Smart Moveability of Architecture

Yanxiang Yang

Melbourne School Design (MSD), University of Melbourne, Melbourne, Australia

Abstract: *Regarding architecture as living creatures, the paper discuss how architecture can also develop its intelligence in terms of mobility or movability and the relations with the function from the point of dynamic systems. Cities of future tends to develop with multiplicity and complexity. Building, as the main component for city, needs to adapt a dynamic environmental change in the future. Elizabeth Diller states "We think of architecture as starting dumb and inert but averaging a better IQ with integrated computing systems that control new behaviours." during his conversation with Cynthia Davidson. Taking the Culture Shed Project as an example, and mobility allows us to commandeer an adjacent site for temporary use sometimes. Our life in the future tends to become more random and flexible. Even more architectures should be temporary to satisfy transitory needs of space. Thus, Movability is more likely to improve interaction between people and space. There is much potential to develop both Mobile architecture and Mobility in architecture.*

Keywords: Moveability, Mobitecture, Mobility in Architecture, Dynamic System, Temporarity

1. Introduction

Mobitecture

The idea of Mobitecture is to exhibit different ways to change the structure of architectural space, and the action of 'creature' includes roll or revolve, inflate, or shrink, fold or unfold, flat-pack or pop-up, slide or float, rather than restricted in 'Architecture on wheels'. These approaches of automatic change encourage designers to develop a series of components or prototypes[1].

Historically, tents and caravans came to world as the earliest form of mobitecture. This moveable space can usually be fast assembled and disassembled. They are more lightweight, adaptable, and sensitive to conditions when they travel to different places. These spaces are usually served as a living, retailing as well as relaxing for a 'coffee break'.

Figrure 1: Opera Karavan (left), Life Pod(middle), Summerhouse(right)

Figure 2: Car-Caravan Hybrids (left), Wow Pod (middle), Cody delivery truck (right)

Nowadays, main advantages of moveable architectures include:

-Diversity: Inside-Space can be used for a variety of functions.

-Adaptability: Moveable space can adapt in multiple situations over a period.

-Temporary: Space is temporary but flexible to change in different places.

Obviously, one of the benefits for mobitecture is to free people from the constraints of daily life. Functional space in the future will not be permanent and keep changing in accordance with the needs of social activities. Lifestyle becomes increasingly diversified, which encourage mobile space to create more flexible ways for people in terms of living, working, playing, relating and communication. The cases in fig2 illustrate how mobitecture can provide service for people typically and it shows the potential of autonomous vehicle in the future. For example, Car-Caravan Hybrids[1] create mobile components in two-scale-system. The larger vehicle as whole object can be served as 'Skybus' or certain functional space like seven-eleven or bookshop, while small vehicle works as sub-component in this system, but it also runs independently to provide flexible services[4].

Multiple mobitectures can form a functional area, which means moveable architecture can take a beneficial effect on shared public space. They work as catalysts for large-scale activities. Temporary market is the main form of aggregation for mobitectures. However, it depends on the way to deploy moveable components; Seoul Bamdokkaebi Night Market is a good example, it is formed by a series of triangle sheltering vendors. Prototypes are the lightweight V-shaped metal frames, which are set on wheels and can easily be folded and rolled away. Modular aggregation is the typical way to create a scene. They have multiple approach to showing a fascinating spectacle at night.

Figure 3: Motoelastico designs foldable tents

Figure 4: Bamdokkaebi Night Markets Seoul's No. 1 policy: foreigners

The housing vehicles are also increasingly inhabitable, and some people without fixed accommodations can even sleep well in their camper. Thus, living spaces are not restricted to residential buildings. Nowadays, mobile housing has the potential to become an alternative living asset which is more affordable, but it is only temporarily available. For instance, Homeless people can gain a home by working for a community. When they earn enough money, they can sell their asset and buy a more comfortable house to live. Moreover, it is also an appeal for university students, instead of spending more on renting a flat, their budget can reduce a lot if they select to live in a small moveable dwelling. In general, the Mobile home offers only a small-scaled space, similar to a single bedroom, but multiple mobile houses can aggregate or combined and create a community, in which the scale can flexibly change based on the site.


