EEE 163
System Design Analysis

Lecture 1 - Introduction

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Aim of the course

"To gain an appreciation of the decisions that need to be taken during the design of an electronic or electrical product"

Learning outcomes

- Appreciate how products are designed and assembled
- Demonstrate rudimentary skills in critical assessment
- Determine the necessary characteristics of materials used in the construction of a product
- Present ideas orally

Course structure

- Lectures
- Seminars (Design, Waste disposal, …)
- Laboratory classes
- Self-learning

Provisional timetable

Lectures (Mappin Building LT1)

Tuesday 1 November 12.00-12.50
Thursday 10 November 09.00-09.50
Tuesday 15 November 12.00-12.50

Laboratory classes (Portobello Building 1st year lab)

Friday 18 November 14.00-17.00
Friday 25 November 14.00-17.00
Tuesday 6 December 14.00-17.00

Further lectures, seminars and labs to follow in new year. Timetable to be advised.

Course Assessment

- Short written report based on critical assessment of certain aspects of one product
- Short verbal reports during laboratory classes
- Short (group) talk at end of course on one product

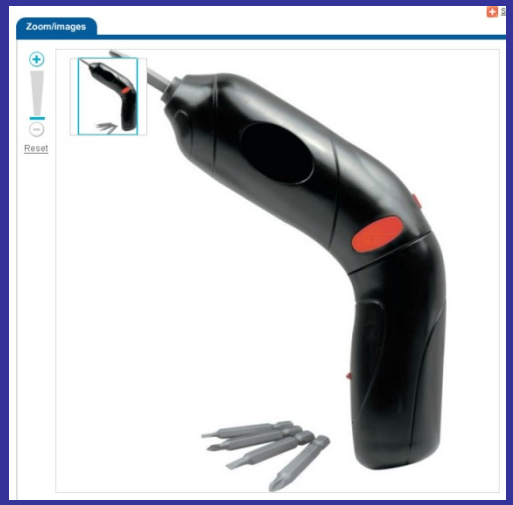
Laboratory classes

- Work in groups of four students
- Pre-determined group allocation
- Guided deconstruction and reconstruction of electronic / electrical product
- ‘Hands on’ approach is encouraged
- Demonstrators available
- Technical support available

Safety

- Do *not* plug any test product into the mains power supply!
- Only use the 12V DC supply after consultation with a demonstrator
- Wear safety glasses when performing any electrical tests
- Wear safety glasses when disassembling /reassembling items
- No test product may be re-used after reassembly!

Example products



Electric screwdriver £5

Compact fluorescent light bulb £5

Data projector £700

Subject to approval, you may nominate ‘dead’ products of your own for analysis…

Product analysis

Function	What does it do?
Method	How does it work?
Inputs/outputs	What goes-in / comes-out of product?
Parts list	Shopping list of sub-components
Raw Materials	What is it made of?
Manufacture	How is it made? Identify design issues?
Power	Mains? Battery? AC? DC?
Working environment	Moisture? Temperature?, etc…
End of life	Materials recovery? Landfill? Re-use?
Safety	Electric shock risk? Fail-safe?
Cost	Single use? High reliability?

Product analysis example

Compact fluorescent light bulb

- Function Produce white light
- Method Electrical excitation of mercury vapour (UV) which in turn excites phosphor (visible)
- I/Os Input – electrical power, output – light!
- Parts list Closed tube with mercury and phosphor, moulded housing, electrical contacts, drive circuitry
- Materials Glass, ceramic, metal, semiconductor, plastic
- Manufacture Moulding, crimping, soldering
- Power Mains supply (240V AC), but with internal transformer
- Working environment Vacuum sealed
- End of life 8000 hours life time, Hazardous waste (3 mg Hg)
- Safety No exposed electrical contacts, mercury vapour necessitates special disposal measures
- Cost Mass production keeps costs low

Function -What does it do?

- Interaction of the product with the outside world (e.g. shining a light)
- May be many different methods to achieve the same function (e.g. incandescence, plasma discharge, light emitting diode)
- May have complex set of sub-functions, but in general only one primary function (e.g. DVD player)

Method - How does it work?

Physical (or possibly chemical) principle on which product is based (e.g. glow discharge plus phosphorescence)

At this stage we are *not* overly concerned with the method by which the electronics works – this will be covered in detail in other courses

Inputs and outputs

- Product *useless* if it doesn't interact with it environment, therefore *must* have some inputs and/or outputs

Inputs

- Electrical power (e.g. power cable)
- Direct electronic signals (e.g. USB flash memory)
- Mechanical (e.g. keypad, joystick)
- Optical (e.g. photodiode sensor on automatic door)

Outputs

- Direct electronic output (e.g. Data comms , though now largely superseded by wireless comms)
- Audio (e.g. loud speaker)
- Optical (e.g. data projector)

Parts list example

- Shell plus strap
- Back plate
- Screws (4)
- Gasket
- Liquid crystal display
- Battery
- Inner case
- Battery contact
- Printed circuit board including:
- Semiconductor chip, crystal oscillator, drive transistors, resistors, LCD contacts, ‘beeper’

Highly complex, even for a ‘simple’ product

Materials types

From electronic perspective, just three classes of materials: *conductor, insulator, semiconductor*

From electrical perspective, add *magnetic* materials

From mechanical perspective, add *stiff*, *flexible* materials

From optical perspective, add transparent, opaque materials

From thermal perspective, add high (thermal) conductivity materials

Etc..

