DeMoLi BRIDGE
[designing an emergency connection]

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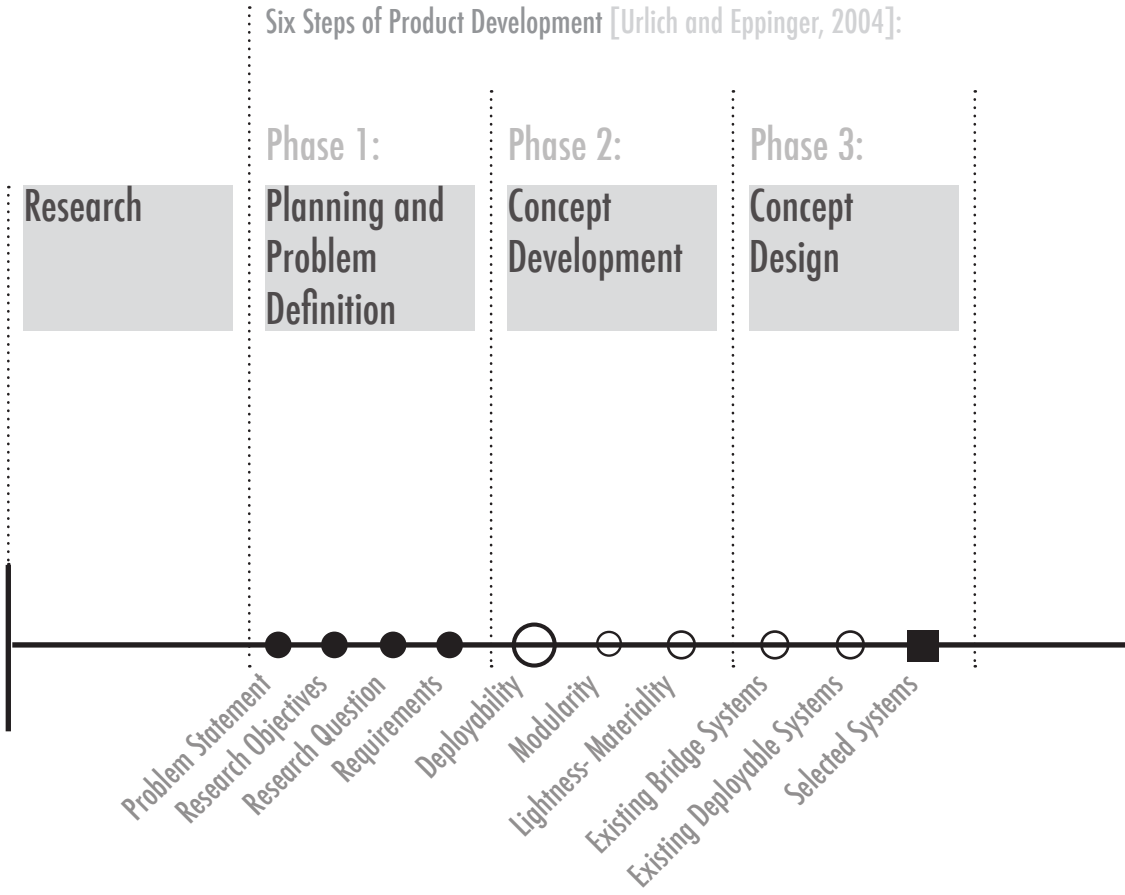


Figure 1 | The Six Steps of Product Development Management and its relation to the graduation process

[P4 REFLECTION]

