DESIGN 2002

INTRODUCING IT IN TEACHING THE ENGINEERING DESIGN GRAPHICS AT THE FACULTY OF GRAPHIC ARTS, UNIVERSITY OF ZAGREB, CROATIA

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1. Introduction

In the last three years, 159, 152, 155 students enrolled, respectively, Faculty of Graphic Arts, Zagreb. All of them attended, in the 1st semester, the course entitled "Basics of Mechanical Engineering 1". Curriculum covers basics of Engineering Design Graphics, and is mostly intended to give fundamentals for courses about packaging construction and design, as well as courses about graphic machines. Until 3 years ago, the only teaching aids were blackboard, drafting triangles and compass. Assignments were made by technical fountain pen on tracing paper.

In the academic year 1999/2000, primary changes were introduced: lectures on 2D/3D CAD/CAM systems and principles; exercises in computer lab, where students learn in deductive manner the curriculum through the use of AutoCAD®, as the first obligatory exercise on computers at the study; assignments have to be made in AutoCAD® and given to evaluation on diskette. The book that covered all the exercises was published in the next year [Bjelovučić-Kopilović 2000.]. In 2001/2002 this book was made freely downloadable at web-site created as a support to the Chair of Mechanical Engineering. Assignment is changed to creation of student's own web page and publishing drawings on it. Lectures are held using LCD projector connected to notebook for demonstrating exercises in AutoCAD®, as well as making and publishing of web pages, and displaying virtual simulations of various models and principles.

For purposes of this article, the questionnaire was conducted this year among the students of the 1st year:

- 72% have access to computer outside the faculty, 23% were educated to use computers in primary school, 72% in secondary school; 55% know how to use Internet, 28% have e-mail address. 98% would like to learn and work on computers at the faculty;

- 25% would like to work in printing house, 52% on packaging construction and design, 20% in graphic products shop, 42% in web authoring, 41% in producing multimedia interactive CD's and presentations

- 56% would like to work in Zagreb, 11% in their native place outside Zagreb, 24% abroad, 27% would like to have a computer work at home for foreign companies (so, to stay in Croatia but earn a salary according to foreign standards)

2. Why AutoCAD®?

AutoCAD®, created by AutoDesk, is the most widely used and the most flexible technical design program, which covers all fields of technical drawing; this fact enables its relative low price in relation to the other, narrowly specialized software packages. It involves 2D and 3D design, and the possibility of photorealistic rendering (from different views and with various lighting and backgrounds) of designed 3D models on which various colours and materials could be applied, either from very opulent materials from a library, either independently created, for example by mapping drawings, photos, bump maps, etc., at the model surfaces. With AutoCAD®, it is possible to make 2D drawings, for example of the folding carton, to create logos and labels, but also to photorealistically visualize and simulate the final look of, for example, 3D model of packaging with print on it (fig. 1) [Bjelovučić-Kopilović 2001.].
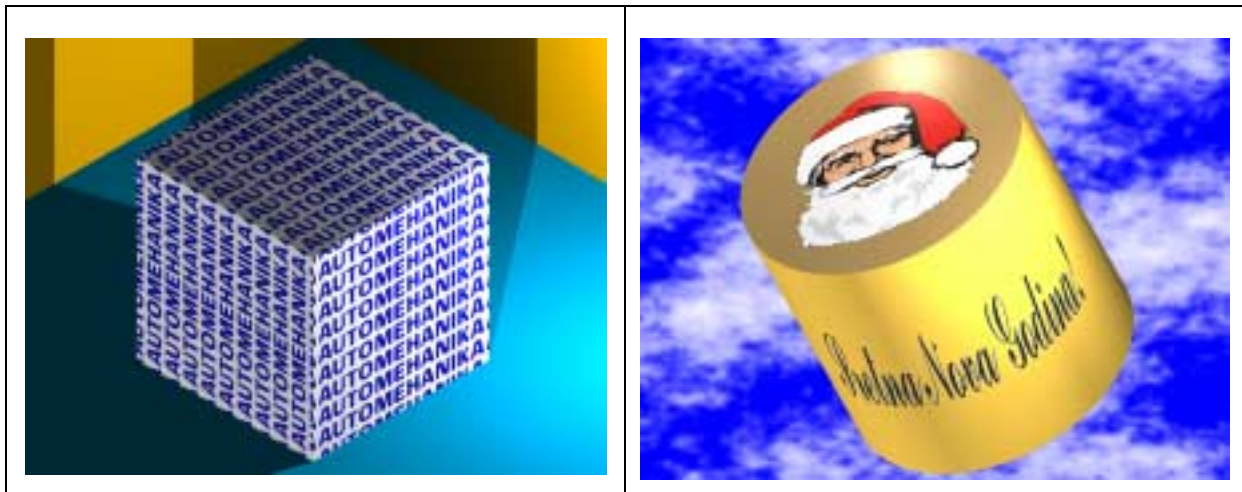

