

INTERNET: NEW EDUCATIONAL FOCUS IN THE MECHANICAL ENGINEERING

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Abstract $\frac{3}{4}$ One of the challenges of the teaching staff is to adapt to the new social changes. Therefore, it is necessary to be aware of the new developments and approaches of the professional world. Thus, teachers should adapt their teaching methods to the new educational trends. This directly affects students, who progressively adapt their learning strategies to the new methods.

Therefore, the new possibilities of the new information technologies, specially Internet, for educational purposes should be analysed taking into account three possible ways of implementation:

- As a complementary tool for teachers in the design of theoretical sessions.
- As a complementary tool for practical sessions.
- As a complementary tool for developing tutorial sessions. It is addressed to student.

All these aspects are developed in more detail in this work, including some practical examples developed by the teaching staff of the Department of Mechanical Engineering of the Polytechnic School of Alcoy.

Index Terms $\frac{3}{4}$ Calculation programmes, Internet, Mechanical engineering, Tutorial programmes.

INTRODUCTION

In a broad context, technological advances occur very quickly. In the field of information, the application of the technological advances has played an important role.

Interaction in the teaching-learning process is not in conflict with the advances in technology; they should rather be closely related, allowing for joint benefits. On the one hand, teaching is a field which permits the use of a wide range of resources, such as personal computers, working nets, communication sources or information exchange. On the other hand, the adaptation and use of computing resources to the teaching-learning process provides new possibilities which could not have been reached in other way. In this respect, this tool provides answers to questions posed by students, for example: How does the system move?, What happens when I change one parameter?, How could I receive self-assessment?, How could I ask a question to my teacher, if distance or time becomes a problem?.

The difficulties of teachers during the stage of design and development of their teaching material is a problem that can be minimised with the use of the new technologies.

Therefore, the advantages of this potential resources available now in Internet extraordinarily help teachers in their task, and improve the quality and variety of the teaching resources in the benefit of the student.

Although from the aforementioned aspects it might seem that Internet can not offer more advantages to the learning process, this would be a mistake, since another possibility of Internet is its capacity to offer on-line courses, such as Virtual Classroom or Video-conferencing.

It should be mentioned, as an illustrating example, the extensive use of Internet to transfer information through e-mail. E-mail allows to ask or send inquiries to far places very fast and even more important, to use a computing language with the possibility of it being modified and reformulated and then re-addressed to different users.

OBJECTIVES

Among the wide range of possibilities provided by Internet, this work analyses the advantages of using Internet for Teaching purposes. More specifically, this resource is analysed as a complementary support tool for teachers. This work also includes practical examples of some common activities developed in the field of Mechanical Engineering. To illustrate these examples, this paper includes some applications, such as the use of Internet for the development of the theoretical and practical teaching sessions, tutorials, the editing of the contents of the course, examination results, etc on the Web. These examples adapt the traditional teaching methods, now outdated and strict, to recent learning approaches which allow for a greater flexibility, thus removing temporal and physical barriers.

METHODOLOGY

The new teaching changes introduced in the Field of Mechanical Engineering at the Department of Mechanical and Materials Engineering of the Polytechnic School of Alcoy (EPSA) are based on the implementation of this new way of understanding the teaching-learning process focusing on three main issues:

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- Complementary tool for teachers in the development of theoretical sessions.
- Supporting tool for the development of practical sessions.
- Complementary tool for tutorials.

COMPLEMENTARY TOOL FOR TEACHERS IN THE DEVELOPMENT OF THEORETICAL SESSIONS

The present situation of teachers in the professional world is determined by the changes produced in society. Far behind are the difficulties caused by the physical displacement of teachers to centres of information and libraries and the time-consuming searches with microfilms.

The new working conditions are based on the use of the new technologies which easily become available. Therefore it becomes a must to know the new tools and technologies available in order to go in pace with these new trends.

This allows teachers to employ traditional sources on paper, such as catalogues and bibliography as well as to use on-line resources for the development of theoretical sessions. The latter possibility provides the teacher with updated information about recent publications, well-known manufacturers of machine components, direct access to manufacturers who are known thanks to their web pages, in addition to the lower costs of edition and distribution for editors and publishing companies.