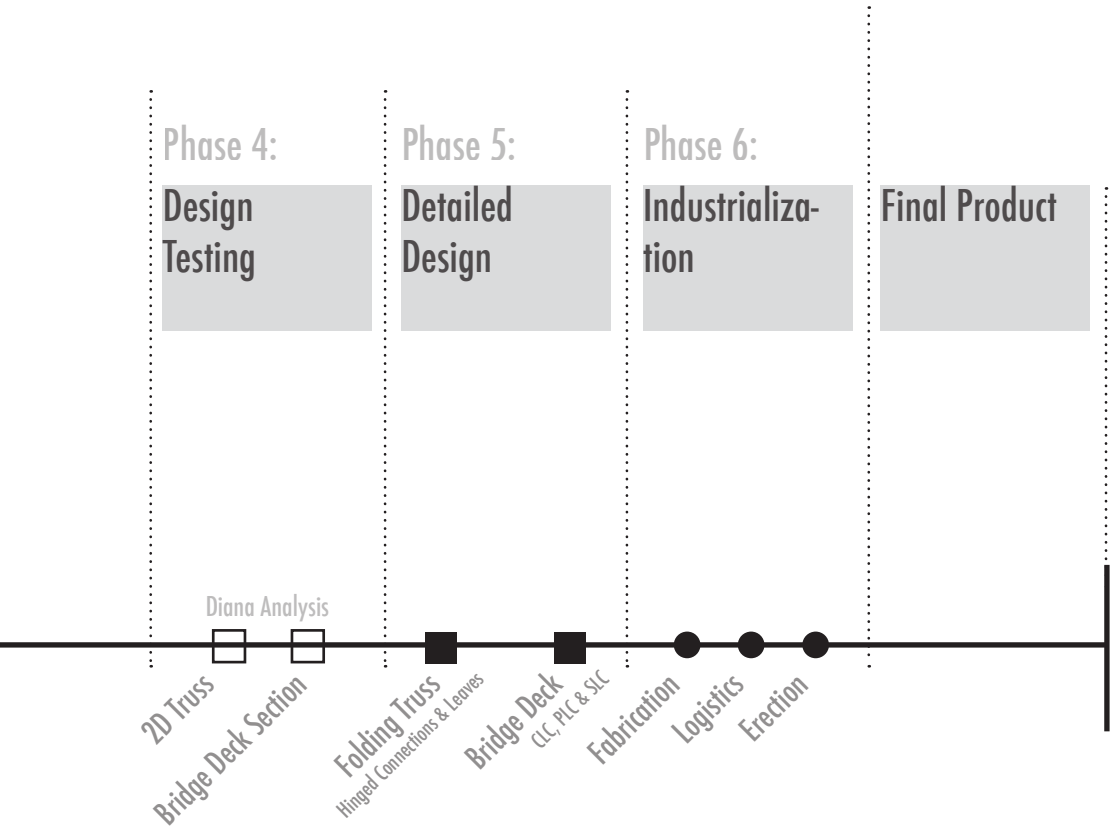
Extreme events, including natural and man-made disasters such as typhoons, floods, tsunamis, earthquakes and terrorist attacks have become the largest destructions around the world over the years. Their impacts can be calamitous devastating entire countries overnight and making millions of people suffer.

Due to the above disasters, bridges were damaged resulting in isolated of residential communities, and the inability to deliver emergency relief supplies. In order to provide quick help to disaster areas, an easy transported and rapid installed temporary bridge becomes critical for transportation of the people, food and medical supplies.

This graduation thesis seeks to the design of a ***DEployable, MOdular, LIghtweight (DeMoLi) Bridge*** *as "an emergency connection" solution for a single-lane bridge that has a span length that varies according to the specific needs from 6 to 21m.*

The instant connection could be used all over the world reconnecting communities and supporting disaster relief.

It is a Warren Pony Truss Bridge, consists of identical prefabricated elements relying on the term of modularity creating a lightweight structure made of aluminum. The construction process and the final assembly realize off-site (in the factory) and the completed bridge is transported on-site in a compacted form thanks to its deployable capability. Finally, it is installed on-site in a limited time and without any special equipment for short term, servicing the emergency needs. After the bridge mission completed, the bridge can be packed and reused in another emergency call.



