Virtual Reality Boosting Automotive Development

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Abstract

Several Virtual Reality (VR) centers have been built in the automotive companies in China since 2004. This article analysed the current status, achievement and issues in these VR centers, and described how to make better use of the VR technology, from the view of VR recognition, VR process and VR application. Then it explored how to improve the hardware and software of VR to meet the requirements of research and development of automotive industry so that the virtual reality could play the even more significant role in boosting the research and development of automotive products.

Keywords

Virtual Reality, Virtual Engineering, Virtual Prototype, Virtual Test, Virtual Manufacture

1 Virtual Engineering vs. Virtual Reality

Virtual engineering is becoming a popular word in Chinese automotive industry. A lot of Chinese motor enterprises are devoting to developing their virtual engineering capability. In October, 2007, SAIC held a forum and invited several famous experts to take part in it, who had offered their valuable suggestions to SAIC theme as system construction of capacity development, virtual engineering and advanced engineering. In the development scheme for 2009, Pan Asia Technical Automotive Center has regarded VE as the critical capability development trend in the future.

However, the virtual engineering actually is not the same as virtual reality. Nevertheless, in terms of current VE application in Chinese automotive industry, the trend is appearing to mix up VR and other computer-aided technology such as CAE analysis or simulation analysis; whereas sometimes VR is mistakenly regarded as the post-process for presenting CAE software, which is blocking the application of VE

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to certain degree. To fully recognize the value of VR and make better use of it, it is essential to clarify them.

First, let's take a look at the definition of VE. You may find thousands of VE definitions. From Wiki, virtual engineering is defined as integrating geometric models and related engineering tools such as analysis, simulation, optimization, and decision making tools, within a computer-generated environment that facilitates multidisciplinary collaborative product development. Virtual engineering shares many characteristics with software engineering, such as the ability to obtain many different results through different implementations [1].

Figure 1 shows connotative meaning of VE. VE integrates CAX technology, to complete the virtual prototype, virtual test and virtual manufacture, etc. with the support of multi-means such as virtual reality in entire environment supplied by PDM system.

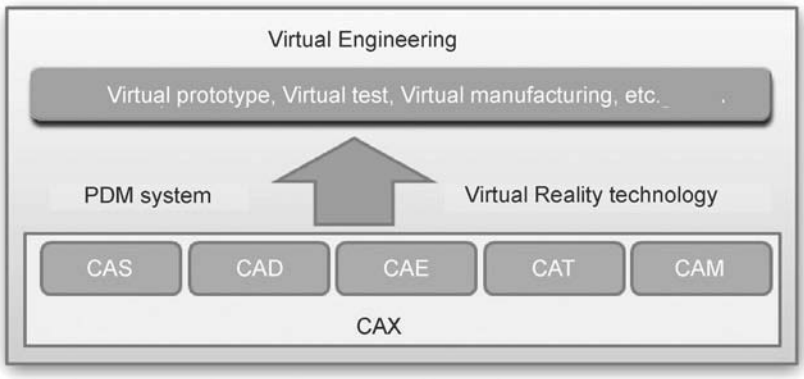

Fig. 1 Connotative meaning of virtual engineering

Now let's take a look at the definition of VR. Virtual reality was firstly raised up in USA in early 1980s, which means building a virtual world in computer and simulate the seeing, hearing and feeling to make the user immersed. Then the user could be interactive with the virtual objects in real time with no limits. VR has four features, namely multi-sensory, immersion, interactivity and imagination, which could distinguish VR from CAX. VR provides the more direct, simple, safe and interactive environment and adds the subjective feelings into the process, so that the digital property can be understood more clearly and thoroughly. Automotive engineers can review the design from any point of view in the virtual world where they could inspect the detail of parts, navigate in the car, even drive the car to evaluate the noise. What's more, VR can integrate the knowledge of multi-disciplines enabling people with different background to share[2].

According to the definition above, we can understand that VE is not VR. We should study VR deeply and make better use of it.