Figure 1. left) Cube-shaped packaging tiled with logo; right) Decoration box with various patterns at the flat and cylindrical surfaces
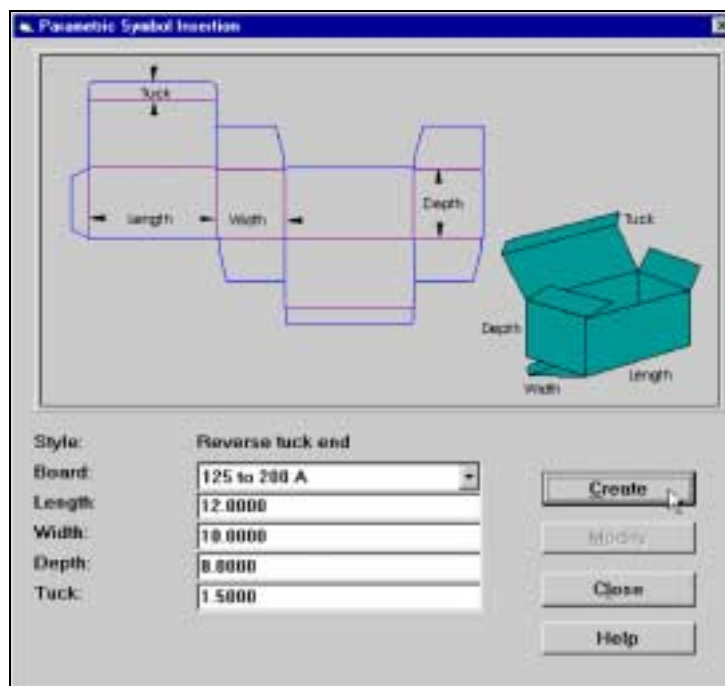

Figure 2. One of the dialog boxes of VisionPack software

There are several narrowly specialized software products on the market for packaging construction and/or graphic design, which are indubitably useful for their purposes, especially which have immediate outputs to NC machines for producing packaging (e.g. plotter-cutter). However, each of them has its own limitations which are consequences of narrow specialization and, on the other hand, consequences of the fact that they have relatively a small number of purchasers so extensions are made modularly according to the needs of the market or according to orders which have their own price. Fig. 2 shows one of the pop-up menus of the VisionPack™ software, made by VisionPack Limited®, with built-in AutoCAD® compatibility, because of extending its own limitations in 2D constructioning. From the figure, it is clear that this program has the possibility of 2D construction of the blank box as well as 3D visualisation of the box from that blank box. However, this kind of 3D visualisation is not photorealistic and can not simulate material, pressed images or fonts. Fig. 3 shows photorealistical modelling, on the example of 3D model of the machine element, which animation is published on the below described web-site, in one of the top softwares for 3D modelling and computer animation - 3D Studio MAX of the Autodesk company. However, this sort of program does not have a possibility of precise 2D modelling. AutoCAD® *has* insufficient depth for executing some narrowly specialized tasks, as is, for example, virtual simulation. That task is, nevertheless, satisfyingly done in the context of education of the students, considering poor material and financial resources intended for science and higher education in Croatia, because the fudamental principles of 3D modelling and rendering, which are built-in in AutoCAD®, are the same as the principles built in top programs made only for that purposes. The knowledge of AutoCAD®-a is needed also in prepress (drawing of schemes and various 2D and 3D drawings). Virtual simulating is very useful, of course, in machine engineering too, beside a lot of other examples of applicabilities of the AutoCAD® in this area of technical sciences. One of these applicabilities, which is also interesting in engineering and designing of the packaging, is a possibility of the automatical creations of the orthogonal projections and intersections of the constructed 3D model. Here lies a great utility for developing the space perception and easier understanding of the orthogonal projections, isometry and perspective, as well as of technical drawing in general, in the education of students. Because of the acceptable price of the software without great hardware requirements and the compatibility with almost all programs for PC platforms which are more powerful for particular specialized requirements, AutoCAD® has been the choice of the software package of the authors of this article for introducing it in the course "Basics of Mechanical Engineering 1".
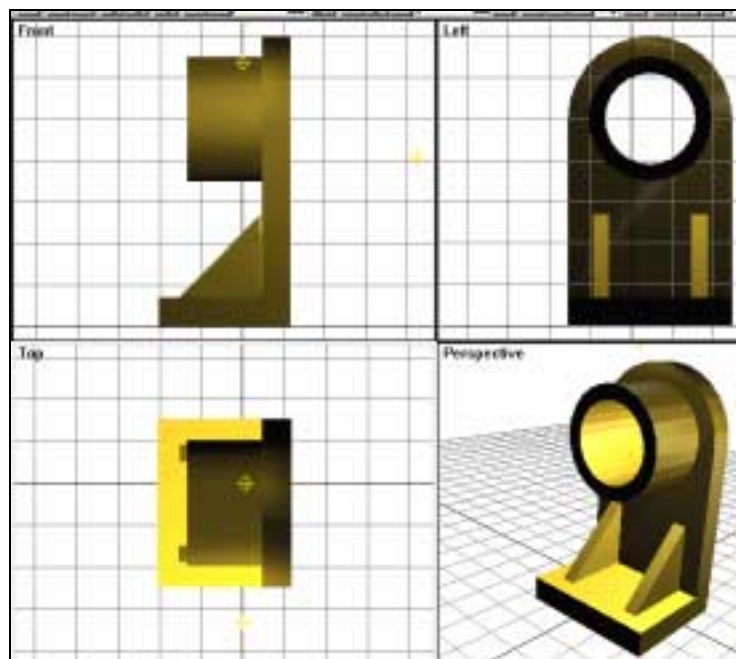

