CHAPTER 6

SETTING UP PBL FOR DESIGN IN PLASTICS

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6.1 Objectives

Many institutions running courses in which product development or aspects of product development are addressed have the need of introducing at some stage the specific problems associated to the use of plastics in Engineering.

In this chapter a suggestion is made on how to introduce the subject in a course based upon the availability of a teaching slot of one lecturing semester with 4 contact hours per week and resorting to the concept of PBL as a learning tool for the students.

This module / subject will cover specific aspects of Engineering such as

- introduction to the methodology of design/development of new products
- revision of fundamental concepts on polymeric materials, their properties and processing, from the point of view of product development.
- Principles of injection moulding and injection mould construction
- Explanation of concepts that are specific to the development of technical products in plastics.

The module imply the use of learning and teaching tools based on computers.

6.2 Organization of the course

The course is proposed to be developed over a period of 12 weeks, assuming that the students do not have any previous knowledge of plastics. It is assumed that the students will have 4 contact hours per week including lecturing modules and modules of demonstration / supervision.

6.3 Methodology

The course delivery was based in the concept of project based learning which involves the application of the acquired knowledge in specific assignments involving group work.

In the preliminary stages of the course, in order to get the students acquainted with the proposed specific softwares individual assignments were proposed to be executed in a short period of time..

The major project to be developed in a group environment must be designed in order to fit within the culture and the technical capabilities of the institution and the course where it is supposed to be carried out.

6.4 CAE programs

The implementation of softwares or computer programs specific of Polymer Engineering implies some investment if the programs are expected to be used throughout the academic year. However if the institution wants to test the applicability of the programs it will be possible to obtain for many of them temporary licences of usually one month duration. Most of the programs available for Polymer in Engineering run in personal computers of the Pentium generation. It is recommended for the running of the course a

minimum number of machines typically of the order of one PC per three students.

The following institutions may be approached to provide program licences or 30-day demos

- Rapra Technology, United Kingdom (www.rapra.net)
- Plastics data base **Plascams**
- Knowledge Base System for Plastics **KBS Plastics**
- C-Mold, united States (www.cmold.com)
    - Software for injection optimisation **Plastics Engineer**
    - Software for injection simulation **3-D QuickFill**
- M-Base Engineering, Germany
- Software for injection simulation **Miniflow** (www.m-base.de)
- Plastics database **MC-Base** (www.m-base.de)
- Plastics database **CAMPUS 4.x** (www.campusplastics.com)
- Bayer GmbH, Germany
    - Viscoelastic database **RALPH**
    - Structural analysis programs **Finel and Flaemo**
- Solid Works, United States
    - 3-D drafting software **SolidWorks 98**

6.5 Supporting material

Further to the availability of licences / demos of the softwares in every PC for the students it is recommended the distribution of hand outs after each lecture and the accessibility to reference

books in the institution library. The following books are considered useful for the delivery of the course:

- ◊ Birley,A.W., Heath,R.J.e Scott,M.J., *Plastics Materials - Properties and Applications*, Blackie, Glasgow, (1988)
- ◊ Birley,A.W., Haworth,B. and Batchelor,J., *Physics of Plastics*, Hanser, Munich (1992)
- ◊ Crawford, R.J., *Plastics Engineering*, 3rd ed, Butterworths, Oxford (1998)
- ◊ Charrier, J.-M., *Polymeric Materials and Processing*, Hanser, Munich (1990)
- ◊ Hawkes, B. and Abinett, R., *The Engineering Design Process,* Pitman, London, (1984)
- ◊ Malloy, R.A., *Plastic Part Design for Injection Molding*, Hanser, Munich (1994)
- ◊ Menges,G. and Mohren,P., *How to Make Injection Molds*, 2nd ed, Hanser, (1993)
- ◊ Powell, P.C., *Engineering with Polymers*, 2nd ed, Kluwer, Dordrecht (1998)
- ◊ Pye, R.G.W., *Injection Mould Design*, 4th ed, Longman, Harlow (1989)
- ◊ Ehrenstein G.W. and Erhard,G., Designing with Plastics, Hanser, Munich (1984).