Figure 5: Cedar Cabin (Shepherd's Hut) Travel Trailer/micro-house

Figure 6: The entire bus in all of its glory. Airstream

2. 'Mobility Urban Plan'

There are many left-over spaces in the city. For example, the car-park area at the central line of the street remains unused when no cars parking, where the mobile home can park as an alternative to ordinary cars. Therefore, left-over space in urban area can be used to provide temporary housing with application of certain mobitectures, which enables to alleviate the pressure of urban accommodation.
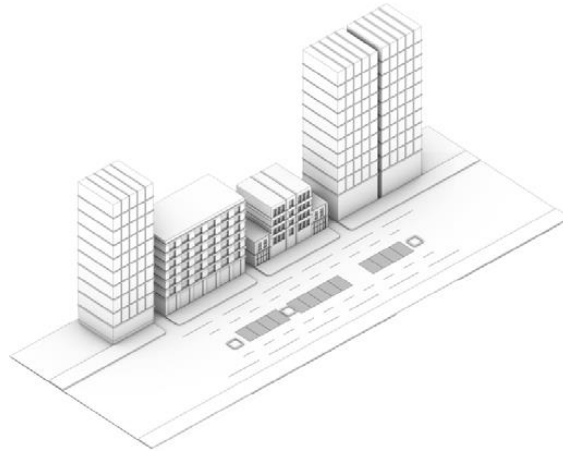
Figure 7: Leftover space of car park area on street

Theoretically, mobitecture can work as a small-scale space for temporary use. The principle of modular aggregation can become a typical method. Car-park area with low using rate in the center of urban street provide opportunities for setting functional mobitecture, and this situation encourages designer to develop a series of prototypes for mobile housing. Each prototype is composed of some specific architectural elements or components. However, every moveable one is based on certain principles of moveability. Moving houses can create a more interesting scene of living under the specific rules of aggregation and stacking. Additionally, some moving parts play a role in the connection between different mobile homes; They are also adjustable in response to a diversified environment of living(fig8).

Considering material and framework, mobile prototypes in city center enable to serve as communal space for people to enjoy a coffee break, which can be more attractive and eye-catching. Alternatively, this structure has potential to be used as a landscape element in the urban area. If we use wood to construct the framework of the prototype, growing plants on the frame or installing some lights are also good ideas to make our city looks better(fig9).

Figure 8: Rules for aggregation of modular residential space
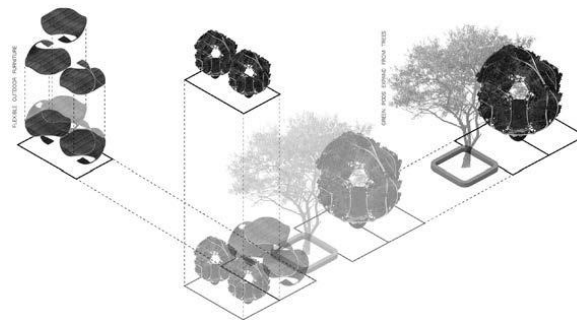
Figure 9: Rules for aggregation of modular communal space

We can use a Pedestrian simulation to justify how pedestrian could be influenced by moveable architecture, the interesting point can be a variate to control pedestrian flow. To evaluate the effectiveness of intervention, the scenario is to set on two adjacent main roads in the campus of Melbourne University. Under the same conditions where the starting points and destination points are the same, more interesting points on a certain road can make the road more popular.

