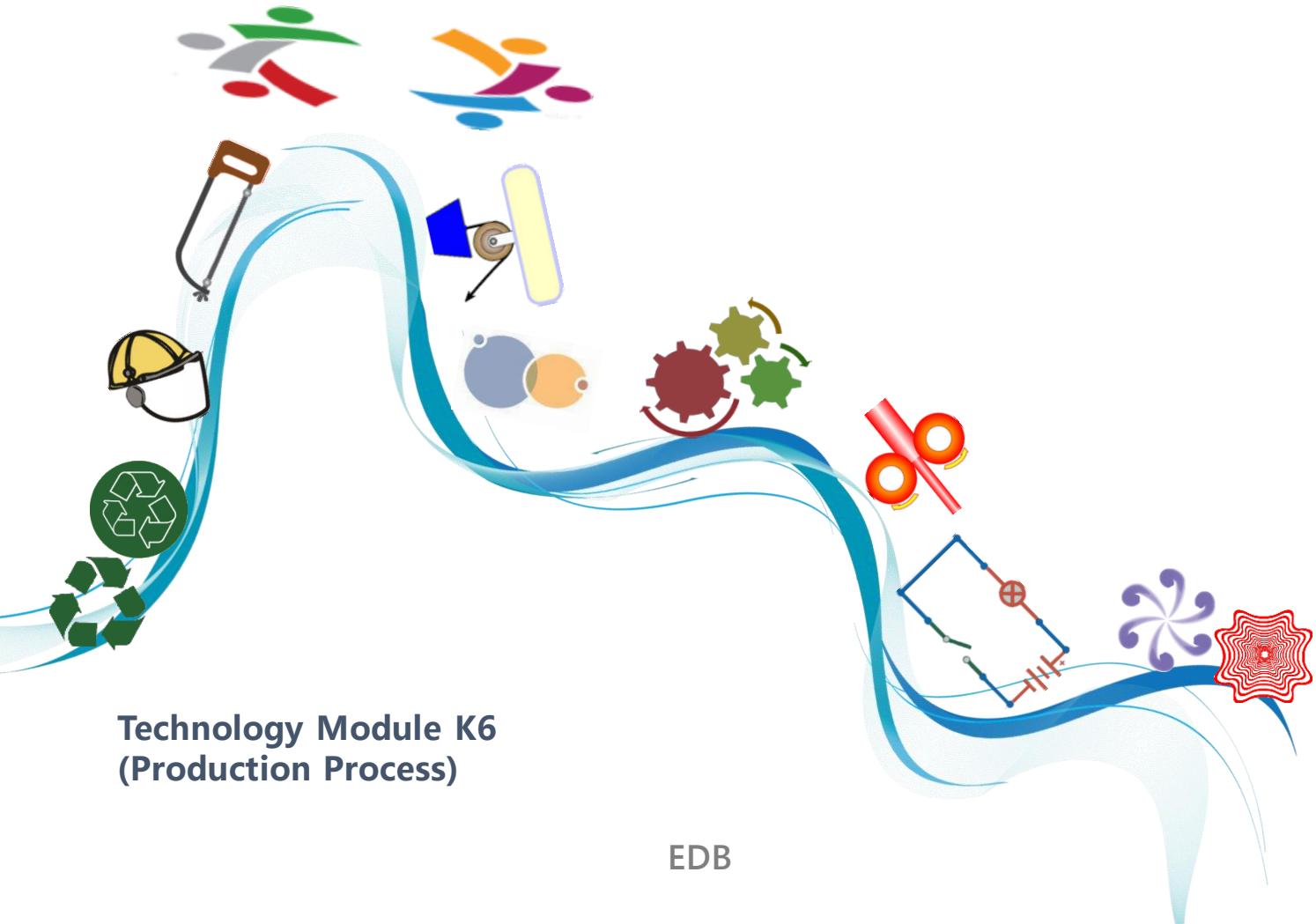
Enriched Technology Education KLA Curriculum

S1 Teaching Material

4

Design Steps & Human Factors



Technology Module K6
(Production Process)

EDB

Preface

To support the implementation of the Enriched Technology Education Key Learning Area Curriculum (Enriched Curriculum) at junior secondary level, the Technology Education Section of Curriculum Development Institute, Education Bureau, has developed a set of learning and teaching resource materials covering technological subjects learning element modules for teachers' reference and use.

The purpose of providing this set of teaching resource materials is to enable teachers to adopt the related technological subjects learning element modules under the Enriched Curriculum for students to acquire thorough understanding and mastery of the three key aspects in Technology Education Key Learning Area, viz. the technological understanding, technological capability and technological awareness, using a flexible approach with reference to the suggested learning progress.

The content of this learning and teaching resources was compiled with project approach. It gives students a purposeful and meaningful learning context through a series of diversified activities such as design projects, case studies, technological exploration and simulation experiments, and thus arouses their interest in technology and devotion in learning, as well as nurtures their ability in problem-solving, realisation, innovation and spirit of entrepreneurship.

For comments and suggestions related to this set of learning and teaching resources, please send to:
Chief Curriculum Development Officer
(Technology Education)
Technology Education Section
Curriculum Development Institute
Education Bureau
Room W101, West Block, 19 Suffolk Road
Kowloon Tong
Hong Kong

Compilation and Authoring:
Mr. LAU Kwok-kuen
Retired Design and Technology Panel Head

Chinese to English Translation and Typesetting:
PEAK Vocational Training Council
Member of VTC Group
VTC 機構成員

The copyright of this set of teaching resource materials belongs to the Education Bureau of the Government of the Hong Kong Special Administrative Region.