Among the different types of resources provided by Internet to help teachers with their teaching tasks, we can mention:

- Searching for specialised bibliography.

Through the different browsers and search engines available teachers may have a direct access to the specific bibliography available on a particular topic, both national and worldwide. Unlike traditional techniques for searching for bibliography, Internet allows to dispose of a greater number of publications, to know the most recent publications and even to have a short abstract of the contents of the documents selected.

- Consulting electronic publications from other universities.

Through the direct access to the web pages available, it is possible to know the state of the art on a given matter or either to know the documents and references used in other universities or institutions.

- Consulting manufacturer's catalogues.

Through the portals provided by the different companies and manufacturers, it is possible to know the latest advances in the standard mechanical components, as well as examples of application, business scope, product offer, prices, selection system, etc.

- Development of transparencies, course notes and publications.

There is a vast range of images, photographs, illustrations, diagrams, simulations, etc., available in Internet, which support and help students understand the subject matter.

- Obtaining useful information from public organizations. This information can be used as a guideline on specific topics for students to consult, so that students dispose of updated data on the latest innovations about legislation and regulations.

Search for specialised bibliography

On-line bibliography search allows to know the publications of different publishing companies on a certain topic. As an illustration of this technique, we offer the results obtained from a bibliography browser for machine components, Fig. 1. It provides details of the characteristics of machine components allowing for the appropriate purchase depending on the required specifications; some of them even offer CD-Rom including computer programmes and simulations.

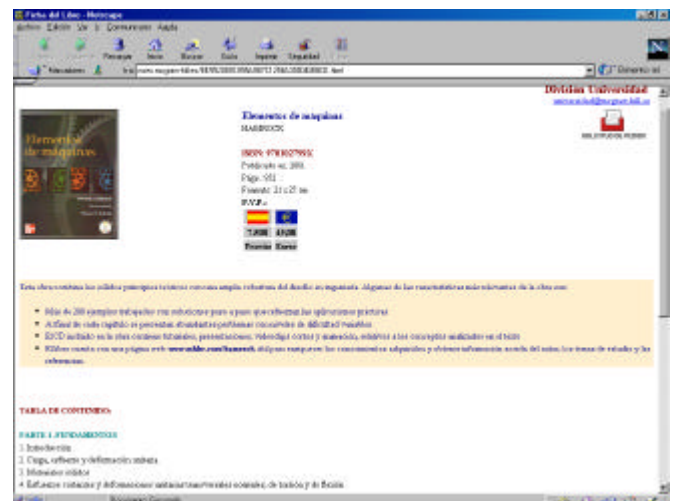


FIGURE 1
INFORMATION AVAILABLE IN BIBLIOGRAPHY PORTALS

Linking to electronic publications from other universities

Through linking to other universities, it is possible to know the approach, course contents and bibliography on a specific subject, offered by other universities. This permits teachers to have a fast access to information which otherwise would not be available to teaching staff different from the staff of the specific university, without physically moving from their working places. Figure 2 shows an example, illustrating all the data available in Internet for the selected subject.



FIGURE 2

DATA AVAILABLE IN INTERNET FOR A SPECIFIC COURSE

Consulting manufacturer's catalogues

The information provided by manufacturers in their webpages presents the characteristics of machine components that traditionally should be required to the factory or suppliers. Internet permits the direct access of the data from any place and at any time. This helps the teacher in the selection of one manufacturer, depending on the characteristics and specifications of the products provided, and to dispose of the complete range of products offered by the manufacturer. In some cases, off-line inquiry about a specific products is available.

The illustration of Figure 3 shows the possibilities of Internet.

