



Oxford Cambridge and RSA

# A Level in Design and Technology: Product Design

**H406/02** Problem Solving in Product Design

Resource Booklet

## Practice Paper – Set 1

**Time allowed: 1 hour 45 minutes**

**You must have:**

- the Question Paper

### INSTRUCTIONS

- You must read this Resource Booklet through before answering any questions.
- The recommended reading time for this Resource Booklet is **35 minutes**.
- This Resource Booklet is to be used when answering all questions.
- The question paper tells you when to refer to the information contained in this Resource Booklet.

### INFORMATION

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- This document consists of **8** pages. Any blank pages are indicated.

The stimulus in this booklet relates to issues and problems that residents encounter in winter.

## ‘Snow-Go’

During the winter of 2011/12 Durham City Council undertook a pilot scheme (‘Snow-Go’) which involved giving residents snow shovels and rock salt to help address the issues associated with winter weather. This is detailed in the following article from The Northern Echo:

20 January 2012

### Council gives residents snow shovels

**NEARLY 800 households have been given free snow shovels and salt to dig themselves out if bad weather returns.**

About 770 homes in Durham City have each received a free snow shovel and 50kg of rock salt. Durham City Councillors hope people will help clear estate roads that would otherwise be untreated.



Councillor Stoker said: “Durham City Council works really hard to deal with winter conditions, but it is a big rural county and it cannot be everywhere. Estate roads are normally left to residents to cope as best they can using grit bins. The idea is to help people to help themselves and we hope people will help their neighbours who cannot manage. It is about bringing back a bit of community spirit”. Councillor Martin said: “Last year, there was a real problem with estate roads. People could not get out. We all know the Council has limited resources and it is quite rightly focusing on main roads, bus routes, commercial centres and places where people are vulnerable”.

The shovels and salt were delivered to households this week along with leaflets explaining the pilot scheme which could be expanded next winter.

Councillor Stoker said: “The Council has never been responsible for gritting estate roads. People acting sensibly should have no fear of being sued for injuries that followed them gritting their area”. Councillor Stoker contributed £13 000 to the pilot to buy shovels and salt for 700 homes around The Sands and lower Gilesgate areas, while Councillor Martin gave £800 to cover 70 homes off Crossgate Peth. Households were given the chance to opt out of the scheme.

### Suggested products for a similar ‘Snow-Go’ scheme in 2018

Two products recommended to the Council for residents to use for the clearing of snow are shown in **Fig. 1** opposite:

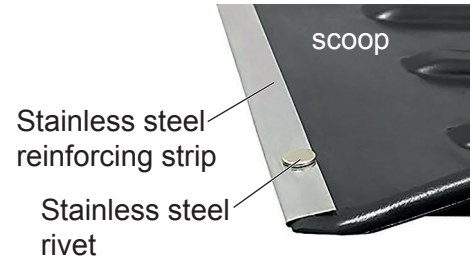
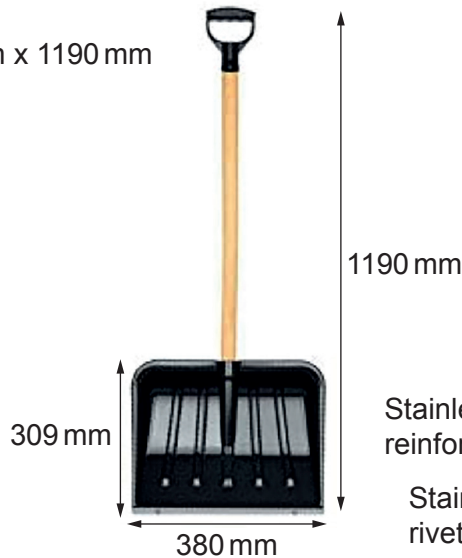
**Snow Shovel** – suitable to be **given** to residents**Cost to council:** £5.00 each

**Materials:** Handle: Injection moulded polypropylene  
 Shaft: Untreated ash 28.5 mm diameter  
 Scoop: Injection moulded polypropylene  
 Reinforcing strip: Riveted stainless steel sheet

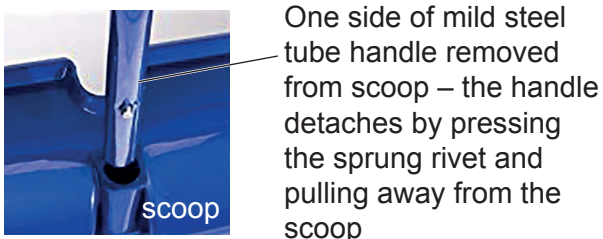
**Weight:** 800 g**Packing allowance:** 50 mm x 380 mm x 1190 mm

Rear view of scoop showing shaft socket and retaining screw.

