



*Innovations in Transportable Healthcare Architecture* is the first book to examine the ways that healthcare architecture can provide better assistance in disaster-stricken communities.

Aimed at architects and other professionals working across the disaster relief sector, it provides:

- an overview of the need for rapid response healthcare facilities;
- global case studies which demonstrate real examples;
- historical perspectives on redeployables used in past military and civilian contexts;
- analysis of the advantages, challenges, and opportunities associated with offsite, premanufactured healthcare facilities and their component systems, for permanent installations or reuse on multiple sites;
- planning and design considerations for transportable offsite-built healthcare architecture;
- state-of-the-art research on pop-up clinics, truck-based configurations, ISO container-based outpatient clinical and trauma care centers, and modularized facilities for contemporary military and civilian contexts.

*Innovations in Transportable Healthcare Architecture* will be an invaluable reference source for architects, disaster mitigation planners, design and engineering practitioners, non-governmental medical aid organizations (NGOs), governmental health ministries, and policy specialists across the spectrum of disciplines engaged in disaster mitigation and the provision of healthcare in medically underserved communities globally.

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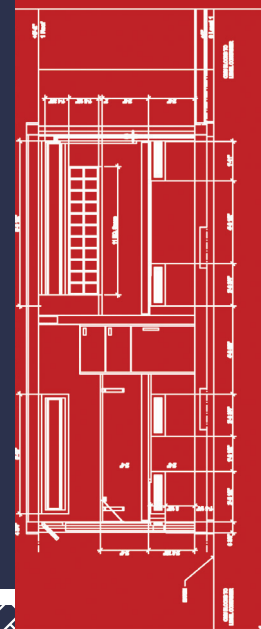
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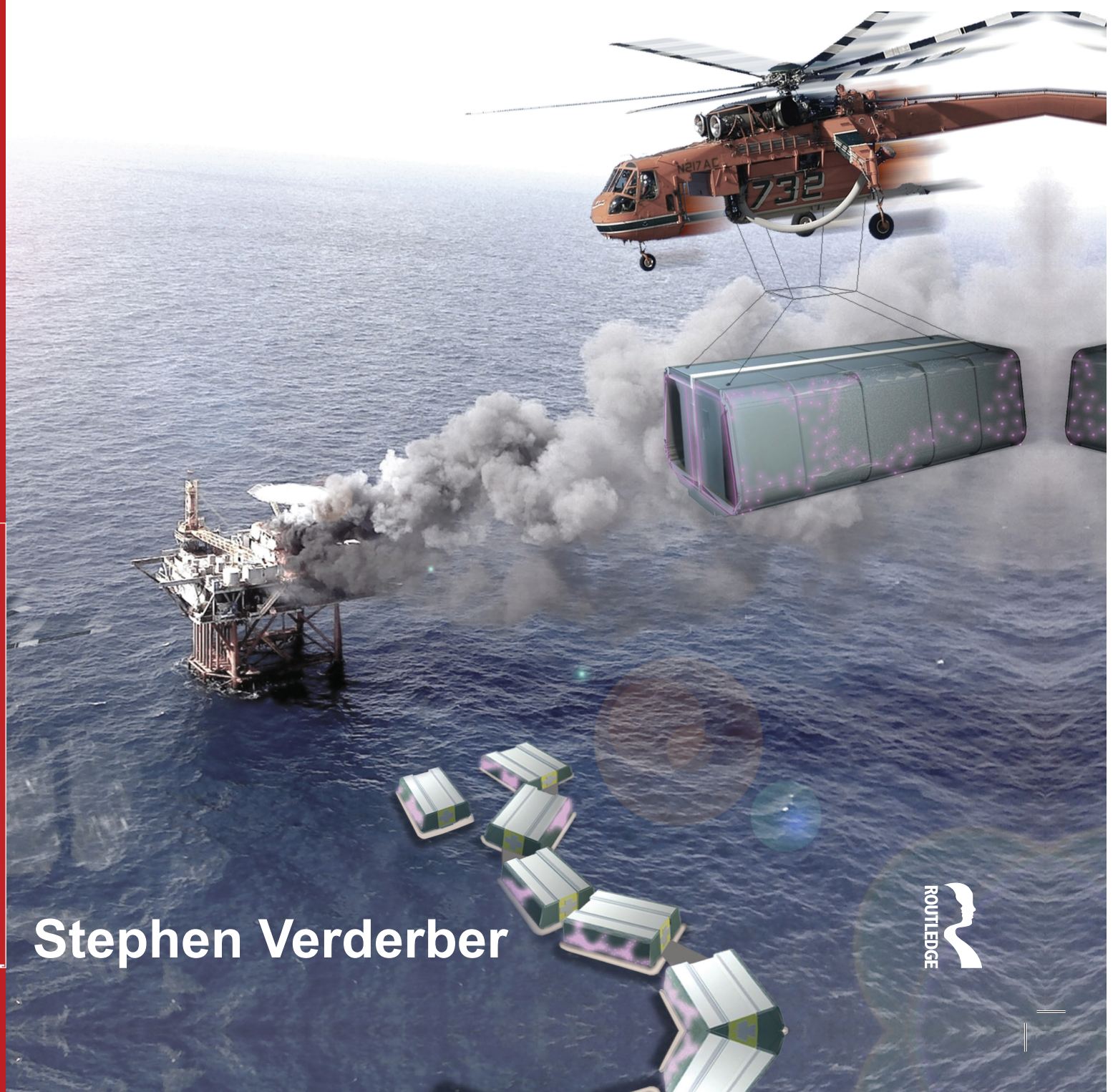
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## Redemption through Activism—Transportable Architecture for Health