**Figure 3. 3D model of a machine element in 4 views**

3. Exercises in Computer Lab

Computer exercises are divided in 3 main parts, in which students:

1. Are introduced into the basics of 2D drafting in AutoCAD® through drawing front and top view of a machine element, and simultaneously have to apply standards of technical drawing relating types of lines, lettering, scales, formats, title blocks, dimensioning. According to dimensions of the top view, they extrude front view into 3D model, so they easily and quickly visualise conversion of orthographic projections into virtual model.

2. Create 3D model of a machine element, given by dimensioned isometric drawing, fig. 4, left, thus introducing computer modelling of solids by Boolean operators; visualise 3D model by photorealistic rendering and by viewing it from different points and kinds of view; then initiate automatic creation of orthographic projections with hidden lines and hatching, fig. 4, right; they only have to provide the dimensions for the obtained projections. By such exercises they easily comprehend orthographic projections, and through learning and experimenting with rendering options guided by the given instructions, they assimilate design principles and rules that apply to displaying information effectively, based upon scientific approach on perception and fundamental principles of the science of color and its implications for data display [Ware, 2000.].

3. From given the top and front views of certain regular geometrical body (fig. 5, left) and intersection lines of a cutting plane, they have to construct a 3D model, which can be viewed in different ways for better visualisation and comprehension (fig. 6). Then, they construct the side view, true size of intersection and the development of truncated geometrical body (fig. 5 right). A great number of instructions make constructing easier, including AutoCAD® calculator which, beside mathematical functions, has a number of functions for calculating and translating the distances of particular points and vectors of the drawings thus enabling easier construction of the developments of the various geometrical bodies, regular and truncated, which are basics for understanding and producing the flat boxes.
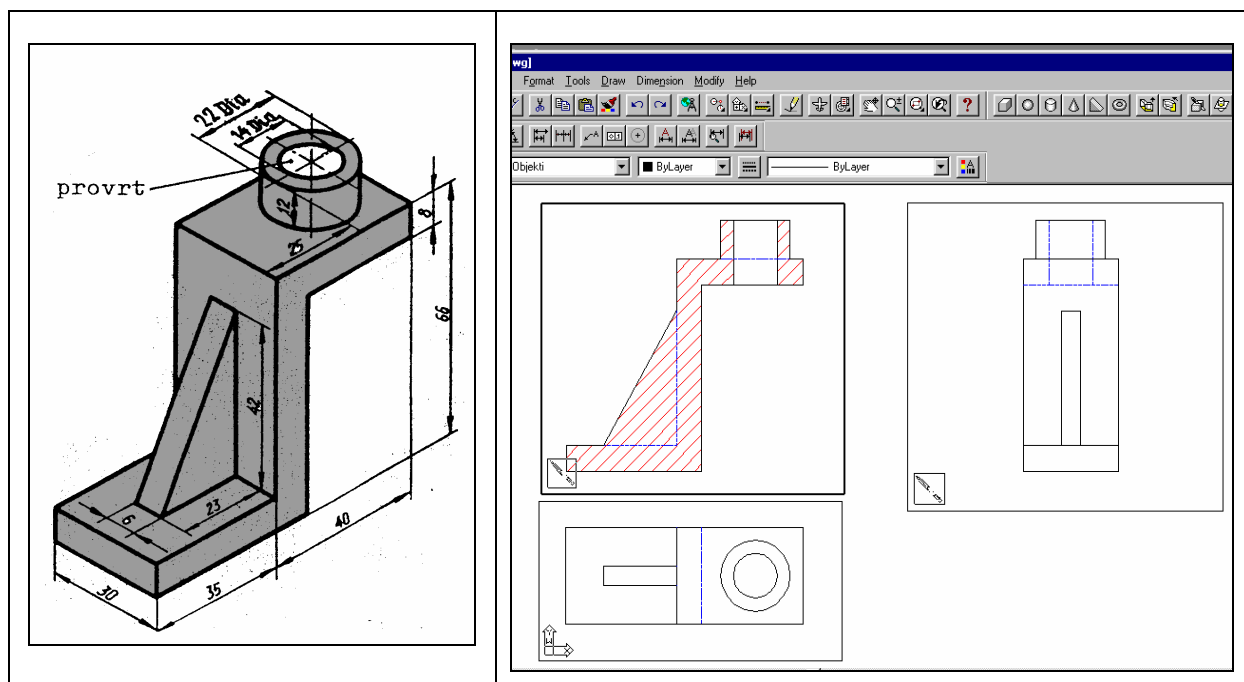
Figure 4. left) given dimensioned isometric drawing of a machine element; right) automatically created orthographic projections with hidden lines and hatching, by AutoLisp procedures SOLVIEW and SOLDRAW
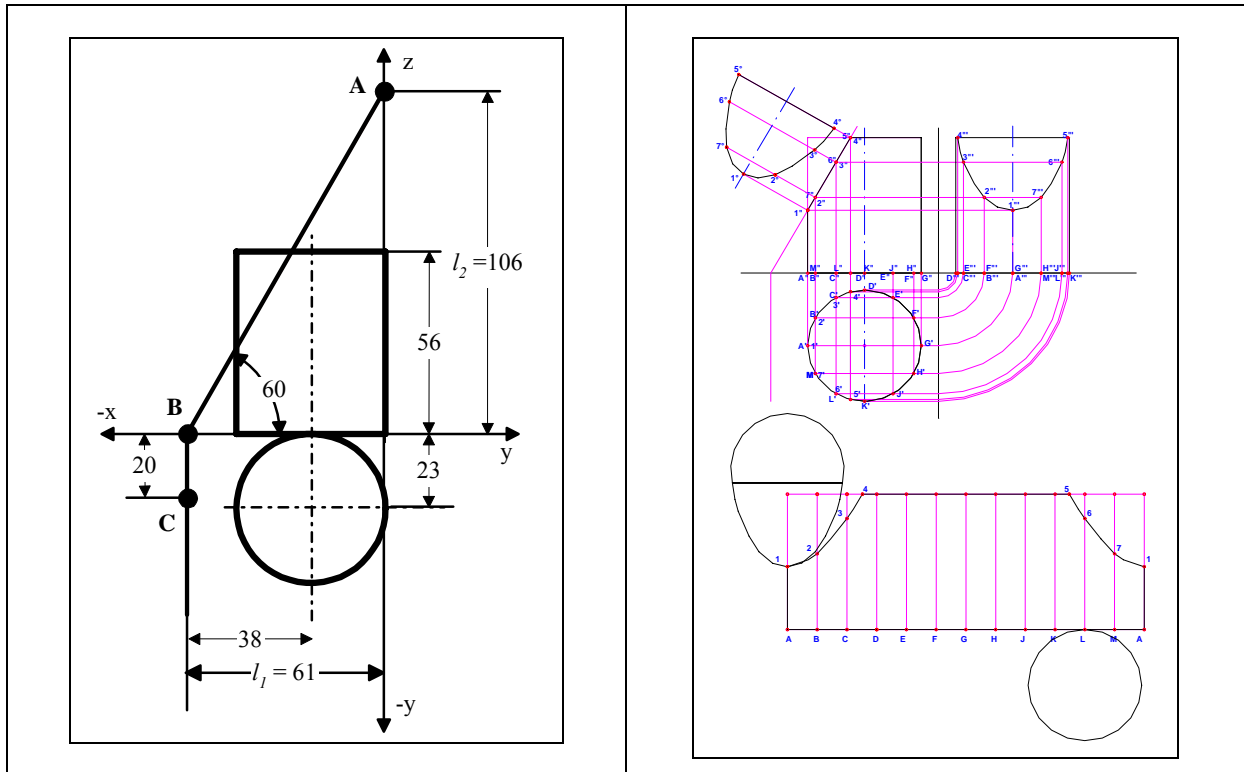
Figure 5. left) Given top and front views of certain regular geometrical body and intersection lines of a cutting plane; right) Constructed side view, true size of intersection and the development of truncated geometric body
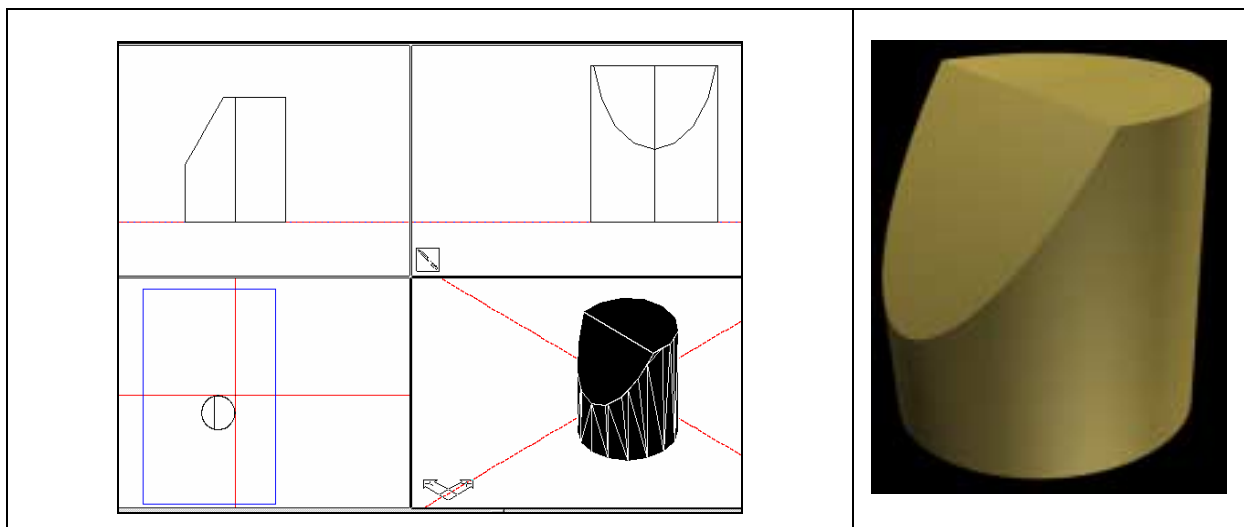
Figure 6. Constructed 3D model according to fig. 5, left, viewed in different ways for better visualisation and comprehension

