The Loughborough University Engineering Design Centre

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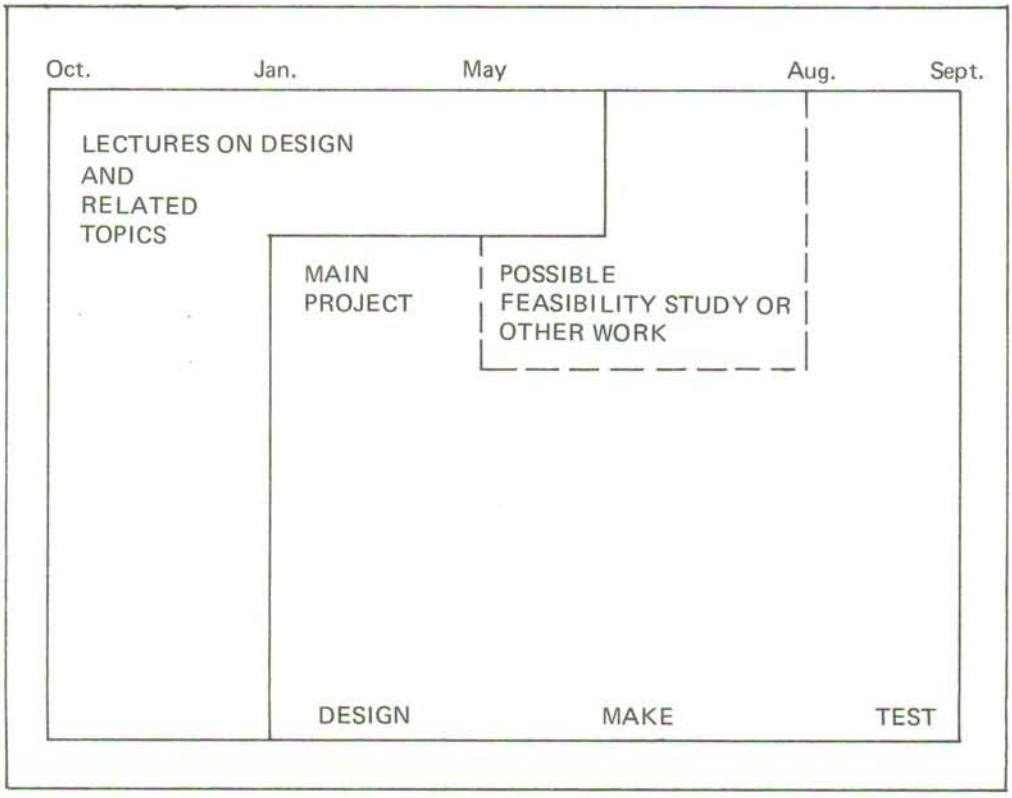
27

The Centre was established in 1966 and developed as an independent unit within Loughborough University until recently, when it joined with other groups into an enlarged Department of Engineering Production. The Centre operates mainly at postgraduate level, with staff recruited, since 1966, direct from positions of Design responsibility in electrical and mechanical engineering.

Emphasis is placed on the timely completion of work of high quality. To this end the Centre is equipped with modern drafting machines, reprographic and microfilm equipment, desk calculators and a computer, including a graph plotter. Students can gain experience of the efficient use of modern equipment. The main work of the Centre is to prepare engineers to assume responsible positions concerned with the design of engineering equipment and systems. It is therefore more concerned with the creation of an outlook and training of the mind conducive to a successful design engineeer, than in the further acquisition of advanced scientific or technical knowledge, although the recognition and use of this is often a vitally important facet of Design.

Postgraduate Work

A one year postgraduate course forms the basis of present activity in the Centre and this normally leads to a Master of Technology degree. (There are opportunities for internal and external students to work for more specialised Ph.D. degrees.) The M. Tech. year is divided up thus:



There is room for about twenty students on the course, although twelve to fourteen is a more comfortable group. A normal industrial year is worked with a week's holiday at Christmas and Easter and a fortnight in the summer.

The work is based upon non-specialist, often innovative, mechanical and electrical engineering and the criterion of success is that the student on completion of the course should be able to lead a small design section in Industry. Student performance is assessed by the staff at three-monthly intervals, and finally by a panel of examiners who have full access to the year's output of work in addition to an extensive interview with each student. The examiners are drawn from inside Loughborough University, and from one other University, and from a senior level in Industry. A very good agreement between the staff and the examiners has always been reached, and this method of assessing overall design ability is well favoured.