Schools and educational organisations are welcome to use the content of this set of teaching resource materials for non-profit educational purposes. Teachers can copy, enrich or delete the contents in order to meet the needs of teaching, but in all cases, acknowledgement must be clearly stated.

Otherwise, all rights are reserved, and no part of these materials may be reproduced, or transmitted in any form or by any means without the prior permission of the Education Bureau. © Copyright 2014

Relevant Knowledge

Design

1. Design Concept

The purpose of "Design" is to solve problems and satisfy the needs of people.

"Design" is not limited to the creation of art, but also includes aspects like the appearance and packaging for a variety of daily products, so as to enhance the products and quality of life. For example, the appearance of early days mobile phones were relatively large and bulky. Through continuous design improvements, the modern mobile phone is much compact than before, also the appearance is more in accord with ergonomical design requirements and the usage is more comfortable and convenient.

(a) Old (left) and new (right) style mobile phones have big differences in the appearance and design

b)
Mobile phones designed in line with ergonomic considerations

2. Design Process

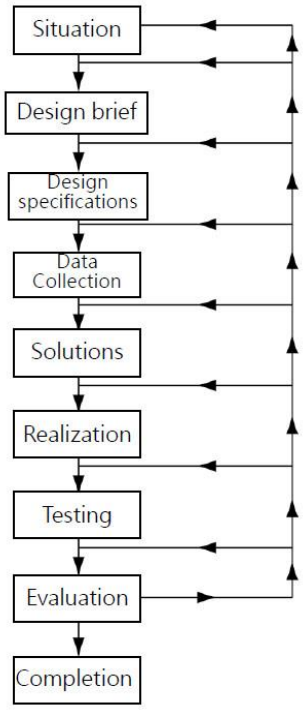
"Design" can be considered as the thinking process for problem solving. This process includes the current situation, the design briefs, design specifications, data collection, solutions and other procedures, and then the actual production will finally be conducted.

For example, construction of the Tsing Ma Bridge is to solve the traffic problems from the new airport at Chek Lap Kok to the urban areas. However, the carry loading, automotive traffic volume, affordable wind resistance and other details of the Tsing Ma Bridge are subject to continuous testing and improvement, and finally comes the actual construction and use.

Another example: primary students are required to carry a lot of books to school every day. The new school bags design would relieve their burden to avoid any harms to the body. In designing the new school bags, designers will collect information about the appearance, choice of materials and the weight of the schoolbags, and then produce some models for testing (test items may include the weight of schoolbags, safety, ease of use, waterproof performance, etc.), whether the product will hinder children's growth, spine and other aspects are needed to be tested also.

After obtaining the test results the design has to be modified, and tested again iteratively until a more perfect product is designed and put to the market for sale.

While conducting product design, usually it is performed according to the following design processes:



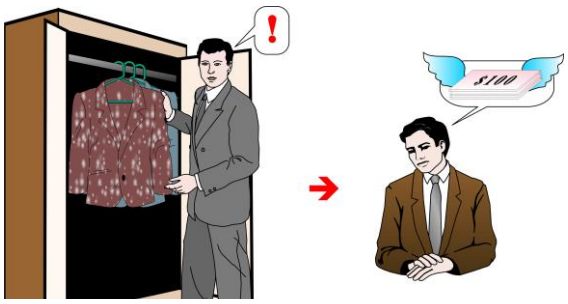
The process of major product design steps

(a) Situation

At start of the design, one must understand the design environment and needs, so as to determine the direction and scope of design. Take an initial thinking of the existing difficulties and then list the problems to be solved in the entire project. Let us use the clothing storage container as an example to explain several major design procedures.

Example of situation

The leather jacket inside the wardrobe always becomes moldy, some solutions must be figured out.

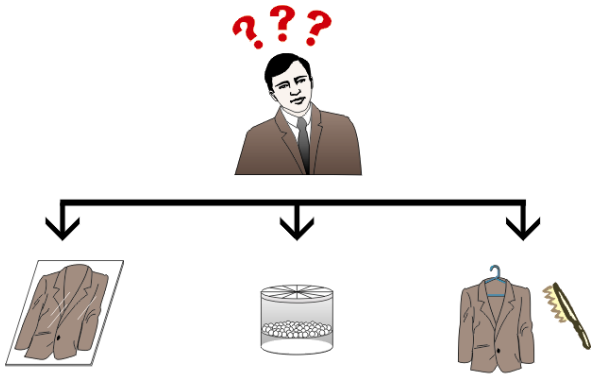


(b) Design Brief

Understand what the problems are and briefly list the solutions.

Example of design brief

Design a sealed container to hold the leather jacket and may add drying agent to absorb excess moisture in the air to avoid moldy. The following are some possible solutions.



Vacuum bag Drying agent Clothes cleaning

(c) Design Specification

Each solution has its own individual characteristic and rationale. At this stage, one must concisely list the design requirements of all solutions in order to facilitate the conduction of data collection systematically.