- Shaft pushes into socket
- Screw is then screwed in to prevent the shaft pulling off the scoop

**Wheeled Snow Shovel** – suitable to be **loaned** to residents**Cost to council:** £30.00 each

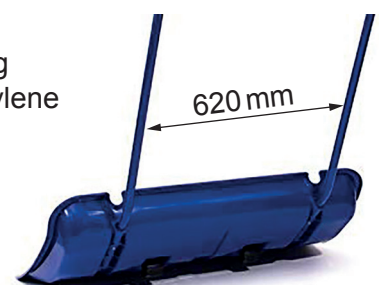
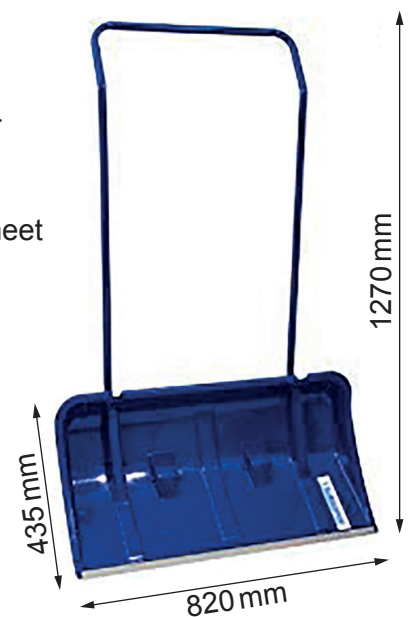
**Materials:** Handle: Powder coated mild steel tube 18 mm diameter  
 Scoop: Injection moulded polypropylene  
 Wheels: Injection moulded polypropylene  
 Reinforcing strip: Epoxy resin bonded stainless steel sheet

**Weight:** 4000 g**Packing allowance:** 75 mm x 620 mm x 1270 mm

Polypropylene wheel – push fit into retaining bearings in the scoop



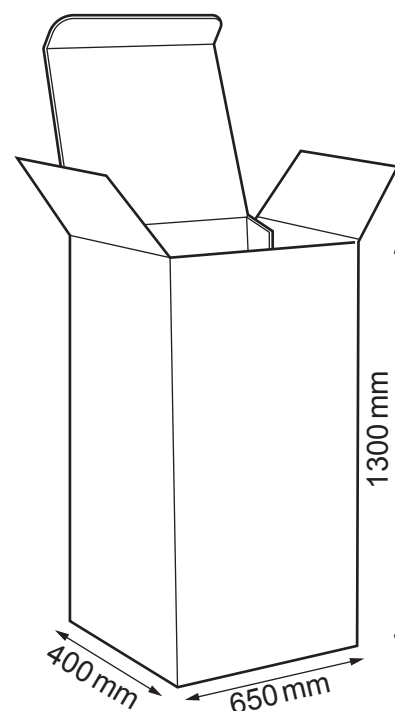
Stainless steel reinforcing strip bonded to polypropylene scoop with epoxy resin

**Fig. 1**

## Transportation of Shovels

The snow shovel and wheeled shovel shown on **page 3** are available from the same supplier.

They can be delivered to the Council depot directly from the supplier in standard tall brown corrugated cardboard cartons as shown in **Fig. 2**.



**Fig. 2**

### 2018 project 'Snow-Go' delivery operation

The Council has decided to consider using an independent delivery company to transport and deliver shovels to residents. The shovels would be collected from the Council depot stores and delivered to individual homes.

A local company called 'Move-It' would be the preferred choice of the Council.

'Move-It' operates Peugeot Boxer long wheel base vans as detailed in **Fig. 3**.

### Quotation

'Move-It' has provided a quotation to enable the Council to undertake a cost analysis of project 'Snow-Go'.