Fixed Interesting Point here is defined as public service elements, such as café, park bench or sculpture, etc. In comparison, the flexible interesting point is created as E-waste Gallery for instance to

intervene in the same scenario. The experiment of simulation below shows the effect that flexible interesting points balance the popularity and contributes pedestrians to spreading to more places.
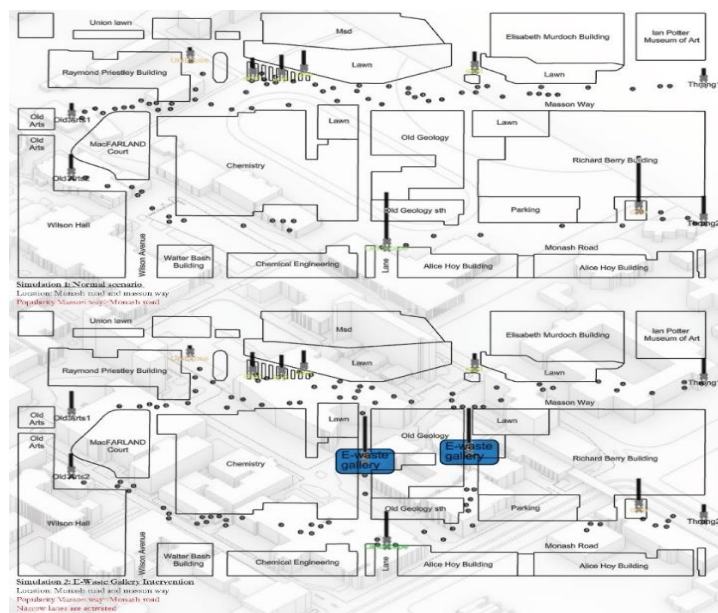

Figure 10: Pedestrian Simulation in comparison experiment, design project of E-Waste Micro Adaptive System

(E-Waste Gallery: When E-waste is recycled, components inside the electric products after being disassembled can be used to produce different kinds of artefacts. Products such as drones, robots, jewelries are potentially created by intelligent students from different faculties, and they can be exhibited or sold in 'Gallery' spaces. Also, it is considered that the screens from multiple electric products can be used to collage a big screen. In this way, these galleries can even be transformed into mini cinemas, positively encouraging people to engage in. The project provides multiple different prototypes, and these prototypes can collaborate to form a larger temporary functional space.)

3. 'Mobility' in Architecture

### 3.1 System of moving components

In the new age, the system of moving components is considered in mega-building structure. 'Mobility' promotes public building to evolve into a more diversified and adaptable urban building complex. The mobile mechanical system in the building enables the architecture to show different performance to public and they always bring a fantastic experience to people.


Figure 11: Diller Scofidio + Renfro with   Rockwell Group, the Shed, 2014

One of successful case, Hudson yards Cultural shed in New York, presents a wide range of activities in performing different kinds of exhibitions and visual arts. Evidently the animation shows the telescoping outer shell can deploy from over the base building and the wheels can both extend and retract the shell, in order to satisfy the needs of performing activities at any time and any scale [2]. Therefore, 'Mobility' in architecture allows space to meet requirements of social activities better and to control human behaviors more easily. The massing diagram below shows the Shed nested (left) and Developed (right):

The boundary of architecture tends to be vague, and events happened inside are not limited in a specific functional space. For Hudson yards, Dailler states" There is no back and front of house, It is all just a big space for the audience, for the tech folks, for the performer alike, all in one space". It seems that rigid division of space is not necessary any more in the future, especially for large public building for performance. To accommodate audience as many as possible, the moveable shell can cover the adjoining outdoor plaza and fixed building provide seating area to the maximum extent[5].
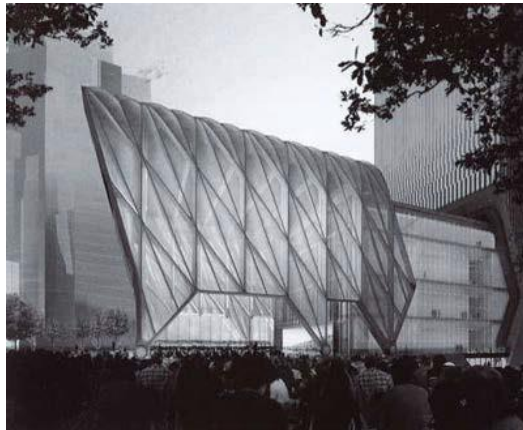
Figure 12: Wheels used to retract or to extend the shell
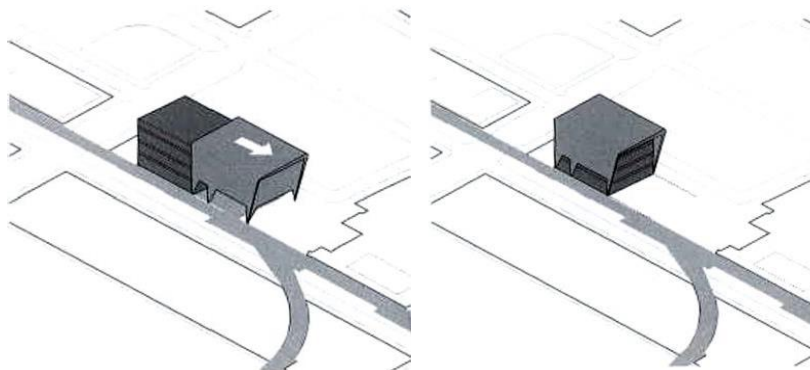
*Figure 13: The Shed, renderings of deployed shed*

