



A Case Study: Designing a Sustainable Recreational Vehicle for the Emerging Market through Computer-Aided Design Process

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ABSTRACT

This design research project was based on a joint PhD research into the Recreational Vehicle design organised by Monash University (Australia) and Tsinghua University (China) during 2010 to 2011. Through a range of comparative research about use habit, lifestyle between Australia and China, the paper formed a design specification for an emerging Chinese market. Moreover, with the latest Wacom equipment and CAD software, such as Sketchbook, Keyshot and Solidworks, this research try to develop a new industrial design process driven by CAD technology. Through a range of practice-based research and computer-aided design practice, ultimately this concept was accepted by Chinese manufacturing industry and finally built a prototype, which was featured in 2012 Beijing Design Week.

Keywords: recreational vehicles (RVs), industrial design, Computer-Aided Design.

1. INTRODUCTION

The term recreational vehicle and its acronym, RV, are generally used to refer to a vehicle that combines transportation and temporary living quarters for travel, recreation and camping. A recreational vehicle normally includes a kitchen, a bathroom, a bedroom and a living room. In some countries the terms caravan or camper van are more common, and the vehicles themselves vary, generally (Wikipedia, 2010).

RVs are intended for everything from brief leisure activities such as vacations and camping, to full-time living, for which they are often parked in special trailer parks. RVs can also be rented in most major cities and tourist areas. Furthermore, they are occasionally used as mobile offices for business travellers and often include customizations such as extra desk space, an upgraded electrical system, a generator, and satellite Internet.

In the early years, this vehicle mainly was used by the nomad people for practical purposes rather than recreation. However, after World War II, new materials and technology have greatly increased the utility, comfort and convenience of the Interior. Moreover, as the RV industry matured, RV services like clubs and camping parks equally developed a professional, systematic industry. They offer a wide range of

affordable, quality accommodation options, top class facilities and are usually in the best scenic locations close to major tourist attractions, which really helps this travelling to be a typical Western culture and lifestyle.

2. LIFESTYLE TRENDS CONTINUE TO SPUR DEMAND FOR RVs

Today, with globalization, the RV industry has been spread worldwide from developed to developing countries (Fig. 2). This shift not only promoted the transfer of manufacturing industry, but brought this new outdoor lifestyle into emerging markets, such as China.

China's RV industry is currently in an embryonic stage, which is mainly engaged in the simplistic manufacturing and assembly of vehicles for export purposes. With the increase of private car ownership in China, RV travel is likely to grow substantially in the near future. This new consumer trend will develop the Chinese RV manufacturing industry and make this enterprise role-transforming from production to innovation, which will have a considerable impact on outdoor travel and consumption patterns and environmental protection in China. In this transformation process, using a sustainable design approach and

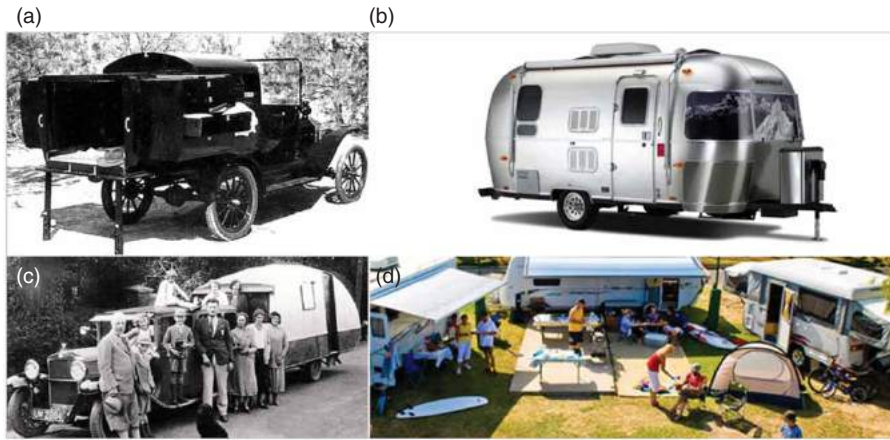


Fig. 1: The development of RV and lifestyle, a: RV in an early form, b: The RV icon- Airstream, c: RVers in Europe 60's, d: RVers in Australia (now).