To provide vans and labour for the following services:

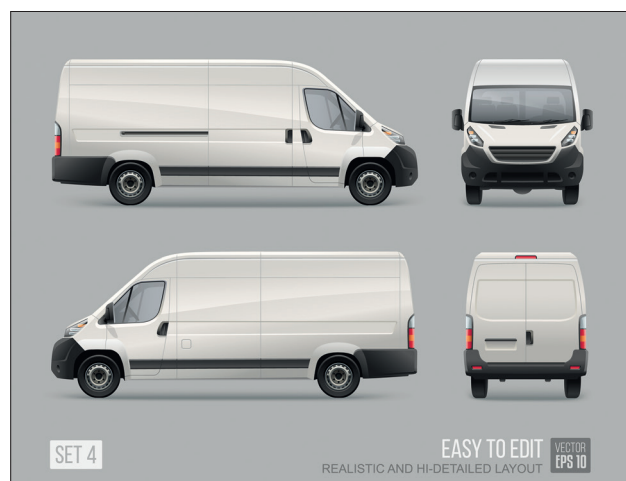
- collect shovels from the depot
- deliver to individual homes
- insure shovels in transit
- return un-delivered shovels
- return cardboard packing cartons for recycling

based on delivery to a single village or suburb within a 10 mile radius of the Council depot:

Flat rate cost per van load: **£300**

#### PEUGEOT BOXER LONG WHEEL BASE VAN

Load length (mm)	2670
Load width max (mm)	1870
Load height (mm)	1662
Load volume (m <sup>3</sup> )	8.0
Gross payload (kg)	1155



**Fig. 3**

## Design Situation

The Council who was using the 'Snow-Go' project in 2018 has become aware of issues relating to the elderly clearing snow as highlighted in the article at the bottom of this page.

The Council has held forums with elderly residents to obtain their views on the situation. There are a proportion of elderly residents that have physical challenges and will need help removing snow. However, many proud citizens living alone, or living in the more rural areas, find obtaining help one of the greatest challenges to their independence.

As a result, the Council has commissioned a designer to explore alternative options to the existing products already available through the 'Snow-Go' project. Their specific brief is to explore the most suitable way of supporting the elderly residents who want to retain their independence and clear their own footpaths and drives.



**INDEPENDENT**

## SHOVELLING SNOW CAN LEAD TO FATAL HEART ATTACKS, RESEARCH FINDS

It causes around 100 deaths every year

11 December 2017

Shovelling snow causes around 100 deaths every year and is dangerous for those aged over 55, a medical study warns.

Following plunging temperatures, ice and some of the worst snowstorms in Britain for four years, experts are warning people not to shovel snow from outside their homes.

An expert in the hazardous effects of snow removal says that the reason for these deaths is because people don't have any idea how taxing it is on the heart.

During the study, which was based on data from 1990 to 2006, research found that when healthy young men shovelled snow, their heart rate and blood pressure increased more than when they exercised on a treadmill.

'Combine this with cold air, which causes arteries to constrict and decrease blood supply, you have a perfect storm for a heart attack' the expert concluded.

Shovelling snow can be particularly strenuous because it requires arm work rather than leg work which can get an individual out of breath more quickly. The expert advised anyone over the age of 55 not to shovel snow at all.

Research published in the British Medical Journal also showed a link between temperature and cardiac deaths.

Researchers found that lower temperatures lead to an increase in the risk of heart attack predominantly operating in the two weeks after exposure.

Similarly, the NHS has warned that people are more at risk of heart attacks in cold weather, particularly in the winter months. This may be because cold weather increases blood pressure and puts more strain on the heart.



## Snow clearing design concept for the elderly

The first concept that the designer looked into was a two-sided, angled snow pusher which was designed to help users who may find shovelling snow a physically impossible task.

### Dual Angle Snow Pusher

Weight: 8 kg

Dimensions: Blade 165 mm × 900 mm  
Handle 1110 mm × 410 mm



**Fig. 4**

This concept was found to be successful to some extent but the designer felt that the concept product was very bulky and there were missed opportunities with the elderly users. Further analysis was needed of the wider lifestyle of these users and how they were physically using other products. Therefore, the designer undertook further investigations to inform their next steps.

## Wider lifestyle of elderly residents living in rural areas

Many elderly residents already have products available to them to tackle the winter weather that they use in other times of the year when gardening. These products are not ideal for use either, so the designer is looking into options to help with not only shovelling snow but also spreading salt and fulfilling the usual gardening requirements.

### Typical Example of a Shovel

Materials: Blade: Steel  
 Shaft and Handle: Ash  
 Weight: 2.5 kg



### Typical Example of a Leaf Rake

Materials: Head: Steel  
 Tines: Oil treated hardened steel tines  
 Shaft: Ash  
 Weight: 2.5 kg



## Ergonomic considerations when shovelling or using a rake



Clearing driveways after snow can be dangerous and lead to lower back and shoulder injuries because of the weight and imbalance of snow and poor posture when shovelling. **Fig. 5** gives an example of poor posture that will lead to lower back pain.

