



大连理工大学
DALIAN UNIVERSITY OF TECHNOLOGY

大连理工大学

第十六届“攀登杯”科技作品竞赛

参赛作品

作品名称：利用 CAE 软件分析对转向系统进行优化设计

作品类别：☐A 自然科学类学术论文

☒C1 大型实物类科技发明制作

☐C2 小型发明创作类科技发明制作

一、 Introduction

With the continuous development of the automotive industry, Baja racing is also constantly developing. Since the beginning of the race, Baja racing has been rear-wheel drive. After years of development, the organizer believes that the lack of a four-wheel drive system makes it increasingly unable to meet the needs of reality in the real off-road. Therefore, in the next season, all Baja cars must adopt a four-wheel drive system. There is no doubt that the four-wheel drive system will significantly improve the off-road performance of the Baja car. However, the most difficult part is the arrangement of the front drive and the steering system. the front-wheel drive system is now installed at the location where the steering was originally installed, resulting in great changes in steering parameters. Therefore, this new set of steering system is to solve the problems caused by front-wheel drive.

二、 Design Scheme

At the beginning of the design, because there was no reference object, we referred to the layout method of the Audi Quattro four-wheel drive system, which is to arrange the front differential first and then let the steering system close to the differential. And this brings a brand new problem - the Ackerman rate is insufficient. The Ackerman angle means that when the car is turning, it must ensure that the inner wheel angle is greater than the outer wheel angle before the car's turning radius can be reduced. It is difficult to achieve with

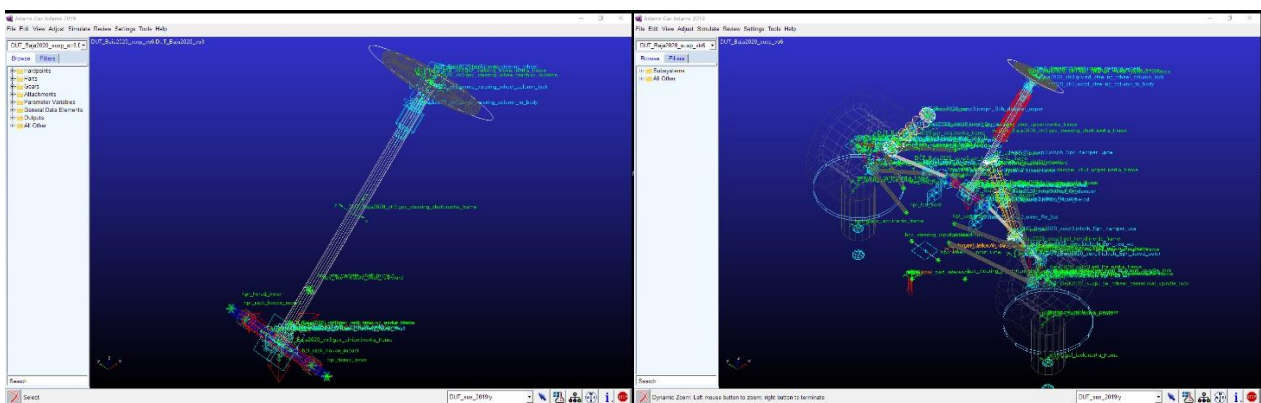
traditional design, so we use the Adams/Car vehicle simulation system to automatically optimize the steering. The Ackerman rate is maintained at about 40% to 60%, and at the same time, it can ensure the stability of the car when the wheel jumps, which is very helpful for passing obstacles at high speed.

To further enhance the steering performance of the car, we chose a longer steering rack and larger gears to form a new gear sleeve system, so that when the steering wheel angle of the car is between $\pm 120^\circ$, the inner and outer wheel angles are 36° and 31° , meet the design goals.

In addition, we also optimized the structure of the steering rod and the assembly angle of the steering rack and pinion to meet the assembly requirements of the front differential, making the entire steering system compact and concise, and achieving optimal steering performance of the vehicle.