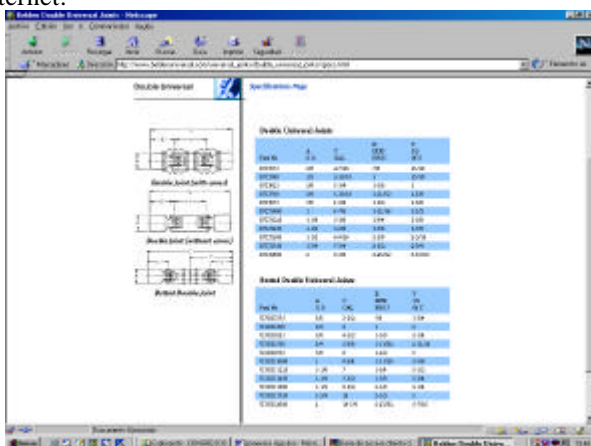


FIGURE 3

DATA AVAILABLE IN INTERNET FOR A SPECIFIC COURSE

Development of transparencies, course notes and publications

The design and development of transparencies and course notes can be notably improved with the use of Internet. This allows students to come closer to real situations. Through the use of 3-D representations of complex elements or simulations, requiring otherwise cumbersome and time-consuming operations, students have the possibility of understanding the subject matter better and more easily.

One of the most suitable fields for simulation is automation. In the case of the course on automobiles, the elements of the car industry available in Internet have been used, to illustrate and improve the students' comprehension of the course contents. Fig. 4 and Fig. 5 show diagrams that illustrate these advantages.

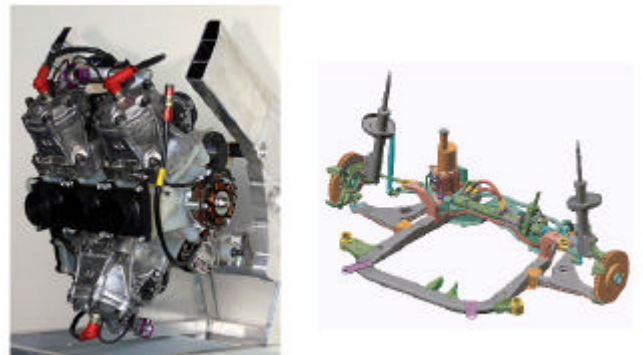


FIGURE 4 & 5

A THREE-CYLINDER ENGINE & FRONT SPRINGING SYSTEM OF A CAR

Obtaining useful information from public organizations

Sometimes it is difficult to find information available about the regulations for a specific sector or field, and it is cumbersome and time-consuming to search for on-paper information. On the contrary, the direct access to the web pages of public organizations and industrial sectors allows users to download the regulations required.



FIGURE 6

REGULATIONS FOR SOLID WASTE

Figure 6 illustrates the possibilities of searching for standards and regulations in Internet. This information has been very useful in the course on Materials Recyclability.

SUPPORTING TOOL FOR THE DESIGN OF PRACTICAL SESSIONS

The information available in Internet permits teachers to dispose of the following type of data:

- Search for getting information from machine component manufacturers to select the appropriate materials, once finished with theoretical calculations, electric motors, gear boxes, belts, coupling, bearings, etc.
- Computer programmes available in Internet for the calculation of bearings, gears, screws, tolerance analysis, etc.
- Consulting technical characteristics of different types of materials (ferrous metals, non-ferrous metals, polymers and composites, ceramics, woods, etc.).
- Unit conversion tables available in Internet.
-

With respect to the practical sessions, there are two types of use of Internet.

Information from different manufacturers available in Internet

It consists of providing students with information about different machine components and parts available in Internet, so that students can have a direct access to the information provided in the practical sessions of the course through UPV net.

Sometimes, it consists of an on-line link to the information, and sometimes through pdf files which can be downloaded to the computer, thus creating a database with the information including pdf images and illustrations of the machine components.

Fig 7 and Fig 8 show an example about the selection and application of three-phase electric motors.



FIGURE 7
ON-LINE INFORMATION ABOUT ELECTRIC MOTORS

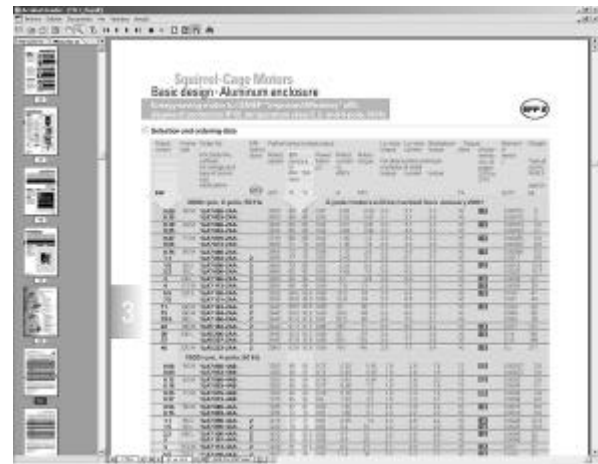


FIGURE 8
CATALOGUE OF THREE-PHASE ELECTRIC MOTORS AVAILABLE IN PDF FORMAT

Calculation programmes available in Internet

The practical sessions of the courses offered by the department of Mechanical Engineering include calculation methods for different machine components and mechanical design.

