INTERACTIVE LEARNING ENVIRONMENT IN MECHANICS – ILEM2001

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Abstract: *Higher education is facing a challenge to meet new demands for the next century. The engineering education must keep same innovation-rate like research and technology progress. Many experts consider that educational pedagogy of the future will be based on distance learning and on-line learning methodologies. In this way the higher education systems will be able to upgrade the new needs of the knowledge-market as result of the effect of globalisation.*

Having in view the quality needs in engineering education in the new dimensions, this paper presents an example of a higher education integrated learning system which enable us - in the field of Mechanics - to place the "learner" at the center of the training process and to preserve the essential role of the teacher. This system is conceived in a flexible way and allows the individualization of the educational process and increasing the efficiency of the learning process. It can be used either in initial education, continuing education and distance education.

INTRODUCTION

The effect of globalisation will produce significant changes within the industry world-wide. The expansion in technology development make many changes of the infrastructure that serves society's needs today. The workplace changes require to be flexible and committed to continuing professional development. The key to survival is establishing a framework for life-long learning world-wide. In the face of business globalisation the engineers must develop their capabilities to use new technologies.

The engineering education must keep same innovation-rate like research and technology progress. Many experts consider that educational pedagogy of the future will be based on distance learning and on-line learning methodologies. In this way the higher education systems will be able to upgrade the new needs of the knowledge-market as result of the effect of globalisation. The phenomenon of the total knowledge growth is accompanied with easy information distribution with free or limited access via world electronic network.

On-line and distance learning have taken on new dimensions. Using a range of instructional technologies, creative instructors can deliver learner-centered curricula and meaningful activities that relate to the students' daily experiences. While many remain skeptical of the quality of learning in a "virtual" classroom, those who have experienced this medium are finding it more interactive and motivating than they expected [12].

Many states and institutions are experimenting with new forms of interactive learning instruments – the electronic delivery of courses or entire academic programs by video and computer. States and individual colleges and universities are considering whether to make major investments in this technology. Providing *interactive learning* via computers can be created a learning community. In these courses, students are developing personal and professional relationships and enhancing their abilities to perform their jobs more effectively. The key to success seems to be the same whether the course is face-to-face or on-line: ensuring that content level is interesting, challenging, and applicable, and that delivery is accessible, and responsive to student needs.

The "Interactive Learning Environment in Mechanics" (ILEM) presented in this paper is an example of a higher education integrated learning system [6,7] which enable us - in the field of Mechanics - to place the "learner" at the center of the educational (or training) process and to preserve the essential role of the teacher. It can be used either in initial education (student), continuing education and distance education [6].

The Interactive Learning Environment is sure that will be developed in new technological conditions in the 21st century. In the last decade, the techniques and the methods for this kind of training (education) has changed significantly by the use of computer-mediated learning, two-way interactiv video and a variety of other technologies.

"TIME" AND "PLACE" DIMENSIONS

"Place" and "time" factors have a significant impact to student learning process. On-line learning and distance learning should provide some advantages relative to traditional methodologies.

It is very important to know the student's perception of new pedagogical instruments. Some studies made by experts relative to students' perception of the new teaching/learning methodologies found out that the students agree these methods rather traditional methods for some considerations:

- they can save time
- enabling to take more courses than traditional methodologies
- matching well with the students schedule.

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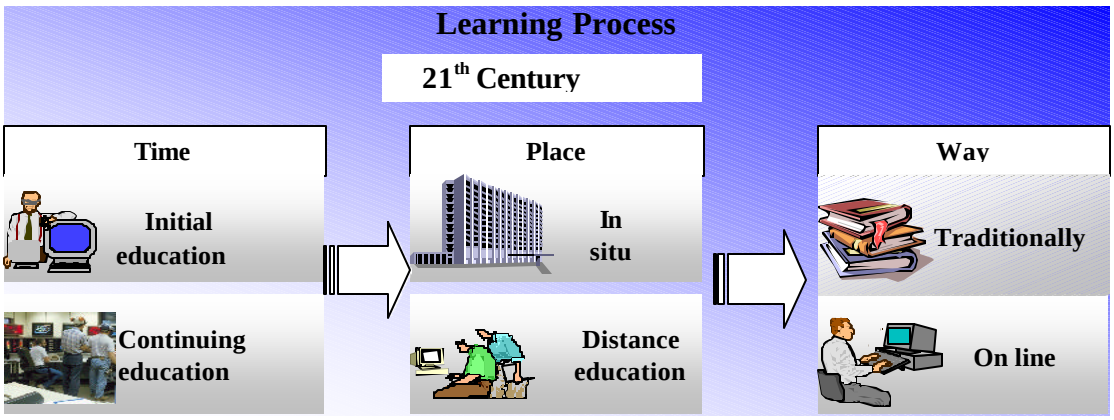

FIGURE 1. LEARNING PROCESS IN 21TH CENTURY.

These facets were considered for the initial educational process. But it is obvious that the education in the universities of the twenty-first Century will be dominated by the concept of life long learning having in view evolution and the impact of new information technology.