三、Design procedures

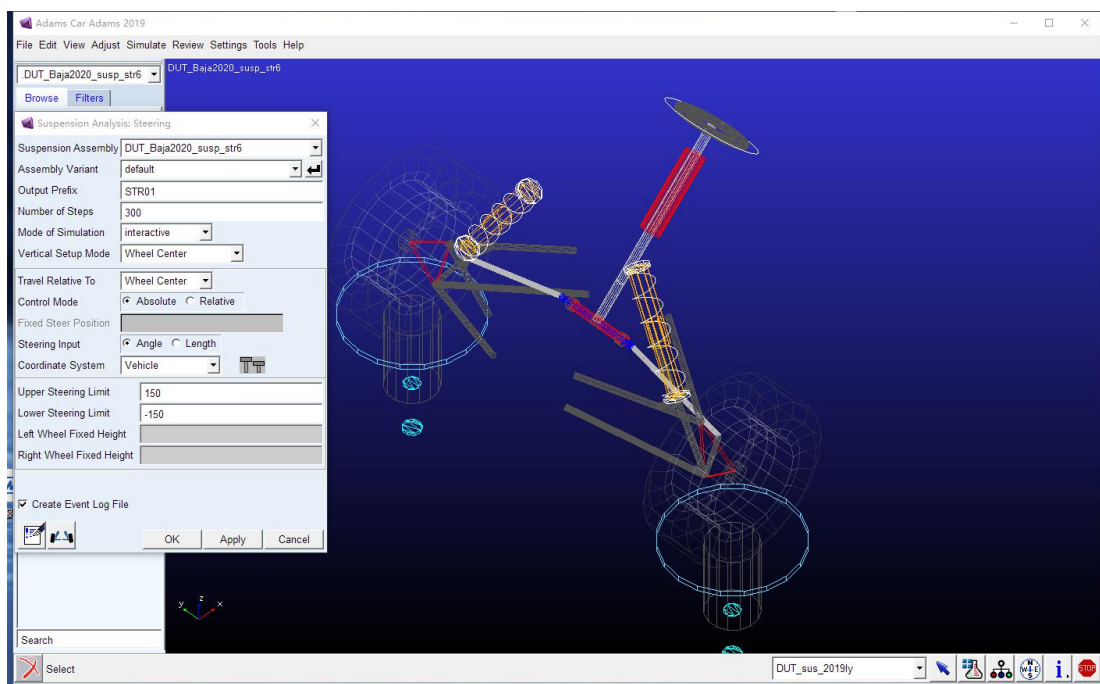
1. Modeling in Adams



The model mainly creates a logical connection for points and test individual

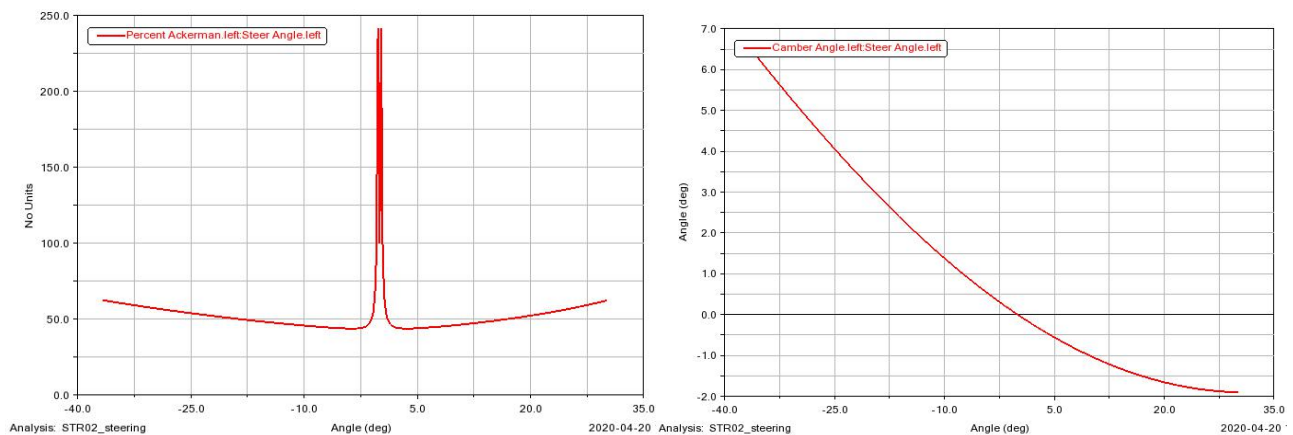
coordinate systems and characteristics so that this kind of vehicle that simulates the real car can be created on the simulation virtual table, and the simulated real car and changes to make the vehicle Meet the design requirements.

