to oversee patient care and assist with the flow of traffic, equally spaced patient beds, storage space for necessary on hand medical equipment, wheelchairs for patients that require assistance, and moveable partition walls between patient beds to provide for privacy and comfort (Figure A.12). The med surg also provides negative pressure isolation rooms for individuals seeking more intensive medical care and need to be secluded from the general population of patients.

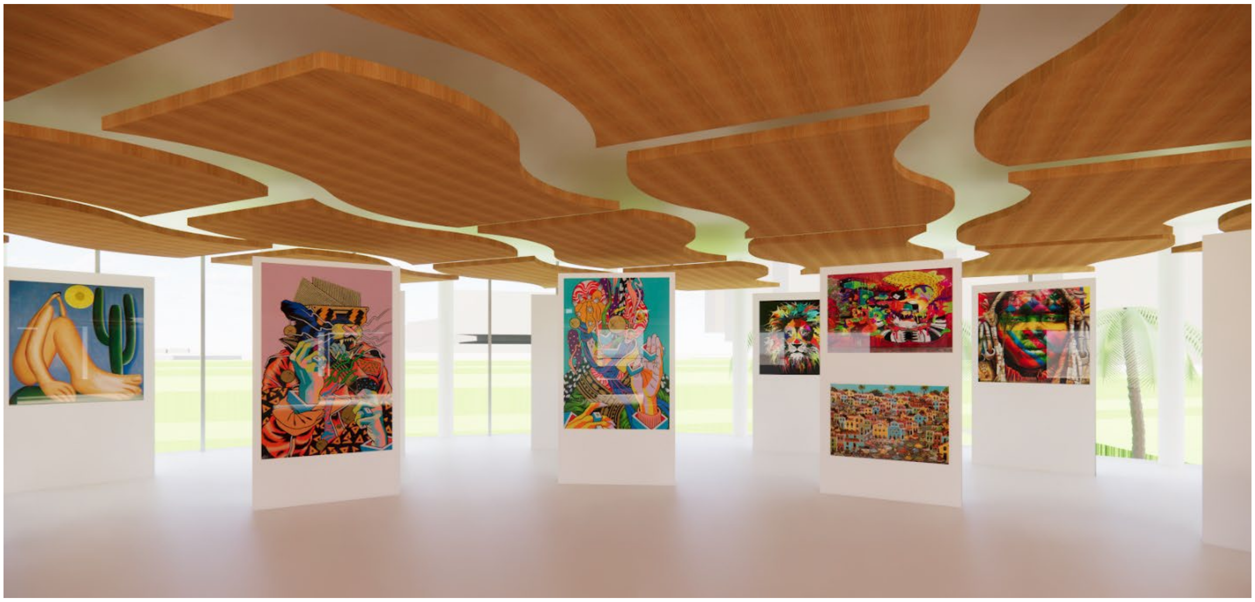

Figure A.11: Seu Museu e Santuário – large exhibit hall showcasing local artwork (primary function as museum)

Figure A.12: Seu Museu e Santuário – trauma center and nurses' station (secondary function as surge facility)

The third level of Seu Museu e Santuário is similar in both layout and operation as the second floor above. For instance, the final level of the museum includes a second large exhibition hall and additional private art galleries. Effectively, the layout of the third floor allows museum visitors to easily transition from one vibrant exhibition to the next. As Seu Museu e Santuário transitions into a surge facility, the third floor provides additional open bed space for patients seeking medical care. Similarly, to the second floor, the third floor of the surge facility is equipped with a trauma center, a centralized nurses' station, an isolation ward for critically ill patients, and ample storage space for medical supplies. With the strategic layout of the building, Seu Museu e Santuário is quickly and effectively able to provide beds, shelter, and medical care in the event of a natural disaster, pandemic, etc. Ultimately, the design of Seu Museu e Santuário not only embraces the Brazilian culture but the building also allows for a medical surge to be quickly and easily constructed. Seu Museu e Santuário is more than a monumental building of remembrance and recognition for the community of Brazil; Seu Museu e Santuário is a reliable sanctuary that has strongly been designed to protect and serve the people of Brazil.