4. Web-site (URL: http://www.sbkgf.com)

The first web-site was made in September 2001, as a personal experimental page of the first author, for two basic purposes: 1) to publish a textbook which is needed for following the exercises in the computer classroom; because the edition from 2000 was sold out, it was the quickest way for the textbook to be available to all students for free, and this confers it a right to be an obligatory reading; 2) to improve the author's web authoring skills. However, because of the great interest of the students for the web contents, web-site has been extended and developed so that on November 8th 2000 it had to be transferred to web-hosting provider with better services, fig.7. It develops continuously; fig. 8

and table 1 show some parts of the statistic analysis of the web-site, which give insight into visiting the site. Fig. 8 shows increase in visiting frequency of the web-site in accordance with its development and in relation to approaching of the exam period.
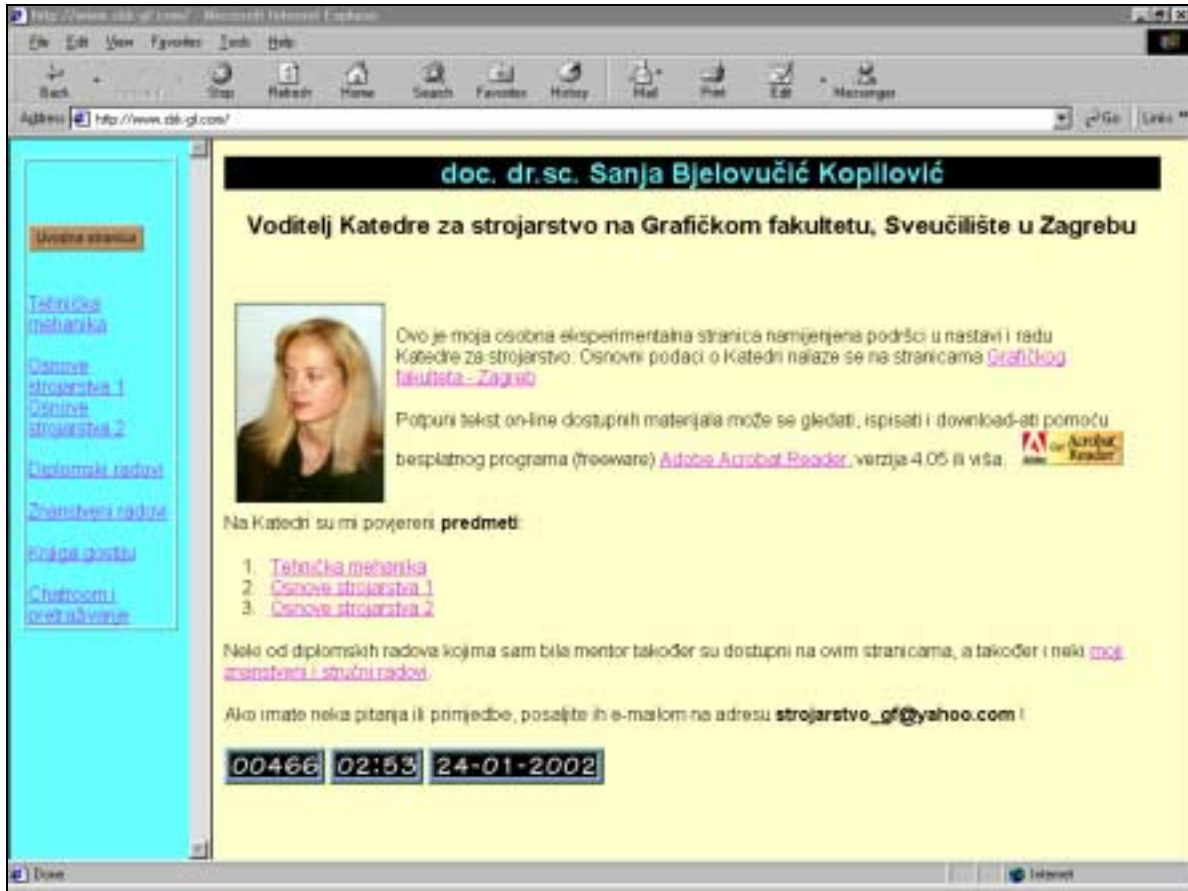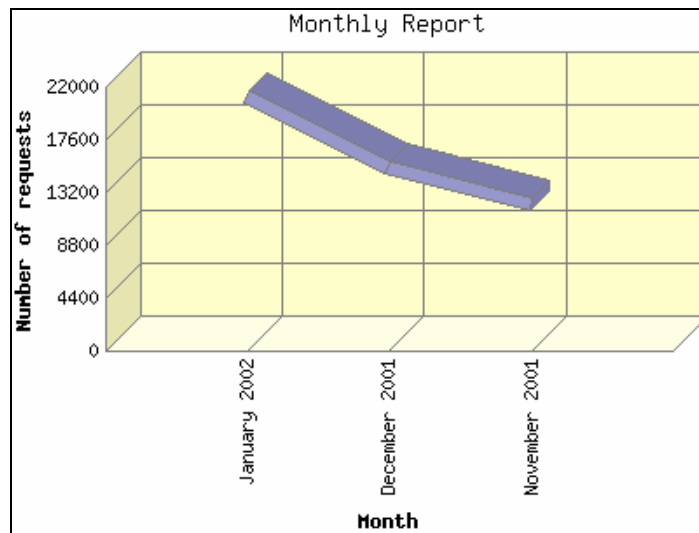

