Development of Computer Aided Engineering (CAE) Applications; Past, Present and Future

by Dr Lim Chin Seong

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On 26th February 2019, the Mechanical Engineering Technical Division (METD) organized a technical on "Development of Computer Aided Design (CAE) Applications; Past, Present and Future" which was held in Malakoff Auditorium at Wisma IEM

The talk was delivered by Mr. Chan Yin Chau, the General Manager of Asia Pacific region (ex Japan, Korea and China) for ESI Group, a global leading innovator in Virtual Prototyping software and services. A total of xx participants attended the talk in the evening. The talk was divided into three major sections. First was the history of the development of CAE technology, secondly the current applications in the industry and lastly the future trend of the role of CAE in recent Industrial Revolution 4.0.

The speaker began his talk by giving the background history of simulation done in the early days. He use the vehicle crash test conducted in 1978 in Germany as an example. In those days, a typical simulation of a frontal impact on passenger car took an overnight computer run to complete. The model were crude and simplified as to accelerate the simulation, yet the hardware used were very complex and expensive in early days.

The success of simulation of car crash scenario had eventually accelerated the optimization study as previously each optimization will require a physical car to perform the study. This had led to significant mass reduction while re using of about 80% of the car parts. It greatly impacted the manufacturing processes, steel and spot weld rupture, windshield rupture and detailed occupant behavior.

Fast forward to present context to look at the industry evolving challenges. In automotive industry, the evolution of different automotive models has resulted in more consumer options and shorter product cycles. As such, the demand for time-to-market in terms of the technology advancement i.e. electric vehicle, autonomous vehicle, as well as the product quality improvement will require the implementation of CAE heavily in the development cycle. Similarly to the electronics, aerospace and energy industries whereby there is a tight timeline in delivering the product, high risk assessment in product life-cycle and maintenance, CAE has become an essential tools to replace the conventional prototype built and test processes. And the trend in the future will be virtual prototyping incorporating CAE software and simulation to break to silos of discipline and domain approach. Instead, concurrent engineering process by looking at the product characteristics in parallel is preferred.

To further illustrate the importance of virtual prototyping, Mr. Chan gave an examples of how in real life CAE is applied in the design and manufacture of a car front hood. The name of the manufacturer was not mentioned for data confidentiality protection. The design of a front hood requirements include the static and dynamic loading and impact capacity as well as to avoid certain frequency

modes. For the initial design a full steel hood panel was proposed with numerous tests to check the hood's characteristics independently. However, in reality the performance of the hood is also affected by the connecting components and interfacing components. The strategy used was modular-based whereby each single core model (component) is independent from the load case. As a result, all the static load tests showed compliant but on the other eigen modes test and pedestrian impact test showed non-compliant to the requirements.

The further iteration of the design optimization used the strategy of employing automated submission of all load cases through CAE approach. The simulation data were interlink and cross checked so that the connection are automatically rebuilt. All domains are updated simultaneously when all core models are concurrently analyzed and optimized. This has led to almost all performance requirements has been fulfilled while at the same time a re-engineered hood design saw the significant reduction in thickness (18%) and mass (40%).

In the aspect of manufacturing, Mr. Chan gave a few examples of manufacturing processes implemented in automotive parts fabrication whereby the application of CAE software helped to improve the material properties i.e. its strength, manufacturing process performance as well as the quality of the manufactured parts. The manufacturing processes that incorporated CAE simulations included metal forming, composites, molding and casting process.

On the outlook of the future application of CAE, Mr Chan emphasized that the coming Industrial Revolution 4.0 (Industry 4.0) has stimulated its implementation in the industry in broader perspective. For example, under the pillar of Autonomous Robots, one of the key area is the autonomous vehicle whereby a fully automated driveless vehicle is deemed as the future transportation mode. The success of this system requires the advanced CAE simulation tool which incorporates the complete virtual environment data, sensors technology and the vehicle's physical properties. On the other hand, the application Augmented Reality in manufacturing has become increasingly important and it allows a virtual manufacturing environment to be created for validation of an assembly line in the conceptual phase. As such, it reduces the time needed for production line optimization and improves the ergonomics at work.

Mr. Chan Yin Chau receiving a memento from the session Chairman after delivering his talk

Mr Chan concluded that the evolving consumer trends, regulatory pressure and the emergence of new players in the industry, etc are challenging the status quo. As such, CAE itself is also evolving and covering more aspects of ICT in terms of the disciplines and domains. There are certainly a lot of new opportunities and threats therefore how well one establish the foundation will determine where one will reside in the value chain.