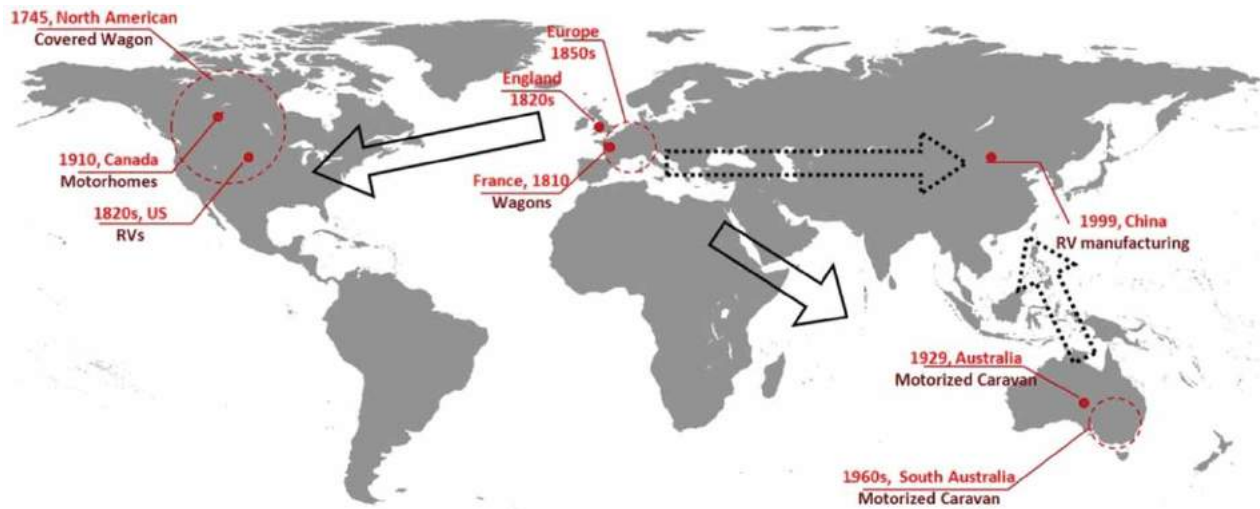


Fig. 2: General development of RVs worldwide.

strategies will help to avoid damaging the environment by the increase in RV consumption and usage. The new design should not only take into account fuel consumption, material/energy consumption during production but also be concerned with direct impact of large volumes of RV users moving into regional China.

3. THE COMPARISON OF RVs IN AUSTRALIA AND CHINA

Chinese RV industry just has only a decade the development process, which is restricted with the development of automobile manufacturing industry in China, and the number of private passenger cars as well. However, with the increase in income, improvement of living standards and individual needs of the outdoor tourism, RVs travel has become a new growth point of Chinese tourism industry.

Based on this thinking, this study takes Australia as a reference case, and makes comparisons with the

introduction of RVs into China. The aim is to find out the difference between these two countries and then provide useful guidelines for research into RV sustainability. Australia, with nearly 50 years of experience as both a producer and consumer of RVs, has formed a mature consumer market and services system. 'Gray Nomads'—retired people who travel with RVs, are an important part of this market. Because of different cultural and historical development, social systems and lifestyle, there is a big difference in RV usage between Australia and China, which can be seen clearly in the following table:

Based on data collection and organization, the survey found the following general characteristics in the Chinese RV context:

- Population and demographic trends favour fast RV market growth.
- New lifestyle trends continue to spur demand for RV.
- RVs are attractive to young buyers.