Professor Stephen Verderber

Climate change, political upheaval, and resource depletion is upending the rhythms of everyday life in developed and developing regions alike, with tens of millions at risk of sudden dislocation from homes and communities. Mass population displacement on this scale represents a descent into uncharted territory, a descent that will require massive humanitarian responses on a level outstripping anything witnessed before in recorded history.

In her own words: the experience of Suzanne Kawmieh, a physician, as translated by Hadia Zarzour:

*"In early 2014, I took a short trip to the Syrian-Jordanian border, specifically the Zaatari refugee camp (in Jordan) for the first time. I had been working on various humanitarian projects related to Syria; however, the focus had not been on the refugees but on those who were still trapped in Syria. The Zaatari tent refugee camp is now the fourth-largest city in Jordan and is home to over 150,000 Syrian refugees. A winter storm hit the camp the week before we arrived, flooding and collapsing all of the tents. Refugees were literally left homeless. What little clothing and food supplies were destroyed. Our trip was an emergency relief trip to provide winter jackets, food aid, portable heating units and medical supplies. This refugee camp is in the middle of nowhere—far from any city or inhabited area. Tall barbed wire fences surround the camp and guards would arbitrarily open and close the camp to incoming refugees, to volunteers, and visitors. When we arrived, the guard would not allow us entry...those who arrived on foot and were Syrian, such as us, and who had nothing but our backpacks, were refused entry. We were finally allowed in after being forced to wait an entire day. Soon, camp residents gathered around crowded tent, sharing hardship stories and pleading for us to do something—anything. They showed us an expired can of lunchmeat they were given as their food ration for that entire week and how their children became ill upon eating it. A mother showed me her young son who was having convulsive 'episodes.' She asked me what was wrong with him and if there was anything I could do to help him...the boy was suffering from trauma and could only scream to drown out memories of past sounds and events. I knew we couldn't do anything; we weren't equipped with the necessary medications, didn't have a mental health professional on our team, and there was no clinic in sight...as we left, we passed back through that same military checkpoint. The guards held their*

*automatic weapons high and a large tank sat to one side...this was no more than one big open-air prison. Once we passed through that checkpoint our passports were returned and I could not bear to look back...a long dirt road led us away from the barbed wire, the tragedies, and the pleas for help.” 1*

By 2050, nearly 80% of the world’s population will reside in coastal zones, and this, coupled with the increasingly menacing ramifications of climate change and societal conflicts, constitutes an ideal recipe for further widespread chaos and disruption. The *World Health Organization* (WHO) calls for research and development (R&D) on sustainable and resilient facilities capable of anticipating and responding to disasters, and especially rapid response architecture. By nearly any measure, architects, collectively, have not yet risen to this challenge. Worse, far too little is being done in University-based architecture schools to train and prepare. In the arena of healthcare, the need is especially acute for redeployable clinics and field hospitals capable of providing rapid mitigation assistance in medically underserved disaster strike zones worldwide—necessitating rapid transiting, erection, and operationalization within tight timeframes, without compromising the high standards of *design excellence*.

Fixed-site, brick and mortar health facilities are sitting targets, and by comparison a transportable is a nimble, fleet footed alternative, as has been repeatedly demonstrated in 20<sup>th</sup> century vehicular and tent-based structures. Offsite-fabricated transportables filled key medical support needs in post-disaster humanitarian relief efforts, including in the aftermath of the Haitian (2010) and Ecuadorian (2016) earthquakes. As for the contribution of architects, they/we continue to be criticized by engineers, disaster aid organizations, and private-sector NGO philanthropies as exceptionally poor first responders. As a result, unfortunately, genuinely effective first response prototypes for health remain few and far between.