Museum SURGE Conversion: Beirut Museum of Fine Arts

The Beirut Museum of Fine Arts is a surge health facility (Figure A.13) that is within the urban context of Beirut, Lebanon. In its primary function, the museum showcases a variety of artwork created by local Lebanese artists, painters, and sculptors. Comparatively, as a surge healthcare facility, the building operates as a shelter in the event of unforeseen natural disasters such as an earthquake or a refugee camp during unpredicted political wars.

Figure A.13: Beirut Museum of Fine Arts by Desiree Allen, Andrea Hartley, and Victoria Saracco

Beirut, the capital of Lebanon, is near the Yammouneh fault line and so there are challenges to create a seismically isolated structure that could resist earthquakes as well as serving citizens whose homes were affected by such events. Not only does the capital suffer earthquakes, but there are also occurring explosions from corruption and outrage within political matters, demanding for the museum design to include resistant materials and security onsite. The culture and environment also play a role in the design and materials while ensuring that easy wayfinding throughout the building exists for occupants to enjoy their experience.

The site is located on the corner of Venus Street and an unnamed newly developed street, with a total site area of 2,689.5 square meters. Skyscrapers surround the north, east, and south sides of the museum, with the west side exposed to the Mediterannea sea, which is 4.13 kilometers away. Some factors included in the site analysis include a climate that consists of warm, humid summers and cool and wet winters. Natural disasters and man-made catastrophes are the two main components that cause for a predictable transition from a museum to a surge facility. Within the year 2020, Lebanon experienced six earthquakes, with the most recent one in Beirut having a magnitude of 3.3. To face these seismic waves, the museum includes base isolators in the foundation and 6-inch moat around the perimeter in order for the seismic vibrations to distribute across the height of the building. Taking into account predictable man-made disasters, the building includes anti-ram bollards to secure the perimeter as well as a guard shack to secure the parking garage. If an explosion occurs, small ribbon windows will stop large glass from falling if it is blown out.

The form of the building is created from two overlapping blocks, each containing three stories. Some of the spaces included in the museum are considered “landmarks", which are a glass-walled court as well as a rooftop garden that stands in the middle of the story that is embedded into the ground. They allow for easy wayfinding while admitting natural sunlight into the building. An atrium with a skylight is located on one side of the building that constructs views for both levels. On the second level, both blocks are connected and combine into one large art exhibit room with service rooms. Some exhibitions feature paintings and sculptures from local artists, including Saloua Raouda Choucair and Ayman Baalbaki, and a permanent enlarged version of Hayat Nazer's sculpture, named "Liberty Lady". What is significant about this sculpture is that it was made from debris left from the most recent explosion in Beirut.

To transform the museum into a surge facility in the event of an emergency, it is easy to understand the contrast between the conversions in the floor plans (Figure A.14). Partition walls that were originally used for separating art will be able to rearrange to accommodate beds, and nurse or staff small desks would use sculpture podiums to adapt to their use. Overall, five nurse stations, ten staff beds, and 27 patient beds would conveniently fit, but if necessary, a maximum of 50 patient beds could fit. Other conversions would occur on the ground floor, as it will turn into a loading area for transportation to the hospital. The office will be used by staff as a conference room, and the lost and found room will serve as a pharmacy. These zones are clearly defined in the program layout of a surge conversion (Figure A.15). Lastly, the roof garden will become a place for patients to interact with nature, which brings well-being to the physical and mental health, with a library and gift shop to be used for educational purposes for children.

