Teacher Notes – 555 Timer Astable Project

Introduction

The aim of this 7 week (2hr lessons) project is to design and manufacture an electronic product based on the 555 timer monostable circuit. The circuit is ideal for timer based projects, e.g. toothbrush timers, cooking timers etc. The project will introduce or reinforce the use of resistors, capacitors, LEDs, transistors and output devices such as buzzers. Students will learn about various aspects of electronics including the systems approach, components and circuit diagrams as well as product design. They will learn new or develop existing practical skills i.e. soldering, graphics and RMT skills.

This is a rough guide and the time needed for each activity will vary between schools and groups. These notes are based on experience with year 9 groups of approximately 20 students of mixed ability and sex in an average state school. The lessons are broken up into 7 2hr sessions.

These project notes are primarily aimed at KS3 students but it is an excellent project for KS4 students as it is covered by the GCSE syllabus. For KS4 students these notes will need to be modified to include greater differentiation by outcome and more emphasis on the various GCSE syllabi.

An excellent way of helping students understand the electronics is by using the training system. It allows students to change various components, input and output and therefore is an effective way of prototyping. It is also very good for exam revision as it is relevant to past exam questions.

If you have any comments to make about the project and notes or you would like to contribute then please contact us.

Aims and objectives

The project is to design and make an electronic product using a 555 timer monostable circuit. The product must use a suitable method to indicate when the product is timing and/or when it has finished timing, it would need an LED or buzzer at a minimum.
The project will enable students to experience the design and manufacture of simple electronic circuits.

CONCEPTS:
- Electronic circuits.
- PCB design.
- Design and manufacture.
- Model making.
- Evaluation.

OBJECTIVES:
Pupils should understand:
- The need to investigate the background to a problem.
- How to select appropriate components to build simple electronic circuits.

- How to select appropriate tools and materials.
- The importance of planned manufacture.
- The need to build models to evaluate design ideas.
- How to improve a product by evaluation.

SCIENCE OPPORTUNITIES:

- Understanding of circuit theory.
- Resistance/ Ohms law.
- The importance of timing circuits
- The 555 timer as a monostable

WIDER CURRICULUM OPPORTUNITIES:

- Accurate measurement and marking out.

IT OPPORTUNITIES:

- Use of Crocodile Clips to develop and test circuit ideas.
- Graphic packages to help generate design ideas.
- PCB design and production.

OTHER OPPORTUNITIES:

- Product styling.

Week 1 – Introduction and Investigation

Please note: There are many different possible outcomes of this project and these notes have been written with the aim of producing a timer enclosed in an MDF case.

Aims:
Review safety in a workshop, state safety rules as a group.
Introduction to project, show previous examples
Explain the different skills they will be learning

- Electronics
- CAD
- Circuit design
- PCB design etc

Write design brief and design specification

Teaching input:
Discuss the project with the class
The importance of product evaluation is the design process
Teach about briefs and specs, their use in industry and importance, use examples such as mobile phones, electrical goods, games machines, cars and other things they are familiar with
Teach about designing products that are fit for purpose and aiming products at particular consumer groups

Student:
Discuss and record workshop safety rules
Evaluate several electronic products – the aim of this is to understand the key components of an electronic product – PCB + components, battery, switches, wiring, case etc
Discuss as a class
Teach about briefs and specs, their use in industry and importance, use examples such as mobile phones, electrical goods, games machines, cars and other things they are familiar with
Research existing and similar products using for example the internet or catalogues, produce an image board in small groups
Design Brief – maybe give them it – e.g. Design and make an electronic timer that indicates to the user in an appropriate way
Specification – discuss as a class

Resources:
Examples of existing practical outcomes
Examples of image boards
Access to ICT or product catalogues
A range of old electronic products to evaluate

Homework:
Bring £1.50 (suggestion) to pay for the project
Diary record

Week 2 – Designing the Product

Aim:
Design the product, an electronic timer, this may a class theme, e.g. egg timer, or an individual theme - concentrate on fitness for purpose and target audience
Produce a 3D model
Evaluate designs

This is a suggestion; modify to suit your requirements
Manufacture a box from MDF with the outer dimensions 15x7x7cm - the case must be big enough to comfortably hold the PCB, battery, switches, LEDs and wiring.

Teaching input:
Explain what is required using examples of previous work or a teacher's example.

Produce an example design and display using an OHP or on the whiteboard

If students are all making the same case then the material will need to be cut prior to making and if they are designing individual cases then they will need to produce a cutting list.

Student:
Students to produce 3 design ideas. These designs do not have to include dimensions but they should be of good enough quality to demonstrate thinking and include labels showing the locations of switches, LEDs etc and evaluate each design. They should produce at least 3 and explain why they have picked the design they will make.

A final working drawing should be produced that includes enough information to allow a 3rd party to accurately manufacture the case without any further intervention from the student. As an extension task a 3d design may be drawn.

The next stage would be to produce a 3d model, depending on how long the designing takes this could be done in class and/or as homework. If it is done for homework then a cereal box can be used.