Figure 14: The Shed, renderings of interior space in moveable shell

4. Dynamic mechanical system

4.1 Mobitecture & Architectural Mobility

Hudson yards, as a successful case, enlighten modern designers about the idea of dynamic system for improvements of commercial complex. With the development of 5G technology and AI, smart devices might enable electric vehicles to drive by themselves. Based on this phenomenon, it becomes possible that moveable architectures can achieve self-driving. At a particular time, this smart space reaches a specific place; it opens and provides service for the public. Also, it closes when getting off work.

Taking container as an example, development of cargo container has broken through during the 21st century, 'Foldable & Tiny House Designs' provides an ideal model for new prototype of mobile container. As the image shown blow, the container has become a flexibly assembled architecture. This kind of space can be used for both living and commercial purposes. Functional containers are now extensively applied to public space, and they can provide services like coffee bars, retailer stores, mini-libraries, campers, and restaurants. Functional space installed wheels mean it becomes an active service with uncertain time and location, which is possible to create a new lifestyle in the future. Not same as housing vehicle, it delivers a futuristic physical model for marketing.
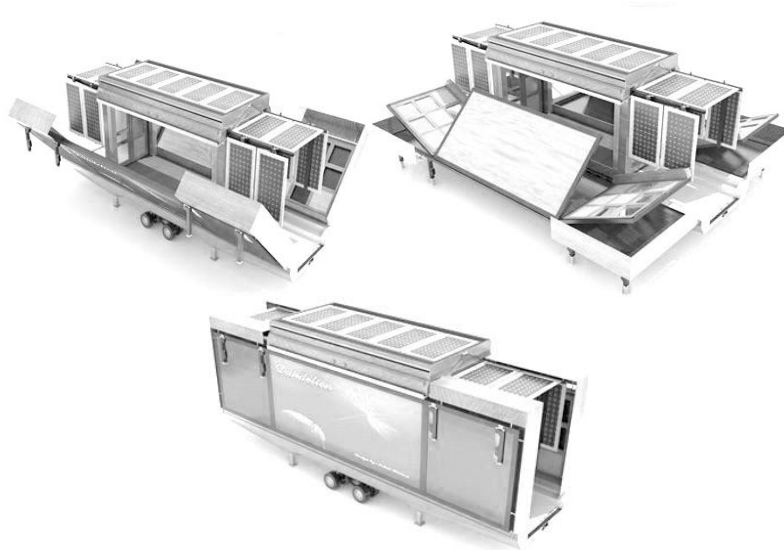
Figure 15: Foldable & Tiny House Designs

To manage mobile containers, a larger system needs to intervene in urban area. Comparing with urban transportation system, taxi, trams, and trains should gathered in a terminal station for management and redistribution within a regulated period. Under the similar notion, designing an urban commercial 'complex' to collect all mobile containers in a certain area is necessary, and this 'complex' means not only a terminal station but a non-fixed market, which depends about functional containers' parking. This 'complex' can be defined as 'Staging post', containing a variety of functional spaces. They can work both steadfastly and temporarily.

