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Study on The Adaptability of FSC Racing Ergonomics

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Abstract: : FSC is the university automobile correlation profession student to display the knowledge and develop the technological innovation national class competition.In this composition, the vehicle'sperformance dependslargely on quality of ergonomicsmanagement strategies.The driver of the vehicle plays a pivotal role in the racing.Designing a comfortable cockpit makes a large effect on the car driver.In this paper, fourstrategies areintroduced to improve performancebased on the theory of ergonomics. These are: the driver's comfort evaluation, design and optimization of the driver's seat, the driver's vision analysis, the establishment of the comfort standard of the FSC racing cockpit.The comfort degree of H and the software that comes with the body posture and comfort assessment .Thebenefits of UG software make it an attractive option for regional instructions in the accessible area of the driver fixed good posture.The control panel layout is developed to establish a feasible system of cockpit layout for racing vehicle.Adaptive optimization with FSC racing driver, it can reduce driving fatigue and improve performance.

Key words: FSC racing; Operation convenience; comfort proposal; Vision checking

I. INTRODUCTION

FSC is the abbreviation of the Chinese college students' formula automobile competition. The event is a automotive design and manufacture of the game, by students in Colleges and universities in vehicle engineering or related professional team to participate in.Events require teams to design a car that it is in the acceleration,braking and steering control and other aspects of a good performance of the car independently in a year.[7][10]

Under the restriction of the strict rules, it is similar to the basic structure, the engine displacement, the vehicle performance and the weight of the FSC of each participating university. Therefore, only to seize the variable factors which can lead toachieve good results in the race. Then, the driver of the variable factors is seen as an important factor in changing competition performance. The car designers is to make the car drivers as much as possible with a relatively comfortable driving posture match. Comfortable sitting posture can reduce the driving fatigue from the high intensity game.It is very good to simulate and research the adaptability of the driver and the carBy using the theory of ergonomics and the design of UG software. The following is a process for the study of Ergonomicsin FSC racing. As shown in Fig. 1:

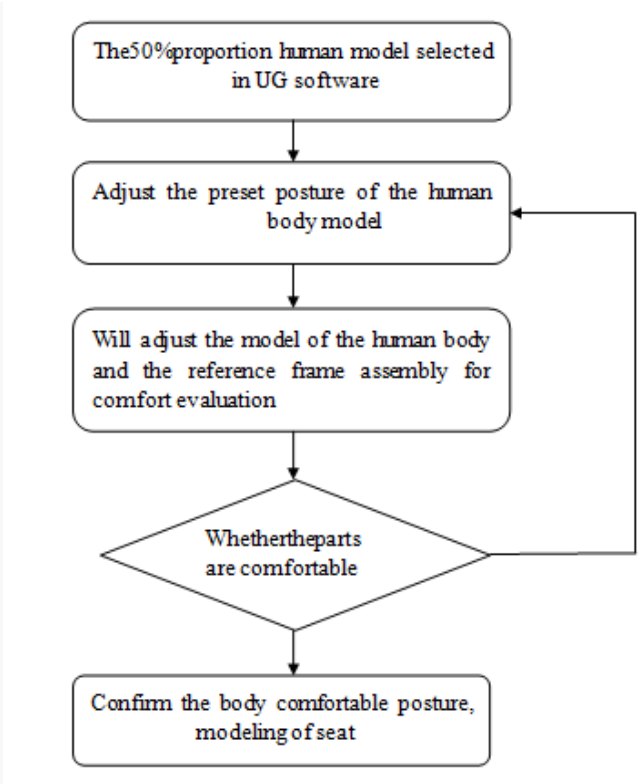


Fig.1 the process of driver adaptability research

II. THE PRESET BODY POSTURE ADJUSTMENT

Firstly, a human model is established in UG software.The driver's sitting posture is simulated by the editor of the human model.The human model head, shoulder, arm, thigh, calf and foot is part of assessment.As shown in Figure 2,the human model is adjusted to the driving state by using the driver's position in the human posture database of the software.Then the human body model and the FSC car frame assembly together.Because the frame adopted has certain binding to human body model, and then in the cockpit model of the human posture fine-tuning.it is no interference between the body and frame as much as possible.As shown in Figure 3,The human body model and FSC car frame parts have no motion interference.