If the students are expected to undertake a mould design activity it is suggested to contact Hasco GmbH, Germany (www.hasco.de) for obtaining a copy of the full catalogue of the standard elements for injection moulds

- ◊ Catalogue Hasco –Normalien, Hasco GmbH.

6.6 Assessment of the student performance

The assessment of the students is based on the achievement in the projects developed during the course and an individual examination / interview to assess their knowledge in specific concepts. The contribution of the individual examination / interview towards the final mark must no be in any case higher than 20 % of the final mark. The mark corresponding to the projects developed both individual or in group must reflect in every case the individual contribution of the student to the final outcome of the group.

6.7 Plan of lectures

Week 1

Duration 120 minutes

Theme Polymer basics: - polymerisation, nomenclature, classification; polymer structure, crystallisation; modification of properties: fillers, reinforcements, additives.

Application Introduction to the 3-D drawing software Solid Works (Solid Works Inc.);

Bibliography

- ◊ Birley,A.W., Haworth,B. and Batchelor,J., *Physics of Plastics,* Hanser, Munich, (1992)
- ◊ Charrier, J.-M., *Polymeric Materials and Processing*, Hanser, Munich (1990)
- ◊ Powell, P.C., *Engineering with Polymers*, 2nd ed, Kluwer, Dordrecht , (1998)

The chapters 2 of Powell's *Engineering with Polymers* and Charrier's *Polymeric Materials and Processing* are very useful for supporting the structure of the lecture. Nevertheless it is recommended that the lecturer introduce more detail in specific

aspects of the lecture, by resorting to more specialised textbooks, as Birley's *Physics of Plastics*.

In order to avoid misinterpretation from the students an objective reference must be made to thermosetting materials and to elastomers alongside the thermoplastics that are the material to be considered in this course. In particular the commercial importance of thermoplastics materials in view of their weight consumption in engineering and commodity parts must be enhanced.

The introduction to polymerisation is important to clearly establish the difference between homopolymers and copolymers in one hand, and between copolymers and mixtures in the other hand. The concepts of polymer structure and crystallisation should be clearly established especially in the aspects that are relevant to material properties (e.g. weldability and glueability), processing. The concept of molecular weight must be perspectivated towards the practical significance of MFI (melt flow index) or MVR (melt volume rate); it is recommended that the students are introduced to raw material manufacturer data where these indices are mentioned for every grade available.

It is to be made clear that this course will not be a course in polymer physics but in application of plastics in Engineering. In this context the importance of drafting as a fundamental tool of the Engineering activity must be clearly established. It is not mandatory that the students are able to mastering a CAD program like AutoCAD or SolidWorks; however, as most of the engineering activity with plastics resorts to the use of computer packages it is suggested that an introduction to a CAD package is given by a specialist colleague and the students are given the possibility to practise its application during the first weeks of the course.

If the Institution is to consider the acquisition of a CAD software it is suggested that it is made in complementarity to the use of plastics CAE packages to be used in the course, e.g, C-Mold 3-D Quick Fill or Moldflow Part Adviser.

Week 2

Duration 120 minutes

Theme Principles and methodology of Engineering Design; The role and the importance of specification in the project in Engineering; Organization of a design activity. Properties of plastics relevant to technical applications. Commercial plastics - general purpose materials; engineering materials

Application How to define the specifications for a project; Introduction to the Database PLASCAMS (Rapra Technology);

Bibliography

- ◊ Birley,A.W., Heath,R.J.e Scott,M.J., Plastics Materials - Properties and Applications, Blackie, Glasgow, (1988)
- ◊ Crawford, R.J., Plastics Engineering, 3rd ed, Butterworths, (1998)
- ◊ Hawkes, B. and Abinett, R., The Engineering Design Process, Pitman, London, (1984)

In many Engineering courses the Principles and methodology of Engineering Design are not specifically introduced. In view of the applicability of the methods of Project Based Learning it is essential that these principles and methodology are explained to the students. Books exist in which these aspects are covered in some depth. Hawkes's *The Engineering Design Process* is a quite useful and readable textbook for the students. More detail can be seen, for example, in Cross's *Engineering Design Methods*, Wiley, Chichester, (1989).

