Design for Manufacture

Module Brief

For Academic Year 2012-13

1. BACKGROUND

Your group is set up as a part of engineering consultancy that conducts design projects on behalf of third parties that include both blue-chip and small companies. In your case, a company with an existing and strong "high street" presence is investigating a new product – **a petrol lawnmower** that would be attractive to consumers used for medium to large gardens (up to approx 600 sq m).

Your task is to conduct a detailed design study that will include the costing of a future product. You need to be aware of the particular factors on the project:

- The resulting product is particularly cost sensitive and you will be asked to conduct a number of specific cost reduction exercises as part of the design study;

- The customer has no strong technical expertise in this area but like that all consumer products are to be impressed with attention to detail alongside a concept that has, at least some, "wow" factors.

Your module supervisors will act as the customer representatives and will deal with questions during timetabled hours as well by email.

2. THE PRODUCT

Performance requirement and constraints
All groups will work on a petrol engine powered lawnmower. The overall requirements are as below

- 3-6 horsepower, 4 stroke petrol engine
- 350-700 mm cutting width
- 5-10 height adjustments
- 30-100-litre collection bag

The product you are working on is a whole lawnmower. The components include a petrol engine with lubrication, a transmission to convey power from the engine to rotary cutting blades and wheels, a grass collection bag, manual start and control units, and wheels with adjustable height.

The petrol engine dimensions are to be decided and you will provide details of starting and running torques. The lawnmower will be supplied by a specialist company who will manufacture a partly assembled unit and a kit of parts. They will need details of the engine assembly required to achieve the characteristics required by your customer.

The customer is concerned that the blades, transmission and other high stress parts are potential sources of weakness in the concept and wants a thorough evaluation of the possibilities. Any could be selected and the customer wants to see a serious approach to each one including a costing and risk analysis. The description about this aspect of the design in the final presentation and a thorough examination of the way in which you decided the best design are expected. Relevant industrial standards must be applied in your design.

For the product you will develop and present as PTC Creo part models assemblies and images/drawings, including the following items:

- Engine unit including main parts: piston, connecting rod, gudgeon pin, petrol tank, lubrication, flywheel, starting and adjustment devices;
- Cutting blades
- Transmission between engine and wheels
- Casing, deflector, handle bar, control levels,
- Wheels with adjustable height levels
- Grass bag.

You will need to specify dimensions, make a materials and part selection decisions based on power and strength requirements. Detailed stress and heat flux behaviour are not required at this stage.

Integration
The end result of this design exercise is a fully integrated product. You will as a team integrate the sub-system designs. You can show the completed design as a General Assembly accompanied by a rendered sketch.

All design models are produced in PTC's Creo Solid Modeller, using Engineering & Design A4/3 drawing formats supplied. All development work, final parts and assembly models and electronic drawings contained within one Working Directory are to be burnt to a DVD and submitted along with hardcopy engineering/technical drawings. All members need to present contributions in the 3D drawings. Member's names must be put on all drawings for assessment.

Assembly cost, life, warranty and maintenance

The product will be assembled in the UK. You should consider the use of some limited automation as full hand assembly will be costly. The production rate of 10,000 per year corresponds to about 50/day. Assume that a semi-skilled assembly worker will cost £35/hour.

The product will run regularly in summer and but will be put in storage in winter. 2 hours per week and 20 weeks per year up to the working life of 15 years.

Environmental specification

The customer is particularly interested to see an innovative solution for the enclosure standard that can be implemented in a cost effective manner. Noise and vibration reduction should be considered. Noise emissions will be 80dBA maximum at 5m.

Competing products

You should consider potentially competing products in your research work. Look for features, cost saving measures, use of brand image, packaging and presentation. Check the web sites of reputable lawnmower manufacturers.

3. PROJECT PROCESS AND GROUP

During the term you will do a complete design, and complete the details and develop a presentation to present to the customer representatives in **Week 11** of the term.

You will apply the Failure Modes and Effects analysis technique early in the design process, and later in the detailed design. You will show in the technical report how the FMEA process was used to identify risks in the design and how you reduce them.