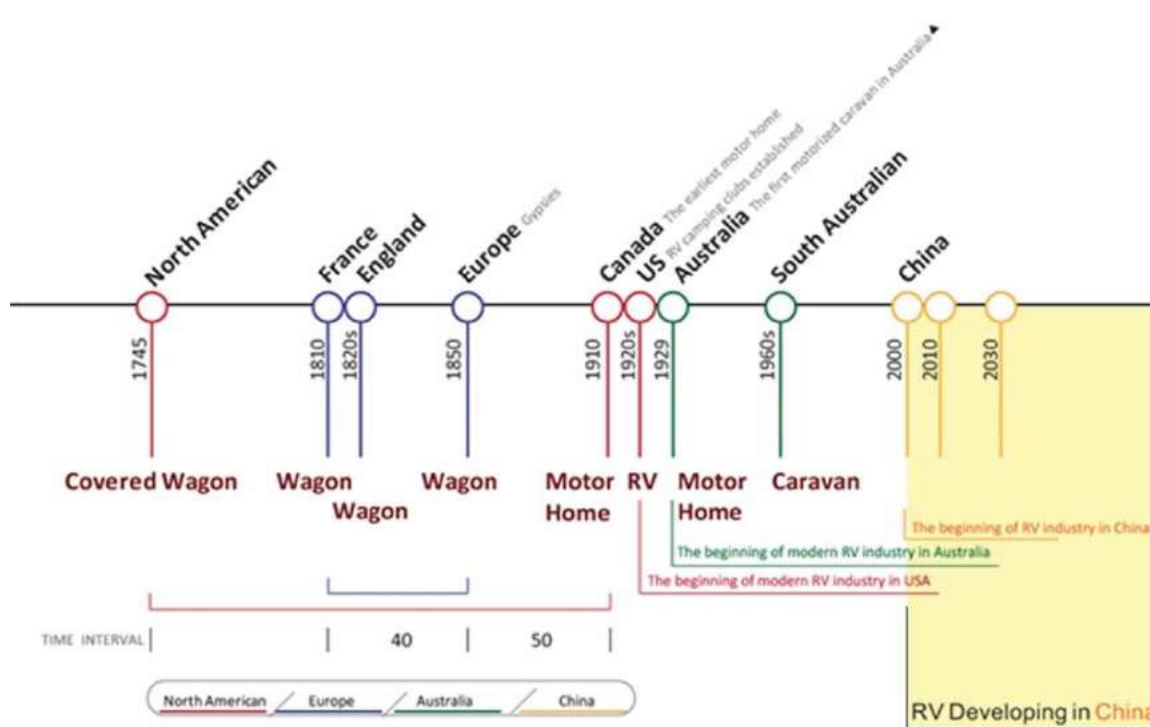


Fig. 3: The RV's history and the process of globalization.

- Ownership of RVs rather than renting accommodation, is more in accord with a deep-rooted culture embedded in the community.
- Camping infrastructure facilities need to be improved to match the improvements of RV industry
- Relevant laws and regulations need to be revised and formulated.
- Comprehensive and flexible dealer network

Apart from data collection, field research has been made in China and Australia separately. The aim is to find out how RVers' behaviour make a visible impact to environment. After all, most RVer's activities related with environment pollution usually are displayed in the process of outdoor travelling.

In addition, based on different context, for the awareness toward RV, usage habits, and environmental awareness, the Chinese RVer still remain big gap with the Western people. As a part of the RV culture, environmental awareness is the inner spirit of this means of travel. In Western countries, currently the rise of GREEN-RV-DIY driven by the RVer, can be seen the embodiment of the environmental awareness.

4. THE GENERAL CHARACTERISTICS OF CHINESE RVERS

Generally, Chinese main RV customers are wealthy people. Therefore RV need to design like a luxury item. Sometimes an RV is even regarded as a sign of

social status, which goes beyond the apparent meaning of this casual living lifestyle. However, with the continued strong economic growth, the popularity of private cars, more and more working-class people are joining this travelling. Moreover, the government is also actively promoting the construction of the camping parks in countryside. Under this situation, we need to ask: was this blind expansion trend based on in-depth study about the local consumer behaviour and outdoor tourism resources? If it was, innovative models will need to be implemented, instead of just copying Western RV models.