The presentation of the main families of thermoplastics materials can be supported by Birley's *Plastics Materials - Properties and Applications* that provides an insight of the main properties of each family of materials. It gives for each of them the description of the properties that make the material suitable for the applications and also presents case studies describing why the material was selected for that specific product.

Crawford's *Plastics Engineering* gives a comprehensive review of the main properties relevant to engineering applications. This review can be supported with the analysis of technical data supplied by the raw material manufacturers with each of the grades that they make available in the market, and also with the information that is included in the computer databases.

The students must be warned about the extensive variety of the materials that are available to the engineer for a specific application. Having done this the introduction to a computer based material selector is to be introduced, attention being drawn for the philosophy subjacent to the use of these tools. The Rapra's Plascams is one of the more better known material selectors which is available on an annual rental basis. It is essential that the students are aware of the need of the product specifications being clearly defined prior to the use of the softwares. In the perspective of using Plascams it is necessary to introduce the concept of relative importance of the specifications and how to use decision matrices to allocate weightings to the specifications.

A preliminary activity for the students can be the identification of specifications that are relevant to a product and how to weigh those specifications. This can be done during the class prior to the introduction of Plascams.

Week 3

Duration 120 minutes

Theme **Tim**e dependent properties of plastics; Product design - design for stiffness: the pseudo-elastic method of dimensioning; sources of plastics creep information.

Application Introduction to the database CAMPUS 4; The concept BAYDISK (Bayer Engng GmbH) and the supporting programs RALPH, Finel and Flaemo;

Project nº1 (individual) Selection of Materials for a specific application (see handout in Appendix 1).

Bibliography

◊ Crawford, R.J., *Plastics Engineering*, 3rd ed, Butterworths, (1998)

Chapter 2 of Crawford's *Plastics Engineering* gives a comprehensive view of the time dependent mechanical properties of plastics, illustrated with solved problems and a proposal of many others with practical significance.

A brief introduction to the viscoelastic models describing the time dependent behaviour of polymers is necessary but it is recommended that the emphasis of the lecturing is put on the experimental characterisation embodied in the creep curves and its application to solving specific problems of engineering. It is important that apart from the use of creep data included in the reference books the students will be asked to gather information from technical publications from the raw material manufacturers and principally from computer based information. If Internet connections are available the students should be asked to download *Campus* from the website www.campusplastics.com.

The reference to BAYDISK, if the package of programs will be obtainable from Bayer Engng GmbH, will be important to illustrate the availability of computer tools for solving many Engineering problems. It is recommended that, within the scope of application of the *pseudoelastic method* (Crawford's *Plastics Engineering* Section 2.5), the use of the time-temperature dependent modulus instead of the Tensile or Flexural modulus quoted in the basic technical literature is stressed.

This is the time for the proposal of the first assignment to be solved by the students. The handout for it must be clearly presented and the deadline defined in order to avoid last minute demands for postponement. In principle one week will be enough for this work. In appendix 1 it is given an example of an assignment of this type. It is essential that a number of computers, typically 1 machine per 3 students, with Campus and Plascams are made available to the students. The access to the machines must be independent from the lecturing periods.

Week 4

Duration 120 minutes

Theme Processing of thermoplastics: - fundamentals, principal processes; Injection moulding; The injection moulding cycle; The fundamental variables of the process; main components of a injection mould.

Application CAE tools of support to injection moulding; Programs for optimisation of the process Miniflow and C-Mold Project Engineer .

Project nº2 (individual) - Selection of injection moulding equipment for a specific application, using the optimisation softwares available (see example of handout in Appendix 2).

Bibliography

- ◊ Crawford, R.J., *Plastics Engineering*, 3rd ed, Butterworths, (1998)
- ◊ Malloy, R.A., *Plastic Part Design for Injection Molding*, Hanser, Munich (1994)
- ◊ Powell, P.C., *Engineering with Polymers*, 2nd ed, Kluwer, Dordrecht , (1998)

Both Crawford (Chapters 4 and 5) and Powell (Chapter 8) give a good introduction to the fundamentals of polymer melt flow and heat transfer problems in injection moulding. However it is important the insight that Powell gives to the dependence of properties and processing in Chapter 9, which is important to better understanding the information obtainable when running flow simulation softwares. The use of Malloy's *Plastic Part Design for Injection Molding* or Charrier's *Polymeric Materials and Processing* (Section 5.13) is suggested for the illustration of the equipment used in the injection moulding process.