Students normally have a first degree and/or membership of one of the Engineering Institutions. However, the course itself does not necessarily demand such formal qualifications and those with, say, H.N.C. and sufficient relevant industrial experience can be accepted and registered for an A.L.U.T. (Associateship of Loughborough University of Technology). A minimum of industrial experience has until recently been demanded of all prospective students. However, there has been no significant correlation between length of industrial experience and design performance, so we are now prepared to accept a proportion of immediate engineering of science graduates. We now feel that any well educated person can understand and benefit from a course of tuition and practice in design, although the depth and usefulness of understanding clearly depends on engineering knowledge, analytical ability and experience.

The postgraduate lecture course covers Design and related topics ranging from methods for creativity to detail design, including project planning, management and product costing techniques. These lectures are supported by minor design projects and other exercises to bring out specific points. In addition some engineering science and analytical topics are introduced, for example materials science, optimisation methods and automatic control. These are subjects which have not been taught consistently to undergraduates in the past, yet which are essential to the designer's balanced and interdisciplinary abilities. Finally, the correct use of computers in design is taught and encouraged. An outline of the syllabus is given in Appendix I.

The main projects are normally chosen by the staff from topics suggested by Industry. Projects of current commercial importance are chosen, of the sort likely to be handled by the design team of a go-ahead company. Ideally they will require effort at all stages of the design process from concept to detail drawings, planning of manufacture and test. Not all projects have this wide problem span and the tutor will promote discussion and thought in areas where the project is less than ideal as a training exercise.

Each project is undertaken by a syndicate of four or so students who act as an extension of the sponsor's design office, but under the day by day tutorship/leadership of an E.D.C. staff member. The students act as unit professional engineers and they receive travelling and out of pocket expenses. The students do all the design and project work including detail drawings, unless these are very numerous. Occasionally the sponsor's draughtsmen or outside 'contract' draughtsmen are employed, in which case the students make the arrangements and give the instructions The design is made, either in the sponsor company's works or by a subcontractor, and then tested by the sponsor to a test specification prepared by the syndicate.

The students have only nine months in which to reach this stage of having a prototype under test, and in order to achieve this the management of design by time planning and cost estimating is practised (as in any firm wishing to gain a competitive edge). A successful project is one brought to satisfactory operation within the required time and at an appropriate cost.

Considerable emphasis is placed on costs and costing. A member of staff has particular responsibility for this aspect of design as part of his work under the auspices of the Smallpiece Trust Limited. Cost awareness is essential at all stages of design and manufacture.

A feasibility study or some other piece of work can be introduced in the second half of the course, depending on the progress of the main project. A feasibility study will be chosen to complement the main project and may vary in emphasis from problems of the environment to the limits of technology. Other work could consist of a study of aspects of the design process or a design method, using the activities of the Centre as source material.

The total staff time spent on the postgraduate course n a typical year is:

Lectures & Tutorials	150 hours	(plus preparation)
Project Tutorship	1400 hours	(normally three projects per year)
Total	1550	Staff hours per year (plus preparation)

Table A

A good proportion of the lecture material on design and related topics is also presented to the postgraduate students on other courses including Civil Engineering Construction Management and Instrument Technology.

Agreements for Postgraduate Projects

It is important to understand the advanced level of the project work. Projects have been and will continue to be chosen from a wide field of engineering activity. By way of example, the following are some of the areas in which projects have been undertaken:

Design project work is not uncommon these days at all levels of education, and co-operation with industry is encouraged at secondary level, through the colleges polytechnics and university undergraduate courses. However, it is only rarely that project work at these levels is of direct commercial significance to the sponsoring company. The Engineering Design Centre has a growing reputation for commercially viable design projects. Project proposals are preferred where the work will lead directly to a saleable product or a routine production machine or system. Thus the students face a considerable design task within a total business and commercial situation.

Turbocharging	Printing machinery
Food processing equipment	Packaging machinery
Chain assembly machine	Laser welding
Compressors	Gas turbine development
Dumper Truck (see Fig 1)	Wire extrusion
Glass making plant	Nuclear quality valves (see Fig 2)

Table B

FIG 1. Student Project 70A. A 2¼ ton dumper truck designed for The Liner Concrete Machinery Company Limited. (EDC Staff – S. Pugh and D.G. Smith).

