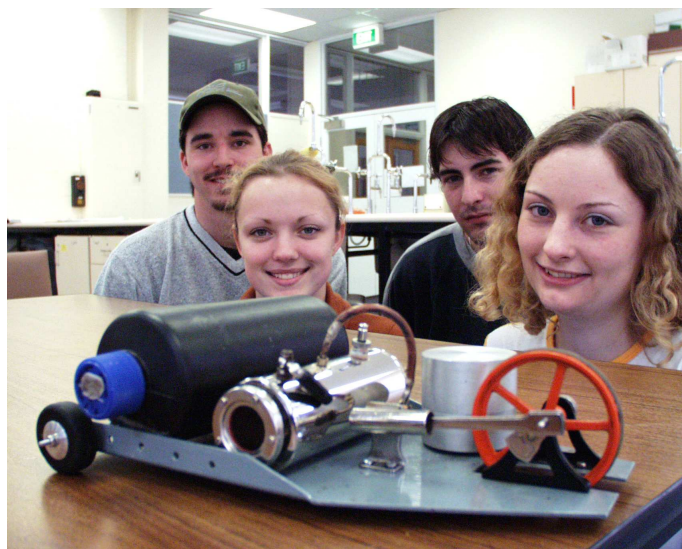


## Chem-E-Car – Some Tips and Ideas for High School teams

### How to build a Chem-E-Car

Every Chem-E-Car consists of three basic elements:

1. **The Chassis** – your car needs to have a body to hold all of the car's components (reactor, fuel supply, water container, etc) together. Ideally the body should be light and sturdy - the team from Adelaide University in 2002 (see picture below) successfully used a thin metal plate for their chassis. You also need a device to transfer the force generated by your chemical reaction into forward motion on the ground. Most people use 4 wheels for this, but you can see below that Adelaide 2002 used only 3 wheels. Can you think of any options other than wheels?



Adelaide University 2002

It is very important that all of your components, including the chassis, are reliable and they perform consistently – so take care in their design and fabrication. Other key performance factors for the chassis are that it should drive in a straight line and, very importantly, there is a low coefficient of friction between the wheels and the ground surface. Do the wheels run freely and easily? How much force does it take to push your car by hand? If you have to push the car really hard and then it only travels a few feet, then you will definitely have problems later on. Finally, while there are no marks for aesthetics, everyone likes to be stylish – so make sure your car looks cool too!

2. **The Propulsion System** – this is the most important part of your car. The propulsion system provides the chemical reaction that powers the car. The possibilities here are endless and only limited by your imagination. The two key issues to think about are: How to generate chemical energy safely and reliably? How to convert the chemical energy into mechanical energy to propel the car?

Some ideas used in the past:

- Steam engine: decomposition of hydrogen peroxide to produce pressurised oxygen that is converted to mechanical energy using a toy steam engine (see Adelaide 2002 car above).

- Galvanic cell (this is simply a homemade battery): uses Zn-Cu electrodes (or other electrodes) to generate DC electricity that is converted to mechanical energy using a small DC motor.
- Hydrogen fuel cell. Toy fuel cells can be purchased on-line quite cheaply. Typically the hydrogen is produced beforehand by running the fuel cell in reverse (ie. by using a power supply to drive the fuel cell to convert hydrogen from water). The hydrogen can be stored on-board (how would you do this safely?) and then combined with an oxidant (usually air) to drive the fuel cell. The fuel cell produces a DC current which is converted to mechanical energy using a small DC motor.
- Model aircraft engine: can be purchased quite cheaply, together with a commercial fuel, from model shops. A propeller can be modified to drive the car, like a hovercraft or swamp boat. Be careful to properly enclose the propeller and be careful when storing and handling flammable fuels!

**3. The Stopping Mechanism** – the objective of Chem-E-Car is to **control** a chemical reaction. So, while getting your car to go is the first priority, in order to excel at Chem-E-Car your car must be able to stop consistently, predictably and reliably. How to do this? While it might be tempting to use an electronic timing device coupled with a mechanical brake, this goes against the spirit of Chem-E-Car (because it doesn't involve controlling a chemical reaction) and is specifically against [the rules](#). There are two main principles that are usually applied to devising an effective stopping mechanism:

- “Depletion of reactants”. This method relies on ensuring that one of the reactants used in the propulsion system is supplied in a limited (and well known) quantity. During operation, the propulsion system ceases to operate once the limiting reactant has been consumed and the car will coast to a stop. Thus, varying the quantity or concentration of the reactant is used to control (increase or decrease) the distance travelled by the car. For example, the Adelaide University car from 2002 (see picture above) used varying concentrations of hydrogen peroxide in their reactor - adding more concentrated hydrogen peroxide caused the car to travel further. For this method to be successful, you need a propulsion system and chassis that both perform reliably and predictably. You also need to do a lot of calibrating and testing of your car so that you know when you add a certain amount of reactant, with a certain mass of water load, then the car will travel a certain distance and will do this consistently and repeatably.
- “Chemical timer”. Another approach is to use some type of a chemical reaction which occurs within a known time period. An example of this is known as an “Iodine Clock”, but there are many variations on the theme. In this case, the propulsion system can be operated at full power and the chemical timer is used to “switch off” power to the wheels. This type of approach works quite well for electrically driven cars, such as those powered by fuel cells or galvanic cells. But, be warned, chemical clocks are notoriously difficult to operate repeatably and reliably.

Of course, don't be limited by only these two suggestions.

So there you have it! - three easy steps to building your own Chem-E-Car. Remember the mantra: predictability, reliability and repeatability. And don't forget to fully consider the risks associated when working with chemicals.

Check online for more ideas. Different Chem-E-Car competitions are held all over the world and some of these have their own websites which are a good resource.

Good luck!