2 Widely Application of Virtual Reality Technology in Automotive Companies over the World

At present, VR is widely used in the automotive industry in USA, Japan and Europe etc. Almost all the main automotive enterprises, such as GM, Ford, Chrysler, Audi, Benz, Porsche, BMW, Volkswagen, Honda, and Toyota,are widely using the VR and scheme. Doubtlessly, the VR shall bring great profits for automotive companies, which has been widely recognized. The VR centres have been established one by one by the automotive companies in the world. GM's VR centre is an early one launched around 1997, equipped with Powerwall and CAVE for reviewing design, evaluating the view of driver and simulating the assembly of the parts. In 1998, Benz completed its digital prototype with VR technology. In April 2000, Benz spent 8 million Marks in building its VR centre. In 2004, Volkswagon spent 20 million EU$ in establishing two visualization centres—one is a powerwall for design review and the other is a CAVE for ergonomics, driver view and interior evaluation and drive simulation. Furthermore, other motor companies have also built their VR centres or actively applied VR in the development. For example, in Mazda, the customer can wear an HMD and groove to change the virtual car's color and accessories, and choose their favourite cars. In Ford, powertrain engineer simulates the engine maintenance in VR. In Nissan, the product line is simulated. The car design companies, such as ItalDesign, Pinifarina,have their VR centres as well. Recently, more and more VR centres are built all over the world. Jaguar and Rover announced to build VR centre in December, 2007 and Volkswagan Brazia formally announced its VR centre on June 15th, 2008.

VR is used in every area of automotive industry, such as styling, engineering, process, test, assembly and manufacturing. It not only provides freer working environment to engineers, but also refines and improves the development process. The promotion and application of VR will trigger a revolution to automotive technology.

3 Application Status of Virtual Reality in Chinese Automotive Industry

The automotive companies in China began to set up VR certres in about 2004, such as PATAC, FAW, HF, SVW, JAC; whereas some other companies including SAIC, Chang' an, Chery, etc., are planning to build VR centres or develope their VR technology . Figure 2 shows the VR centre in PATAC.

Most applications of VR in Chinese automotive companies are mainly in design engineering and manufacturing, including styling, assembly, CAE visualization, process visualization, etc.

The computer systems used in these VR centers include SGI super computer which is in the early VR system and PC cluster based on UNIX. But now they are

Fig. 2 The virtual reality centre in PATAC

moving toward PC cluster based on Windows while computer performance increases. Sometimes, only a workstation is competent. The reason is that VR system must be integrated into the whole vehicle development process. Windows and PC is the mainstream in the automotive industry.

Powerwall is the only projector mode adopted in Chinese VR centers at present, with the screen size as 7.2 m×2.4 m. It is enough for full size car. Few companies are using the CAVE, whose strength lies in giving a better immersive environment. That is more valuable to interior design. However, both GM and Opel design centers abandoned their CAVE, because they don't think immerse is critical to styling review and unsuitable for review by many people. However, as the data shows, GM engineering center keeps the CAVE. Actually, some other companies, for example, Renault uses the CAVE to assemble virtually.

The main software is the commercial software in these VR centers. Just for instance, for design review, Deltegen in RTT, Opus studio in Opticore (acquisitioned by Autodesk), Showcase in Autodesk are used; whereas Simens has applied VisMockup for virtual assembly and CEI uses EnSight for CAE visualization. What deserves to be mentioned is that Dassault Systems bought Virtool last year which is applied by Renault for virtual assembly. Recently DS is positively developing new 3D Via aiming at enhancing their capacity in virtual design and assembly review.

In addition, to improve the capability or upgrade the system, some VR centers are developing the VR with the cooperation of universities and academes. For example, PATAC did some study in VR technology cooperating with Shanghai Jiaotong University, Zhejiang University and Tongji University.