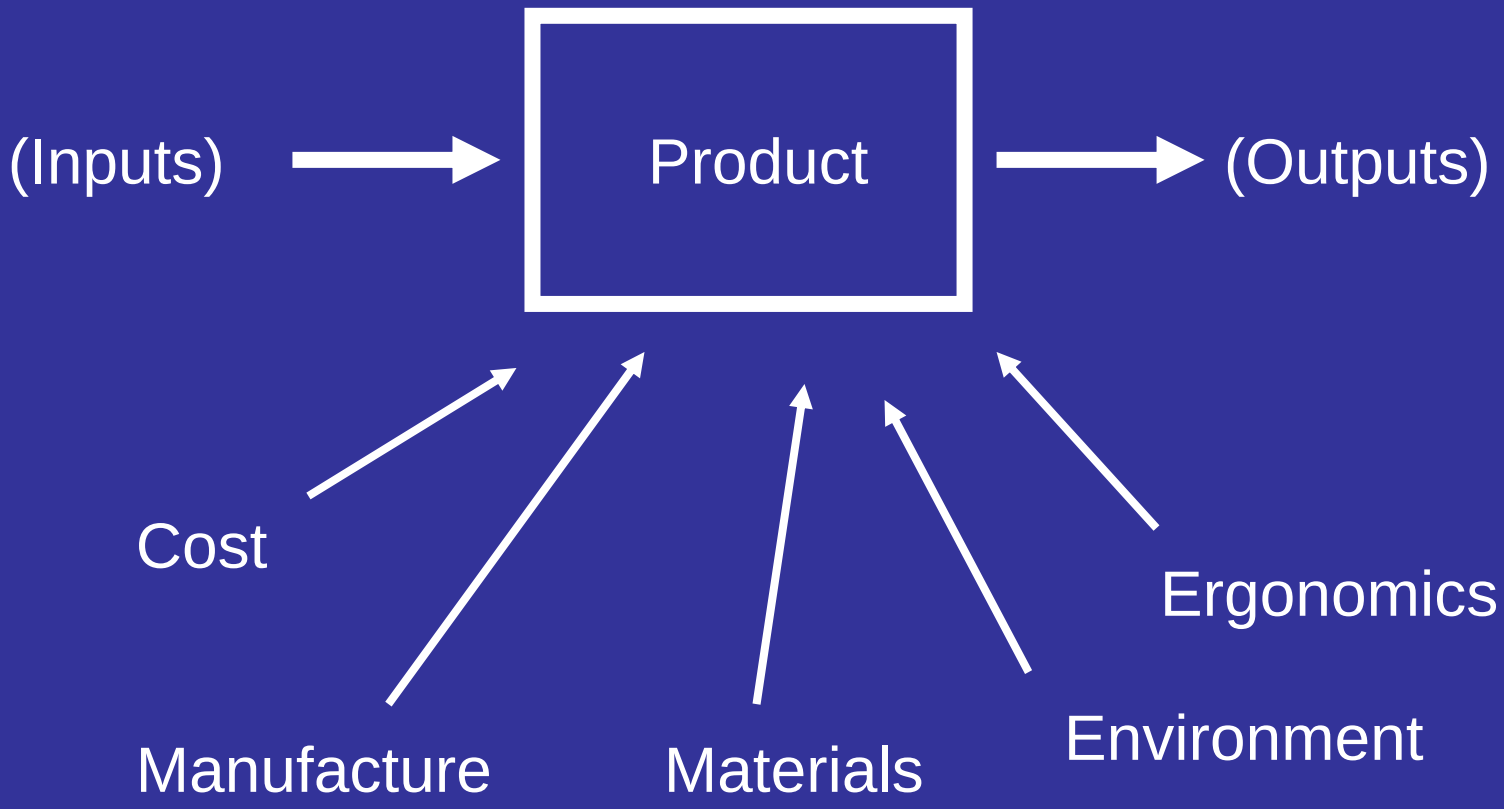
- An electronic / electrical product must cope with *all* relevant perspectives, not just the electronics.

Materials

- Semiconductor (Si, III-V, etc) – logic, opto-, piezo-, expensive!
- Metal - electrical/thermal conductor, strong
- Ceramic – electrical insulator, strong, brittle
- Glass - electrical insulator, transparent, strong, brittle
- Polymer (plastic) –easy to mould, cheap
- Composites – enhanced properties

Design

Many different aspects. All need to be considered simultaneously.



Power

All products require electrical power:

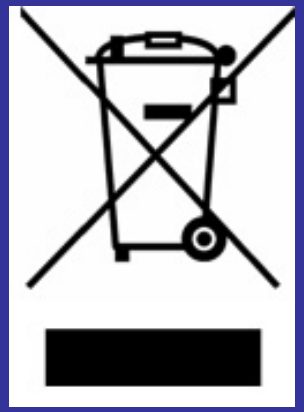
- Mains (120/240 V, alternating current AC 50 Hz)
- Battery (1-12 V, direct current DC)
- Remote (e.g. RF tag, USB flash drive)
- Internally generated (e.g. induction motor)
- Internally rectified (AC$\rightarrow$DC)
- Internally transformed ($V_1 \rightarrow V_2$)

Where will it work?

Product design must take into account the *environment* in which it will be used, for example:

- Temperature (office? car?)
- Humidity (desert? bathroom?)
- Pressure (drill shaft? space?)
- Vibration (pocket? aero-engine?)
- Electromagnetic interference (operating theatre?)
- Orientation (‘This way up’?)

What do we do with it when it's broken or obsolete?



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Reuse
Recycling
Bury, burn, …

Waste Electrical and Electronic Equipment Directive (WEEE) – manufacturer responsible for disposal of product (Europe)

Lecture 1 Summary

- Engineers make *useful things* out of *stuff*…
- The *stuff* that is used must be *appropriate* to the task
- Many, often conflicting, factors must be balanced when designing the product