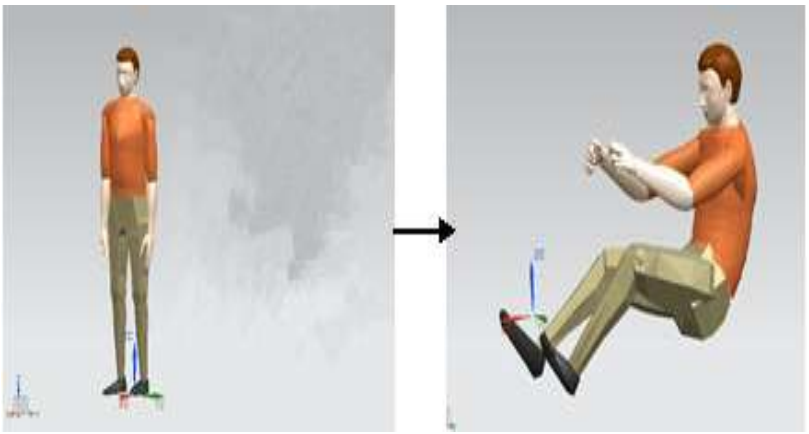


Fig.2 preset driving posture

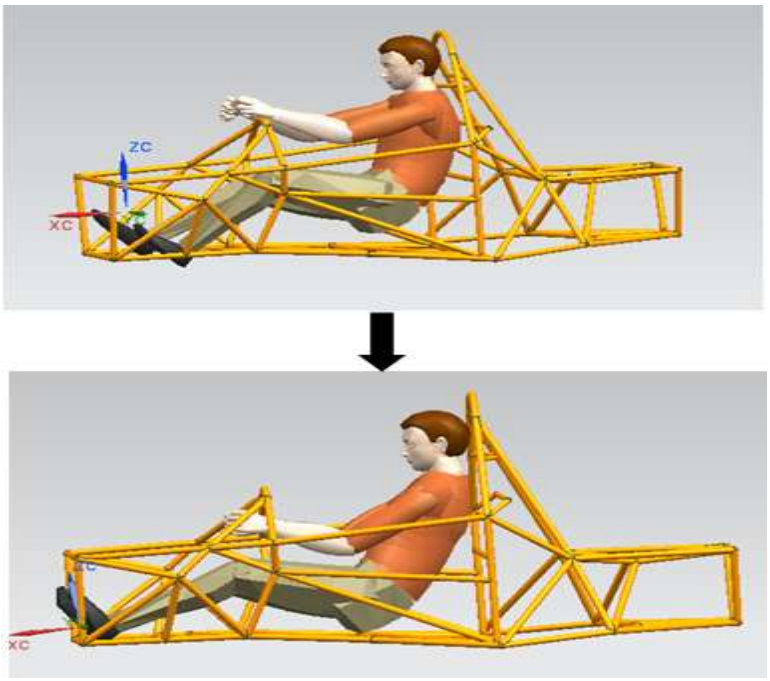


Fig.3 preset driving posture and frame assembly

III. COMFORT EVALUATION AND DESIGN OF FSC DRIVER SITTING IN THE CAR SEAT

The key reference point of comfort evaluation should be established before the driver's sitting posture evaluated.There are H points, AHP points and SGRP points.

It is to carry out the comfort standard setting after determining the three key points.The comfort standards isPorter(1998).Comfort standard is to set a comfortable posture on the body of the joint, provide a reference to a variety of body state data.

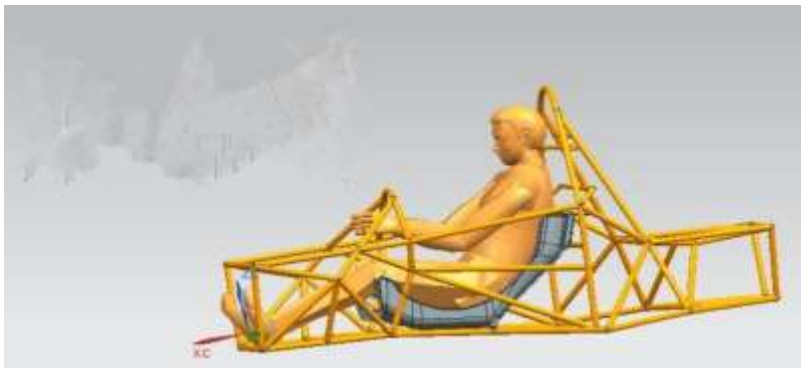


Fig.4comfort standard setting

The driver's sitting posture can be evaluated after setting the standard of comfort.The assessment is applied to the software which comes with UG instruction comfort analysis.The various parts of the body has a relative comfort area,where the green is relatively comfortable, red is uncomfortable position.Finally, the evaluation result is a comprehensive evaluation of all these factors, when these parts of the human is in a comfortable state, then the driver is the most comfortable posture.