Aspect 1
The relationship between research and design

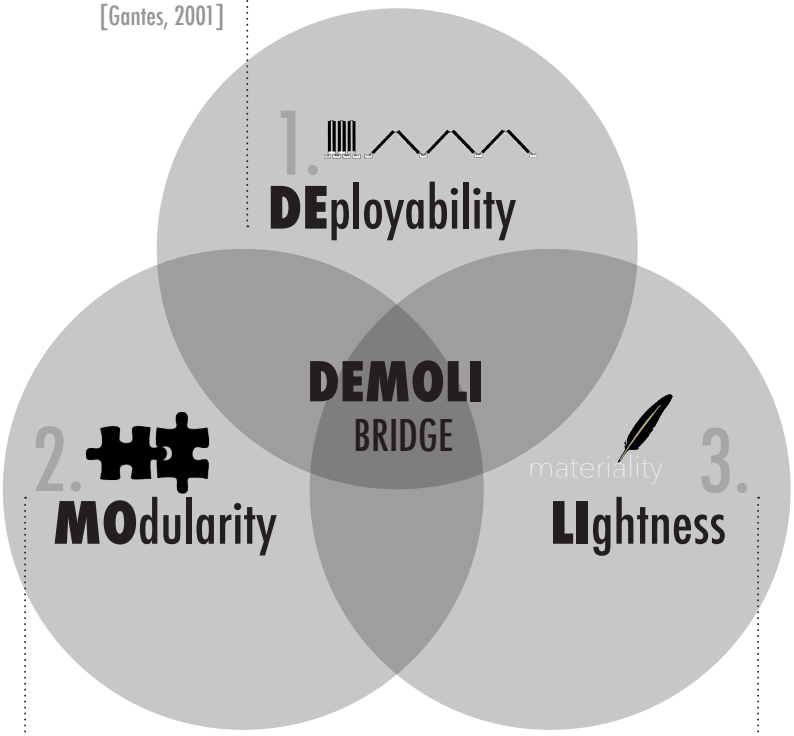
From the very first steps, the proposal framework process of the graduation thesis feds on the Six Steps of Product Development Management [Figure 1]. These are: 1. Planning and Problem Definition, 2. Concept Development, 3. Concept Design, 4. Design Testing, 5. Detail Design and finally 6. Industrialization. All of these phases were highly useful during the whole process for improving the design of the proposed emergency truss bridge.

Through these steps, the main research question: *"How to provide services to the transportation community in an emergency case, through the design of a temporary bridge, which is fast, simple and flexible constructed, transported, installed and uninstalled, servicing the needs of emergency?"* was explained, analyzed and visualized deeply.

Every " emergency" matter is a delicate issue, which has to be always dealt with respect and shifty in order to be efficient. Therefore, an initial research relevant to emergency situations was carried out. According to this, three fundamental principles (*Deployability, Modularity and Lightness*) were proved as suitable in proposal design and a deeper reacher was started. There is no doubt that the above terms can work together efficiently covering the objectives of the emergency bridge. The terms Modularity and Deployability are inextricably linked and in combination with the selection of a proper lightweight material can offer the promising solution. Firstly, through research study and then by doing design testing, the three fundamental strategies tried to apply in the proposal design.

Looking now the final product, after seven months of intensive work, I can say that the goal is fulfilled and all the research progress is evident in the design. The

Deployable Structures is a generic name for a broad category of prefabricated structures that can be transformed from a close compacted configuration to a predetermined, expanded form, in which they are stable and can carry loads.
[Gantes, 2001]



"Modularisation = decomposition of a product into building blocks (modules) with specified interfaces."
[Ulrich and Eppinger, 2004]

Composites
Non-Ferrous Metals

Figure 2 | The three De-Mo-Li (sh) Strategies from research to design

bridge is deployed by using two folding truss, which reduces erection time to few hours. Then, the modularity is obvious since the bridge of every required gap consists of only three interconnected components. Finally, lightness achieves a really lightweight structure, for less than 10T for 21m span.

Aspect 2
The relationship between the theme of the studio and the subject/case study chosen by the student within this framework (location/object)

The objective to current graduation project is the detail design of an emergency deployable bridge. Therefore, according to the three different themes (Climate, Façade and Structural Design) of Building Technology track, the focus has a structural perspective.
Sustainability is simultaneously approached through the social character of the bridge, its reusability but also through the different construction processes.