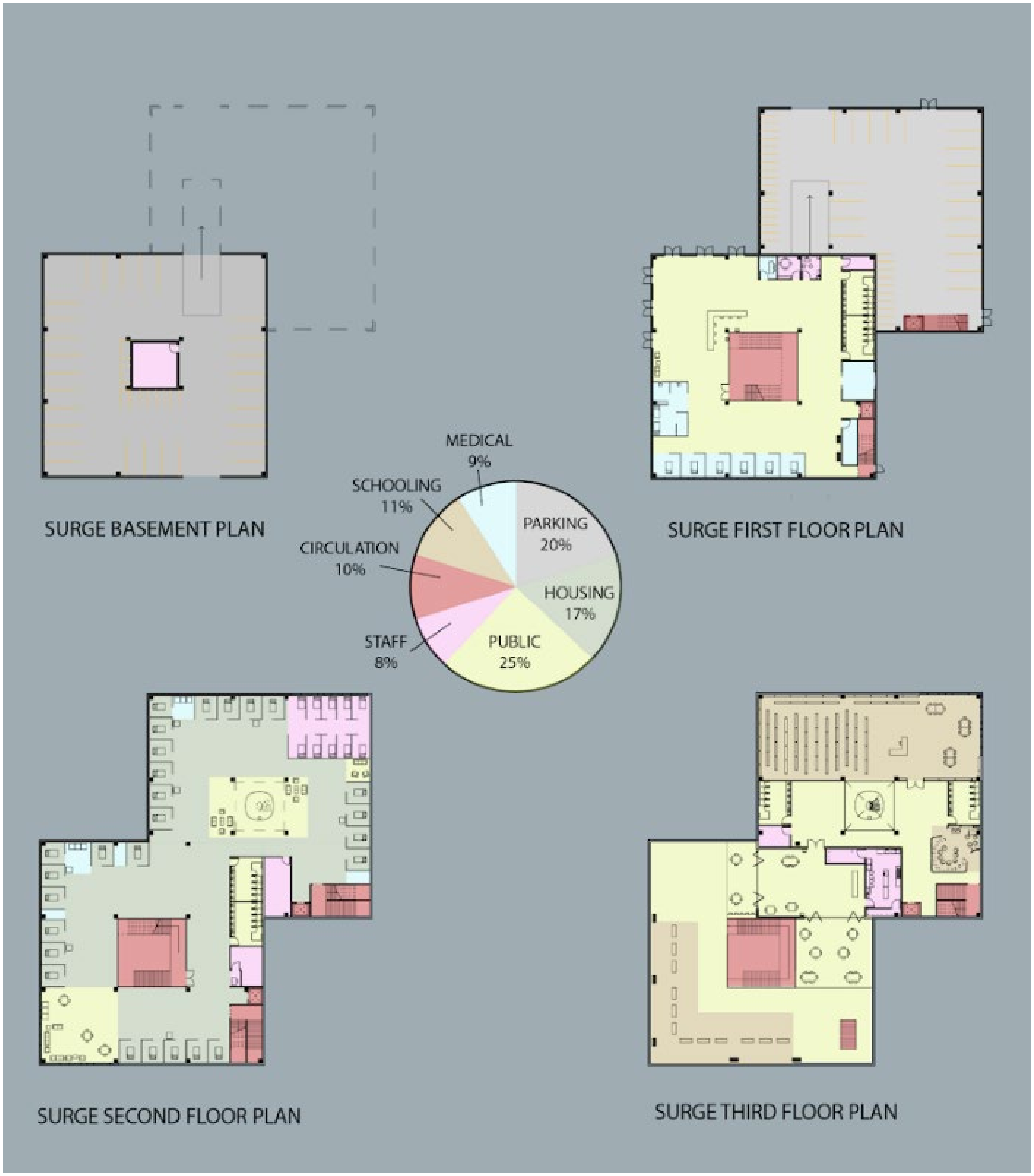

Figure A.14: Beirut Museum of Fine Arts – surge floor plan (secondary function as surge facility)