Major design requirements generally include:

(i) Material used

(ii) Time constraints for making

(iii) Costs for making

(iv) Use / functions

(v) Size limitations

(vi) Appearance

Under normal circumstances the questioning method is used to help producers understand the various requirements, through specific and detailed answers to the questions, the designer will be able to find out the right direction for solving the problem.

Example of design specification

List some problems that will actually be encountered at this stage, such as:

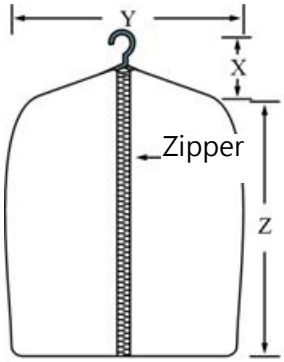
(i) Where will the leather jacket be placed?

(ii) The volume requirement for the container?

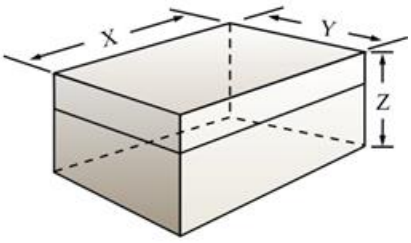
(iii) What materials can be used to make the container?

(iv) How long will it take to make the container?

(v) Who is responsible for using and keeping the container?



Plastic cover for clothing



Two different kinds of containers for clothing.

(d) Data Collection

After finalising all detailed items, data collection work can be started.

Example of data collection

(i) Conduct market survey

Observe and search in the market to look for existing finished products, or search the Internet to find whether there are related finished products or information.

(ii) Compare the relevant data

Conduct data comparison and analysis to match with the requirements of design specification.

(iii) Collect relevant data about suitable production processes.

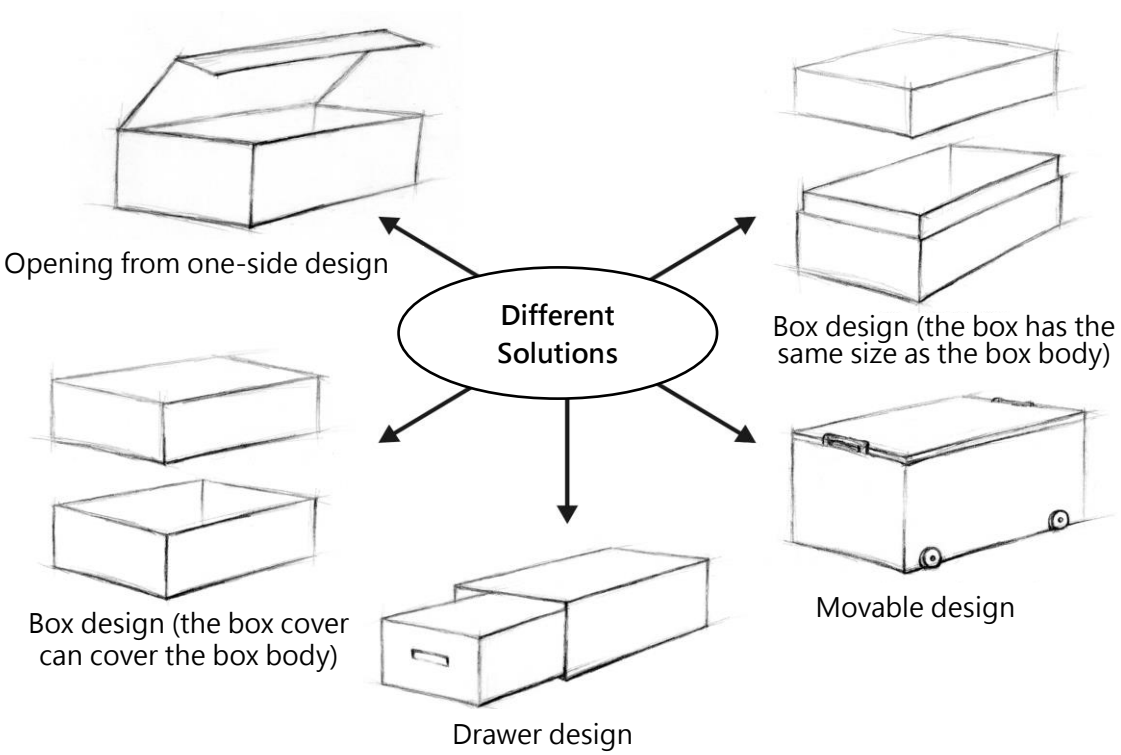
(iv) Consider suitable materials and compare their production costs and effects.

(e) Solutions

After organising all information, some practical design sketches can then be drawn. These sketches must list the main structure of the product, basic dimensions and materials used in detail, and briefly outline the production methods. After a specific design has been finalized, the working drawings should then be drawn according to scale.

(i) Example of solutions

Draw the shapes of different containers such as the pockets or the boxes for clothes.



Sketches of different box style design

(ii) How to select final designs

After formulating different solutions, the final design has to be selected and started making. While choosing the final design, select the one which is closest to or can best serve the design specifications.

For example:

- Clothing container that can preserve the size and quantity of the clothes;
- The material costs for making the clothing container;
- The space that can accommodate the clothing container;
- The moisture-proof design of the clothing container.

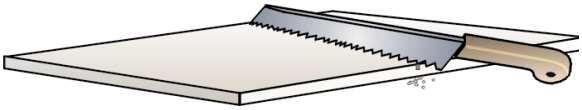
Relevant Knowledge

(f) Making

List the entire making process, required making method, tools and time according to the contents of the working diagram, and start making.