Fig.5 first comfort evaluation results

When the first human comfort evaluation, the various parts of the comfort evaluation showed that the head and the left leg is in uncomfortable state in the sitting position**.** When all the provisions of human are in a comfortable state, that the human body is comfortable sitting posture.Therefore, it is also needed to adjust the body model of the sitting posture to weigh all the joints.As shown in Figure 6,when all of the parts are in a green area, the relative comfort of the human body model is confirmed. It is the establishment of the seat to fit the body of the driver's seat modeling and design.

Finally, when all the corresponding regions of the joint are all in a more comfortable sitting position and the appropriate joint angle, the seat of the comfortable sitting position can be modeled.Figure 7 shows the point of view of the body in a comfortable sitting position.

Fig.6all joints are comfortable body model

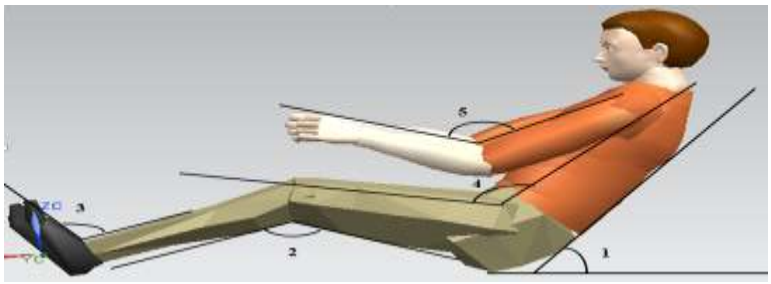


Fig.7comfortable sitting posture angle model

After adjusting the relative comfort of the human body model, the curve of the human body model, the back, buttocks and feet of the human body model is obtained by using the UG software,As shown in Figure 8 for the FSC racing seat model.

At the same time to give the following suggestions in the seat design:Lateral support is needed for the driver's arm and waist;Lateral support is needed for the driver's buttocks;[8][9]There should be sufficient lateral support for the driver's thigh.When the driver in the high speed steering and the lateral force and the great centrifugal force, the car seat can provide enough support and package, improve the safety of the driver in driving.Figure 8 is the overall assembly body model, car seat and FSC of the three car frame.

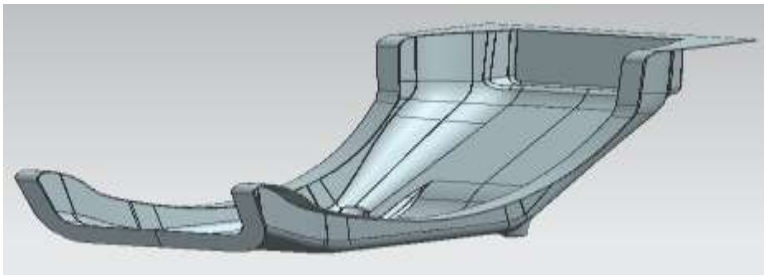


Fig.8racing seat model

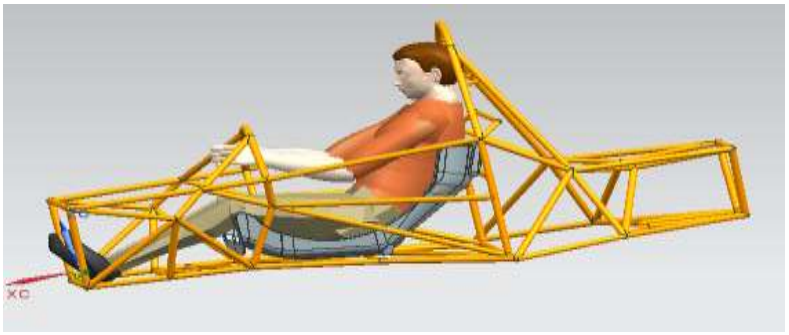


Fig.9 complete assembly drawing

IV. ANALYSIS OF FSC RACING DRIVER OPERATION

First of all, the human body contact area is analyzed, and the accessible range of the left and right hand is set.The results of the analysis are shown in Figure 10;