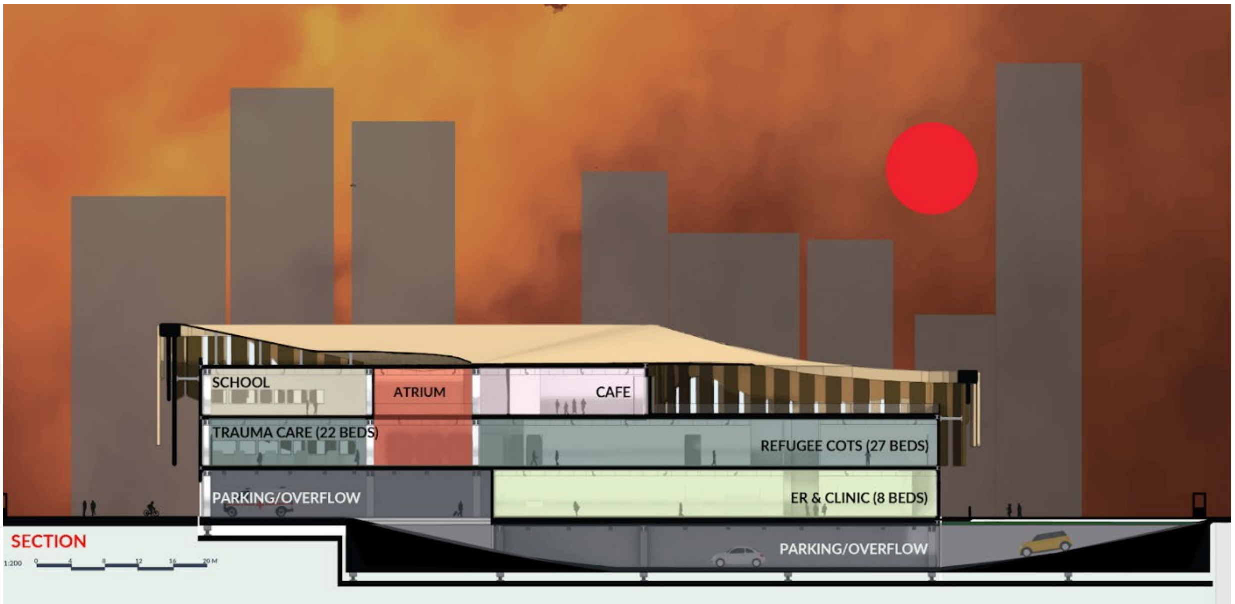

Figure A.15: Beirut Museum of Fine Arts – section and zoning diagram (secondary function as surge facility)

School SURGE Conversion: Osuna Middle School

Inspired by the natural disasters that occur in the surrounding area, Osuna Middle School (Figure A.16), located in San Diego, California, has been designed to easily convert into a wildfire and earthquake refuge. Additionally, the design concept for the middle school was inspired by the varying topography and environmental conditions of California. Ultimately, Osuna Middle School was created with the intent to not only provide an academically stimulating environment for students, but to provide safety and shelter to the community of San Diego.

Figure A.16: Osuna Middle School by Mariana Cardenas and Melanie Guerrero

To understand the building and the concept that went into the initial design, we have to first understand the building layout for a normal school and factor that into the design decisions. The design of the building has to accommodate an organizational method of spaces throughout the plans of the three sectors that the building is divided into. As a result of the topography of the area, there is a certain organizational method that has to ensue on each level. For instance, on the ground floor sector there is a library, cafeteria, gymnasium and locker rooms which take up the large spaces and common areas for the school whilst the middle sector contains the main circulation area and the front entrance of the building which allow for staff offices, counseling rooms and a nurse's office. The building itself is also a direct response to the earthquake and wildfire dangers that are prevalent in the area so there are also certain labs within the building that are used for science research and such. To be able to achieve a building with the duality of a functioning school and refugee space, there had to be research done to make sure the faculty design was appropriate and was able to accommodate both functions. The ground floor as mentioned earlier held the large common spaces such as the gymnasium and the cafeteria which act as large wards to house a large number of people looking for refuge, and an example of utilizing this space is shown in two images of the gymnasium with its original use versus its surge conversion (Figure A.17 & A.18). There are also certain spaces such as the patient care room located next to the office area and a vestibule that allows for an extra amount of security to go into the building in case of emergency. In addition to these aspects of the building, most of the rooms are converted into either pharmacy areas, lab areas, storage space, or break rooms for the refugees. In all, The Osuna Middle School functions as a wildfire and earthquake refuge in order to meet the needs of San Diego, California. The site location was strategically chosen in a low earthquake risk zone in which the wildfire threat level was virtually 0% yet the building is near these zones for the refugees' convenience. Ultimately, the safety of San Diego's residents was the main priority in the design of the building as both Osuna Middle School and a surge facility.