Example of making

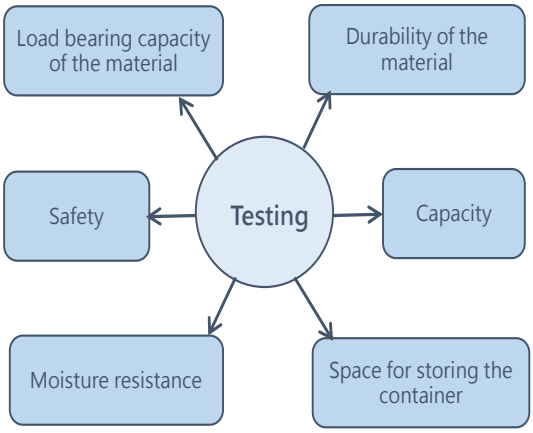
Start making a simple model after selecting the box container.



(g) Testing

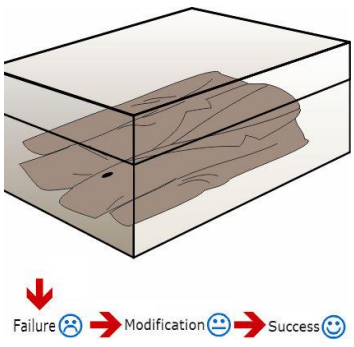
After completing the entire design, the maker must conduct testing for all items according to the design details for evaluation purpose.

(i) Example of testing items



Formulation of different testing items

(ii) Example of actual testing



Make use of a model or the physical product to conduct various testing, clearly record the test results for analysis and modification.

(h) Evaluation

Use the test results to list the advantages and disadvantages of the product in detail. Write down the methods for improvement or proposals for refinement such that performance of the product can attain perfection.

Example of evaluation

If the box container passes the tests, propose some modification methods to make the product become even better.

Advantages
1. Can be placed anywhere
2. Convenient in production
3. Enable adults to keep the container
4. Nice looking
5. Robust
6. Can place many pieces of clothing

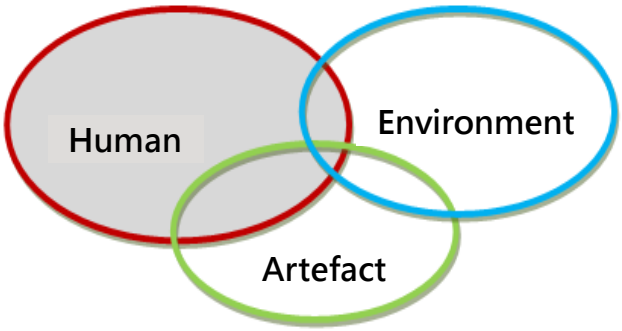
Disadvantages
1. Large volume
2. Bulky and not convenient for transportation
3. Humid air will enter the box
4. High costs

Modification methods
1. Add wheels to facilitate transportation
2. Add partitions to store moisture-proof material
3. Add handles to facilitate transportation

Relevant Knowledge

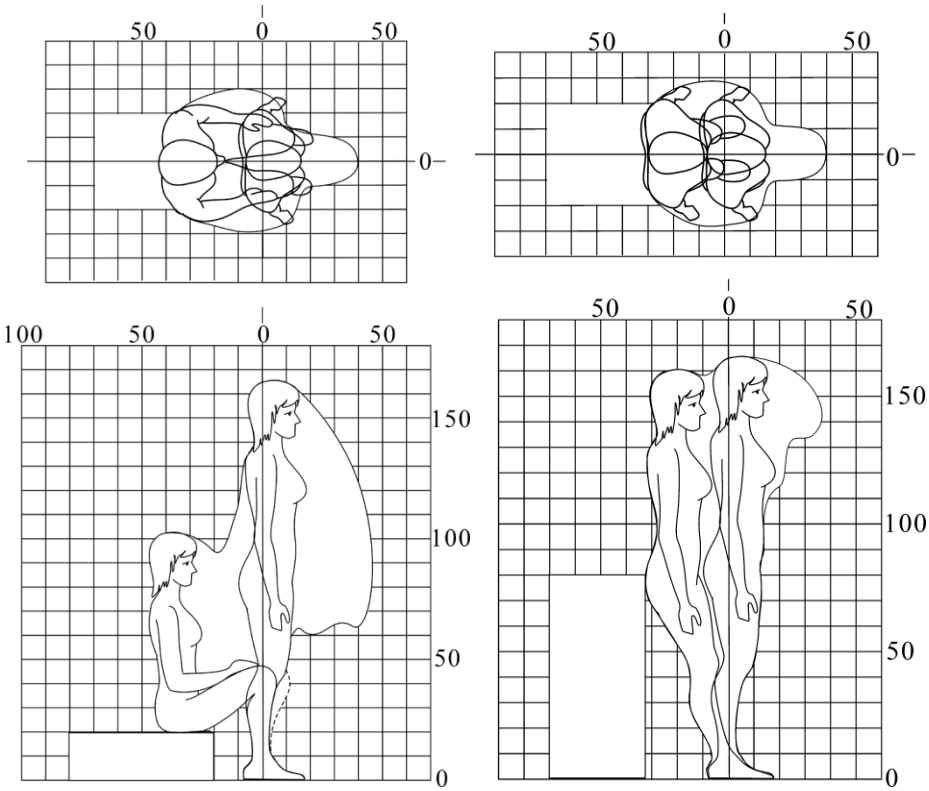
3. Human Factors

A Humanll useful designs are conducted to satisfy human needs, and so all products or systems are relevant to humans in some way. During the design process, we can set many standards or specifications, but the size of human body, capabilities and responsiveness cannot be standardized. Therefore, many researchers have spent a lot of time to study the relationship between human body and work, such kind of knowledge is called ergonomics, its purpose is to apply design, technology and work to improve human safety, health, comfort and performance.