In a city where business distribution is uneven, or there is a large gap between the rich and poor, it is hard for people in different place to share an equivalent resource. Melbourn is typical city that resources are highly concentrated in city centre. Most local people live far from city because the city is occupied mainly by migrants for government maximizing the economic value from the commercial services supplying for international people. Melbourne central shopping mall contains all kinds of stores and restaurants, but overall, people have higher transportation costs for shopping in terms of time and money. In other words, for those who live far from the city centre, they may change their decisions because of the inconvenience in the distance. Thurs, under the developed tram and train system, outflow of goods is also a possibility.

What about these stores and restaurants can run out of the building? we can try to package different stores or restaurants and put them into mobile containers. These functional containers can be arranged to flow to other places to serve people. These portable containers may become the subcomponents of the complex. The rule for allocation can be shown as diagram below:
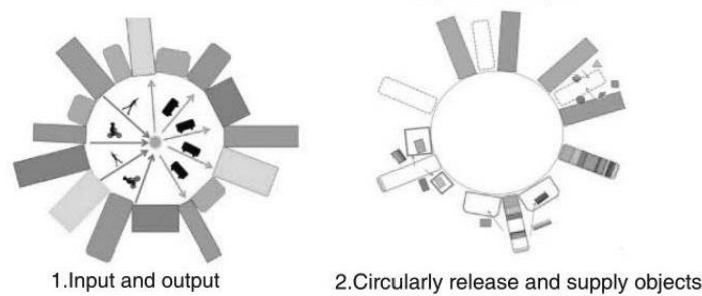
1.Input and output   2.Circularly release and supply objects

Figure 16: Diagram of allocation system, design project of 'Master Station' for mobile container

Considering the larger system, it is a mega-building with mechanical structure to support unfixed commercial services. It may work as a staging post to supply commodities or food for its mobile components. This concept forms an extensive framework on the scale of the city, and it could build the connection between the complex and people around Melbourne, so it is also an external system. City is activated to a different extent at different times. We can regard the original mega building as 'master station', which output container mobiles.

Moveable services have potential to become a tendency in the future. When imagining the complexity of transportation, the management of master station needs to control mobile containers more effectively. Considering the aspects of energy supply and signal control, we can create an energy flow structure as systematic diagram shown below, and it illustrates how system bring positive changes to the city.
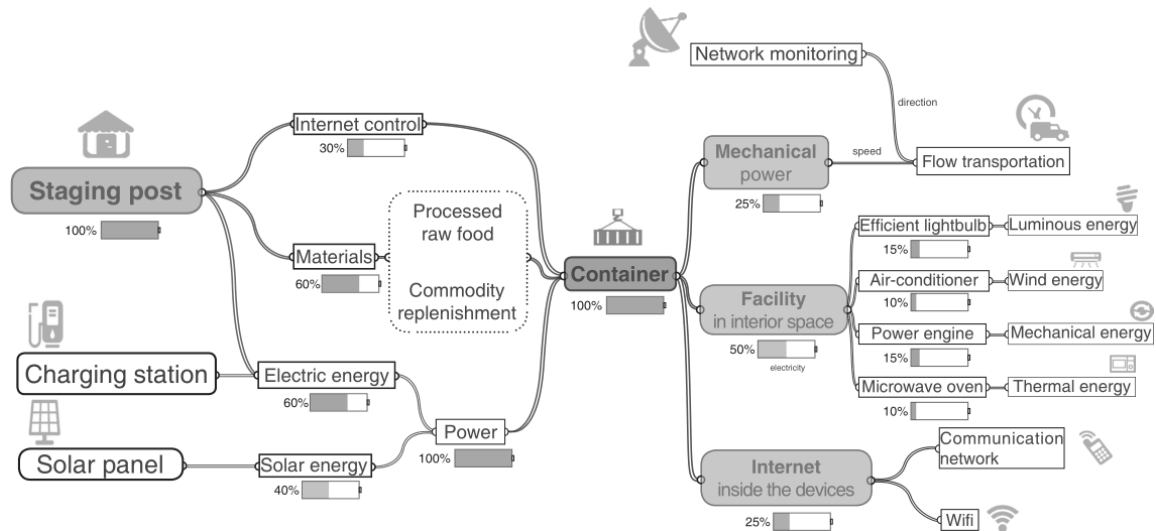