Figure A.17: Osuna Middle School – interior perspective of gymnasium (primary function as school)

Figure A.18: Osuna Middle School – interior perspective of gymnasium (secondary function as surge facility)

Hospitality SURGE Conversion: The Refuge Hotel

The Refuge Hotel (Figure A.19) was designed as a luxury hotel with surge conversion capabilities embedded into the initial form, rather than implemented as an afterthought, or a retrofitting of emergency medical equipment. With being located in Houston, Texas, the Refuge Hotel seeks to provide not only a comfortable stay for hotel guests but necessary medical care in the event of a natural disaster such as a flood.

Figure A.19: The Refuge Hotel by Gustavo Marin and Rylan Severance

With the considerations of surge facilities and alternate care sites, the design of The Refuge Hotel aims to effectively respond to the unique flooding conditions of Houston. Considering the flood zones in downtown Houston, The Refuge Hotel has been elevated off the site and has instead been configured on a series of stepped terraces with drainage capabilities

(Figure A.20). Fundamentally, the elevated terraces lift the structure (excluding the ground floor which utilizes flood-rated glass in the event of rising waters) approximately fifteen feet off the ground, allowing excess water to proceed through the site as opposed to allowing the standing water to consume and level the infrastructure (Figure A.21).

Figure A.20: The Refuge Hotel – exterior perspective of elevated site (primary function as hotel)

Figure A.21: The Refuge Hotel – site during flood conditions (secondary function as surge facility)

In the event of natural disaster, terrorist attack, or pandemic, The Refuge Hotel has servicing capabilities that allow the hotel to rapidly transform into an alternate care site, providing medical care and treatment to the community (Figure A.22). For instance, the spacious layout of the design lends the hotel to be able to push the bounds of the initially allocated 60 guest suites to provide shelter for over 300 inhabitants (the hotel rooms were intentionally planned to be able to accommodate 2-3 patients comfortably). Furthermore, the larger and more open zones of the hotel such as the ballroom, conference rooms, and lobby have been prepared to flex into surge capabilities: trauma centers, triage zones, central nurses' stations, and command centers.