Resources:
Drawing resources
Card for 3D models
Examples of previous work

Homework:
Finish designs and 3d model
Diary record

Week 3 – Manufacturing the casing

Aim:
Manufacturing the case
Decorating the case

Teaching Input:
Review health and safety
Provide assistance to students during practical

Resources:
Each student will need materials to allow them to manufacture their case
Access to suitable materials
Access to tools
Access to paints

Demonstration:
Demonstrate to the students how to manufacture case with appropriate tools and methods paying close attention to H&S
Holes will need to be drilled for the switches, LEDs etc
Demonstrate how to use a pillar drill to drill the holes for the switches, LED etc

Student:
Students to manufacture their cases
Students to drill the holes for the switches, LEDs etc
Students to decorate their cases

Homework:
Maybe finish decorating at home or during lunch/break/after school
Diary record

Week 4 – Electronics

There is quite a lot in this lesson and it may be that some bits are left out. If you have the facilities available a good idea is to concentrate on Crocodile Clips and Real PCB. This lesson will differ between KS3 and KS4, for KS4 refer to the appropriate GCSE syllabus for information of what is required. Textbooks are an excellent source of information and there are some excellent UK based websites with some excellent and relevant teaching and learning materials, e.g. BBC Bitesize.

Aim:
Introduction to electricity and electronics – current and voltage
Power supplies – Mains, solar, wind, sea, batteries, parallel and serial
Introduction to the Systems approach – systems have an input, process and output, relate to examples they are familiar with, e.g. microwave oven

Teaching input:
Discuss the lesson aims with the class and use Q&A to reinforce.

Student:
Worksheet – Identify Input, Process and Output components on a worksheet, stronger students can state the function of the components by using research material, class books, wall charts etc.
Discuss as a group
Introduce the electronic circuit with a worksheet – this could be constructed using Crocodile Clips, the circuit being used is a 555 monostable circuit
The first task if for students to identify the various components and suggest their function
Go through the answers with the group then give an explanation of the circuit and how it works.
Introduction to PCBs and Q&A – what they are, what they are made of and why, where they are found, how they are made etc. This maybe a good opportunity to do a demo of how to make a PCB using a workshop etch tank – if possible. This is also a good opportunity to introduce Real PCB or an alternative PCB design package and allow students to design a PCB of their own, this could be reinforced using a worksheet where students identify mistakes in a PCB design

Resources:
Worksheets
ICT facilities including Crocodile Clips and Real PCB
Examples of components
PCB examples
Etch facilities

Demonstration:
Using Crocodile Clips and Real PCB
Producing a PCB in an etch tank – there are some good resources for this on the Rapid website

Homework:
Apply the systems approach to a household appliance, differentiate by ability, more able to do a more complex appliance, less able simpler.
Worksheet, for example identify mistakes on PCB designs
Diary record

Week 5 - Soldering

Aim:
Introduction to soldering
Students start soldering

Teaching input:
Q&A session, what is solder, why these materials, why solder etc
Discuss health and safety
Discuss quality issues

Demonstration:
Demonstrate soldering, insert component securely, bend legs back a little, heat the area including the leg for 5 seconds, apply a small amount of solder, take solder away, take iron away – aim for a neat 'mountain' of solder around the leg, it is very important that soldering is not rushed and that legs do not touch as this will cause a short circuit – there are some good resources on the Rapid website

Student:
Activity – Start soldering
This will depend on the individual teacher as to how it is organised. It may be that 1 component is soldered at a time; each student doing the same or the students may be given the component list and components and be allowed to complete the task independently

The LED(s)
How this is done will depend on the final outcome. If wires need attaching to the LED these steps may be followed. Remember long leg is +ve.
Cut a length of red wire
Strip about 2cm of the plastic sleeving
Twist to stop fraying
Wrap around the longer leg
Apply a thin coat of solder
Snip off any excess wire
Insulate with rubber tubing/heat shrink
Repeat with black wire for shorter leg

Resources:
Soldering equipment
Tools

Homework:
Storyboard on how to solder or make LEDs with wires (6 steps), this helps reinforce the skill as it would be likely they will solder again in the future in D&T
Or
Led worksheet – identify 10 things at home that contain an LED
Diary record

Week 6 – Finish Soldering and Assemble Product

Aim:
Finish soldering
Finish any other practical work
Construct final product
Test

Teaching input:
Discuss with Q&A quality control and testing
Discuss test sheets
Help students as required

Student:
Finish all practical work
Students to produce a test sheet
Test circuit using test sheet

Resources:
Access to tools

Homework:
Diary record

Week 7 - Evaluation

Students who have not finished practical work should complete any unfinished practical work and assemble final product

Aim:
Evaluation

Teaching input:
Discuss the importance of evaluation in design and technology

Student:
Produce a detailed production plan of their projects
Evaluate their work
Complete any unfinished work
Put folders into order
Students may complete a test based on the project – this may be set as homework

Resources:
Worksheets
Test sheet
Access to tools

Homework:
Diary record
Complete test