(a) Anthropometry

Anthropometry is the subject of human body measurement; it measures and consolidates data about the size or capacity of the human body in order to improve product design. For example, the place where the hand can be stretched to, the movement spaces for sitting down, standing, the maximum strength that can be exerted by the hand and so on.



(a) Movement space while sitting down *(b)Movement space while standing and leaning back*

Anthropometry is very helpful to design. For example, clothing manufacturers can take advantage of the data about men, women and children to determine different size standards (XS, S, M, L, XL, etc.), such that the clothing produced can meet the requirements of most customers.

(b) Psychological Effects

Psychological effects must also be considered in designing. For example, young children used to stay with people they are familiar with, and are usually reluctant to go to an unfamiliar environment alone. Therefore, kindergartens usually use a variety of special designs to reduce the worries of young children who are on their own in the class. For example, cartoon animals are affixed on the wall; toys are placed in obvious places, the use of light-coloured walls, sufficient lighting, and so on.

(c) Comfortable and Effective

It is very important to make people work or live easily and comfortably with the environment and appliances. For example, some bank tellers need to sit and work on high chairs which make their feet hang above the ground. After long hours of working it will easily lead to muscle soreness and reduce work efficiency. If a pad is added to support the legs underneath, the chance of muscle soreness can be reduced and work efficiency can be improved

High chair makes the legs off the floor

For example, the new style mouse can better support the hand. Many products have also added flexible designs, for example, height-adjustable chair to suit the needs of tall and short people.

New style mouse

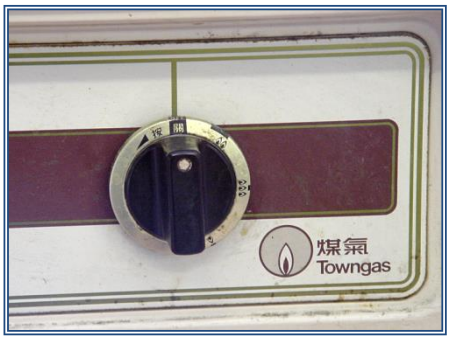
Height-adjustable chair

(d) Safety Design

Most common unsafe products usually have sharp edges and corners, toxic or easy to cause improper usage by the users. Recently the popularity of smart phones and related products also highlights the danger brought by incorrect usage of batteries. For the sake of protecting young children, there are stringent rules for the products or toys used by them, such as not to be too small, too thin and the pigments used should be almost non-toxic.

In analysing whether the product is safe, you should consider the product's manufacturing, usage, storage, carrying and disposal processes, and find out the potential dangers in various processes.

Comparing the safety design of gas stove is an example for analysing the level of product safety. Many families use gas stove for cooking, but the gas is toxic and flammable; a large volume of leaking can be extremely dangerous. Therefore, some gas stoves are bundled with safety designs. For example, the switch will only stop in the fully off or in-use positions to avoid leakage when the switch is not completely off. Adding a safety gas outlet port to the gas ring such that when the gas stops burning and the ring cools down; the outlet port will automatically be closed to prevent gas leakage due to the fire being extinguished.



Gas stove switch

Gas ring of gas stove

4. Interactive Information

	Websites	Brief contents	Language
1.	http://www.williamson-labs.com/design.htm Design Flow Chart (設計流程圖)	Use design flowchart to introduce the design process step by step.	English
2.	http://tds.ic.polyu.edu.hk/ds/db/08_pd1/index.htm The design process (基本產品設計過程)	Briefly introduce each step in the product design process	Chinese

5. Glossary of terms

設計	Design	解決方法	Solution
設計過程	Design process	實踐	Realization
處境	Situation	測試	Testing
難題	Problem	評鑑	Evaluation
設計概要	Design brief	傳意	Communication
設計細則	Design specification	人體測量學	Anthropometry
資料搜集	Data collection	人體工學	Ergonomics

Lesson Activities

Exercise 1A

At beginning of the term, the students design a classroom library corner. Try to discuss the following questions based on its situation.

1. What is the purpose for designing the library corner of the classroom?

_____

_____

_____

_____

_____

2. How to properly place the untidy books?

_____

_____

_____

_____

_____

3. Why not set up a library in the classroom but rather a simple library corner instead?

_____

_____

_____

_____

_____

Try to summarise the answers to the above questions as "The situation" highlights:

_____

_____

_____

Exercise 1B

What "human" factors have to be considered in designing the classroom library corner?

1. _____

_____

_____

_____

2. _____

_____

_____

_____

3. _____

_____

_____

_____

4. _____

_____

_____

_____

Exercise 1C

1. Basic requirements of the classroom library corner proposed by the class teacher:
   - Can accommodate around 100 books;
   - Reserve space to place simple stationery and the borrowing log book;
   - Reserve space for the librarian to handle the paper work.