How can architecture become a meaningful part of this equation? Much can be learned from civilian and military precedents of transportables with demonstrated track records. Study their advantages, shortcomings, and benefit-risks. Second, acquire working knowledge of offsite, prefabricated design and manufacturing processes—become versed in prefab/onsite tectonics, environmental support systems, transiting requirements, commissioning processes and day-to-performance requirements—without sacrificing the Vitruvian precepts of commodity, firmness and delight. Inventiveness is prerequisite. The majority of transportables originate in military organizations; private sector portables typically originate in NGOs. Generally, three types of transportables for health exist at this time: *Redeployable Health Centers* (RHCs), a *Redeployable Trauma Centers* (RTC), and *Permanent Modular Installations* (PMIs) and five variants of these are operationalized in the field:

- *Vehicular-based Nomadics*—Prefab modules are installed on a truck chassis with interior compartments dropped in prior to final assembly. Alternately, a two-component apparatus is preferred, with a truck cab pulling modular medical unit(s) with components built independently. The mobile field Hospital proposed for the Moroccan Ministry of Health in 2010 consisted of a 48-bed inpatient hospital housed in a number of semi-trailer truck modules. The MONARCH Corporation teamed with Hord Coplan Macht, of Baltimore, Maryland to develop this nomadic, redeployable field hospital. The 48-bed RHC/RTC inpatient installation as depicted here would be housed in up to 58 vehicular units with some functioning as docking port satellites enabling their transiting to and from nearby yet remote sites.
- *Tent and Pneumatic Systems*—The tent, and yurt, predate all contemporary systems in use today. Tents are lightweight, versatile, and adaptable to diverse cultural and occupant needs, responsive to topographically challenging terrain, and many climatological contexts and have evolved significantly in recent years, i.e. modular pneumatic systems. The majority of tent and pneumatic systems for health applications are commissioned by military organizations for deployment to combat theaters. With the dramatic increase in the occurrence of disaster events these systems are essential interventions in humanitarian missions.
- *Containerized Systems*—The standard modular intermodal-shipping container is preferred by many healthcare organizations, for their structural resilience in difficult transiting conditions; containers can be densely close-packed and custom-built for specific installation contexts, whether extreme cold (arctic) or subtropical conditions. In the aftermath of the Haitian earthquake in 2010, an American NGO, Containers-2-Clinics (C2C), commissioned three women’s health outpatient clinics. Generic containers provided a blank canvas for STANTEC/STACK Design’s response. This installation consisted of three modules sited in close proximity around a courtyard.
- *Flat-Packs and Pop-Ups*—These systems consist of kit-of-part assemblies shipped in standardized (generic) intermodal containers, or in specially designed containers. Upon arrival on-site, contents are removed and assembled. Transiting modules are stored nearby on site, available for ancillary functions (such as storage). A second variant, pop-up clinics, either PMIs or RHCs, are also effective prototypes in medically underserved communities. In this scenario, an existing *host structure* houses pop-up modules within. In a research project in Charleston, South Carolina and in New Orleans, Louisiana (US) in 2013, a range of types were ‘pretested’ as hosts, including a shopping mall, vacant big box retailer, churches, school gymnasiums, banks, and a movie theatre.

- *Hybrids*—These systems consist of *composite facilities*, a synthesis of mobile vehicular unit and/or tent or shipping containers combined with conventional tent systems or pneumatically activated structures. Hybrids are advantageous for their aesthetic possibilities, fabrication, and transiting amenity, and an ability to effectively re/distribute internal functions between the ‘hard’ and ‘soft’ zones of an installation. The *SmartPOD* (2013), is a hybrid RTC capable of operating remotely or tethered to a stationary, fixed-site brick and mortar hospital. It is inspired by the generic intermodal container and portable infirmaries in military combat theatres. This 40’ long custom-built module complies with international codes and is transited and erectable with its own equipment shipped onboard.

A transportable for health is, by its very nature, designed and fabricated for use at an unknown site. Few design students are exposed to this mindset while in school, and this is unfortunate. Selecting an installation site is governed by multiple determinants. A system typically arrives on-site with its own site prep equipment including earthmoving devices, forklifts, prepackaged electrical generators, and modular surgical suites. Open spaces, rooftop-parking decks, sufficiently wide streets, paved parking lots, parkland, and open fields are preferred. A system can function autonomously, or when tethered to a fixed-site conventional structure. The members of this Thesis Option Studio this term will have the freedom to explore multiple prototypes for application in highly diverse climatic conditions. This will include the design of fixed-site prefab long term care facilities for the aged, as well as redeployable clinics for disaster strike zones. The first few weeks will be devoted to research on the state of the art, followed by the design phase. This will be the first time the recently published book, *Innovations in Transportable Healthcare Architecture* (London: Routledge, 2016) will be ‘road-tested’ in a studio context. That said, I am open to and supportive of diverse thesis topics/project proposals beyond prefab/portables *per se*, as pertaining to universal themes in *design + health*.

1. Excerpt from Chapter 3 in S. Verderber, *Innovations in Behavioural Health Architecture* (London: Routledge, forthcoming 2018).