4 Virtual Reality Boosting Car Development

The competition pressure is forcing the car companies to develop more new products within a shorter time. However, it is not feasible any more to just relying on the traditional development process. Every car company is studying how to accelerate its development. GM started to implement its GVDP since 1990s mainly developing their math-based R & D capacity. Now it comes to its version 5.0, in which the computer-aided technology has been widely used. For example, in the past, there were several prototypes built during the process. Now, six kinds of virtual cars are used, replacing most of physical prototypes. GVDP is still constantly improving its development. One of its directions is to implement the VR, especially at the concept design phase.

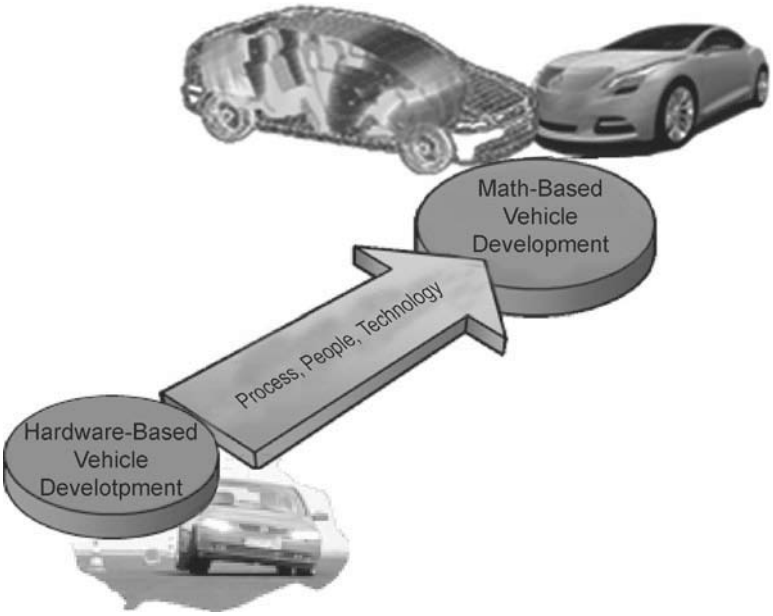

Fig. 3 Vehicle development: hardware-based to math-based

In China, VR is also showing its value in accelerating the car development, including styling, assembly, engineering and manufacturing [3].

In styling, with VR, the proposal can be reviewed by the realistic virtual model. All details can be evaluated to get the true feeling of the design. Thus the requirement of the physical model decreases, while the efficiency increases.

In engineering design, the capacity of VR providing the huge data loading and virtual assembly enables the engineers to sit together to review structure, assembly and

Fig. 4 Realistic vehicle modeling in virtual environment

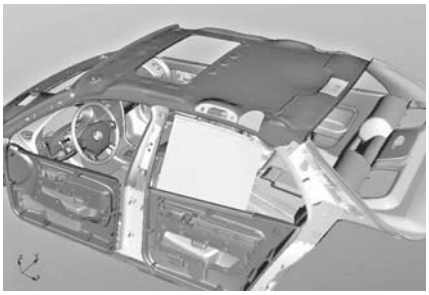

Fig. 5 Virtual assembly based on vehicle digital mockup

manufacturing feasibility. It is very useful to find the issues and make decisions. Even the workers can join in the discussion, which could avoid a lot of mistakes in low level. The prototype process gets faster.

In engineering analysis, the presentation of physical phenomena provided by VR makes the complex calculation results showed out in a more natural way. As a result, the un-expert engineers and designers etc. could fully understand and make use of the result. It is helpful to CAE to expend its utility.

In experimentation, with the introduction of VR, the test data can be dealt in better methods. By combining the physical and virtual properties, the test accelerates and some physical processes are simplified.

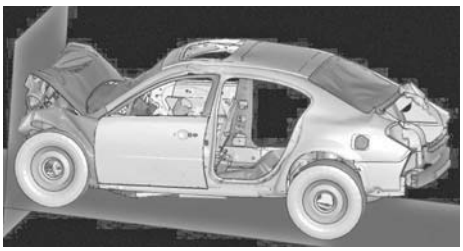

Fig. 6 Visualization of vehicle collision engineering analysis

Fig. 7 Vehicle test in virtual environment

In manufacturing, marketing and training, VR can find its application as well.