Aspect 3
The relationship between the methodical line of approach of the studio and the method chosen by the student in this framework

The methodical approach can be described as a *design-through-research* process. In general, the methodology suggested by the studio, which is the sequence of research, design and evaluation, was kept as a general plan with some back-forward steps. Specifically, P2 presentation was the fundamental stone where the scope of research was presented (planning and problem definition and concept development). Then, in P3 presentation, a more detailing design (concept design) was shown with some very first structural testing and now, reaching P4, the detailed

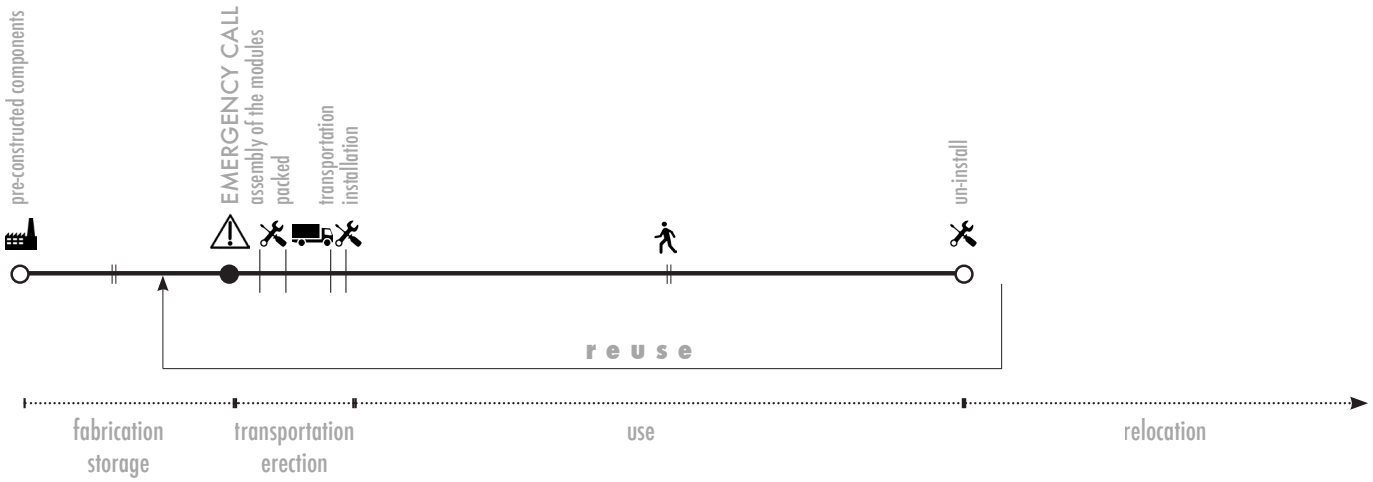


Figure 3 | The three De-Mo-Li (sh) Strategies from research to design

design is at its final stage. The only remaining issue for the P5 presentation is a mock-up of two nodes of the final design in scale 1:2.

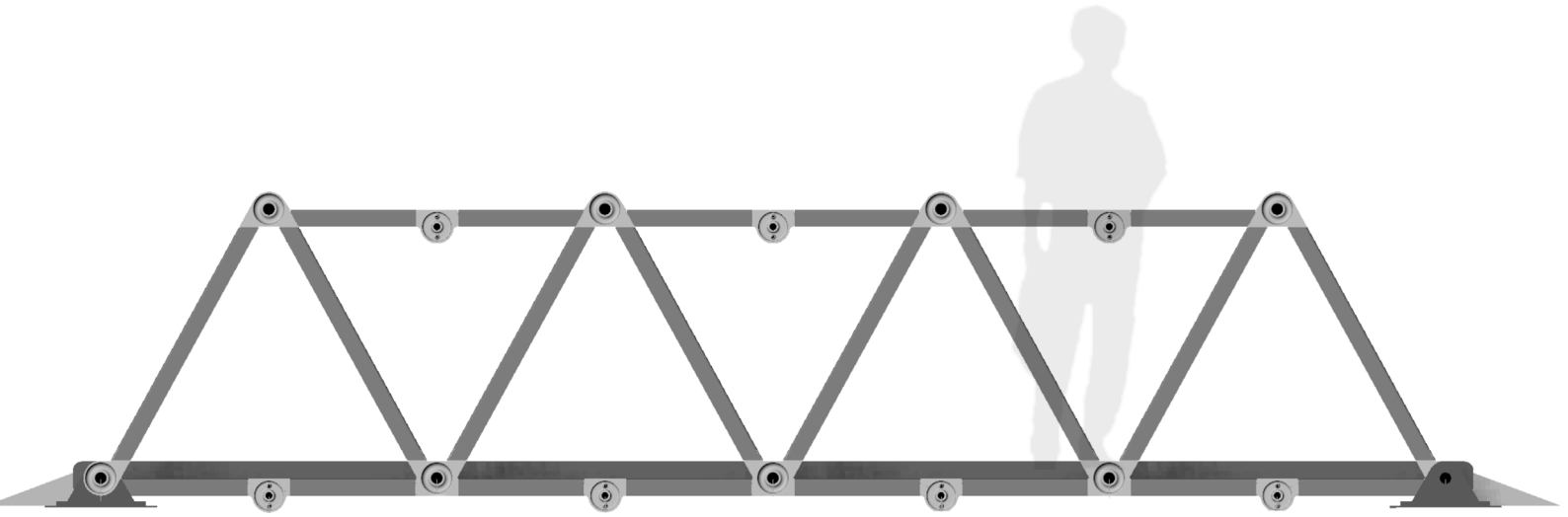
Aspect 4
The relationship between the project and the wider social context