2. Simulate Ackerman geometry in Adams



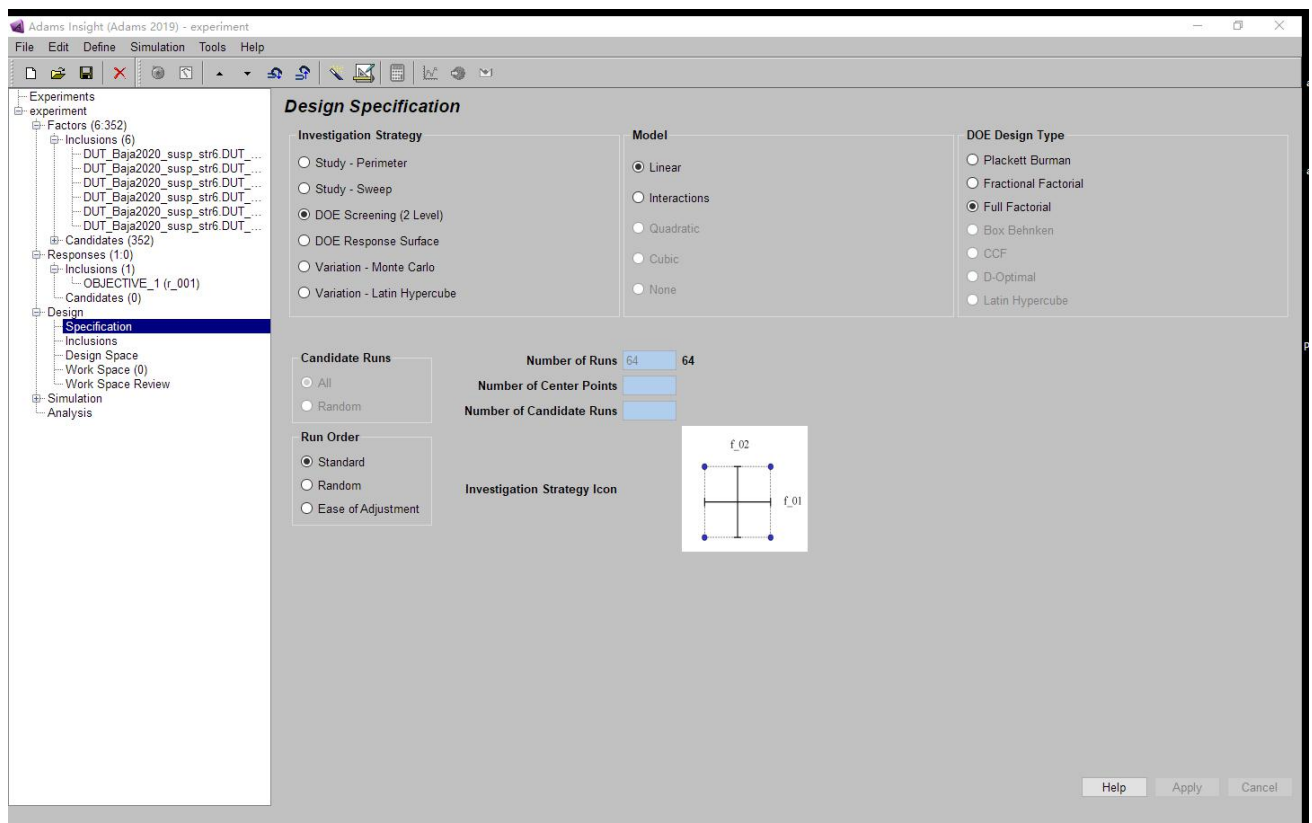
Set steering angle and rack and pinion ratio for kinematics simulation.

3. Achieve Ackerman curve and Camber curve



he Ackerman rate meets the design interval of 40% to 60%. Camber graphics conform to the characteristics of the tires when turning