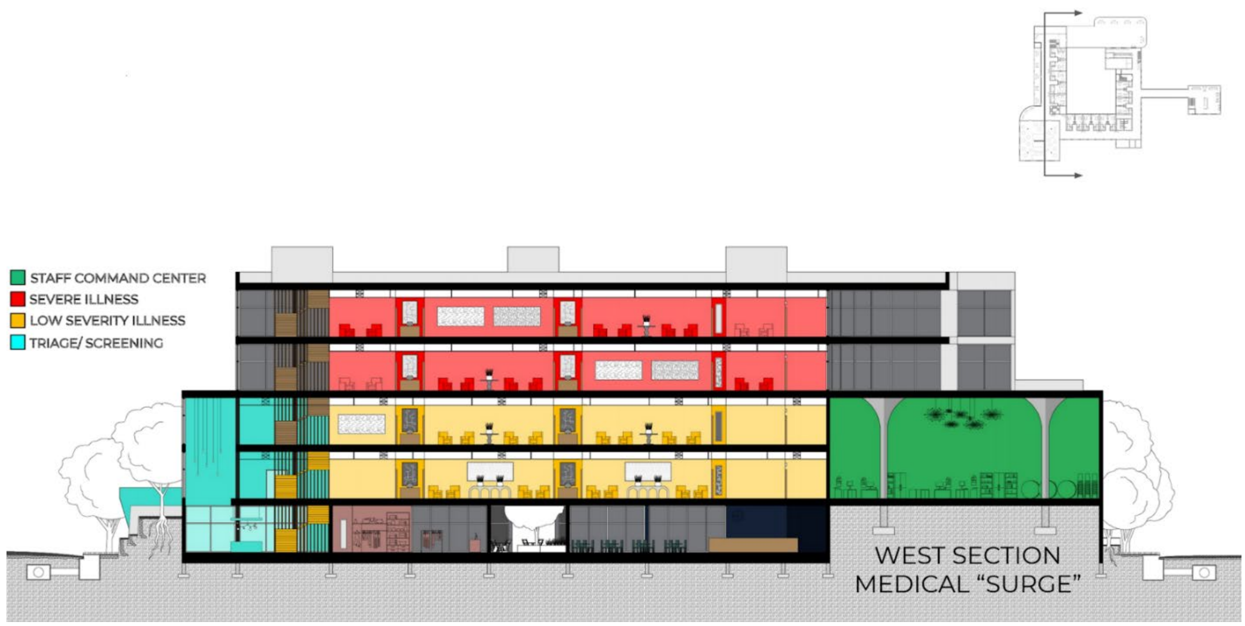

Figure A.22: The Refuge Hotel – section and zoning diagram of medical surge (secondary function as surge facility)

Art Center SURGE Conversion: The Alameda Arts and Community Center

The Alameda Arts and Community Center (Figure A.23), tailored for the community of Alameda County, located in Los Angeles, California, has been designed to serve two functions. On one hand, the community center serves as a gathering space for special events such as theatrical performances, artistic presentations, and musical productions. On the other hand, the Alameda Arts and Community Center has been designed to be able to transition into a healthcare facility to provide shelter and medical treatment to members of the community.

Figure A.23: The Alameda Arts and Community Center by Stefany Rodriguez and Valerie Andrade

The site of Alameda County was considered when it was realized that the community needed a center for everyone to come together as well as a place for businesses like street vendors to comfortably run, rather than using the edge of an intersection. The state of California suffers frequently from severe cases of wildfires, as well as occasional, sudden earthquakes. For residents that are vulnerable to these disasters, the location is accessible for an extended stay.

The center accommodates a black box theater, a library, multipurpose rooms, a cafe, kitchen, and a community garden. These spaces are able to be converted into a surge facility for the convenience of residents if wildfires occur, and they can access small clinics, and an emergency care center. A helicopter pad and ambulance entrance are also located on the site for emergency health transportation. Residents are able to use some of the amenities the community center has to offer such as laundry rooms, showers, restrooms, outdoor space, the cafe and kitchen.

When planning the functionality switch from a community center to a center, it was crucial to designate the largest spaces to serve for the residents. To implement this strategy, flexibility was a key component in order for existing furniture and equipment to be stored away properly as well as allowing there to be changes in the layout. Main entrances on the site are wide enough for emergency vehicles to drive in from different locations and access the front, but there is also a separate emergency trail on the side of the building for them to use so that crowding of the residents outside does not prohibit them from properly transporting a patient, which is shown in an aerial view of the building on the site and in a closer view (Figure A.24 & A.25). Sufficient parking is made available for the residents, and the shaded main entrance gives them the option to be dropped off. Staff parking is separated from residential parking and is located behind the building. On another side of the building is waste disposal and is intently kept away so that service can be efficiently completed, uninterrupted. Overall, the Alameda Arts & Community Center aims to give the residents a close connection with the community, while prioritizing their health and happiness.

Figure A.24: The Alameda Arts and Community Center – exterior perspective of emergency vehicle access and helicopter pad (secondary function as surge facility)

Figure A.25: The Alameda Arts and Community Center – emergency vehicle access/driveway (secondary function as surge facility)