Figure 7. Home page of *http://www.sbkgf.com/*

Figure 8. The Monthly Report identifies activity for each month in the report time frame. Web statistics report produced by: Analog 5.03, *http://www.analog.cx/*

Table 1. User Agents Report. This report was generated on January 22nd, 2002, for January 2002. Web statistics report produced by: Webalizer Version 2.01, *http://www. mrunix.net/webalizer /*

			Top 15 of 51 Total User Agents
#	Hits		User Agent
1	539	12.03%	Mozilla/4.0 (compatible; MSIE 5.0; Windows 98; DigExt)
2	431	9.62%	Mozilla/4.0 (compatible; MSIE 5.01; Windows NT 5.0)
3	379	8.46%	Mozilla/4.0 (compatible; MSIE 5.5; Windows 98; Win 9x 4.90)
4	276	6.16%	Mozilla/4.0 (compatible; MSIE 5.0; Windows 95)
5	216	4.82%	Mozilla/4.0 (compatible; MSIE 4.01; Windows 98)
6	205	4.57%	Mozilla/4.0 (compatible; MSIE 5.5; Windows 98)
7	160	3.57%	Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0)
8	153	3.41%	Mozilla/4.0 (compatible; MSIE 5.0; Windows 95; DigExt)
9	143	3.19%	Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.1; Q312461)
10	138	3.08%	Mozilla/4.0 (compatible; MSIE 5.01; Windows 98; BCD2000)
11	131	2.92%	Mozilla/4.0 (compatible; MSIE 5.5; Windows 95)
12	131	2.92%	Mozilla/4.0 (compatible; MSIE 6.0; Windows 98)
13	128	2.86%	Mozilla/4.0 (compatible; MSIE 5.01; Windows 98; VIPonline1)
14	122	2.72%	Mozilla/4.0 (compatible; MSIE 5.5; Windows 98; Win 9x 4.90; H
15	116	2.59%	Mozilla/4.0 (compatible; MSIE 5.5; Windows 98; HINET6)

Webalizer is a web server log file analysis program, which produces usage statistics. Yearly, monthly, daily and hourly, usage statistics are presented, along with the ability to display usage by site, URL, referrer, user agent (browser), search string, entry/exit page, username and country. Each User Agent reports itself in a unique way to the server: with the browser name, the version number, any sub-level designation, the system type, sometimes ISP and some other data. Accordingly, 51 Total User Agents regularly means 51 different computers, except if the browser, OS or something else is meanwhile changed in the computer. Sites are the number of unique IP addresses/hostnames that made requests to the server. Many users can appear to come from a single site, and they can also appear to come from many IP addresses so it should be used simply as a rough measure as to the number of visitors to the server. For the first three weeks of January 2002 Webalizer has registered 107 usages by sites, and 51 Total User Agents. Taking into account that it is possible that more computers have User Agent of the same specifications, especially if they form a network, and that there were some visitors others than students (not much, however, according to other statistical data) and that more students could reach the Internet from the same computer, a rough estimation would give that at least 50% of the students visited this site in the first three weeks of January 2002 at least once, and at least some of them several times.