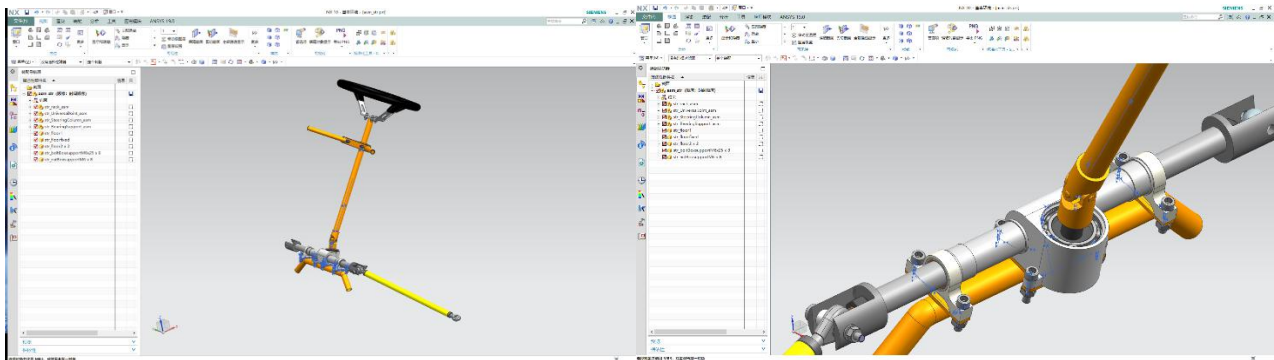
4. Use Adams Insight to optimize design



This process is equivalent to automatic simulation. The premise is to set the

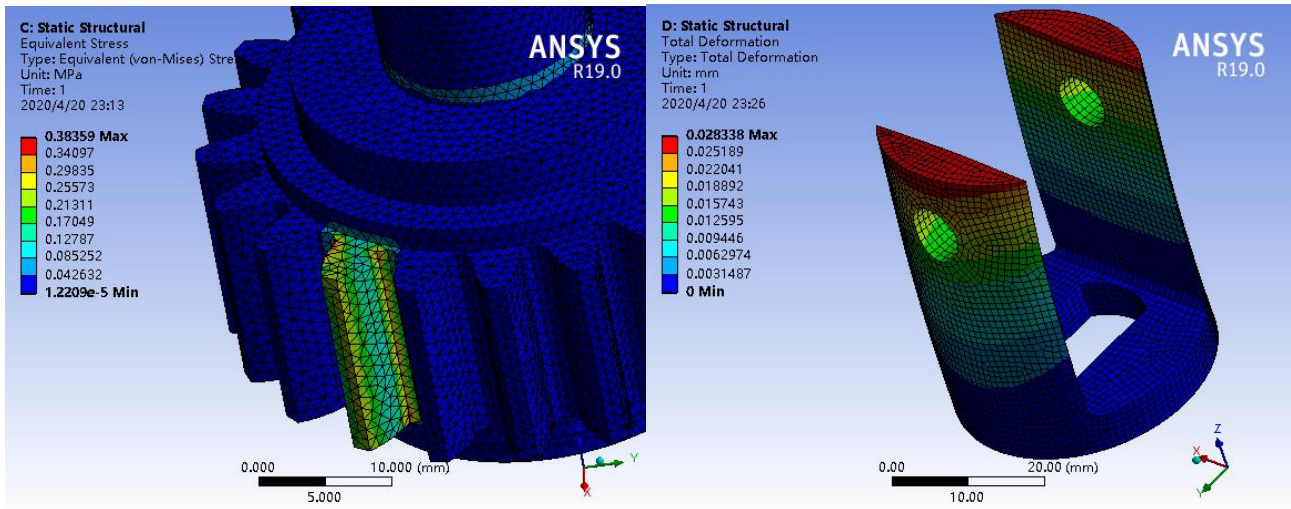
optimization parameters and optimization goals. Then the computer will continuously simulate according to different algorithms, and find the optimal solution within the set range.

5. Solid modeling



The solid modeling adopts the current popular 3D modeling software UG NX10.0 in the machinery industry. Determine the position of each component of the steering system and the length and strength of each component (steering rod, steering gear, universal joint, steering gear fixed base, etc.), and use bottom-up modeling methods to perform final product modeling. After selecting each component material and determining the assembly relationship, the assembly result is shown in the figure.

6.Strength Check



In this process, the force of the gear and the U-shaped clamp is analyzed, and the strength is checked against the actual material to make it meet the design requirements.

四、significance

For college students Baja Racing, this year's four-wheel drive is a big challenge for every school team. There is no best in engineering, only better. With the development of additive manufacturing and multi-axis machine tools, as well as the emergence of new cloud simulation/modeling software (such as fusion360), there will be more and more innovations in engineering. Compared with before, these new CAD software will bring more scientific workflow and more efficient methods to our work.