The reference to the injection moulding cycle and the variables that likely influence the duration of each phase of the cycle is important prior to the first contact with the CAE tools that will be used by the students.

It is important to consider that, if datasheets of injection moulding machines or raw material technical data are available, they may be input in the CAE tools that are suggested (Miniflow or C-Mold Project Engineer). Miniflow is a software that is closer to a more academic approach to the problem of injection moulding simulation whereas C-Mold Project Engineer will provide a view closer to a non-expert in polymer melt flow and rheology expert. The latter is also of interest as it will provide a comprehensive view of the engineering implications, namely in terms of final product cost. It is recommended that the students will work by themselves the product processing implications: this may include the sketching of the impression layout (Charrier's book section 5.13.3 may be helpful), the preliminary design of the runner system architecture, the prediction of approximate runner sections (see Powell's book chapter 8 or Crawford's chapter 5) and the expected clamping force. This work further to acquainting the students with the theoretical aspects of the problem will allow them to have a critical position when the first software results appear.

It is expected that the students will show some difficulty on sketching the first approach to the mould design. It is therefore important that some moulds are available for inspection or, if at all impossible, some injection mould technical drawings can be inspected in the project room(s).

In the context of the Project nº 2 it is recommendable that further to the use of the available softwares the students are asked to produce meaningful drawings where the different function systems are clearly identified and to work out from theoretical principles the process implications of the solution (injection and cooling times, clamping force, for example). This assignment may be quite time consuming; therefore a week time being given for the solution it may provide an example of how to optimise the energy and resources put in view of the time available. Help can be provided in the assignment handout by specifying clearly the contents of the report and likely extension of each part of it.

Week 5

Duration 120 minutes

Theme Injection moulds; Function systems of injection moulds; Hot runner moulds; Design of function systems. Basics for mould design

Application Project nº3 (individual) Simulation of the injection moulding flow using the program C-Mold 3D Quick Fill in simple moulds If the institution has injection moulds, use them in the assignment.

Bibliography

- ◊ Pye, R.G.W., *Injection Mould Design*, 4th ed, Longman, (1989)
- ◊ Menges,G. and Mohren,P., *How to Make Injection Molds*, 2nd ed, Hanser, (1993)
- ◊ Hemsley, D.A., *Failure Analysis of Plastics*, in Bever, M.B. (ed.) *Encyclopaedia of Materials Science and Engineering*, Pergamon, Oxford (1986)

Pye's *Injection Mould Design* can be seen one of the more comprehensive textbooks to introduce mould design and the description of their components. Nevertheless, many other books can be used instead to provide a more introductory level support to the mould design aspects. Malloy's *Plastic Part Design for Injection Molding* is helpful for showing how specific part details may influence the mould design.

If the students had the opportunity of using a 3-D drawing software it is now the opportunity of showing how readily softwares like C-Mold 3D Quick Fill can give a quite accurate view of what will go on in the injection moulding process and how decisions, for example with respect to gating, influence the processability. It will be interesting to ask the students to compare these results with data they can readily get from *simpler* softwares (e.g, C-Mold Project Engineer).

It is convenient to recall at this stage that the critical aspect of this assignment is not the availability of the simulation software

(available from the Internet in a 30-day demo version) but the ability to draw a part using a 3-D solid modeller.

Week 6

Duration 120 minutes

Theme Principles of design with plastics; Golden rules; Constant stress beams – changing the cross section as a way to minimising the use of material – principles of dimensioning and recommendations towards the application in products.

Application Utilisation of the flow simulation software C-Mold 3-D Quick Fill.