4.1 Structure of the web-site

Navigation bar presently navigates to follow the main fields: 3 of them are separate curriculums of the Chair for Mechanical Engineering: "Technical Mechanics", "Basics of Mechanical Engineering 1" and "Basics of Mechanical Engineering 2". The others are: graduate theses done at this Chair, scientific publications of the head of the Chair, communication with students (Guestbook, Chatroom), and Search Engine of the Site. Graduate theses and scientific publications are not only enumerated but some of them are completely available, especially that which contain data which could be of help for students as an auxiliary literature in comprehending the curriculum. Inside the particular subjects, web-site branches as follows: oral exam questions, examples of solved exam problems, notes from lectures. For the teaching of the Engineering Design Graphics in the curriculum "Basics of Mechanical Engineering 1", which this article is about, tasks and problems are given and instructions for working

out the seminars are provided. The students on the list are correlated with number of the pictures by which the tasks are given to them. Pictures are in GIF format, optimised for web from TIFF-format with satisfying high resolution that it could be printed clearly on the printer. GIF format is chosen because it enables the students to copy these pictures from the web to diskette and to insert them in their own web-pages as well as on the front page of their seminars which have to be handed over in printed form. On their web-pages, students have to provide their personal data, insert copied drafts of tasks, make rendered pictures of constructed 3D model of a machine element and 3D model of a given truncated geometrical body in JPEG format, with descriptions of the suppositions of the rendering along with the descriptions of the contents and formats of the pictures and the way of construction of the web-page. Rendering has to be executed with 24-bit colour depth and the picture has to be stored in TIFF format, because: 1) it is not possible to render directly from AutoCAD to JPEG or GIF, the latter being the two formats of pictures which are supported on all browsers and 2) for quality printing of the pictures. After that, the picture in TIFF format has to be optimised for the web using the program Macromedia® Fireworks® (downloadable shareware) in JPEG adaptive color palette. The first idea was that students have to publish their AutoCAD drawings on the web, but it came out too complicated. Enabling most users to browse the pictures in DWF-format made by AutoCAD versions 14 and 2000 on the web, require such a knowledge in HTML programming that extends over the curriculum of the subject. To enable people using either Netscape Navigator or Microsoft Internet Explorer to view DWF files, the <object> tag for Microsoft Internet Explorer and the <embed> tag for Netscape Navigator have to be added. Part of the <object> tag for Microsoft Internet Explorer *codebase* must specify hard coded URL to identify where users of the Microsoft Internet Explorer get updates of the WHIP! ActiveX Control. Part of the <embed> tag of the Netscape Navigator *Pluginspage* specifies a URL where users, who do not have the WHIP! plug-in, can go to download the plug-in. Because of the above mentioned reasons, students are directed to the most simple variants:

- to build their personal web page at *www.geocities.com*, the largest free home page community on the web (Yahoo! GeoCities). Creating web pages is easy with popular tools Yahoo!PageWizards (simple, step-by-step method for absolute beginners) and Yahoo! PageBuilder (for designing and customising pages easily with powerful and full-featured editor),
- or, if they have a free of charge web-space on their own ISP, they can use Microsoft Word and its option Save as HTML.
- for students who already have advanced knowledge, there is a possibility to make web page as they wish with the condition that a given task had to be completed.

Instructions about the possibilities of changing the background colour and fonts from the original HTML, exclusively in web-safe palette, how to avoid banding when colour depth is lessened, explanations of basic concepts and procedures of Internet Fundamentals, needed for publishing their web page, are all provided. Primary means of the publishing of the students' seminars is fulfilling the need for informatization and internetization already from the first year of study, which contains the greatest number of students. Secondary, because these pages will be connected with the web-site of the Chair for Mechanical Engineering, they will serve next generations as well. In these ways, web-site will be extended with students' works also, which will be differently conceived each year to make a comprehensive database of knowledge and data for future generations.

5. Conclusion

University of Zagreb published on May 28th, 2001, a document "Iskorak 2001, Razvojna strategija Sveučilišta u Zagrebu (teze za raspravu)" ("Leap 2001, The Developmental Strategy of the University of Zagreb" /theses for discussion/) on the web-site of the University http://www.unizg.hr/global.doc, by which the academic community is summoned to take its responsibility for improvement of the University in the process of the integrating into European academic integrations. In this document, SWOT – analysis is given (S-strengths, W-weaknesses, O-opportunities, T-threats) of the current state, on which basis developmental aims are determined, expected outcomes are formulated along with difficulties and obstacles, and strategic steps to be undertaken.

Authors of this article recognised many of their own difficulties and obstacles, measures undertaken,

strategic steps and expected outcomes reached in the applications of information technologies, in lecturing generally and in the managing of the quality in the sense of striving of the lecturers for perfection in the approach which is directed towards students with the focus of a construction of "useable knowledge" instead of accumulating of a "stored knowledge".