Every year severe floods, typhoons, storms, hurricanes, landslides and other natural disasters but also explosions and terrorist attacks have been dramatically increasing in both number and intensity, cause havoc in communities and immense suffering for millions of people around the globe. Damage and casualty percentages have reached record levels every year during the last decade. The number of people affected by natural disasters is alarmingly high, estimated in the hundreds of millions.

When disaster strikes, whether natural or man-made, urgent priorities such as evacuation of habitants, care for the injured, food and water are vital important but a lot of times can be severely hampered and unfeasible, especially in cases that transportation network is interrupted due to bridges collapse, resulting the inability of relief workers and supplies to reach stricken areas.

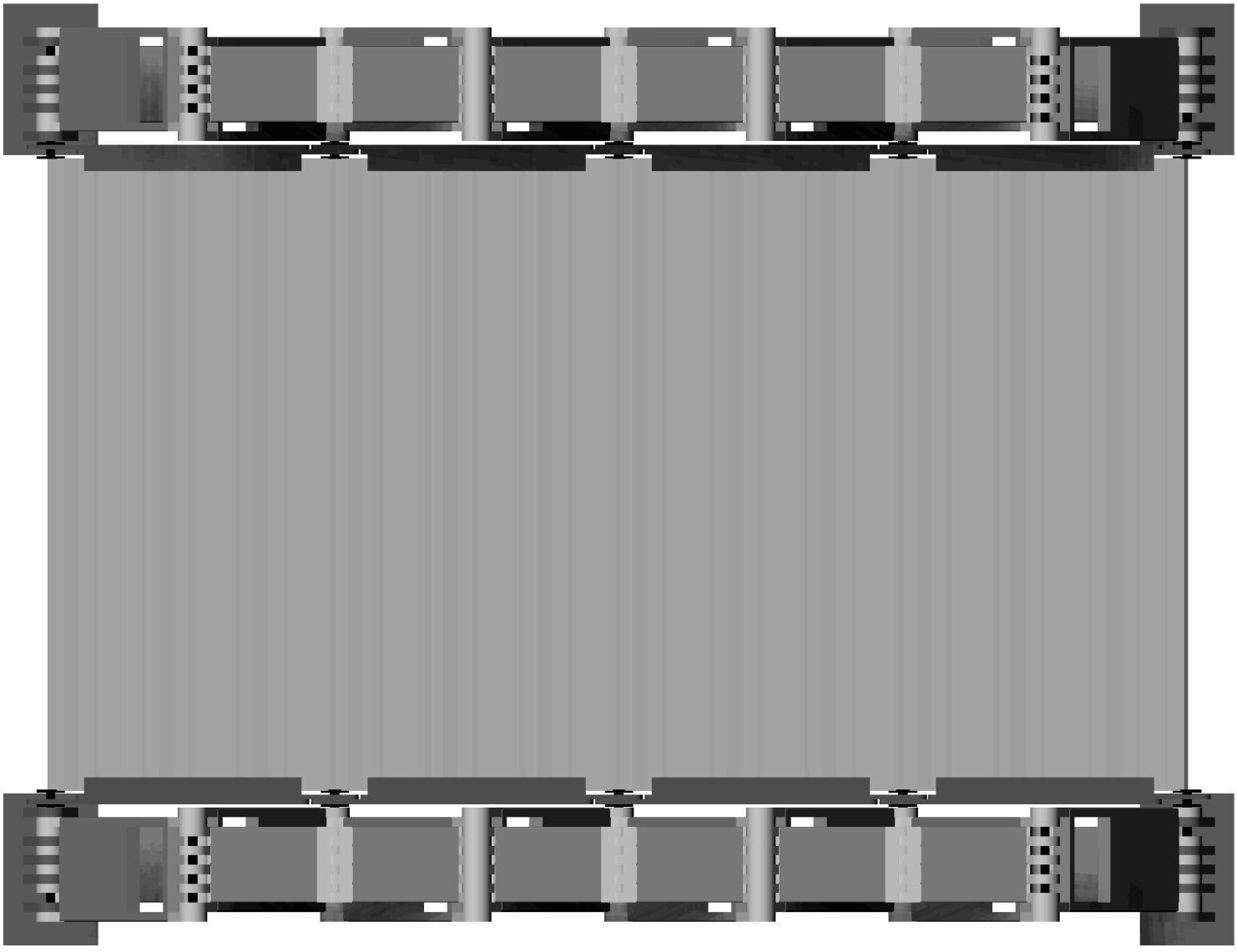
We know that we cannot underestimate the importance of emergency planning. If an earthquake or terrorist attack hits, we won't necessarily have advance alerts or opportunities to double- and triple-check our plans and therefore we have to arm ourselves with the necessary equipment. Part of the plan is the design of an emergency prototype bridge able to reconnect communities by providing an uninterrupted access to the effected area and by reestablishing the former ones. Nowadays, in most of the above circumstances, rescue teams and locals built really temporary and unsafe connections made of tree trunks or worthless objects that they can found around. Also many times, international donors are helping them by providing helicopters and boats. However, these solutions are not always possible, effective or safe.

