

Outreach Activity Report: Bioengineering- prosthetic leg activity

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Engineering has many different areas and applications, however one which is often forgotten about is its application in medicine. The aim of this activity is therefore to increase awareness of these applications as well as bring in some concepts of structure and design. Bioengineering can be defined as “The use of artificial tissues, organs or organ components to replace damaged or absent parts of the body, such as artificial limbs and heart pacemakers” (The Oxford Pocket Dictionary of Current English, <http://encyclopedia.com/doc/10999-bioengineering.html>), the students activity was therefore to design an artificial leg for a member of their team as if they had lost their lower leg.

The students were provided with the following materials;

- Cardboard
- Bamboo
- Sponge
- Scissors
- Saws
- Glue guns
- Sellotape
- Tape measure
- String
- A boot or trainer

It was permitted to tape the prosthetic to the knee of the student however the leg must fit into the shoe without being fixed to enable a user to change shoes if they so wished. The leg would be assessed by testing how far the student could walk, putting weight on the leg, before the leg failed. The leg would also be weighed, demonstrating the importance of the leg being lightweight to enable regular use and comfort for the user. A metric of length/weight would then be used to determine a winner.

Before starting the activity an outline of a general design process can be given to the students as follows;

- Understand the problem or need
- Come up with creative ideas
- Select the most promising idea
- Communicate and make a plan to describe the idea
- Create or build a prototype or model of the design
- Evaluate what you have made

The students could be asked to come up with some ideas of useful design features, before being given some suggestions as below.

- Strength
- Stability
- Durability
- Shock absorption
- Lifelikeness
- Weight
- Comfort
- Safety

For the running of this activity on our outreach day a PowerPoint was prepared to present this information to the student, however, being the last activity of the day, we were running very short on time and so the PowerPoint was scrapped and these ideas were just touched upon in a brief introduction before the activity started. From a safety point of view students were also advised to be careful of splinters and to use the saws carefully, and low temperature glue guns were used to prevent and injuries.

Throughout the activity students were guided to help them to avoid obvious mistakes that had been discovered when trying out the activity before, however were generally left to work on the design themselves. The main direction was that the sponge was used to act as a cushion between the knee and the prosthetic, to help prevent any injuries when walking. The students were given 20 minutes to build their design.

When it came to testing the designs a tape measure was laid out to enable the distance travelled to be measured. The other students in the team were to stand either side of those testing to support their team mate if they were to start falling over. Measuring the distance fairly proved a fairly challenging task since many of the students would pretty much be hoping, barely putting any weight on the leg at all. A 'winner' was therefore never actually declared. However by this stage that wasn't the important point and they all had fun giving it a go. Were this to be improved everyone could perhaps design the leg for one person to fairly try them all.



The most successful legs were in the end the large cardboard ones with a good interface between the knee and the prosthetic which prevented the leg slipping from side to side and allowing the full weight to be put on it. Failure was usually due to the knee going side to side

or the leg bending at the joint with the shoe rather than any buckling. Although most students dived straight in for the bamboo, being probably the most interesting material, those with just card proved the most effective. This was a good demonstration of how often the simplest designs are the most effective. Two example designs (built by us beforehand) can be seen above.