5. CHINESE RV INDUSTRY'S BOTTLENECKS

Although the development process is shorter, rapid and drastic changes are taking place in the Chinese RV industry recently. The reasons for RV industry growth are as follows:

- Export boom and the huge potential domestic market
- Lifestyle trends continue to spur demand for RVs
- Low technology barrier : Many auto industry into the area surrounding
- Government policy support
- Small and Medium enterprises: flexible marketing strategies
- Labour-intensive enterprises to take advantage of China's rich labour resources

	Australia	China
RV Culture or History	<ul style="list-style-type: none"> • Long a typical lifestyle in Australia • Available to ordinary people 	<ul style="list-style-type: none"> • New way of outdoor travel—just 10 years old • New attempt for a few wealthy class
RV Industry Status	<ul style="list-style-type: none"> • 50 years of experience in mass manufacture • About 105 manufacturers • Labor intensive industry • Volume of production: 18,900 (in 2008) • About 1700 camp parks • Custom engineered to suit the requirements of the local consumer • 96% of all RVs are manufactured in Australia with the remaining 4% imported from other countries 	<ul style="list-style-type: none"> • 10 years of experience in OEM manufacture • About 20 manufacturers • Labor intensive industry • Volume of production: 600 (in 2008) • About 20 camp parks • Custom engineered to suit the requirements of the international consumer • 80% of all RVs manufactured in China are for export to other countries
Features of consumption	<ul style="list-style-type: none"> • ‘Grey Nomads’-retired people • RV purchase cost from 4000-50,000 AUD • Used for holiday travel (from 2 days to half a year) • Parking in their home (backyard) 	<ul style="list-style-type: none"> • “Urban middle class”-young people, white collar • RV rental (from 800-1500RMB per day) • Used for weekend travel (from 2 days to a month) • Parking in purpose-built parks
Organization/association	<ul style="list-style-type: none"> • Industry Association (RVMAA) • Professional clubs • Appointed Dealer Networks • The majority of manufacturers are Members of CIA 	<ul style="list-style-type: none"> • Voluntary organizations or Civil Group
Policy or Regulation	<ul style="list-style-type: none"> • Comprehensive legal and regulation system 	<ul style="list-style-type: none"> • RV- driving on highways are prohibited in some cities • Lack of insurance for RV

Tab. 1: RV comparative research between Australia and China.



Fig. 4: The field research in the issue of sustainable during the RV camping (a: in China, b: in Australia).

- RV manufactures are innovating to give consumers an array of product choices

After experiencing 10 years as a basic manufacturing industry, the Chinese RV industry is going through two changes. The first is industrial restructuring which will change from OEM to independent innovation. Another change is the target market,

which has changed from an export to a domestic market, because of the upgrading of domestic consumption. Therefore, a new serious disequilibrium has occurred in the balance of development and environment protection. The following table lists several of these characteristics:

A much greater challenge is to integrate sustainability thinking into a company's business processes

Environmental Problems	Phenomenon
<ul style="list-style-type: none"> • Environmental destruction and pollution • From Camp construction • Air pollution • Water Pollution • Noise pollution 	<ul style="list-style-type: none"> • Construction camps will choose the scenic places • Construction of fixed and temporary buildings will destroy the existing harmony, natural ecosystems • Automobile exhaust • Camp activities, such as barbecues, bonfires • Camp activities, such as diving, boating, surfing, motor boats • Legacy of waste, oil, chemical cleaning agents and high-quality residual • Brings car noise to the original ecosystems • Has psychological and physiological impact on local residents

Tab. 2: Environmental issues involved in the process of RV camping.



Fig. 5: RVers' innovation for a 'green' RV.