Figure 17: Diagram of allocation & energy system, design project of 'Master Station' for mobile container
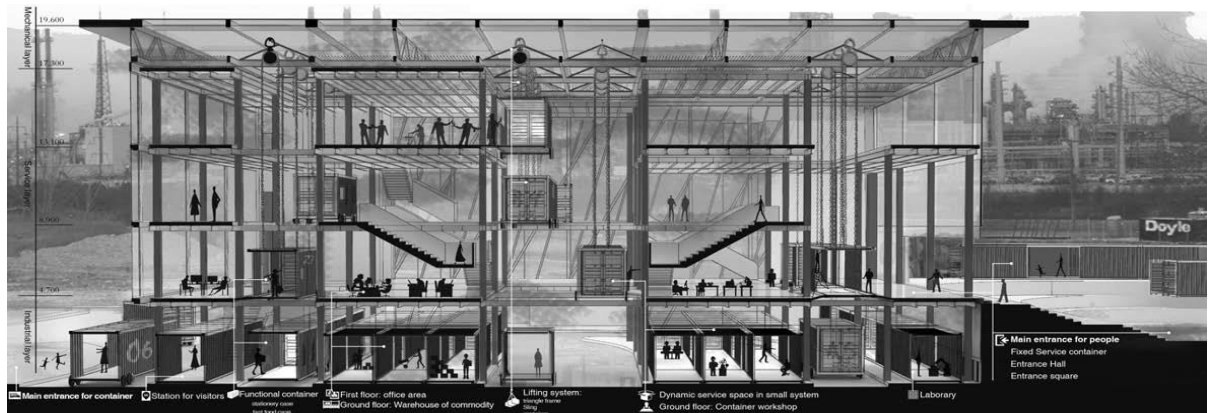

Figure 18: Staging Post. Master Station of Mobile Container, design project of 'Master Station' for mobile container
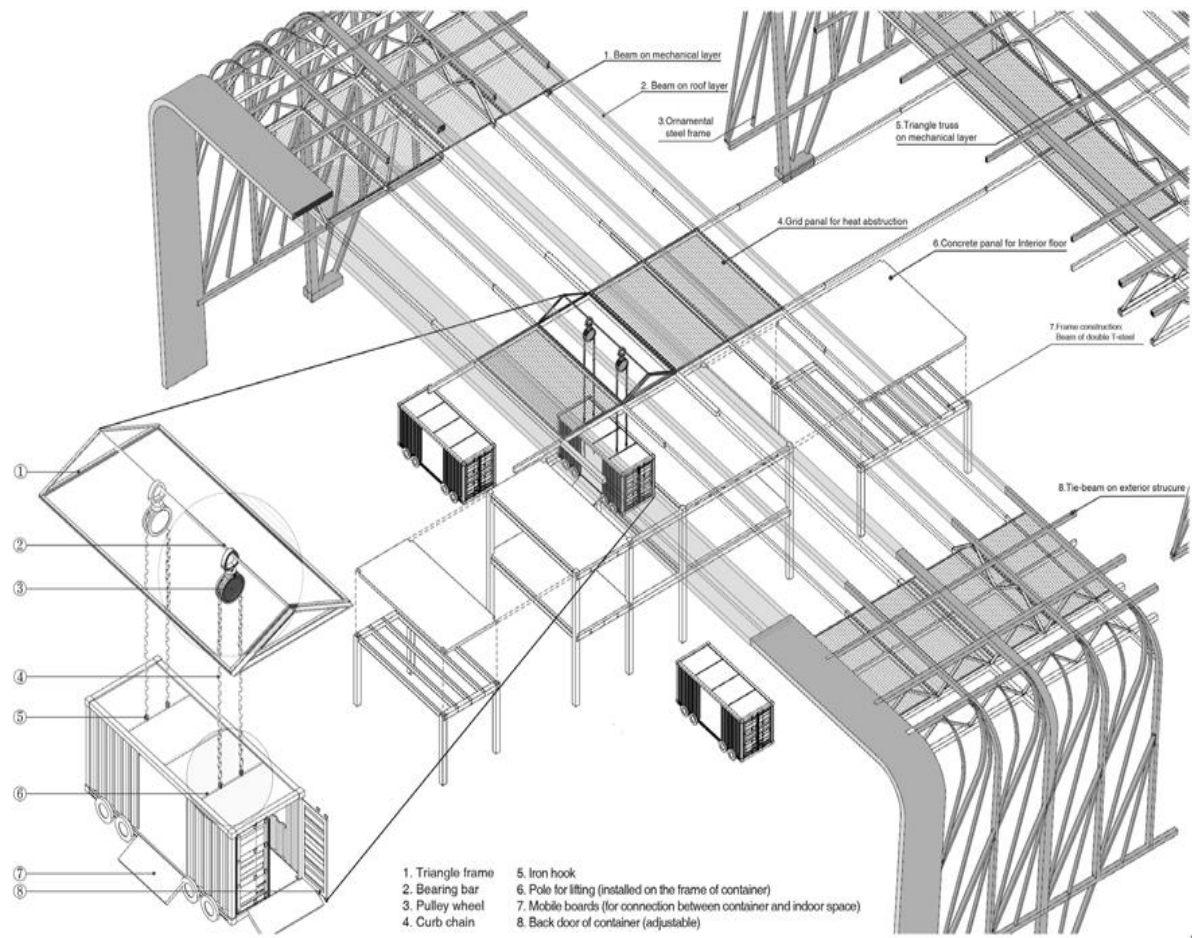
Figure 19: Mechanical system mobility in architecture, structure detail, design project of 'Master Station' for mobile container