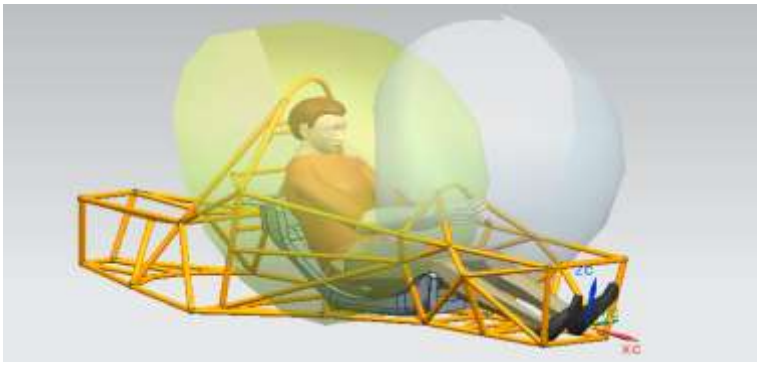


Fig.10driver's hands touch range

In the operational analysis can be divided into three aspects of the FSC racing steering wheel operation optimization, the optimization of the FSC racing pedal and the evaluation of the FSC racing car.

(1)FSC racing steering wheel operation optimization

Racing steering wheel is the most recent device in the driver's operation and the distance from the driver's head and chest position.[6][7] It has great influence on the safety, comfort and convenience in the driving

process.There are listed for FSC racing steering wheel operational optimization project and program in table 1.

Table 1FSC racing steering wheel operation optimization

project	Optimization scheme
Steering wheel material	Carbon fiber material、Monomer forming Hands holding area、The anti slip material package
Steering wheel size	Steering wheel disk size：Lateral 250mm、 Longitudinal 175mm、Steering wheel section radius 30mm
Steering wheel angle	Steering wheel steering ratio：Left 90 killed Right 90 killed、Total angle 180 degrees
The steering wheel shift paddles	With paddles on the steering wheel rear gear shifting device，Shift mode：Left for downshift、Right to add files
The steering wheel mounting angle	Steering wheel level and frame front ring Qi Ping、Vertical and vertical plane into 15 degrees

(2) Optimization of FSC racing pedal

The clutch pedal, the brake pedal and the accelerator pedal are related to the safety of the drivers and the control ability of the drivers, which directly affects the performance of the race.There is listed in FSC racing pedal optimization program in table 2.

Table 2 parameters of each pedal

	Pedal length（mm）	Pedal width（mm）	Pedal stroke（mm）	Pedalmountingangle（°）
Acceleratorpedal	170	58	78	With the ground was 80 degree
brake pedal	110	65	30	With the ground was 90 degree
Clutch pedal	110	55	75	With the ground was 75 degree

(3)Evaluation of FSC car import cabin

As shown in Figure 11,The height setting of the 1% percentile human body model used for simulation is 160cm.The human body model and frame assembly phase, will be adjusted to the preset posture into the cabin of the state of the human body model.[4]

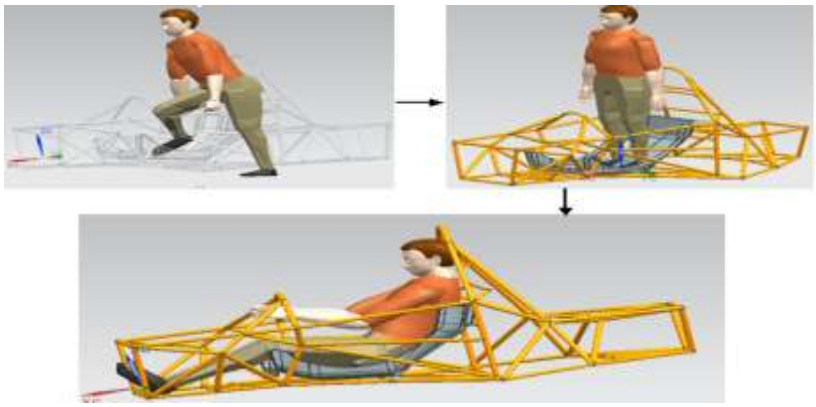


Fig.11. Select the 1% percentile human body model to simulate in and out of the cabin

In the simulation of the software, the smallest of the 1% percentile of the human body model can easily cross the height of the car frame,Other percentile models can facilitate the driver's access to the car compartment.It also meets the requirements of the event.