When shovelling snow, experts recommend:

- a wide grip should be maintained on the shaft of the shovel;
- the shovel should be held as close to the body as possible in order to minimise strain and discomfort;
- twisting the torso and throwing snow from the shovel up by the shoulders is not recommended.

### Good posture:

- Strong grip close to torso
- Wide stance provides stable base and lowers grip position
- Centre of mass is roughly central
- Muscles in both arms and legs do a lot of the work



### Bad posture:

- Leading arm is over-reaching
- Narrow stance provides tall unstable base and leads to over-reaching and stretching. Rear leg lifts.
- Centre of mass is above or in front of the leading leg.
- Muscles in the lower back are over-worked



Fig. 5

## ‘Ergo Kit’ concept development

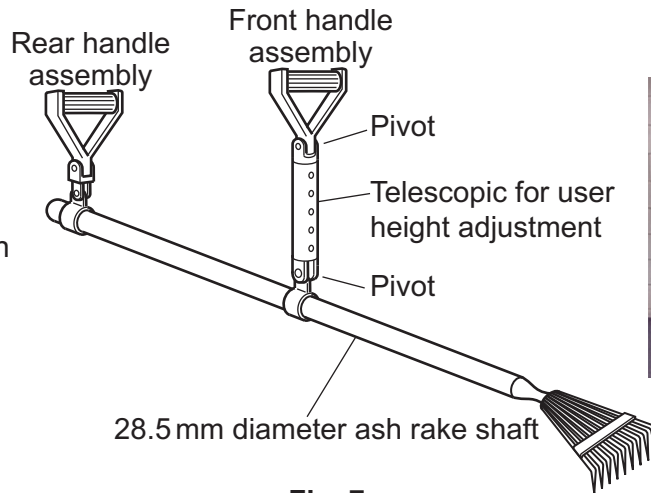
The designer takes inspiration from an existing ergonomic snow shovel shown in **Fig. 6** to develop a new multi-purpose product that comes complete with an accessory kit that can fulfil all gardening and snow clearing requirements.

The concept is called the ‘Ergo Kit’. It comprises two handle assemblies – a rear handle assembly and a front handle assembly. These assemblies share some components as detailed in **Fig. 7** below.

The designer also aims to enable users to change the end of the ‘Ergo Kit’ to a shovel or rake end, so they are able to shovel snow or spread salt with minimal bending of the back. The posture shown in **Fig. 8** is desirable.



**Fig. 6**



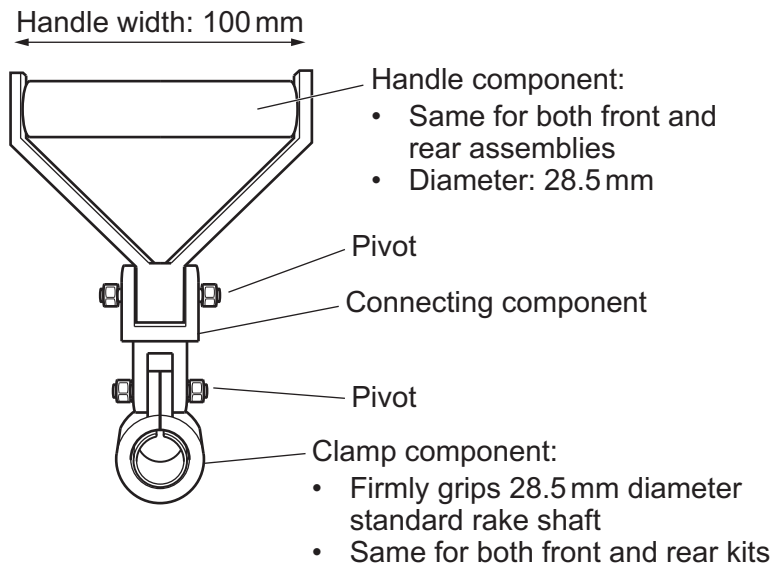
**Fig. 7**



**Fig. 8**

Using rapid prototyping the designer has created prototypes, such as the rear handle assembly prototype in **Fig. 9**.

The prototypes were successfully tested as shown in **Fig. 10**.



**Fig. 9**



The Ergo kit prototype is tested on a leaf rake. The user successfully rakes leaves without the need to bend her back.

**Fig. 10**

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