The sponsor company has, of course, to pay for project work at this level although recognition is made of the educational facilities effectively provided. The sponsor pays the travelling and out of pocket expenses of the project team. He manufactures the design and provides facilities for testing; or alternatively pays for these activities to be done by sub-contractors. In addition, a small fee is charged in part payment for the time spent by staff and students. The staff will, if requested, accept professional responsibility for a project and agree to see it through to completion even after the particular syndicate of students has left the Centre. Fees received over the years enable the facilities of the Centre to be maintained and expanded for the benefit of future students.

Agreements also cover such matters as the final ownership of designs and the ownership of patent rights.

Undergraduate Teaching

A specially prepared course of lectures on Design has been presented to the final year Social Science & Technology undergraduates (ex Humanities & Technology) in recent years. These have been based on the post-graduate work and have been generally well received. The course includes a feasibility study/project chosen to have particular social and economic implications. In this case assessment is made both on the project work and by means of a written examination.

Similarly, a limited time has been spent with second year undergraduates on a General Engineering Degree course. In this case lectures have been closely related to a small design and detail project, which is subsequently manufactured and tested by the students.

Other service teaching is done by individual staff members on request.

Short Courses for Industry

The Centre began running short courses for industry soon after its inception, basing the course content on the M.Tech. course. This work has now been rationalised into a modular system of six short courses presented once a year. The modules can be taken singly or, if all six are attended, they form a complete course. The format and content of the modules were devised in consultation with training officers and technical directors in industry, and this prior consultation has certainly paid off in that the courses have been very well subscribed from the outset.

The six modules comprise:-

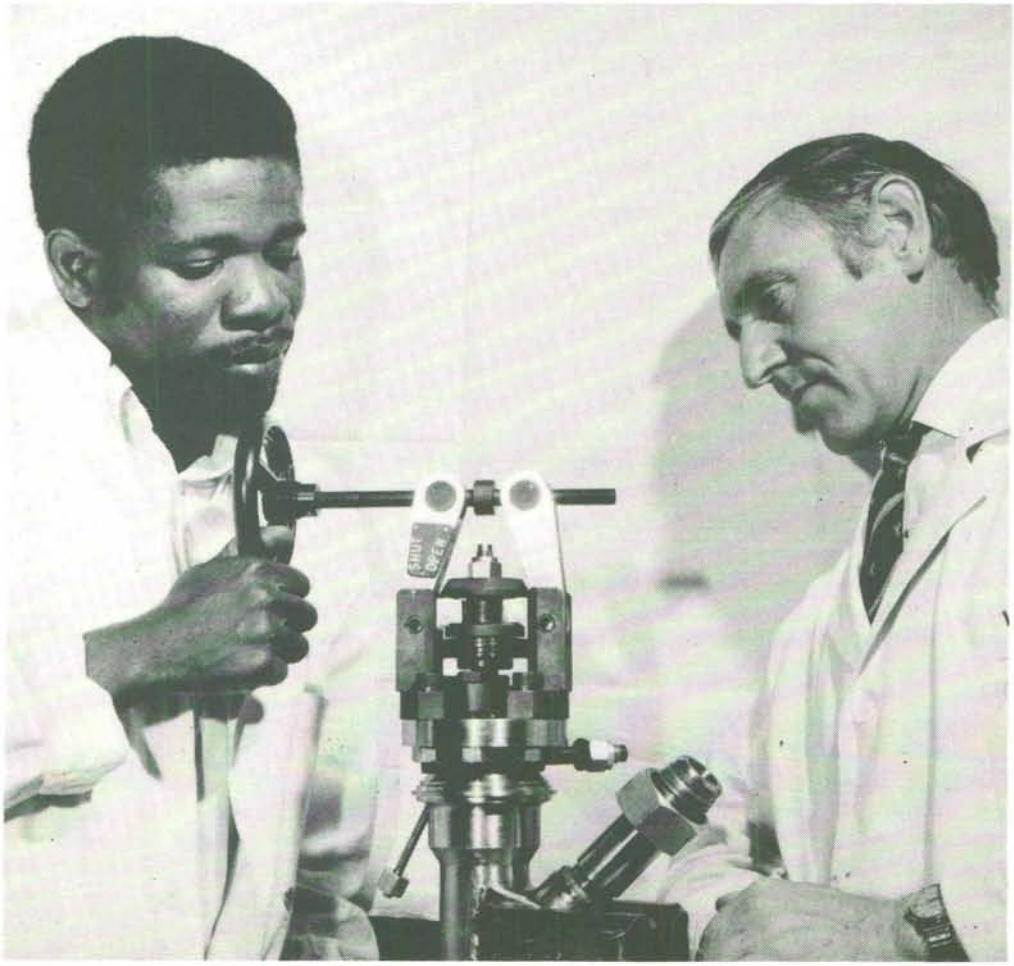
Management of Design
Cost Enlightenment in Product Design
Creativity for Designers
Methods Materials & Design
Decision Making in Design
The Compleat Designer