5 More VR Technologies Required by Chinese Automotive Industry

There are so many types of CAX software applied in the automotive industry, especially CAE. There are different types for different application. How to integrate CAX has become a very important issue for the companies to make better use of the work from each area and set up the perfect virtual development capacity. As a natural interactive

tool of "people and virtual model", VR provides a good base to integrate knowledge which could be shared by the technicians in the whole chain. Consequently, VR is able to provide a big help to improve the development capability of companies.

Currently, VR is used in designing more than in manufacturing. The reason possibly is that manufacturing lacks the foundation data. Even in design, only display capability is used at most of time. Sometimes display is not enough, such as evaluating the acoustics and interacting with math model in real time.

Actually, VR can find its room in many areas, for example, ergonomics review based on virtual model, headlight illumination test, virtual crash test, noise evaluation, etc.

Additionally, collaboration is important for global development. How to make use of VR in collaboration is worth studying.

6 Approaches for VR Technology Better Satisfying the Needs of Automotive Industry

Even though VR is in development constantly, it still has some shortages. The perspective is an issue for Powerwall as there is only one position can get a correct perspective with the stereo glass while used for designing review by many people. As a result, everyone would get their own perspective which is different from each other. That is fatal to review. Therefore, the stereo has to be shutdown during review. That is why GM design center changed its powerwall to a big size screen some years ago. The stereo is regarded as worthless for review by a team.

The resolution ratio is another issue. Normally resolution ratio just reaches 1,200 pixel at maximum in the screen with the height of 2.4 meters, which is not enough to show the details clearly. This happened in one of our program, with the purpose of evaluating the driver's view based on the virtual model. But we could not clearly see the scene from the side mirror of the virtual car and got trouble in tracking the eyeball. We have applied the infrared camera to track the eyeball's position, but it is impossible in stereo model as eyeball is hided by shutter glass.

We also had a trial to con-review the design by VR model from different sites. However, each site has to keep a copy of the whole data, which could not be accepted by everybody.

Data rework is another issue. Most of VR need to rebuild the math model from CAD. If CAD data is changed, it needs engineer to update the virtual model manually, resulting in that the data can not be updated in time. This definitely limits the usage of VR. Now, the hardware rendering is attracting more attention. CAD data can be used for virtual model directly in a high level display card, which is the general trend.

The complex operation of software also limits the VR's usage. It is a tool for experts and the engineers or designers to follow the function set by the experts, as they can not operate the virtual model as the same as the physical model. Therefore, it is necessary to work out the software as simple as possible, to become a daily tool for engineer/design. Furthermore, it is quite important to popularize the VR.

In scientific calculation visualization, VR expands slowly. We made a program

to replay CFD simulation in a VR environment. But CAE engineers didn't show their interest in it. They still regard VR as one of the post-process software.

Therefore, within the current situation, we can start our application of VR from the following aspects for making better use of VR.