5. Discussion

Arguably, in the book 'Mobitecture PHAIDON', Rebecca Roke notes that 'We no longer believe in the monumental, the massive and static, and have enriched our sensibilities with a taste for lightness, transience and practicality.' from one futurist Manifesto declared in 1909.

Our predecessors aspired to this life even more than 100 years ago. However, why moveable architecture has not to be applied extensively to our lives until now? From the perspective of history, human society tends to follow a stable rule to develop, which is why non-moveable architecture is dominant all the time. But we cannot deny the feasibility of complete automation.

Nowadays, we can identify some advantages of moveable structures; they are lightweight, transportable, quickly erected and usually inexpensive. However, we have not done enough exploration to test its strength. the most challenge of mobility in architecture should be considered in terms of constructability, the development of mobile system is not always keep improving. As we try to incorporate more, constructability must compromise. And it is expected to be limited to a point with more and more complex things happen.

6. Conclusion

Smart Moveability/Mobility has revealed a bright future, although it does face many technical challenges contemporarily. From the opportunity of urban development, 'Architectural Movability' processes potential to adapt people's lifestyle prospectively. This idea should be encouraged to continue to develop, to experiment, and to make breakthroughs. The next generation is an era of digitalization, automation, and intelligence, which means the development of human sociality needs to focus on the way to combine technological science in different industries. 'Architectural mobility' has been regarded

as a mobile intelligent product from the perspective of market, and it is looking at emergent opportunities that bring manufacture and Internet of Things back into city.

References

[1] Rbecca Roke.(2017). Mobitecture-Architecture on the Move. Romania, open university press.

[2] Cynthia Davidson.(2016). Moving Parts: A Conversation with Elizabeth Diller.

[3] Andrew J.(2010). Witt. A Machine Epistemology in Architecture. Candide. Journal for Architectural Knowled-ge No. 03(12/2010), pp.37-88.

[4] Ross Bryant.(2014, November 26).Homepage. IDEO envisions a future where self-driving workplaces website. Retrieved November 20, 2019, from https://www.dezeen.com/2014/11/26/ideo-self-driving-driverless-vehicles-car-21st-century-mules-cody-truck-wow-pod-work/

[5] Diller Scofidio.(2016).Homepage. THE SHED a new arts centre for the 21st century website. Retrieved November 20, 2019, from https://www.hudsonyardsnewyork.com/discover/shed