Project nº 4 – 1st phase - Proposal of the theme for the design exercise to be developed within the frame of the course (Annexe 3)

Bibliography

- ◊ Hawkes, B. e Abinett, R., *The Engineering Design Process,* Pitman, London, (1984)
- ◊ Malloy, R.A., *Plastic Part Design for Injection Molding*, Hanser, (1994)
- ◊ Powell, P.C., *Engineering with Polymers*, 2nd ed, Kluwer, Dordrecht , (1998)

At this stage, the students must have a reasonable understanding of the interaction between processing, product properties, and production time. The introduction to a software like C-Mold 3-D Quick Fill will enable the visualisation of the complex process that injection moulding is; of course it will be necessary for running this program that a 3-D solid modeller, like Solid Works, is available.

The introduction of the golden rules for designing with plastics can be supported by Powell's *Engineering with Polymers* in Chapter 10. The introduction of the constant stress beams can be seen either as an opportunity to show the need that plastic

engineers have to master more advanced topics of Mechanics of Materials or to use structural analysis softwares.

The proposal of the theme for the design exercise must appeal to the culture and the ingenuity of the students, i.e. a specific product must not be proposed but only a *need* or an *opportunity* for the application of plastics in Engineering. Examples of projects are given in the Chapter 5. Proposals like

- How to improve the safety of cyclists by night
- Contributing to the comfort of holiday makers in the beach
- Improving the recycling of domestic waste
- Develop a corporate image product for the Department

are examples of themes that can be proposed to students.

Week 7

Duration 120 minutes

Theme Principles of design with plastics; Snap fits as a means to minimise the assembly operations – main types, dimensioning and recommendations for the geometric details.

Application Introduction to an integrated design environment based on a personal computer: the knowledge base KBS Plastics (Rapra Technology). Emphasis to be paid to the demonstration of the module *Sensan* for anticipating the functional attributes that must be integrated in the preliminary phases of the design exercise.

Project nº 4 – 1st phase – Presentation of the concepts that were proposed for the project; definition of the assessment criteria; assessment and selection of the concepts that will be eligible for further development.

Bibliography

◊ Malloy, R.A., *Plastic Part Design for Injection Molding*, Hanser, (1994)

Week 8

Duration 120 minutes

Theme Principles of design with plastics; Integral hinges as an example on how to explore the specific characteristics of thermoplastics, to minimize the number of components and to simplify assembly. Introduction to the *Eco-design* or design for recycling.

Application Introduction to the standard element catalogue for injection moulds Hasco-Normalien. How to use it considering the specifications of the injection moulding processing equipment.

Project nº 4 – 2nd phase – assessment of the technological implications associated to the concept being developed.

Bibliography

◊ Malloy, R.A., *Plastic Part Design for Injection Molding*, Hanser, (1994)

Week 9

Duration 120 minutes

Theme Principles of design with plastics; Cost factors of plastics products – sources of information for prices; concept of production efficiency; how to obtain the machine hour rate of an injection moulding machine; production costs as function of the technology.

Application An example of the cost build up with detailed considerations of the implication of the production run size on the technological process to be used.

Project nº 4 – 2nd phase – assessment of the implications of different gating systems in the mould design.

Bibliography

◊ Birley,A.W., Heath,R.J. and Scott,M.J., *Plastics Materials - Properties and Applications*, Blackie, Glasgow, (1988)

In the design activity it is essential to stress the importance of the design and process options in the final cost of the product. The cost factors associated to the production of plastics products must be detailedly explained paying particular attention to the role of the raw material cost and the production cycle time. It is important also to acquaint the students with the fact that the mould cost (which in injection moulding is usually very high) is to be supported by the product run or expected number the parts to be produced and not depreciated in a time basis.

Birley's *Plastics Materials - Properties and Applications* gives an interesting overview of these aspects in Chapter 1. If the use of Engineering supporting softwares like *C-Mold Project Engineer* is available, this cost aspect can be thoroughly appreciated on running the program.

Week 10

Duration 120 minutes

Theme Principles of design with plastics; Assembly of injection moulded plastic parts using mechanical fasteners; insert assembly and its technological implications.

Application Project nº 4 – 2nd phase –.

Bibliography

◊ Malloy, R.A., *Plastic Part Design for Injection Molding*, Hanser, (1994) – chapter 6.

The students may be suggested that all plastic products are obtained ready for use from the injection moulding operation. This lecture is important to alert for the possibility of using mechanical fasteners as it is common in the conventional product manufacturing. Malloy gives a thorough description of the principal methods and solutions for this type of operations. It will be also possible to complement the information to the students with technical catalogues of manufacturers of mechanical screws or of metal inserts.