At present, these methods are implemented in Internet so that most calculations explained in the theoretical sessions can be actually implemented in the practical sessions, using the calculation programmes available in Internet. There are several web pages available for mechanical design.

The following web page shows an example of the calculations obtained from a British web page, Fig.9, that allows to perform all type of calculations for machine components, such as screws, shafts, gears, tolerance, etc.

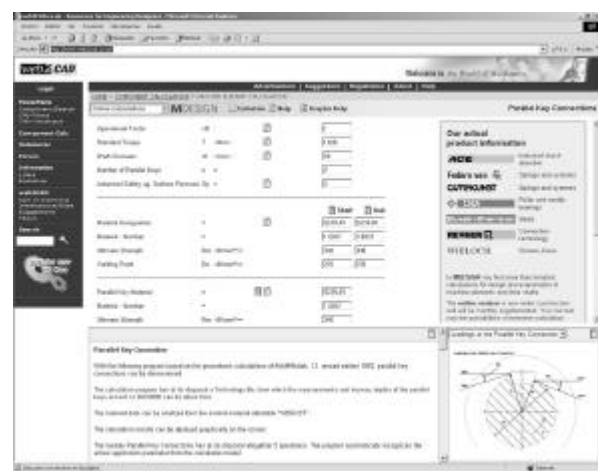


FIGURE 9
WEB PAGE OF AN ON-LINE CALCULATION PROGRAMME AVAILABLE IN INTERNET

This illustration shows the web page for data input to calculate a pin. The starting parameters must be indicated: transmission torque, shaft diameter, shaft material, coupling, including the elasticity and breaking values, operational temperature, calculation standards, pin dimensions (width, height, length), slot depth, etc.

The results of the programme are shown in Figure 10, also including a graphical representation of the forces acting on both elements, being of great help to show the students the positioning of the forces. It also includes comments on the maximum forces or stresses for the selected material.

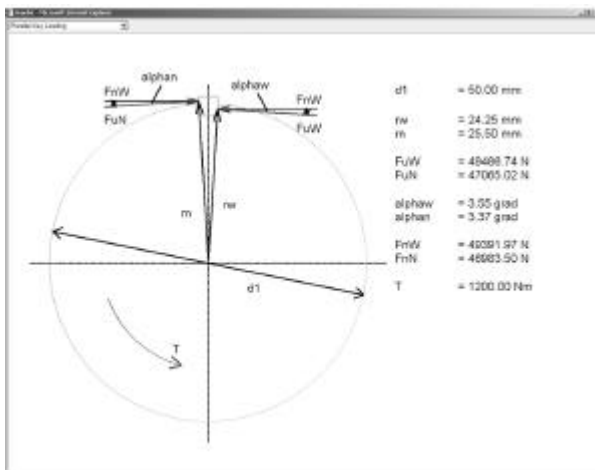


FIGURE 10

RESULTS OF THE ON-LINE PIN CALCULATIONS, INCLUDING THE FORCES ACTING ON IT

Information about the resistance characteristics of the materials

With respect to the information about the mechanical characteristics of the materials, there are two types of web pages, some general web pages provide information about any kind of material, from metals to woods, and some more specific web pages provide information about a certain type of material.

Figure 11 and Figure 12 show an example of the kind of information available in Internet. The first one refers to a general web page where the search is for the mechanical characteristics of 6082-T6 aluminium.

The second one refers to the search for the characteristics of polypropilene. This web page provides information about the mechanical, thermal, electrical and rheological characteristics of this polymer, and graphs of its tensile strength, creep, shear module at different temperatures, and possible applications of the material.

Aluminum 6082-T6

Subcategory: Aluminum Alloy; Nonferrous Metal; 6000 Series Aluminum Alloy

Close Analogs: 6082 is commonly used in the UK in the types of applications for which 6061 is used in North America. MatWeb's entry for 6061 has more property information.

