ENGINEERing challenge workshop for science museums in the field of electricity

Electrical engineering

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ENGINEERing challenge workshop in the field of electricity

Workshop ID card

Name of the workshop: Sweep thing up

The Challenge: Design a small vacuum cleaner

The Engineering field: Electrical engineering

The science field: Electricity

Target audience: Families with children from the age of 8 and / or pupils grade 4

Type of activity: drop-in activity / workshop

Duration of activity: 20-75 minutes

Context

This unit introduces the field of electrical engineering. It can be anything from the smallest electronic components in computers and mobile phones to the generation and use of electricity. The workshop let the audience to be introduced to the Engineering process and electrical engineering. In the workshop the participants will use a motor and a battery to get a fan to work, to become aware of the different parts of a vacuum cleaner and how it works and design a small vacuum cleaner.

Maximum number of participants: 25
Number of facilitators (intern): 1
Location: A workshop area
Set up time needed: 20 minutes

General objectives

The Engineer Museum Activities:

- ✓ Offer the participants to find and experiment different solutions to solve a "real" engineer problem
- ✓ Give a new perspective on Engineering as a field, a process, a way of thinking and working
- ✓ Introduce and exemplify the EDP (Engineer Design Process: Ask, Imagine, Plan, Create, Improve), or part of it
- ✓ Give the participants the possibility to reflect on what they have done and how the Engineers work.
- ✓ Are based on IBSE - Inquiry Based Science Education and are not gender oriented.

Specific unit objectives

- ✓ to be introduced to electric circuits
- ✓ how to use batteries, small motors and fan
- ✓ to become aware of the different parts of a vacuum cleaner and how it works

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Resources

material	Total amount	Expendable	Non- expendable
Toilet paper role	10	✓	
Insulated wire with alligator clips on each end	20		✓
Motor (1,5V-3V)	10		✓
Batteries (3*1,5V or 4,5V)	10		✓
Battery box (depending of witch batteries you use)	10		✓
Recycled Cardboard, with different thickness and looks and thicker paper		✓	
Flower/craft sticks	10	✓	
Sticky tape			✓
Scissors	10		✓
Paper A4	10		✓
Needle	1		✓
Glue pistol	1		✓
Recycled Plastic bottles	10	✓	
Aluminium foil	1	✓	
Recycled Plastic lids/ plastic packaging	10	✓	

Aside from the motor assembly, the materials are simple and easy for participants to use, which is ideal for the design and building part of the workshop. Participants can design a variety of fan blade types – size, stiffness, shape, number of blades, etc. A variety of bottle

shapes, sizes and mouth sizes will ensure different outcomes in the design of the housing and nozzle. It might be helpful to have a couple of different prototype example just to get visitors thinking about the variety of possibilities

The workshop

Introduction

Welcome the participants and tell who you are. Ask the participant how we think when we are planning and creating things. The participants give example.

They ask a lot of question so for example say "you ask questions", and they also say that they build and create. Facilitator could then ask if the plan and so on. Show them the EDP and tell about the five steps. And start the main activity.

Tell them that you have problem with debris.

The main activity

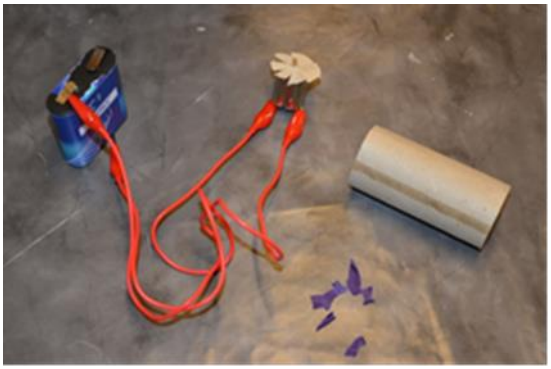
1. Show what material they can use for the whole workshop. Tell them about the design problem. The design problem is: They have to design a vacuum cleaner that could sweep up some debris. . The critera of sussess is to design a maschine that can make a sucktion. The debris could be debris from the hole puncher or small pieces of silk paper.

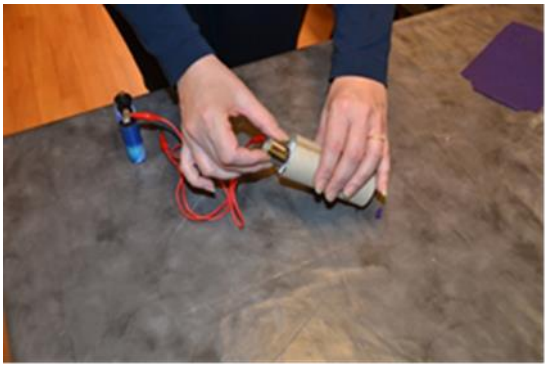
2. Group the participants. Best is to put two persons in each group.

   Give all groups one motor, one battery, 1 toilett role , 2 wires with aligator clips ,1 paper and 1 small pices of rubber band. Tell the participants that the toilett role is the housing of the vacuum cleaner and that the fan should be attached to the motor and then put inside of the housing. For more information about desingning of the fan and tips how to attach it to the motor see**: Tips and tricks** about **Design a fan and attach it to the motor**

3. After that let all groups try to link the motor with the battery and then design a fan. If some of the group need help show how to link a motor to the battery. When they are designing their fans let them try it in the housing to see if it works. Let them hold the motor with their fingers. Do not fastened the motor before they know that it works. If the fan blows instead

of sucks, change the direction of the current by switching contacts on the battery so the current goes in the other direction.