Each one runs from a Monday evening to the following Thursday night, giving those attending a day in the office at the beginning and end of the week. The level of work is set to suit young engineers and draughtsmen, up to the first line of management in Design and Development organisations.

Consultancy & Commercial Development

Staff members also undertake design project consultancies and research work separate from the student activities described above. Such work is normally organised via Loughborough Consultants Limited, which is a company established to assist and co-ordinate such activities throughout the University. A wide range of specialist expertise is available in support of or in addition to design and development efforts.

FIG 2. Student Project 71A. Two students with the nuclear quality valve designed as part of range for G.E.C. Reactor Equipment Ltd. (EDC Staff – C. Rodwell).



33 APPENDIX 1

Outline Syllabus for the M.Tech course lectures

1. Total Design

This series of lectures forms the framework of the course. The total design procedure. Problem analysis. Creativity, group creativity, decision making, mathematical modelling. From statement of the problem to successful operation of hardware for customer.

2. Detail Design

Properties of materials, detail design of weldings, castings, forgings, machined parts and assembly. Use of British Standards.

3. Optimisation

How to make the optimum decision, a wide range of techniques both mathematical and non-mathematical. The emphasis being the recognition of the potential of such techniques.

4. Control Engineering

Survey and comparison of electrical, pneumatic and hydraulic systems, sequence control, linear control, dynamic systems, in both theory and hardware at all stages.

5. Manufacturing Technology

Metal forming, metal removal, NC machines, welding, metal deposition, heat treatment, testing and inspection. Emphasis is on the knowledge a designer needs by practical demonstrations.

6. Materials Science

Metals, polymers, ceramics. Structure. Deformation. Strengthening mechanisms. Fatigue, creep, thermal shock, corrosion ablation. Phase diagrams, crystallography. Testing.

7. Project Planning

The elements of critical path methods — planning, analysing, scheduling and controlling. Resource allocations and resource levelling. Cost control. Use of computer library programs. Introduction of activity-on-node systems.

8. Computers

Introduction to computer hardware and computer systems. Programming in FORTRAN, programmable calculators, graph plotter and use of library programs.

9. Information & Communication

Information retrieval. Library, office and personal sources of information for engineers. Communication during design and between members of design teams.

10. Production Engineering & Organisation

Types of industrial organisation, role of production engineer, interaction with design.

11. Industrial Design

Short history of industrial design. Aesthetic of design with respect to style, cost, consumer appeal.

12. Cost in Product Design

Techniques and information necessary for product costing during the design phase, including global and detail costing methods. Factual relationships between cost and product classification. The emphasis being placed on factual rather than theoretical or comparative costing methods.

13. Probability, Reliability & Quality Assurance

Simple probability theory is developed for general application. Basic reliability and quality assurance ideas are examined for industrial use.

14. Value Analysis

Historical background. Types of value. The Value Analysis method. Value analysis teams. Organisation aspects.

15. Patents

The law related to patents. Trademarks. Registered designs. Copyright.

16. Corrosion

Bimetallic, stress and fretting corrosion. Erosion. Pitting. Intergranular and microbiological attacks. Polymers and refractories. Use of surface treatment and cathodic and anodic protection. Testing methods.

17. Project/Product Management

The various forms of organisation used in industry and Government are compared and analysed. The requirements for accurate estimating of time and cost are shown. Case studies illustrate the discussions.

18. Discussion Groups

From time to time during the course, informal discussion groups are held when subjects having a wide application in design are discussed, e.g. ergonomics, marketing, responsibility to environment.

19. Visits

Visits to other educational establishments, research organisations and industry are arranged as appropriate.