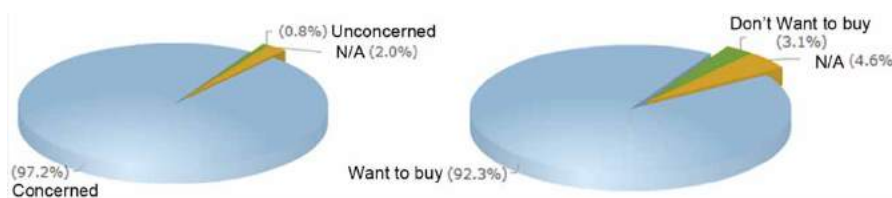


Fig. 6: Survey of Chinese consumers' concern and possibility of purchasing an RV.



Fig. 7: Chinese working-class family feature and trend.

to achieving significant, lasting change. In particular, to perform Design for Environment consistently and effectively is challenging for several reasons:

- The necessary environmental expertise is not widely available among product development teams, including marketers and engineers.
- The complex and open-ended nature of environmental phenomena makes it difficult to analyse the effects of design improvement.

- The economic systems in which products are produced, used, and recycled are much more difficult to understand and control than the products themselves.

6. DESIGN SPECIFICATION

From the diagram below, it is clearly that Chinese RV market development will be generally divided into three stages, which also demonstrate the process of

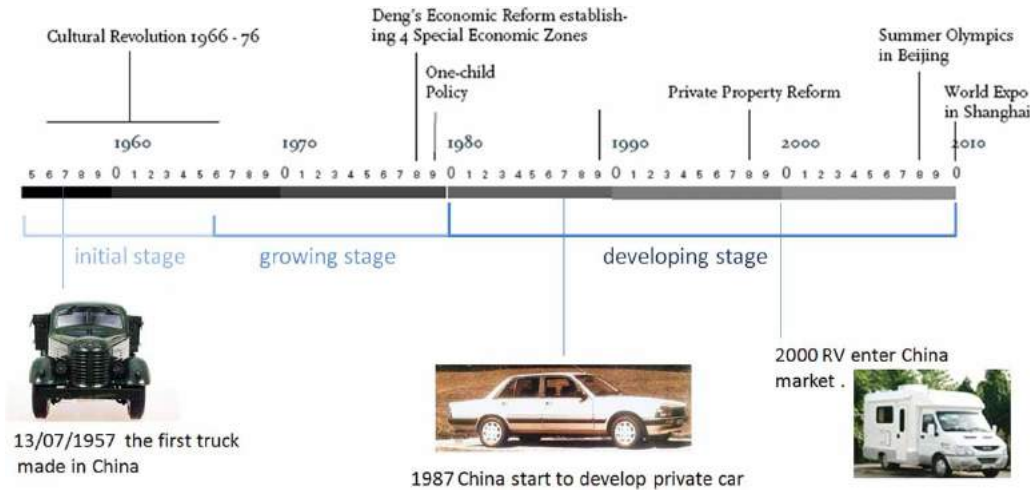


Fig. 8: Development of automobile manufacturing and RV industry in China.

Bottlenecks and Issues Of Sustainable	Design Strategies
<ul style="list-style-type: none"> Limited history of RV travelling and manufacturing Traditional Chinese ideas about the nomad lifestyle restrict growth The lack of RV camping sites restrict China's outdoor industries RV Relevant laws and regulations are not perfect RV production technology and energy consumption The lack of RV design expertise and research 	<ul style="list-style-type: none"> Enhanced RV design and cultural exchange and understanding To combined the local traditional culture with consumer future trends To promote sustainable design in the role of camp construction Adaptive design strategy Design Innovation and Value Engineering The development and searching about design resources worldwide

Tab. 3: Chinese RV industry development issues and design strategies.