Week 11

Duration 120 minutes

Theme Presentation techniques: how to make a presentation appealing to the audience. The difference between the contents of a public presentation and a technical report. The structure of a technical report; specific recommendations for this project report.

Application Project nº 4 – 2nd phase –.

Bibliography

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At this stage the progress of the student work is reaching its end. Most of the material must be ready not only for a public presentation but also for the compilation of the final report. The objective of the lecture that may even be given by an invited specialist in communication is to provide the students some ideas on how to organise their public presentation in the last session of the course, but also the final report to be submitted within a fixed schedule after the completion of the course.

Week 12

Duration 120 minutes

Theme Presentation of the project(s)

This session closes the principal part of the course. The students are expected to present their work within a tight time schedule, typically 20 minutes is viable time scale. The session may be open to other students and to external people that might have been involved in the setting up of the project. After the student presentation a period should be allowed for questions from the audience or from the team of lecturers. The performance of the students during this session must be taken into account for the final marking of the project.

6.8 Handouts for projects

In the following pages example are given of assignments proposed to students in different institutions. The reference to CAE programs reflect the corresponding availability to the time of the assignment.

Assignment 1: (4.5 hours) Selection of a material for a given application, using computer databases (PLASCAMS and Campus), and preparation of a short summary about the chosen material.

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MATERIALS TECHNOLOGY FOR PRODUCT DESIGN I

Consider the following application for which you have been asked to select an adequate thermoplastic material

Note: *Each student must be proposed a different product*

You have the possibility of using the following databases
PLASCAMS, from Rapra Technology
CAMPUS 2, from several companies
EPOS, from ICI
CS, from Dow

1. Define as precisely as possible the specifications that you consider critical or relevant to this application.
2. Establish the relative importance of the specifications and attribute weighing values to each of them, e.g, 1 for Spec 1, 3 for Spec 2, 1.5 for Spec 3, etc.
3. Start the PLASCAMS program (c:\PLASCAMS\plascams (CR)) and set **Your Country** as the default country.
4. Use the **Single Pass** option to obtain a short list of materials adequate to the proposed application, by using the specifications set on 1.
5. Using the **Combined search** option order the materials remaining in the shortlist.
6. Get information on the manufacturers that produce the first three materials and decide which one you will consider for application. Go through the information data on the selected material (s).
7. In Utilities set the option Printer to **File.DRV** and choose your own file name. Use the printouts for your report.

8. Switch to the raw material manufacturer database which you choose on the previous search (e.g, c:\CAMPUS\campus (CR))and select the grade more appropriate to your application from the type of material suggested by PLASCAMS.
9. Repeat the search selecting all the materials produced by the manufacturers as possibilities. Comment if this search produce a result different from 8.
10. On the chosen material go through the design information that is available.

11. Produce an assignment report describing the strategy of your search and commenting the steps taken. The printouts of the search must be included as appendices. In the main text you can include information which you consider useful for the reader.
    Go through the textbooks available for the course and prepare a short literature review on the material selected. This review, that must be 2 to 4 pages long, should include information on the material such as statistics of use, main properties and related properties, processing hints, ...

The report must be submitted by the 16th August, 9 a.m.

A.S.Pouzada
12 August 1994.

Assignment 2: (5.5 hours) Definition of process requirements and processing conditions for a given product. Selection of equipment and layout of the mould.

University of …

MATERIALS TECHNOLOGY FOR PRODUCT DESIGN I

The product shown in the figure is to be injection moulded using the raw material that is indicated. The mould to produce the parts has the number of impressions which also is indicated.

Note: *Each student must be proposed a different product*

It is expected that you propose

1. A sketch for an injection mould suitable for the production.
2. The minimum machine requirements for producing the parts.
3. The likely processing conditions and the cycle time.

In order to satisfy requirements 2. and 3. you may use the injection moulding simulation program SIMPOL which will be available for use on the 17th during the morning.