Key Words: EU Numerical EN-AW-6082; EU Chemical AISI1MgMn; AA6082; Sweden: SS-EN-AW-6082; Aluminum 6082-T6;

Composition:

Component	Wt. %	Component	Wt. %	Component	Wt. %
Al	87	Mg	0.6 - 1.2	Si	0.7 - 1.3
Cr	Max 0.25	Mn	0.4 - 1	Ti	Max 0.1
Cu	Max 0.1	Others (total)	Max 0.15	Zn	Max 0.2
Fe	Max 0.5				

Material Notes: Aluminum content above calculated as remainder. Material specs taken from SAPA / Indalex manual on extrusions.

[Click here for a list of companies that sell this material.](#)

PHYSICAL PROPERTIES	VALUES	COMMENTS	US / Other Units
Density, g/cc	2.7		2.7 g/cc
Hardness, Vickers	95		95
Tensile Strength, Ultimate, MPa	290	(Value is 310 MPa for wall thickness > 5 mm.)	42.061 psi
Tensile Strength, Yield, MPa	250	(Value for wall thickness > 5 mm is 260 MPa).	36.250 psi
Elongation %; break	10		10 %
Thermal Conductivity, W/m-K	170		1,100 BTU in/hr-ft ² -°F

FIGURE 11

CHARACTERISTICS OF 6082 -T6 ALUMINIUM, AVAILABLE IN INTERNET

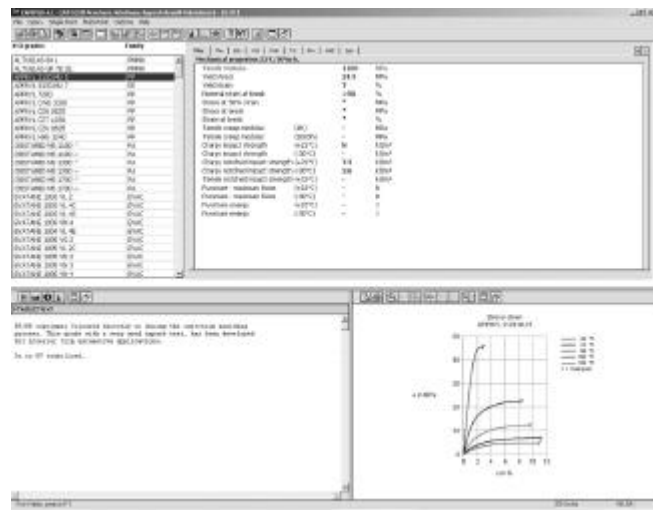


FIGURE 12

POLYMER CHARACTERISTICS AVAILABLE IN INTERNET

Unit Conversion Tables

In the practical sessions or direct access of students to Internet, a wide range of web pages are used which provide unit conversion tables. Figure 13 shows an example of conversion for Engineering units.



FIGURE 13
CONVERSION OF PHYSICAL UNITS AVAILABLE IN INTERNET

COMPLEMENTARY SUPPORTING TOOL FOR TUTORIALS

The learning process requires the verification of the correct acquisition and understanding of the concepts explained in the course. It is through these control systems how we can assess the correct acquisition and understanding of the course concepts, serving also as feedback. Therefore, the quality of the knowledge acquired by students will greatly depend on the control and assessment tests designed by teachers, so that the greater the number of concepts (or rather practical applications of the concepts) to be evaluated, the better the quality of the learning process.

At present the possibility of performing exhaustive evaluations for each unit of the course is impossible for both the teacher and the student using the conventional assessment methods. Thus learning quality becomes lessened, as the teacher cannot cover all the concepts studied in the course in just one or two control tests or examinations, then being constrained to the basic concepts of the subject matter. On the other hand, if the student is only provided with one or two assessment tests or examinations, the feedback process also becomes limited.

A possible solution to this problem could be a teaching system and tutorial assessment through two possible methods:

- On-line tutorials.
- On-site tutorials.