2. Write down the design brief according to the above design requests of the classroom library corner:

   Design a classroom library corner,

   _____

   _____

   _____

   _____

3. Discuss the effects of the following factors to the design of the classroom library corner:

   Material

   _____

   _____

   _____

   _____

   Time limit for making

   _____

   _____

   _____

   _____

   Costs for making

   _____

   _____

   _____

   _____

   Use / Functions

   _____

   _____

   _____

   _____

   Size limit

   _____

   _____

   _____

   _____

   Appearance

   _____

   _____

   _____

   _____

Activity 1

Brief:

1. Divide students of the class into groups of four.
2. Examine the dimension of different parts of the chair; point out that if the dimensions are inappropriate, it will cause the users feeling uncomfortable.
3. Use a ruler for the measurement and record the size limits you all consider comfortable.
4. Discuss and share the results with other groups.

Activity 2

Brief:

1. Divide students of the class into groups of six.
2. Each group to design three handles to be installed on the wooden door to match with the following functions:
   (a) Pull
   (b) Push
   (c) Turn to open the door
3. Use paper clay or plasticine to make models of the handles and conduct the following tests:
   (a) Size
   (b) Comfortable level
   (c) Compare the results of discussion with other groups.

Project Activity - Material Handling 1

Notice clip

Guidelines for project activity

1. Objective

Students have a basic understanding about the design procedures and safety usage of hand tools. Use appropriate communication skills to express the design ideas and use appropriate hand tools to make the products.

2. On completion of the project activity, students should be able to:

1. Make use of communication skill to express the design ideas;
2. Use hand tools to make the products.

3. Situation

Everyday when there are important things to do, Wai Hung uses a pen to jog things down on notice pads and place on the table, which are occasionally covered by books or other items. Sometimes he hopes the late returning parents to do something for him; he also writes on the notice pads and places on the table to remind them before going to bed, but finally the things are not done because the notices were blown by the wind onto the ground. Hence he wants to design and make a notice clip to solve the above problems.

4. Design Brief

Design and make a notice clip with strong personal characteristics to remind yourself and others about some important things to be done.

5. Recommended Time

8 lessons x 40 minutes (Total 320 minutes)

6. Material Required

(i) A piece of wood: 50mm(Length) × 50mm(Width) × 50mm(Thick)

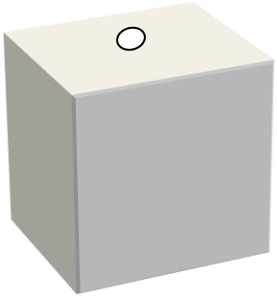
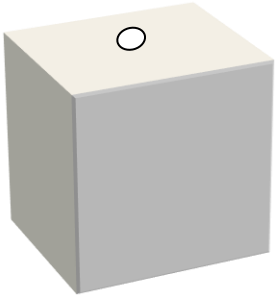
(ii) Mild steel rod: Diameter 2.5mm x 200mm(Length)

(iii) One small alligator clip

7. Contents of Activity

(i) Design the base and the connection rod.

Draw the two designs below: (May consider pictographic, geometric or free shapes)

Design 1	Design 2
 Theme:_____	 Theme:_____

I will choose design ____, because_____.

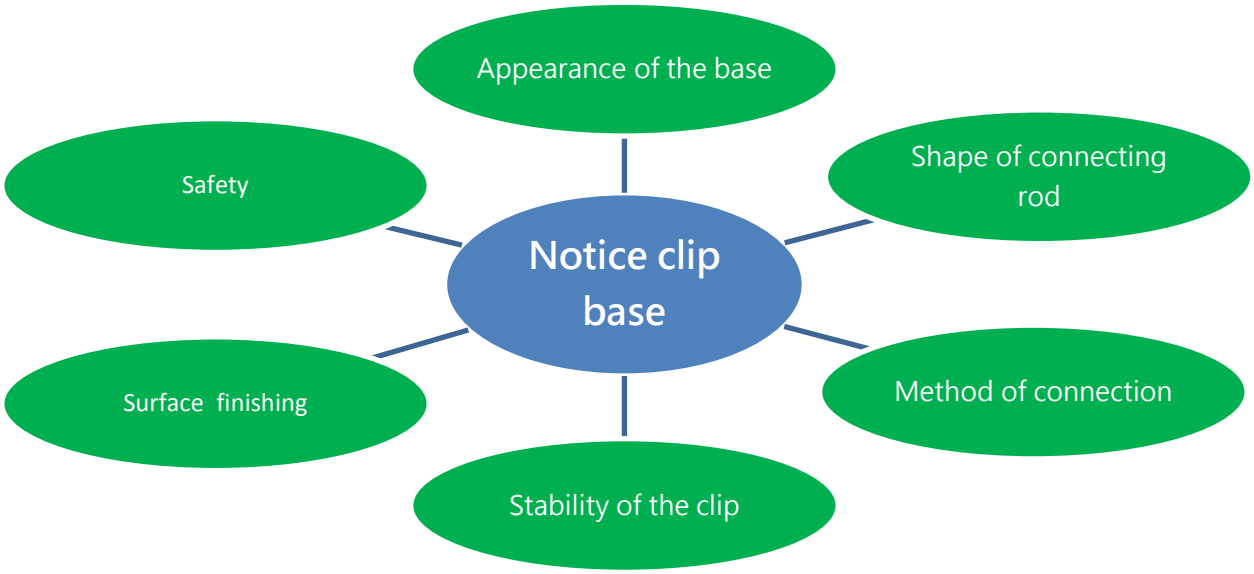
Use not less than twenty words to describe the design you chose:

_____

_____

_____

(ii) Consideration factors



The following questions should be considered in designing and making the notice clip:

(i) What is the shape of the base?

