

## Teacher Notes – Transistor Switch Nightlight

### Introduction

The aim of this 7 week (2hr lessons) project is to design and manufacture an electronic nightlight that lights up in the dark and turns off in light conditions. The project will introduce or reinforce the use of resistors, transistors, LEDs, thermistors and sound outputs. 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 practical skills i.e. soldering and develop existing 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 8 groups of approximately 20 students of mixed ability and sex in an average state school. The lessons are broken up into 7 2hr sessions.

The project is primarily aimed at KS3 students but is also excellent for KS2 students where suitable facilities exist and also KS4 students as the transistor switch circuit is an important part of the syllabus and is a popular subject for exam questions.

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 the circuit is very similar to exam questions asked in the past.

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 nightlight. 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 working of the voltage divider.
- The transistor as a switch.

**MATHS 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**

### **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
- PCBs 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 nightlight, the sensitivity must be adjustable

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 nightlight**

### **Aim:**

Design the nightlight - concentrate on fitness for purpose and target audience  
Produce a 3D model  
Evaluate designs

This is a suggestion; modify to suit your requirements  
Build with an MDF base and an MDF background which has been shaped and decorated and drilled to accommodate LED(s) – 5, 8 or 10mm, the PCB will be behind the background as will the battery – PP3

### **Teaching input:**

Explain what is required using examples of previous work or a teacher's example. A good way to do this is to cut the base from a piece of MDF 15x15cm and use a small block as a stand at the back, glue together with PVA  
Produce an example design and display using an OHP or on the whiteboard

### **Student:**

The designs can produced by students drawing a 15x15cm box and drawing the design inside it, it must be pointed out that the design cannot be too small or just the square they started with. Around the design the students should put labels and underneath evaluate the design stating who it would be for, a particular person or group. They should produce at least 3 and explain why they have picked the design they will make.

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 base and background**

**Aim:**

Manufacturing the base and background  
Decorating the base and background

**Teaching Input:**

Review health and safety  
Provide assistance to students during practical

**Resources:**

Each student will need a piece of 3mm MDF15x15cm for the background and a piece of MDF 15x15cm for the base  
Access to tools  
Access to paints

**Demonstration:**

Demonstrate to the students how to cut and finish MDF bases and backgrounds with appropriate tools paying close attention to H&S  
Demonstrate how to use a pillar drill to drill the holes for the LED(s) paying close attention to H&S

**Student:**

Students to cut and finish their backgrounds with a coping saw and glass paper, make sure the room is well ventilated  
Students to drill the holes for the LEDs  
Students to decorate their backgrounds

**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.

### 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 first task is 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.

Or

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 of 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 and adjust the sensitivity with a variable resistor (if used), LEDs should turn on in the dark

### **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