5.1 Difficulties and Obstacles

Difficulties and obstacles, which we encountered in our work, are very similar to difficulties and obstacles in general development of the Republic of Croatia and they can be classified as cultural, infrastructural and financial:

- Insufficient present investments for upbuilding of the information infrastructure of the University and non-existing of financial resources for future investments; insufficient resources for introducing new technologies in lecturing at the Faculty of Graphic Arts.
- Studies are treated in a great deal as a social category but not as an educational category, which contributes to the lack of motivation on the part of the students and to a slow rate of progress in the study. There is a lack of the needed attention for enrolment policy, both on a national level and on a university level, though it influences, directly and indirectly, the quality of lecturing process and this situation leads to "enrolment fever" and to frequent changing of the studies after the first year of study. We have noticed, during these 3 years, that about 60% of the first year students are informatically illiterate, have weak general education and weak logical thinking. All of these have a lot of influence on the course of lecturing (for example, during the first exercises, while some of the students click the mouse button for the first time, the others have already tried all the tools for drawing). The rest of the students, about 40%, comprehend the lectures very well taking active part in the course of lectures.
- The system of professional education in planning and executing the course of lectures is not composed. Lecturing and professional activities are not adequately valued in appointing procedures in comparison with scientific activities. There is no standardized efficacious mechanism for recognising and rewarding the excellence and quality, both at the University and at the Faculty of Graphic Arts. Mediocrity and "equilizing" are still models of functioning at the Croatian universities. This is a serious drawback from the point of view of managing of the quality; the aim of managing of the quality in course of the studies at the university is to build up and place such a system which will continuously improve lecturing activities and motivate the lecturers for excellence, comparing his or her own results in lecturing with the best current achievements world-wide (introducing new contemporary methods, interactive approach to students).
- Non-existence of decent and appropriate work conditions, non-availability of contemporary lecturing technologies as well as lecturing materials, devices and literature; insufficient investments from Faculty's own income and resources for material basics (outfit and organisation of classrooms, working spaces and inventory for improvement of the ergonomic conditions). Concretely, until January 1st, 2002, we had only one computer lab with dimensions cca. 3x3m, with 6 computers forming a network, connected to Internet. Now we have another computer lab with 15 computers, but these computers do not form a network and they are not connected to Internet; beside that we share this classroom with Graphic secondary school. There are no connections for network in the other classrooms; LCD projector is purchased only this year but the notebooks must be bought by ourselves if lecturers want to use the projector! At the Chair for Mechanical Engineering there is only one computer, which is 8 years old! For scientific research, preparing the lectures, making web-pages and all the other materials, our own home computers are used as well as a modem access to Internet. Statistic analysis of visiting the web-site showed that the most of the students also use their own computers at home and they have to pay for the access to Internet.
- Non-existence of the centre for applying the IT for the education at the Faculty, as a support for lecturers; we have only one system-engineer who works half time at the Faculty. Non-defined lecturing obligations and lecturing norms due to changed approach to realisation of the

lecturing; norm consists only of lecturing hours but preparing, forming and updating of the lectures aiming to improve the course of lectures are not included.

5.2 Strategic steps and measures we have undertaken

- We educate students about possibilities and for using and applying of the IT; we ensured that all the students of the Faculty of Graphic Arts get equal and appropriate education in using and applying of the IT already in the first year of study. We strive to be one of the positive examples, which will support all activities and make positive environment at the university also and in all relevant structures outside university.
- We include colleagues and experts outside the Faculty (from academic area, but also from educational sciences) in the continuous dialogue about the development and evaluation of the curriculum; we regularly renew and refresh the curriculums with new achievements.
- We make study materials available (on the web-site, including the e-book) and introduce new technologies into lecturing; we consider writing and editing the textbooks as our obligation as lecturers.
- We continuously accomplish in the fields of lecturing processes and scientific research. By educating ourselves, we ensured that 100% of lecturers at the Chair for Mechanical Engineering know how to use IT. Unfortunately, Chair consists of only two lecturers, without technical assistance and administrative assistance personnel, and this causes that carrying out all the work and tasks is very hard and time consuming.
- We decreased the time of sitting in the classroom and increased the time of active and self-study and research in computer classroom, library and on the Internet.

5.3 Expected and Achieved Outcomes and Results

- Our curriculums rely on results of scientific research and the development of technology, so they improve efficient inclusion into labour market, adapting in accordance with its changes. They also enable fast achieving of high-level of competitive skills and knowledge, their renewing and change. Students show greater interest for curriculum contents because they have been constantly adapted towards students' interests and wishes.
- The results of exams show that applied IT has helped the easier coping with curriculum, develops space perception, encourages creativity, enhances informatic literacy. A great attendance at the multimedia lectures, computer classrooms and numerous visits to the web-site are proofs of students' satisfactory attitude towards these kinds and forms of lectures, which is one of the requirements of quality managing (to fulfill the expectations of services users, e.g. students)
- Future longitudinal studies will give qualitative and quantitative indicators of final effects of our efforts.

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