This system allows the student to study and evaluate his/her knowledge without the direct interaction of the teacher, going to the traditional tutorials to learn those concepts not correctly understood or assimilated. On the other hand, this will also help to relieve the overcharged traditional tutorials, allowing the teacher to offer a more personal contact to his/her students. The new technologies,

especially Internet, permit the use of new approaches which allow for a better tutorial of the student, especially in the case of on-line tutorials.

Some of the practical applications being implemented through Internet are:

1. Learning through the use of tutorial programmes.
2. Interactive assessment.
3. Distance tutorials.
4. Edition of course notes, problems, comments, etc. available in the web.

Each of these aspects is developed in more detail here below, showing examples of the activities developed by the Department of Mechanical Engineering and Materials of the EPSA.

Use of Tutorial programmes

Some sections of the courses require more graphical support than others, as their understanding and comprehension require a greater level of abstraction from the students. In these particular sections it is possible to help students through the inclusion of colour images, animations, sounds, etc. The use of Internet permits to distribute these tutorials to the students, allowing for modifications and changes based on the comments provided by students.

Figure 14 shows the display of a tutorial about Robots developed by the Department of Mechanical Engineering of the EPSA, addressed to students of Industrial Organisation in the subject of Robotics in Production.

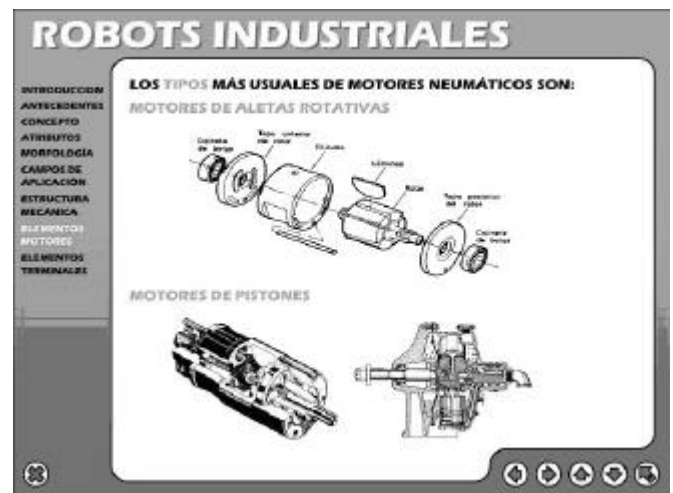


FIGURE 14
TUTORIAL ADDRESSED TO STUDENTS

Interactive assessment

The edition of on-line assessment tests allows students to perform the tests when they consider as appropriate. In addition, this relieves the teacher from the timeconsuming task of marking huge numbers of tests. If tudents have any doubts, they can solve them studying the contents of the unit, or either they can ask the teacher.

In the course of Machine Design, one of the units with the most theoretical content is the unit about bearings. Bearing selection, in addition to the calculation of the bearing operating life, requires the specific knowledge of other factors necessary to understanding bearing durability and estimation of the bearing operating life: angle adaptability, self-alignment, capacity to absorb combined loads, accuracy, etc. Therefore, this topic includes a wide range of concepts as important as the calculation itself. A battery of 45 items is used to assess these concepts, developed by SKF, Figure 15, consisting of multiple-choice questions that show the student his/her wrong answers. These questions cover all the basic concepts about bearings and provide a useful tool for the students' self-assessment and self-evaluations.

