

2008-9 THIRD YEAR ENGINEERING GROUP DESIGN PROJECT

A Portable Dent/Deformation Removal Device

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1. Background

Car bodies and aeroplane frames can sometimes be accidentally hit by blunt objects to create dents and deformation during their services and usages. Even during the manufacturing process, defects of this type of dents may occur. It is desirable to remove these defects quickly and at low cost. Although there are some devices available in the market and services provided by various industries to recover dents and deformation, a product of more convenient, low cost and versatile for dents of different shapes and sizes is still very desirable. This project aims to design a portable dent/deformation recovery system that is practical to use and affordable by average income households as well as for the potential use by the motor and aerospace industries.

2. Design Brief and Objectives

The portable dent/deformation recovery system must be designed to satisfy the following:

- Suitable to mild steel (zinc coated and painted), aluminium alloy and Ti alloy (Ti-6Al-4V) of 1-2 mm thick with minimum or no damage to paint.
- Suitable to recovering dents and deformation of sizes of 25 mm – 100 mm in width and 1 -10 mm in depth.
- Access for dent/deformation recovery from one side (external face) only.
- Suitable for flat and curved (radius of curvature > 1 m) surfaces.
- Can operate using car battery supplied (from the cigarette lighter point) or 240 V AC standard mains power supply.
- Total weight of the operating head (hand-held) not more than 3 kg.
- Total weight of the whole system including power supply, not more than 10 kg.
- The sale price of the system is not more than £50 (This can be relaxed and negotiated depending on the function and quality of the product, but must have market appeal and has commercial viability).
- Satisfying EU and International safety standard and product /environmental regulations.

3. Other Requirements

As this is an engineering and scientific design project, all the design approaches must be justified scientifically and supported with references and calculations. All engineering drawings (this does not include the sketches during the conceptual design stage) must have full dimensions, component specifications and names (for electronic/electrical components) and materials details. Cosmetic and ergonomic considerations would be an optional added feature.

4. Project Organisation

The project will be undertaken in groups of 4-6 students. Each group will be allocated an academic supervisor. The team should work together on particular problem areas, and coordinate individual work. Success requires that you fully utilise the time, effort and skills of all members of your team; this requires effective management and collaboration. The project is divided into stages:

Stage (1) Requirements discussion, Design Specification, and Conceptual Designs

- 1.1 Week 1: Initially you should consider the **needs** of the Client. This should also act as an introduction to the project. Your client, on request, *may* be able to supply further factual information. Where full factual information cannot be obtained in the available time, use judgement and estimates (state assumptions clearly).
- 1.2 Week 2-3: Explore the problem and write a design **specification**. This should be brief but comprehensive including the functional requirements. Quantitative and qualitative statements should be included. Some requirements will have higher priorities than others, and some are essential: clarify these, i.e. "D"=Demand, "W"=Wish. **Discuss** your draft design specification with your supervisor in class. Any deficiencies must be made good before you proceed to the next stage.
- 1.3 Week 4-5: The conceptual design stage is a brainstorming activity. Creative ideas and thoughts are generated and compared. Prepare a group **report** to show the ideas generated. You must discuss it in class with your supervisor and get it approved.
 - Use annotated sketches and flowcharts;
 - **Compare** pros and cons (quantitatively if possible).
 - Identify aspects of the design yet to be resolved (e.g. materials, dimensions, and theoretical calculations)
 - State which design concept you will pursue and why.
 - Management Scheme - specify the responsibilities of individual group members for the rest of the project. Include a project leader for coordination, to include the collating of reports.

Stage (2): Design development, embodiment and costing

1.4 Week 6: Act on feedback on your first report. Identify reasons for change in your final report.

1.5 Weeks 7-12: **Develop** the selected conceptual design to meet the specifications. Expect to go through several iterations of sketches, calculations and drawings.

- Illustrate the design with a general arrangement (GA) drawing. A well-detailed GA shows internal assembly and overall views. *A single isometric view is not enough.* Drawings of small parts are not required. Include a parts list, showing materials for manufactured parts and suppliers references for bought-in parts.
- Estimate the costs of development and of materials, parts and assembly. It is not expected that undergraduates will have experience of this process, but it is important that you try.
- Support the design with calculations and simulations.
- Report writing: The final report may contain sections prepared by individual group members but, collectively, they should provide a unified report. Close collaboration between group members is essential. The report outline is shown below.

Timetable and teaching arrangements

FIRST REPORT end week 5, Tuesday 3rd March 2009

This must be discussed with, and approved by, your supervisor in class. If you don't meet approval, you will have to rectify some parts before you will seek approval again.

Introduction 4 pages maximum

- Discussion of client needs
- Specification

Conceptual design section 6 pages maximum

- schematics, sketches,
- evaluation, selection
- management scheme

A good design specification is achieved by creative thought and considered writing. It should be the result of careful investigation of the problem and should express the design requirements constructively. It should not be so superficial that it is meaningless, nor should it be so detailed that it contains solutions. Do not regard the design specification that you derive as being rigid. It is your starting point. It may be that, after exploring certain conceptual schemes or even during detail design, you have to return to the specification to question some aspect of it and change it.

FINAL REPORT and DRAWINGS end week 12, Tuesday, 12 May 2009

The final report should follow this format:

- Executive summary (1/2 page) and a brief introduction and should be understandable by a reader who has had no previous contact with the project.
- Describe the outline design
- Summary of special features
- Discussion on development requirements. Describe the reasons for any changes from the first report
- Provide relevant supporting analyses (e.g. calculations and model simulations)
- Major conclusions
- General arrangement drawings (may be freehand or CAD)
- Parts list
- Materials and leading dimensions should be specified.
- References: refer to sources.

Overall report and presentation: **(30 marks)**

Technical content: **(45 marks)**

The final report must be concise and clear. Remember your client will read it and they do not want to see a long wordy report. Some aspects of the first report can be included in the final report. The maximum permitted length is **20 pages** excluding appendix. Drawings can be included in an appendix.

POWERPOINT/MODEL PRESENTATIONS

Each group is required to present their designs in the form of Powerpoint which may include animation/simulation. If a physical model is available, it can also be used in the presentation.

The presentation will contribute **25 marks**.

IMPORTANT NOTES:

- Copies of data sheets/manufacture's descriptions/web sites are **not required** – they should be referred to where appropriate.
- Drawings larger than A4 size will not be accepted. Format the GA views accordingly, and use scrap views/sections to details.
- All group members will be awarded equal marks for submissions unless staff are requested otherwise by group members.

Lectures to be given:

Dent/deformation classification, existing dent removal products/methods in the market, deformation mechanics and finite element modelling.