(ii) Is the shape of the connecting rod pictographic, geometric or free shapes?

(iii) How to connect the base and the connecting rod?

(iv) How to connect the connecting rod and the alligator clip?

(v) Can it still stand steadily after all parts have been connected?

(vi) What methods to use for surface finishing?

(vii) Reduce the risk of getting hurt while using the notice clip.

(iii) Steps for making

(i) Design the shape of the base. (Small bevel edge)

(ii) Use file, plane, sandpaper and so on to make the base.

(iii) Design the shape of the connecting rod (pictographic, geometric or free shapes)

(iv) Sketch the shape of the connecting rod on paper with full scale.

(v) Make use of tools such as the hand vice to twist the mild steel into the shape of the connecting rod as designed in full scale.

(vi) Connect the connecting rod and the base.

(vii) Connect the connecting rod and the alligator clip.

(viii) Test the durability of the notice clip.

(ix) Conduct the surface finishing processes for the notice clip.

If time allows:

1. Add design graphics on the surface of the base.
2. Paste lovely small animal patterns at the back of the alligator clip.

(iv) Design folio (Make references to the exercise for book buckle)

The design folio may include the following items so as to record the design process:

(i) Cover

(ii) Table of contents

(iii) Situation

(iv) Design brief

(v) Design specification

(vi) Data collection

(vii) Solutions

(viii) Realisation, can use photos to record part of the making process

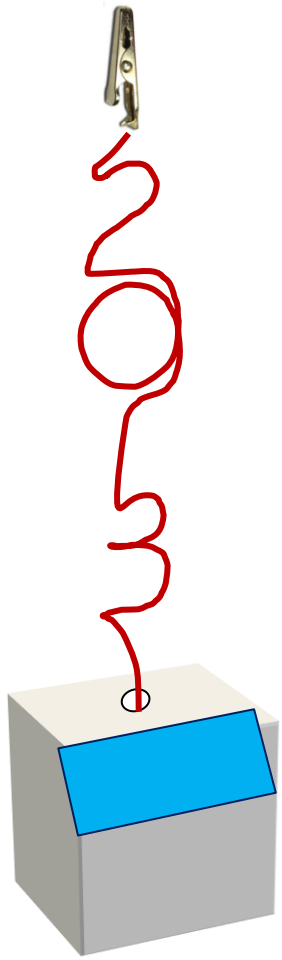
(ix) Testing

(x) Evaluation

References

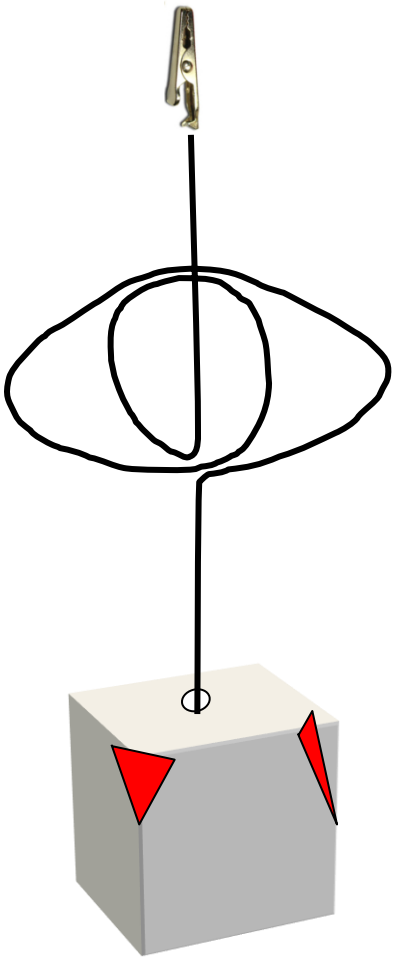
Design the base and the connecting rod

The following diagram is an example of three designs:



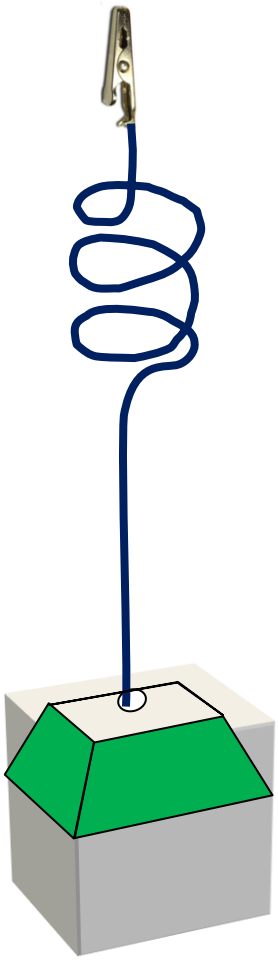
Theme: 2013

Trim away a small beveled edge from the base; twist the connecting rods into the wordings 2013.