When it works, let the groups start to **improve** their designs. Now they can use their toilett role or change to other housings like bottles or tubes, they can make nozzle/tip to create better sucktion, they can fasten thier motor etc. For more information about attach the motor to the housing see**: Tips and tricks** about **Fasten the motor.**
Below are some pictures of improved designs of the vacuum cleaners.

Conclusion

Closure

All groups show their designs and tell about their designs. Look at the EDP and ask wich step they have used.

Information for the facilitator

The assembly of the motor and fan will be tricky for many participants; it could be very helpful to encourage participants who have built a successful assembly to assist other groups who are struggling with theirs.

Supervision is needed if participants are cutting the bottles! Some thicker plastic can be difficult to cut, which may cause participants to slip and jab themselves. It can also create sharp edges. It may be a good idea to have a supervised cutting station for cutting bottles.

Providing the facilitator with a few starter questions that they can use to help them guide participants can be helpful. This also helps to integrate the engineering design cycle throughout the workshop.

For example:

- Engineers build off of other's ideas. What do you think of the sample prototype? What parts work well? What could be better?
- What do you think [choose a material] might do? Do you see anything that might work even better?
- Here is a trick that worked really well for me; do you think it might help you? Is there anything you could do to improve my idea?
- What are you trying to get your prototype to do? Did it work? Did it do what you wanted or expected it to do?
- Engineers are good at learning from failure! Did you see what part of your design is not working? What is it doing wrong?
- Engineers never build anything perfectly the first time. Can you think of anything you could change to see if it will fix the problem?

Background information

Vacuum cleaners work by suction. ("Suction cleaner" would be a better name than vacuum cleaner, in fact, because there's no actual vacuum involved.) The mechanical / electrical part is really a strong motor that blows air, usually out the top or back of the vacuum, which creates a suction force at the bottom (where the dirt gets pulled inside). They all work the same in principal....if you attached a motor that blew air (say a fan) to one end of an object that had an opening at the other side, it would work the same and cause air to flow first inside the object, then out through the fan.

If you want to know more about how vacuum cleaners work you can look at these webpages:
http://home.howstuffworks.com/vacuum-cleaner.htm
http://www.explainthatstuff.com/vacuumcleaner.html

Problems you can encounter

If the vacuum cleaner does not work check that:

- is there connection between the motor and the battery,

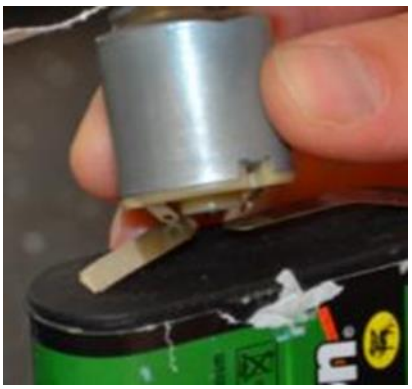


Figure: Battery and motor in contact.

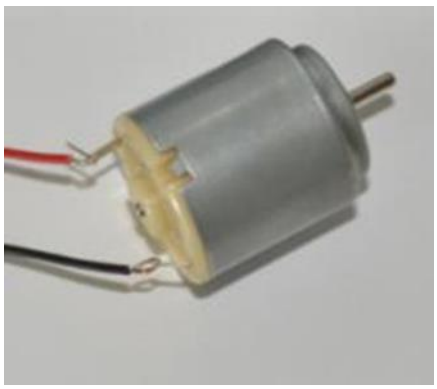


Figure: Motor with wires on contact poles .

- the motor works,

- the battery is charged,
- the fan is stacked to the shaft of the motor,
- if it blows instead of sucks, change the contacts on the battery.

Remember that air has to be able to pass through the material or that they have to make some small holes if they choose to seal the cover.

Some participants can focus a lot on the cover and how to seal it. It is not necessary for the task to seal the cover. Focus on the task of getting debris into the cover.

Tips & tricks regarding the materials

To save time, place the audience in groups of 2-3 persons from the start.

Tables and chairs are needed so that the audience both can listen, discuss and work in groups.

Design a fan and attach it to the motor

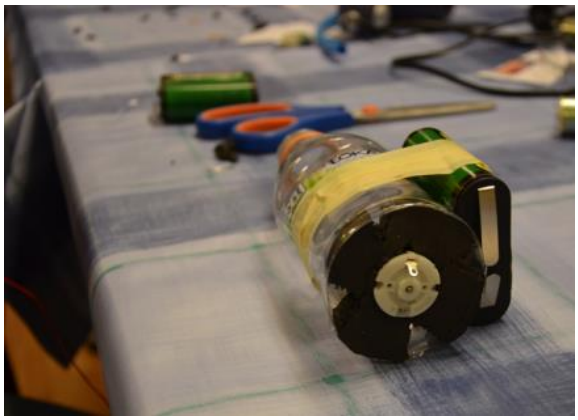
The fan can be made in many different materials. One material that is easy to work with and easy to adjust is cardboard. It can be cardboard with different thickness and looks. It can be from packaging of milk, cereals, pizzas etc.But you could also use aluminium foil, plastic ets.

Let the participants design the fan and then attach it to the motor. If the fan will come loose from the motor, use pieces of rubber band or sticky tape.

Fasten the motor

The group can hold the motor with the fingers or they can choose to fasten the motor to the cover. There are many ways to fasten the motor. Here are some examples of how they can fasten it.

Figure . The moter fasten with flower sticks and glue.



Remember that air has to be able to pass through the material or that they have to make some small holes.

Figure . The moter fasten with foam rubber, notice that there are small holes so that the air can pass through.