Your assignment report must include

a. A brief justification for the dimensions used in the mould.
b. The indication of the main systems of the mould (e.g, runners, extractors, cooling lines).
c. A schematic drawing of the mould showing the impression layout and a cross section view of the mould.
d. The printouts of the SIMPOL simulation.
e. Any comments/justifications on the options taken for the chosen grade of material or the SIMPOL input variables.

The report must be submitted by the 19th August, 9 a.m.

A.S.Pouzada
16 August 1994.

Notes for using SIMPOL

To start the program:

A: (CR)
A: SIMPOL (CR)
type option **1 (Quick analysis)**
Input customer code **MIK**
Create a new cavity
then follow the instructions of the program.

After input of all the data, select option **R - edit runners** and edit the dimensions according to your mould layout.

Return to the previous menu and select option **O - optimize**

Select option **U - Detailed analysis** and observe the process data

You may change the machine type by selecting **Z - machine codes**

At the end of a simulation you may get a summary choosing **T - Final summary.**

All the screens may be printed with **PrintScreen**. Each screen takes about half page.

Group Project: (14 hours) Design of a plastics product from basic specifications up to technological requirements, including product concept, material selection, basic stress analysis, production requirements.

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Design with Plastics

Project nr. 3 – Product design with thermoplastics.

O DEMa está interessado em aproveitar a oportunidade de ter uma pequena equipa pensando em aspectos do projecto com termoplásticos para contribuirem para uma acção de promoção de imagem and reforço de espírito corporativo. Em particular decorre o processo de criação de um novo logotipo para o DEMa. Pretende-se da equipa de projecto com termoplásticos uma

Contribuição para o desenvolvimento de produtos baseados no novo logotipo.

2 OBJECTIVES OF THE PROJECT

The objectives of the project are developed in two phases:

PHASE 1: Generation of concepts

1. The group of up to 5 elements will propose within two weeks, ideas or concepts for products that might be developed (kye holders, *pins*, etc).
2. Assessment and grading of the proposed concepts

PHASE 2: Development of the selected concept

The design group must develop the following tasks:

3. Assessment of the needs for production on an annual basis.
4. Define the functional specifications of the selected concept.

5. Selection of the raw materials suitable for the product or its components. It is expected that computer databases will be used for the selection of the material types and the grades to be used. The data bases de dados *Plascams* and *Campus 4.x* are installed in the Computer Room.
6. Technological optimisation including the sketching of the moulds for production of the parts, assessment of the capabilities of the departmental injection moulding machines and determination of the cycle time. In the drawing skectches the location of the impressions and the different functional systems must be shown. For the optimisation of the injection moulding machine use the program *Dr C-Mold*[1]. The presentation of the simulations *Fillcalc V*[2] os recommended to visualise potenctial production problems.
7. Mechanical design of the product, considering the viscoelastic properties of selected materials (use the information of the databases Cam*pus* 4, *BAYDISK\RALPH* or in technical information publications)
8. Execution of technical drawings of the components and a preliminary project of the injection mould.
9. Determination of the production costs and of the expected cost of the product.

3 TASKS

The following tasks are distributed to the members of the Design Group:

1- Coordination of the team and organisation of the reports.
2- Specifications, selection of materials and assessment of the production needs.
3- Mechanical design and rheological analysis.
4- Definition of the production tools.
5- Execution of drawings (and models, if necessary).

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[1] This program of AC Technology was replaced by the new software C-Mold Plastics Engineer

[2] This program was acquired by C-Mold who proposes now the alternative C-Mold 3D Quick Fill instead

6- Costing

4 TIMING

The report must be submitted within the **21 December 1998**.

5 MARKING

The individual marks in this project are calculated from:
60% of the component of individual responsibility
40% of the global mark of the project.

Suggested chronogram

Task	26.Out	02.Nov	09.Nov	16.Nov	23.Nov	30.Nov	08.Dez	15.Dez
2	Specifications	Sel.Mat.	Production requirements					
3			Structural analysis		Rheological analysis			
4	Scheme of the moulding		Dr C-Mold	Fillcalc				
5		Preliminary drawing		Mould preliminary project			Product drawings	
6		Raw material costs and suppliers				Production costs		
1		Meeting		Meeting		Meeting		
Report