Theme: Magic eye

Twist the connecting rod into the shape of an eye, while trimming the two corners away from the base, which looks like the two teeth of a one-eye man.



Theme: Spiral

Trim away four beveled edges from the base to simulate the roof of a small hut, the connecting rod is then twisted as a spiral.

Case Study - Ergonomics

Water taps

Guidelines to case study

1. Objective

Students have a basic understanding about the design process, and conduct ergonomics analysis for the products.

2. On completion of the project activity students should be able to master

1. Conducting specific analysis for the product;
2. Making use of communication skill to present the results of analysis;
3. Making modifications to the product based on the difficulties encountered.

3. Situation

We use the water taps every day and feel very useful, but also feel that the designs of some taps are inappropriate. In case of epidemics, there is the fear that virus or bacteria will spread through it.

4. Brief of special activity

Items suitable for "you" to use may not be suitable for "me", while for "him" is likely to be completely unsuitable. Attempt to analyse the designs of different water taps, compare and see if they are more suitable for "someone" to use?

5. Recommended time

3 lessons x 40 minutes (total 120 minutes)

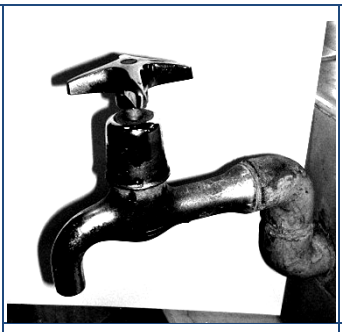
6. Required material

Worksheets

7. Contents of activity

1. **Product comparison and analysis**

The diagram below is three commonly used water taps, try to compare their features and advantages / weaknesses.

Shape of the water taps			
	Water tap (1)	Water tap (2)	Water tap (3)
Describe / draw the action for opening the water taps			
Which design is more suitable for **ordinary homes in Hong Kong**? Explain the reasons.	**Water tap ( )** **Because** _____ _____ _____		
Which design is more suitable for **public areas (such as public toilets)**? Explain the reasons.	**Water tap ( )** **Because** _____ _____ _____		
Which design is more suitable for **an elderly suffered from a mild stroke**? Explain the reasons.	**Water tap ( )** **Because** _____ _____ _____		

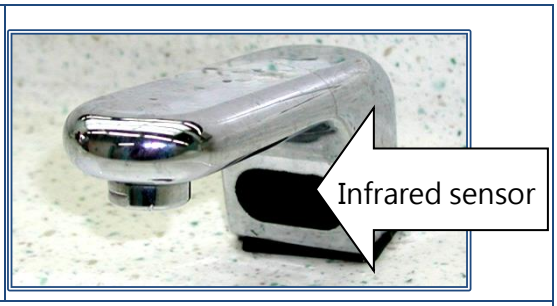
2. Technological Principles

Infrared detection sensor

Infrared in use daily can be grouped into active infrared (sensor itself emits infrared light to detect moving objects), and passive infrared (infrared sensor itself does not emit infrared light, but rely on the objects' heat source movement to trigger the sensor).

- Active infrared is also known as the "irradiated" infrared systems, mostly with two units used together as one group. One is to emit infrared beam (Transmitter), the other is to receive the infrared beam (Receiver). It is suitable for use in point to point straight-line distance in indoor or outdoor environment.
- Passive infrared is suitable for use in closed indoor spaces (e.g. common indoor anti-burglary infrared alarm sensors). If used outdoors, it will be affected by the differences in temperature and climate, the external factors such as wind, rain, pass by cars, and etc.

Since active infrared continuously emits infrared light by itself, the chance of false reporting due to disturbances is less, but on the other hand, the boundary it can detect is limited to a straight line from point to point.

The right diagram is an "infrared sensor" controlled water tap, what is its advantages?	
In the three different environments described in the previous page, which one is most suitable for using "infrared sensor" controlled water taps? Explain why.	

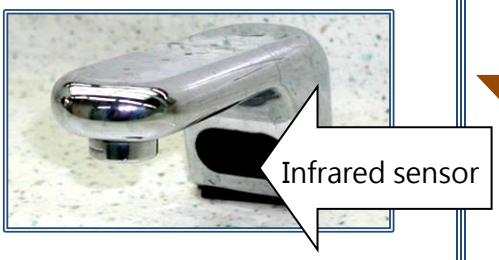
3. Design Modifications

(Read the following passage, then analyse and answer the questions.)

Before doing an operation for the patient, the surgeon must first wash and sterilise his hands, and then put on surgical gloves. XX hospital installed for trial "infrared sensor" controlled water tap (picture on the right) for the surgeons to wash their hands. Initially the effects are good but after a month the following situations occur:

(a) There is frequent situation that water supply is "intermittent".

(b) The hospital had experienced power outages, as there is no back-up power supply for the "sensor", therefore it cannot be used.



Why the situation of “intermittent” water supply frequently happens?

_____

_____

XX hospital decided to remove some of the "infrared sensor" controlled water tap and switch to non-electronic controlled methods.

Modify and adopt one of the water taps on the "first page of products comparison table" to develop a mechanical method to control the water taps. Use sketch and text to present your ideas below, the design must meet the following requirements:

1. Can be controlled by the user himself without assistance from others;
2. When finished using, the water tap can be closed immediately to avoid wastage;
3. When finished using, no need to touch the water tap by the palm in order to keep clean.

Design of mechanical water taps