V. ANALYSIS OF FSC RACING DRIVER VISION CHECKING

We must introduce vision check two standards: GB is GB11562-1994 vision check standard and SAE standard J1050 vision check.In the standard, we should know the basic concept used in vision check, respectively is the origin of the line of sight, field boundary, oval eyes, vision blind area, V and P.[2][3]
The first step is to establish the driver's eye ellipse.As shown in Figure 12:

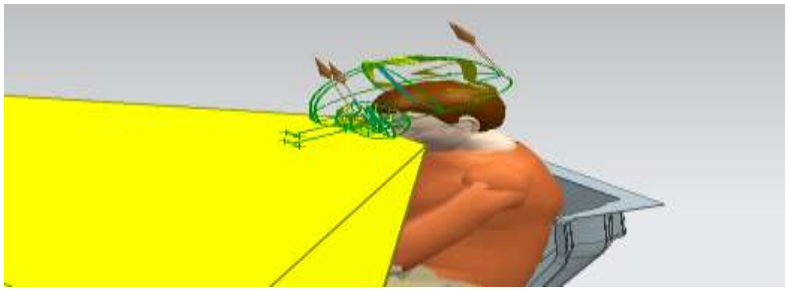


Fig.12 establishes a good driver's eye ellipse

Next, we should establish the driver's point of view and then proceed to the driver's direct visual field check.As shown in Figure 13:

Fig.13 confirms the position of the left and right eye

After the establishment of a good starting point, the driver can be carried out in front of the visual field check, As shown in figure 14:

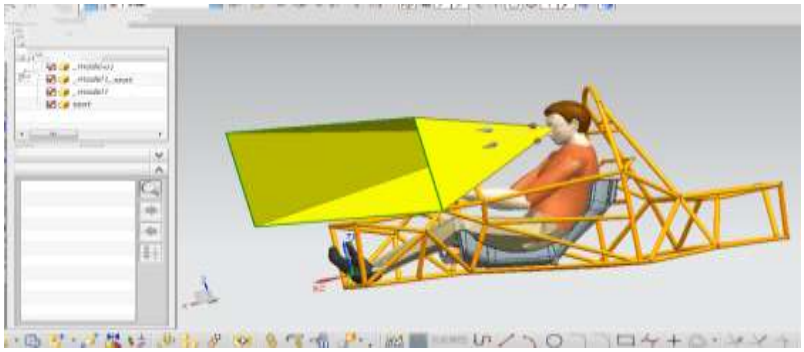


Fig.14 drivers direct view

VI. FSC DRIVER COMFORT STANDARD RECOMMENDATIONS

We make a summary of the comfort of the driver, as shown in table 3.he list of some project FSC racing driver need evaluation in static condition.[1]The team can make a detailed assessment of the adaptability of the racing car.

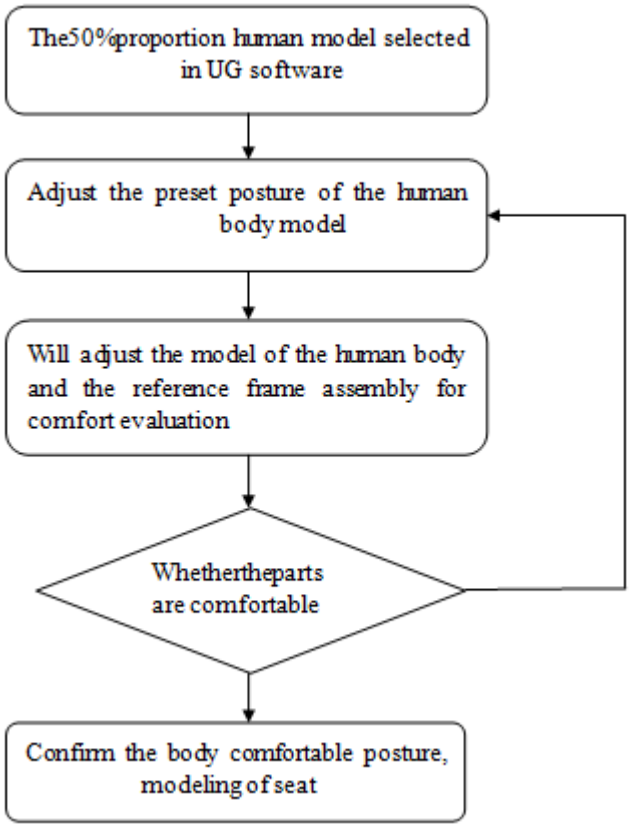
Table3 FSC racing driver comfort evaluation table