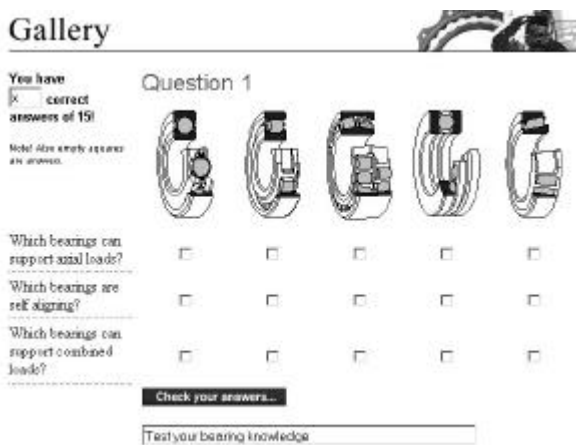


FIGURE 15
TUTORIAL ADDRESSED TO STUDENTS

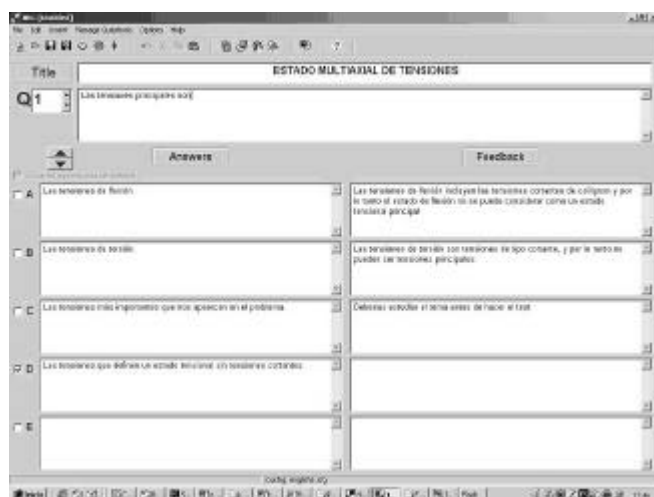


FIGURE 16
MULTIPLE-CHOICE TUTORIAL

For other topics, the teacher can design multiple choice tests for those sections of the theoretical part of the course

which may require them, using already made programmes available in Internet. The teacher provides a number of multiple-choice questions to be answered by the student. For the wrong answers the programme provides extra comments or help on the specific issue. Figure 16 shows an example.

Distance tutorials

Through the use of the electronic mail, the student has the possibility of asking questions to the teacher without physically moving. This type of tutorial is very useful when the student has problems to go to the teacher's office due to working or health factors. This system should not be used indiscriminately or be considered as the substitution of the on-site tutorials, but as a complementary method.

One application of these tutorials was developed last year for the students of the Materials Engineering Degree. Most students were studying and working at the same time, so that it became difficult for them to attend tutorials within ordinary timetables. In the course on Machine Components, the method used for the practical sessions was to edit the contents in the web, as well as the required material to develop the practical work. Subsequently, those students unable to attend the practical sessions or who had questions or doubts could ask them through the electronic mail. These questions include Word or Excel files, showing the students' progress in the practical sessions.

Edition of documents in the web

The edition of course notes, problems, comments, etc, provides students with direct information about the course. In this way, the student can retrieve from the web the units explained so far and print them, thus avoiding queuing at the photocopier, and with better printing quality than conventional photocopies. As mentioned in the previous paragraph, distance tutorials can be complemented with the edition of complementary material in the web.

CONCLUSIONS

Although the issues here mentioned are but a few of the possibilities provided by Internet, from the teaching point of view, the use of computer resources opens a wide range of possibilities unthinkable only a few years ago. Since the 80s, personal computers have been increasingly employed in the teaching methodology, helping teachers in the development of their teaching tasks and activities and allowing them to know the latest bibliography, manufacturer products, catalogues, or even on-line tutorials or on-line administration resources to know the regulations existing on a certain topic.

CONTRIBUTIONS

Among the different fields in which Internet can play an important role, this paper has analysed those areas closely related with teachers, teaching and students. More

specifically, this paper presents the possibilities of Internet in the following aspects:

- Development of theoretical sessions.
- Development of practical sessions.
- Support resources for students.

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RECOMMENDED URL

Link	Description
http://www.efunda.com/	Tutorials and questionnaires on Mechanical Engineering.
http://www.matweb.com/	Database about all types of engineering materials
http://www.campusplastics.com/	Database about plastics
http://www.web2cad.co.uk/	Calculation programmes for machine components
http://buscario.com.br/mecanica/	Calculation programmes for machine components
http://www.terra.es/personal/eca/vog/	Catalogue of machine components
http://www.mech.f2s.com/	Questionnaires about physics, mechanics and thermodynamics.
http://www.lanzadera.com/auto/matas/	Tutorial of robots and hydraulics
http://www-sci.lib.uci.edu/HSG/RefCalculators.html	Links to web pages providing calculation programmes.
http://www.abb.com	Electrical component manufacturer
http://www.siemens.com	Electrical component manufacturer
http://www.fag.com/	Bearing manufacturer
http://www.skf.com/	Bearing manufacturer
http://www.bonfiglioli.com	Reducer manufacturer