DeMoLi Bridge could be the key in the above problem providing reliable, simple, flexible and cost-efficient solution in every emergency call.

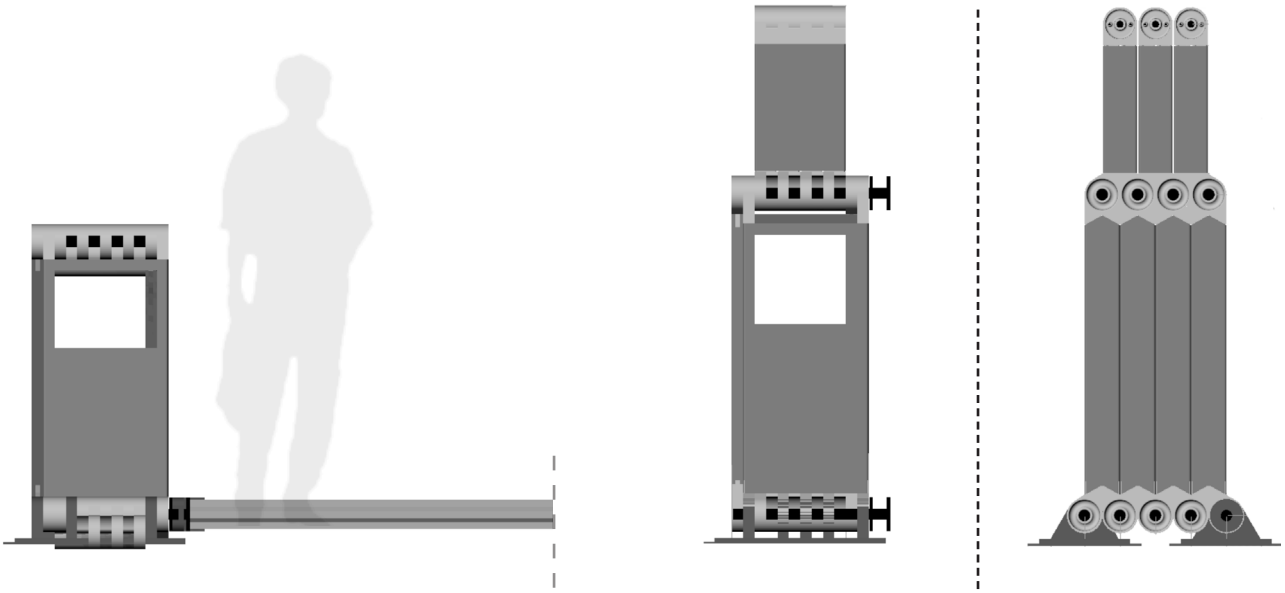


Front View

