Abstract: This paper presents the general design of a small radio controlled car with its main systems and also the process and phases of modeling the body work for this kind of car. The modeling started from the sketch of a real car, a Porsche 997, shaping the clay to its final form looking like a mixture of Nissan GTR and Porsche Cayenne but keeping the proportions of the 997 to a scale of 1:14.

Keywords: design, body work, car, modeling, clay.

1. INTRODUCTION

A radio controlled car seems to be a toy at first glance but these models can be as complicated as a normal car, having electric motors or a thermal engine, control unit, batteries, transmitter and receiver for control, power steering unit, functional suspension and differential or gearbox. These models are part of the professional class, with superior driving dynamics designed for enthusiasts.

Nicholas Tesla invented the radio control in 1893 when he remote-controlled an unmanned boat. In World War II this technology has greatly expanded, both the radio (radar discovery) as well as the radio-command (German aircraft used radio-guided bombs against enemy ships). In the 40-50s began to sell radio-controlled models using vacuum tube technology. With the discovery of transistors and integrated circuits in the 60s and 70s who have low power consumption began to spread ever more this RC cars. From 1990-2000 the cost of production for radio-controlled toys have become increasingly smaller.[1]

2. GENERAL DESIGN

There are a lot of RC car models on the market that fall into several big categories:
- depending on the engine: electrical and thermal;
- depending on the field: for touring and for off-road;

The models with thermal engine (Figure 1) are usually two-stroke or four-strokes and are using as fuel a mixture of nitromethane, methanol and oil, such models are called "nitro" and have an engine capacity of 2 cm$^3$ and even up to 35 cm$^3$. But the fuel used is pretentious, expensive and produces more oil and toxic gases.[2]

Newer engines use gasoline (plus oil) two-stroke Fig. 2 but for larger models, engines with larger capacity than the nitro ones are usually 80 cm$^3$.

![Image of Petrol engine](image)

Fig. 1 Motor Nitro Star K9

![Image of Petrol engine](image)

Fig. 2 Petrol engine

Electric models are powered by electric motors, small yet powerful and rechargeable batteries like nickel-cadmium, nickel metal hydride or lithium-polymer. Car model systems include:
- propulsion:
  - engine - mechanical energy source;
  - energy storage: tank for fuel, batteries or photovoltaic cells
- transmission - transmits the power from the engine to the wheels, ensuring a correct correlation between travel mode and operating mode of the engine for thermal engines
- running system - ensures contact between the car and the ground to ensure the movement of the driver as he wants;
- chassis - structural part on which are connected other systems;
- body - has aesthetic role and help define the dynamic behavior of the model;
- suspension - helps to control the behavior of the car on the road;
- steering system - control the direction of movement performed in accordance with the wishes of the driver, architecture depends on the type of road (touring or off-road);
- braking system - slowing the car down to a stop.

Example of a RC model car: HPI Sprint 2 Flux Porsche 911 GT3 Scale 1:10.[3]
Body work modeling and general design for a radio controlled car

3. BODY WORK DESIGN
The design of the body work is not only to make the model look good but it has a important function : to protect the components inside of the model in case of a crash, so it has to be made from a tough material like lexan, fiber glass or even carbon fiber.

Also the body has to be a scale replica of a real car, the designed body is based on a Porsche 997, scaled down to a ratio of 1:14.

4. BODY WORK MODELING
The body-work can be made by several methods depending on the material used:
- plastic can be molded or by injection molding;
- polycarbonate can be heated and placed over the form and with vacuum the car take its form;
- fiber glass or even carbon with resin placed in a negative mold;

The images below illustrates the process of shaping the clay model for making the mold.

First step is to create the basic shape of the car but bigger then the final model.

The Sprint 2 Flux is a model which has high performance and durable components that push this model to the amazing speed of 85 km/h. It contains water-resistant components, a radio control system which works at a frequency of 2.4 GHz on 3 channels that automatically change the channel if interference or losing the signal or damage to the controls of the car. The electric motor is a brushless type with a coefficient Kv of 5900, 4-pole magnetic rotor for greater torque and triple coils isolated for long life. The controller is made specifically for this engine to improve performances by increasing the torque at high speeds.

The suspension is an independent type with two arms and oil dampers for better traction (Fig. 5). Steering and suspension components are made of aluminum and steel.

Fig. 3 Body work
Fig. 4 Inside of the model
Fig. 5 Suspension
Fig. 6 Starting the clay model.
Fig. 7 Adding material where is needed.
Fig. 8 Cutting the excess material.
Fig. 9 Detail of the basic shape.
Working with clay is not easy because if you’re not careful it dries and it gets very difficult to shape it so when it starts to stick on tools it needs to be sprinkled with water because when it’s wet is very easy to work with it.

Fig. 10 Shaping the car.

Fig. 11 Shaping the back of the car.

Adding material to the back side in order to shape it and make it round looking like a real car.

The tools I used are pretty basic, like a ruler, a cutting knife, a plastic knife with edges, which you can see in Fig. 6, Fig. 11, Fig. 14 and Fig. 19.

Fig. 12 Shaping the side of the car.

Fig. 13 Smoothing the edges using water

Fig. 14 Adding material and furthermore smoothing the edges

Fig. 15 Shaping the back.

Fig. 16 Detail of the back side.

The back side is pretty round but before I finish the project it will look different, it will have some details like a place for the number plate, a back bumper, stop lights.

Fig. 17 Starting work on the right side and adding material

The right side looks like this because I started to shape the left side first and after that the right side, I didn’t worked on both sides simultaneously.

Fig. 18 Working on the right side
I tried to shape the front of the car to look like a Porche 997 with the famous headlights and to give a clean, aerodynamic shape, because the air resistance is very important if you want the car to go faster and have a high top speed and it plays a major role in stability if the car has a back wing.

It is needed to put some lines on the car for better spatial references, to see better the shapes and lines of the car.

The wheel arches are very important in giving the model the look of a real car because it adds some new lines and shapes that completes the model.

5. CONCLUSION
Clay is a fun material to work with because you can adjust the shapes very easily by adding material or cutting the excess one.

The final clay model is 290 mm long, 140 mm width and 70 mm height.

This clay model will be used to make the mold by adding layers of fiber glass and resin on top of the model and after that inside of the mold can be poured layers of plastic or policarbonates to make the actual body of the car.

This model is a work in progress even after 2 full days of working on it so this is not exactly the final shape of the car and even after finishing the body-work it still needs many components for making it work because radio controlled cars are very complex.

REFERENCES

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