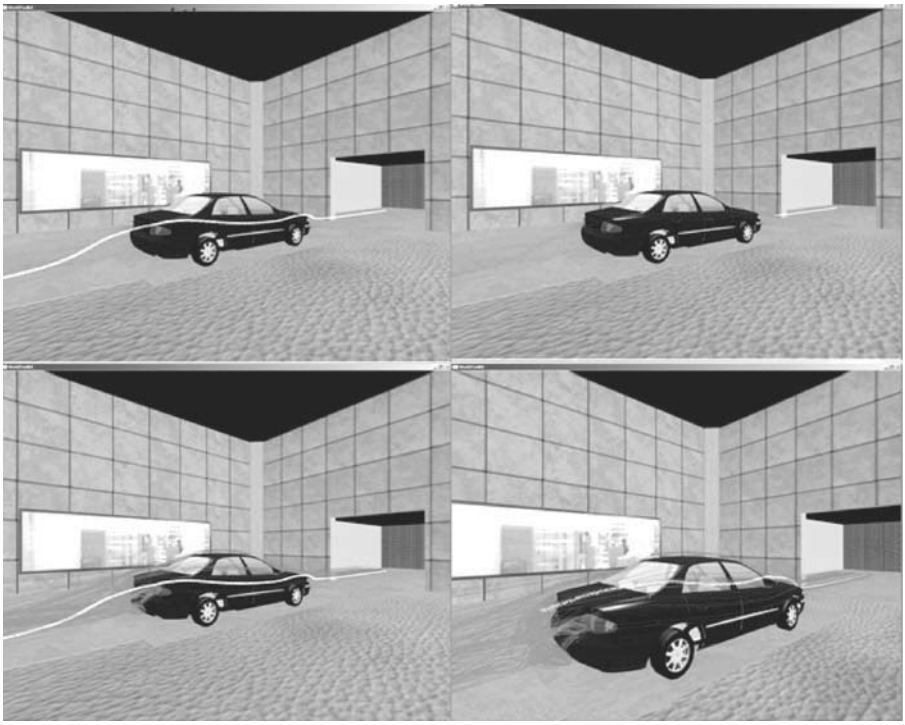

Fig. 8 Flow visualization of automobile CFD analysis

Firstly, enhance the integration of VR and CAX. VR must be seamlessly integrated into the whole development process with other CAX technology.

Secondly, start from the application which is not so timely expensive, such as ergonomics, driving simulation and virtual assembly. CAE application needs long time to calculate, which is not suitable for real time interaction.

In addition, AR, combining the virtual and physical model, is also very useful for automotive industry. However, because of the complexity, it is very hard to simulate everything by VR in automotive development. Making use of the physical model to simplify the simulation can give a more accurate result.

7 Conclusion

VR model is able to partially replace the traditional physical prototypes, as it is very

helpful to accelerate the development, reduce the development cost, and especially to improve the capability of Chinese automotive industry. The math-based technology has been widely used in Chinese automotive industry. How to build up the whole virtual capability is crucial to the automotive companies now. It is great that automotive companies are laying store by VR. However, VR is still under development at the moment, both for enterprises and VR technology. The VR is just initialized in Chinese automotive industry and more effort is needed to better understand and make use of it. Besides, VR needs to be more improved to meet the requirements of automotive industry.

It is well known that Germany is the precursor in manufacturing. The VR is emphasized in the automotive companies in Germany. When Volkswagan launched its VR center in Brazia, the premier of Germany and the board chairman of Volkswagon attended the ceremony.This demonstrated how Germany emphasized the VR. At present, VR is used in the detailed works such as parts design, interior design, aerodynamics and crash simulation. According to the VR director of Volkswagon, VR is increasing the competitive capability. Germany uses VR to change the traditional industry[4]. It can be regarded as a model for the integration of digital economics and traditional economics. Germany is going ahead of the world in VR. It should be relative to German government's emphases on VR, which could be a reference for Chinese automotive industry.

Shanghai has put the advanced manufacturing on a very important strategy position and it is greatly supported by government to develop the advanced technology. As a high-end technology, VR should have a very good future within this environment.

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Mr. Manqing Jiang joined SAIC in 1994. He started his career from Alias sculptor in SAIC technical center. He joined PATAC in 1997 since PATAC had been launched.

He has worked on several positions such as Packaging, program management, studio management, etc. In 2003, he became the digital senior manager of design department. His responsibilities include managing the digital design team to build math model, reviewing digital model, and releasing the math data. In 2004, he set up PATAC's VR center as the program manager. He is very interested in VR and pays a lot of attention to the math-based strategy in car design area and has written some articles and given some speeches about these topics. Besides, he has a very strong passion on new technology and has some collaboration with the universities, such as Shanghai JiaoTong University, Zhejiang University and Tongji University.

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