Expanded Configuration



Plan



Side View

Compacted Configuration

Figure 4 | Architectural Drawings

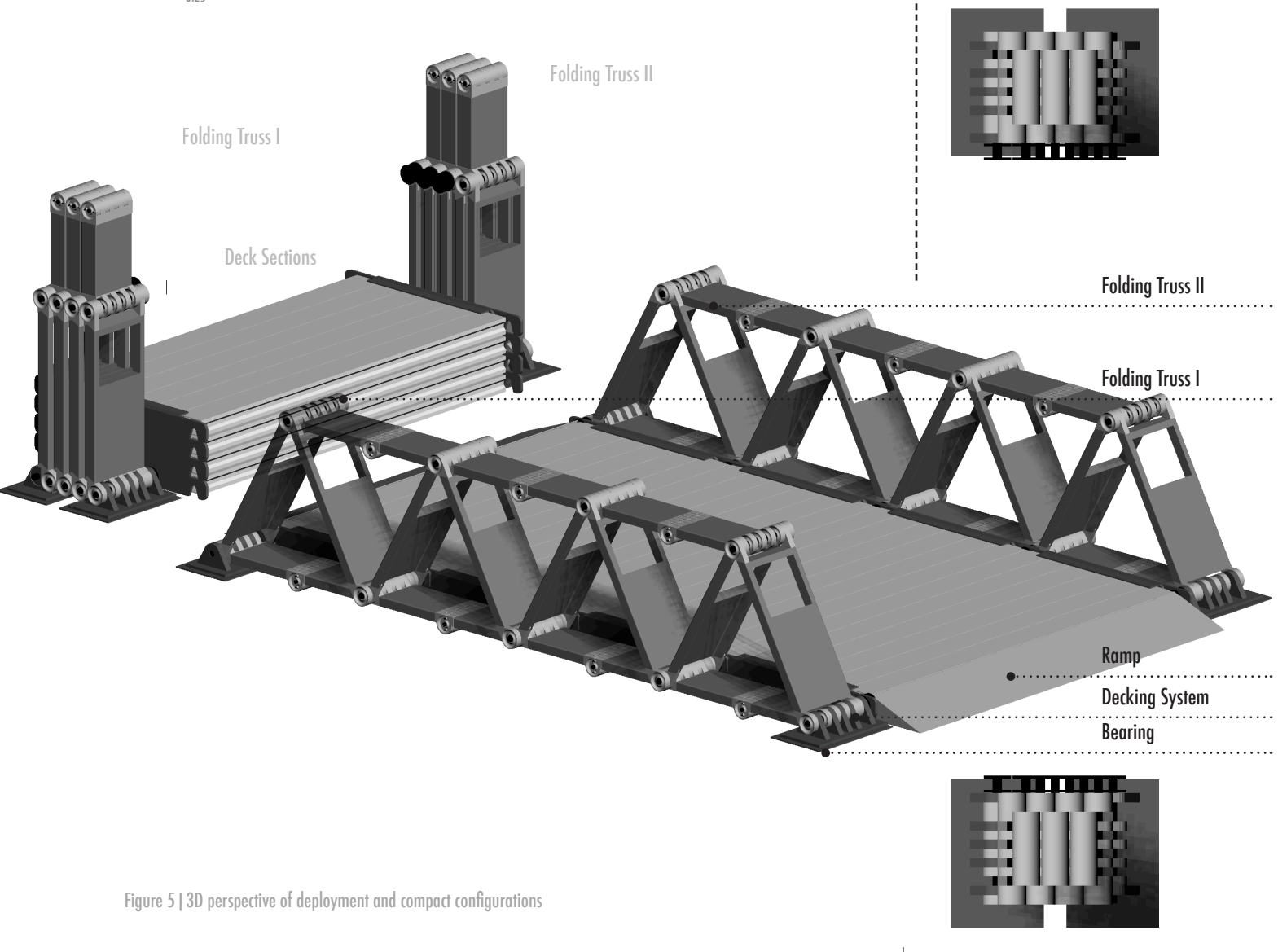


Figure 5 | 3D perspective of deployment and compact configurations