Your teams will be formed by the module supervisor, approximately 6-7 members. Each group has a cross section of disciplines needed to complete the task. Therefore, groups will be as balanced as possible. There are challenging mechanical design tasks as well as the range of product design requirements. The processes of a project are important and you will need to apply sound project management techniques that include:

- Allocation of team roles and responsibilities
- Appointment of a project manager
- Formulation and maintenance of a project plan.
- Weekly design review meeting
- Minutes, individual effort and contribution record

Design review is a part of the group meeting activities. The process is widely practised in industry. In it, the team meets simply to discuss design decisions. A Chairperson ensures that the business is conducted in a fair and reasonable way. Each member presents his or her design decisions and may be questioned by any team members. In particular they should be able to justify choices with reference to the original specification and to subsequent decisions made by the team. The team is looking for errors and omissions that once they emerge should be handled in a dispassionate way. The discussion will result in a series of recommendations that must be noted and actions created in the form

of a detailed set of minutes. Try to avoid discussion about project difficulties, team working or indeed anything that is not a design issue. There must be no personal criticism, and it is the chair's duty to ensure that each person has their say.

Each group will maintain a logbook intended to be a record of activities. A list of design issues, actions and the identity of the actionee should be noted. It should also include sketches, calculations and key sources of references. The team policy with regard to maintaining a master project record rests with the Project Manager. The master record can be maintained electronically.

A typical group structure, approximately:

Position	Tasks
Project manager	Coordinating activities, chair meetings, and maintain record (plus some specific jobs below)
Mechanical Engineers	Petrol engine design, Power and torque calculations, Bearings, Transmission design, Dimensions, Materials, Integration, Ventilation, Lubrication, FMEA, Packaging, Environmental Specification, Pro-E modelling/drawings: parts and assembly,
Product Designers	Use design techniques, Aesthetic aspects, Branding, Technical brochure, Pro-E modelling/drawings: parts and assembly.

4. ASSESSMENT COMPONENTS

1) Technical Brochure
The technical brochure will describe the product and its merits as a sales document. The technical performance should be given the form that a sophisticated technical purchaser would require to make a purchasing decision. It should be well illustrated and capture the brand and values of the customer.

2) Group Presentation
The group oral presentation will take place in **Week 11**. This is a sale presentation which should describe the merits of your design and your qualities as a team to merit the award of the major contract. You will be given 15 minutes for the presentation and 5 minutes for questions with an industrial panel. All members are expected to participate in the presentation.

3) Technical Report
The technical report will consist of an introduction, a series of chapters describing the new product and how the design decisions were reached and finish with conclusions and recommendations. Each chapter should be responsible by specific team member or members who will be identified and should be approximately 1200 words (or 7-10 pages). Each chapter will be concerned with distinct aspects of the development of the product. It is suggested to include:

- Specifications with technical calculations, including power, torque, energy source;
- Engine unit design with lubrication and fuel supply,
- Cutting blades, transmission to wheels,
- Casing with push handles, wheels with adjustable height levels, grass bag,
- Manufacture, safety and environment issues (noise and emission regulations),
- Project management methods, FMEA, critical evaluation of activities,
- Costs, market, branding,
- Others: Background introduction, conclusion, references, etc.

Whatever the choice the team must cover all aspects of design in the chapters. The report should include a critical evaluation on design processes of key areas, including comments on the formulation of the product specification, suggestions for improvement in your roles, suggestions for improvement in project management, such as using management tools, coordination, dispute/crisis handling procedures, comments and suggestions for the use of standards

In the report to be submitted you will include on a DVD of your team lawnmovwer assembly and main individual components modelled using PTC's Creo along with hardcopy drawings. Every member must contribute at least one solid model to the overall design along with hardcopy engineering drawings. The drawings must be clear, detailed, including tolerances and Titleblock information with the author name, and conform to drawing standards, in A3 or A4 format. All electronic files will be viewable on Engineering & Designs copy of PTC Creo.

Additional submission: Records for assessing individual contributions
Each team maintains a record of member's input efforts by numbers of hours for each week, signed by the team manager and checked regularly by the module supervisor. In addition, at the end of project, a percentage contribution breakdown to the project report from each member must be agreed by the whole team, and signed by the members. The module has 15 credits therefore you are supposed to spend 150 hours in total per team member.

Assessment Summary

Assessment Item	Group/Individual	%	Time
Technical brochure	Group	20%	Thursday Wk 10
Group presentation	Group and individual	20% (10% group, 10% individual)	Friday Wk 11
Technical report	Group and individual	60% (30% group, 30% individual)	Thursday Wk 1 Assessment Block 1

All hand in times are 16:00 except the group presentation. The group presentation will be arranged and assessed in Week 11

5. SCHEDULED TEACHING/PRESENTATION

Week	Classroom teaching and tutorial content	Lecturer
1-4	Lectures on briefing, technical calculations	W Wang
1-12	Design using Pro-Engineer 3D modelling	M King
5,6	Use of design techniques	Product design staff
7	How to make good sale presentation	Industrial speaker

Full course information is located at STUDY DIRECT.