FSC racing driver comfort evaluation table					
	Measurement project	Measured number	Comfort range	Evaluation result	note
	Back angle		50°～56°		
	Foot angle		70°～110°		
	Arm angle		120°～135°		
	Thigh and upper body angle		100°～130°		
	Thigh and shank angle		120°～150°		
	Headtoshoulder distance		280mm～285mm		
	Shoulder to hip distance		485mm～490mm		
	Steering wheel size		250mm～285mm		
	Steering wheel angle		90°～110°		
	Steeringwheel mounting angle		90°～100°		
	Acceleratepedal mounting angle		80°～90°		
	Brakepedal mounting angle		80°～90°		
	Clutch pedal mounting angle		80°～90°		
	Accelerator pedal stroke		60mm～80mm		
	Brake pedal stroke		30mm～50mm		
	Clutch pedal stroke		70mm～80mm		
	H point to ground Distance(H70)		50mm～65mm		
	Head to Hpoint Distance(L31)		1200mm～1280mm		
	Distance from steering wheel center point to the center of the front axle		0mm～20mm		

(1) Recommendations for comfortable sitting posture of FSC racing drivers

At first, a suitable model of the percentile human body is established in the UG software, and the corresponding preset position in the human body model is selected;we should establish the human body model and frame assembly position and adjust them for assembly.Later, it can be adjust the layout of the frame according to the model of human body posture, comfort evaluation of human body model using comfort evaluation criteria.According to the comfort level in the body of the joint model ，that determine the location and comfortable

uncomfortable position, the red area is not comfortable, green is comfortable.Finally, it can be designed when the comfortable sitting position was determined.



The three car pedal position affect the positions of AHP directly, there is necessary contact between AHP and the driver's comfortable sitting posture.In the FSC game, there are usually 2 to 3 team racing drivers to participate in the competition,it can not be achieved in driving racing car when the fixed design can not be adjusted.The car pedal can be designed before and after the adjustment typein order to adapt to the different height of the racing driver.At the same time, it should be reasonable to confirm the three pedal arrangement angle and stroke.The accelerator pedal is about the response of the accelerator in the process of the design of the pedal.In the setting of the brake pedal, the design layout of the brake pedal has a direct impact on the production of braking efficiency .Because the FSC does not exist when the car brake booster, brake pedal design should take into account the reasonable arrangement of brake lever principle to allow the driver to brake on the brake pedal in more effort.In the clutch pedal with regard to the arrangement, although the frequency of using of the pedal is relatively small, it is very important in cluthjuegan and hardness for the driver.Therefore, the design of the clutch pedal should not be neglected.

(3)FSC racing seat design proposal

It can be modeled on the car seat design after the establishment of a good driver comfortable sitting position .The curved surface of the seat is provided according to the curve of the back curve and the hip of the human body model which determines the comfortable sitting posture.It should be considered for all parts of the driver's seat itself and the ability to support the anti roll in the shape of the seat design.In the design, it should be set aside four point type seat belt in the middle of the seat position. According to the requirements of the safety belt width, the width of the reserved hole on the car seat should meet 76mm.

VII. CONCLUSION

FSC racing is a platform for the students majoring in automobile to learn professional knowledge, cultivate practical ability, display their academic style, strengthen the team cooperation.In this paper,it analyzes the adaptability of FSC racing driver based on the theory of ergonomics.The research conclusions are as follows:

1) Comfort evaluation of human model was made by using SAE model of human body.According to the

evaluation results show that the model of the human posture adjustment, until all the joints are in a comfortable range. It makes preparation for the design of car seat.
2) The FSC racing seat model was built according to the comfortable human body model.
3) It is put forwardthe optimization scheme of the vehicle steering wheel, pedal, instrument panel and the operation convenience of the driver's cabin. Itfocus on improving the driver and put forward feasible measures for reducing driving fatigue.

FSC racing is a great event for the students of the College of automobile.The team can achieve good results in the race through the optimization.It makes the members enjoy the pleasure in the racing .

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