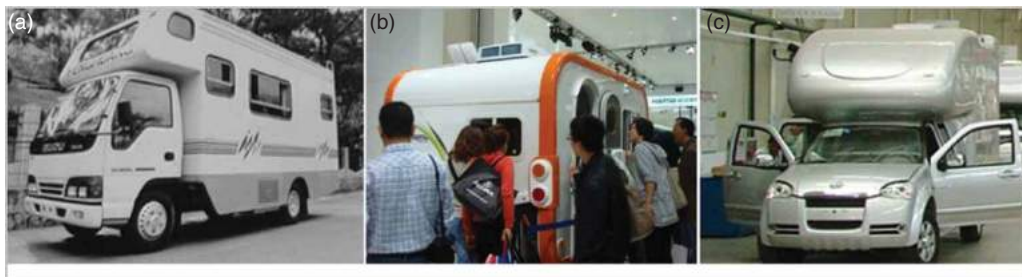


Fig. 9: The development of Chinese RV industry, a: the first 'cubic-car' in China 1999, from SHENZHEN DAILY, b: Beijing RV show 2010, c: new RVs from GRATE WALL.

the Western RV cultural integration with the Chinese culture. In the Physical stage, the RV development will focus on the tangible level design combined with technological innovation. The key issue in this stage is to recognize the basic design principle of RVs, which will be much help to develop the appropriate RV strategy for Chinese market. Moreover, through new technology, material introduction, it's very important for Chinese manufacturing set up a special production process. In the second stage, the Contextual, it will be important to explore the brand

new transport system for RV travelling in Chinese context. From the systematic innovation perspective, the research will be conducted based on the Chinese feature of RVs camp and outdoor travel habits. With that, it will help to organise a more reasonable and environmental protection way to travel with RVs. Then in the Meaning stage, the research will be more focus on the possibility of reconstruction the RVs on the cultural level, which will establish a kind of new Chinese RVs cultural connotation finally.



Fig. 10: Diagram development of RV in China.

According to design specification, one of my concepts, called GREEN NOMAD, was presented particularly for those living in the Chinese big city. However, rather than possess vehicle, this special RV sharing system will make people enjoy the RVs travel based on a rental and sharing system. As a new concept, it will not break the existing Chinese transportation system. The main idea is to build the RVs' body with the shipping container, and then run the rental system under an internet-based organization. The benefit of using shipping container as the RV's body is because it has been a mature system for both manufacturing and transporting from a long term. More importantly, we cannot neglect the reality that currently China is the biggest manufacturing base of shipping container around the world, which will bring the cost and manufacturing advantages. Meanwhile, as a kind of green design trend, the house built by shipping container has been a quite popular topic in architectural design field. However, transforming the shipping container to RVs will be a new challenge for industrial design. Another issue is to build a good rental system to suit Chinese living standard and s purchasing habits. Therefore this design strategy will provide a brand new model for Chinese RVs travelling.

7. DESIGN PROCESS

The design process of the project includes four main stages, such as sketching, body storming, mock-up

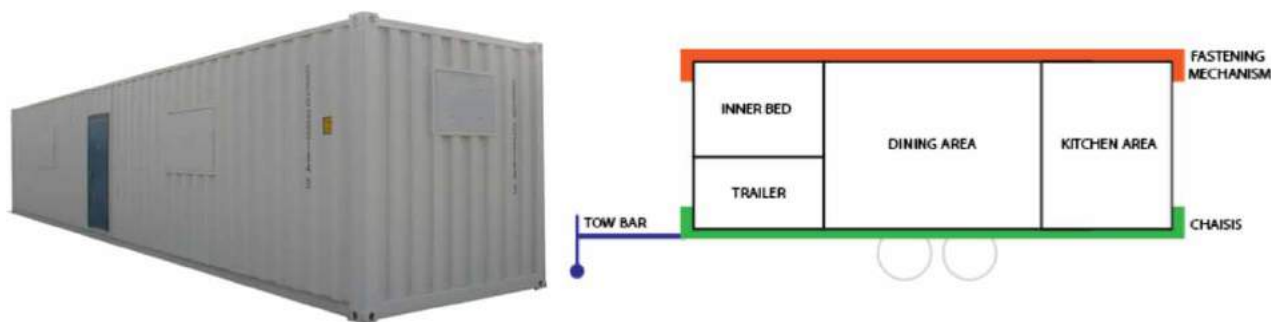


Fig. 11: The transportation concept of GREEN NOMAD.



Fig. 12: Wacom Inkling, Cintiq 22HD and sketches.

and prototype making, which are involved with new design tools and studio-based methods to make this design practice going smoothly.

Particularly in the conceptual sketching, there were two types Wacom digital tools used in the stage: Inkling and Cintiq 22HD, which provided a great experience in this concept design. From the specific point of view, the benefits are below:

- Inkling.

It is a smart device that enables designers to start off artwork the traditional way, and also enhance professional workflow by capturing digital data while sketching with a ball-pen on normal paper. Inkling is an indispensable tool for quick drawing. Especially during the process of interview with the RVers, with the Inkling, designer can draw and communicate the idea simultaneously. Moreover, all strokes are recorded electronically, which can be imported as raster or vector artwork in to preferred graphics application for further editing.

- 2. Cintiq.



Fig. 13: Body storming and Adobe Photoshop rendering.

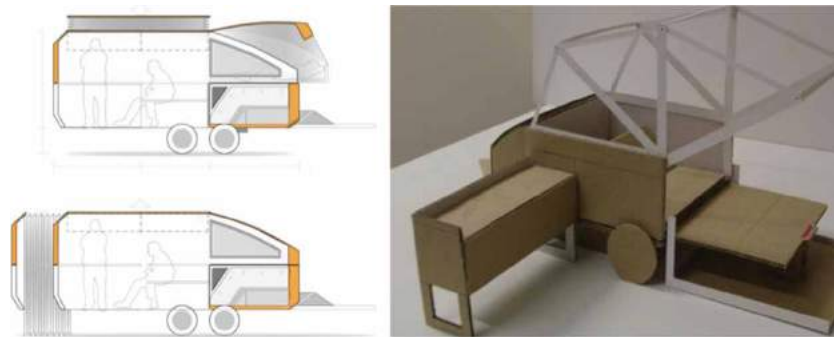


Fig. 14: Mockup making based on 2D rendering by Adobe Illustrator.



Fig. 15: CAD model of Solidworks and images rendering by Keyshot.



Fig. 16: GREEN NOMAD featured in 2012 Beijing Design Week.

Cintiqs are designed to replicate the traditional experience of working with conventional tools such as pens, markers, brushes, canvas and paper, photographic exposure retouching tools, or sculpting tools

and clay, while at the same time allowing users to work with all of the power and flexibility of advanced creative software applications. It provides me the best experience of digital drawing, and the efficiency.

Body storming and prototyping making were both the key parts of the RVs design research. Compare with Western RV, there are many major difference in terms of interior of Chinese RV, such as kitchen, living room, and entertainment area. More importantly the Chinese RVers' requirement and use habits is quite different with the Western, which post a challenge for ergonomic research of RV. Through the rapid mock-up making and body storming, some important ergonomics dimensions are well tested and record, which make industrial designer to clarify the important information for next steps. During this process, with the help of Adobe Photoshop, designer can clearly demonstrate more possibilities and potentials. And then those rough ideas will be well transferred to next stage of refining design.

8. PROTOTYPING AND MANUFACTURING

In addition, with the CAD model by Solidworks software, all the outcomes from ex-research was converted to 3D model with more accurate details. This modeling process with Solidworks helps designers to make the further application of different materials and structures, and also offer more possibilities to finalise the design details. More importantly, with this CAD model, a good communication platform has been built between designers and engineers, which would promote a smooth development for next manufacturing. Moreover, images rendering by Keyshot will further inspire the enthusiasm both from designers and engineers.

This research finally gained the support from Chinese manufacturing. Especially under the help of CIMC (China International Marine Containers), the first prototype of "GREEN NOMAD" was successful built in the factory of CMIC and also featured in the exhibition of 2012 Beijing Design Week.

9. CONCLUSION

The case study is a research into the Chinese RVs market and lifestyle, which is based on collaboration between China and Australia Universities. The research exhibits cross-cultural design research approaches and demonstrates latest design software, hardware technique as well. The design methods involved in this research embodied the idea of practice-based design methods through a series of computer-aided design and prototype making.

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