Most Western Europe universities, particularly the continuing education departments, realized the importance of teaching adults. In this process they should take account of what an adult learner represents, what he or she already knows, and especially, how he or she actually learns. In parallel one should take into account the impact of the new communication technologies upon the education in general and the education of adults in particular.

Both distance education and on-line education change the traditional "rule of three unities": *time*, *place* and *way*. Now the learner can choose the place, the time and the way he is learning. Moreover, now, the choice of the learners is generally dictated the level not by their wishes but by the needs of their professional situations. We take into account the fact that many students are part time workers, so the breaching of the rule of the three unites will become the new rule. This new rule implies thus the use of "multimedia training" in the sense we have given in the introduction, will become the normal situation in higher education. It means that the universities must accept their new situation for the 21st century and must be ready to provide all kinds of teaching demanded by the society, especially to use and/or produce software tools.

This has been done for many years at the University "Pierre et Marie Curie" of Paris in many fields. At the University "Valahia" from Targoviste, in Romania, the Mechanical Electronics Manual is the latest multimedia created tool in the field of mechanics.

ABOUT THE INTERACTIVE LEARNING ENVIRONMENT IN MECHANICS

Distance education allows to the learner to choose the place, the time and the way he is learning. This is essential in the case when trainer/learners are workers who continue in employment while studying. This situation implies that the time for formal instruction is limited and must be tailored to the circumstances of each individual. Gathering them together at the same time and in the same place is not the best solution, especially when the level of knowledge varies from learner to learner. The solution to this problem is a tendency to individualize the educational process by adapting it to each person and by using new communication instruments (such as telecommunication devices, computers, networks, the Internet) or training systems making use of these new instruments (distance teaching, individualized learning, self-learning) [5]. Moreover, now, the choice of the learners is generally dictated not by their wishes but by the needs of their professional situations. Very often the companies impose their employers study in a given working day in the week, or in the evening or during the weekend. The fore if we take into account the fact that many students are part time workers, the breaching of the rule of the three unities will become the new rule. This new rule implies thus the use of "multimedia training" in the sense we have given in the introduction, will become the normal situation in higher education. It means that the universities must accept their new situation for the 21th century and must be ready to provide all kinds of teaching, especially to use and/or produce software tools.

This has been done for many years at the University "Pierre et Marie Curie" of Paris in many fields. At the University "Valahia" from Targoviste, in Romania, the Mechanical Electronics Manual is the latest multimedia created tool in the field of mechanics. This tool is a pedagogical instrument to teach theoretical mechanics and is part of an ensemble of multimedia tools which includes general software training (like Mathematica, Mathcad etc.) and dedicated software for CAD/CAM/CAE technology (fig. 2).

This system is conceived in a flexible way and allows the achievement of the following objectives: 1) the individualization of the educational process; 2) increasing

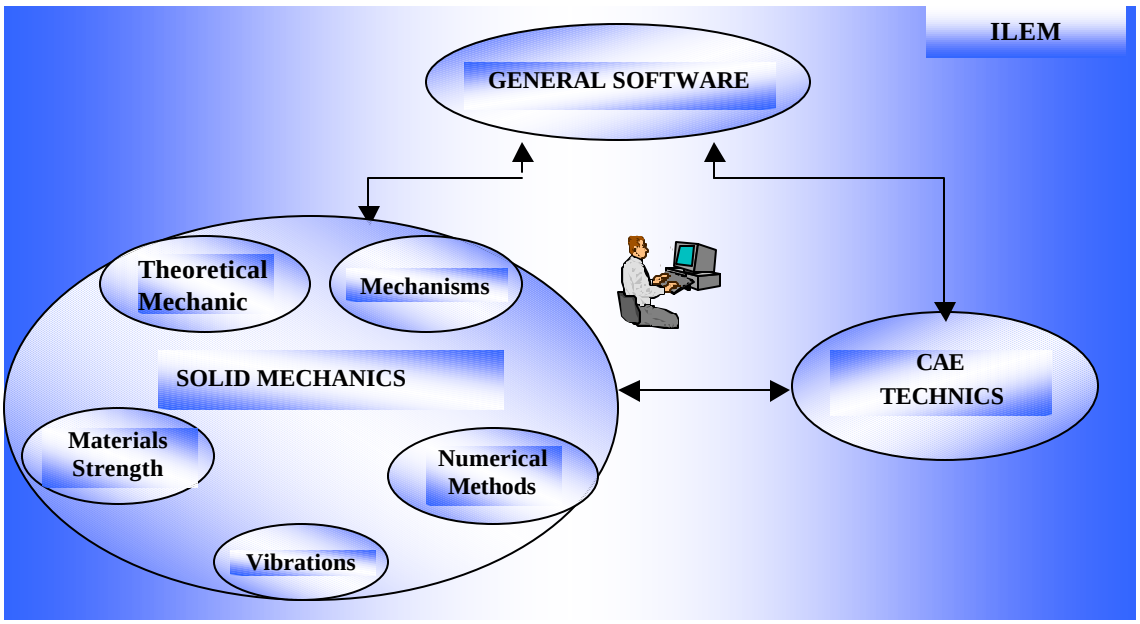

FIGURE 2. INTERACTIVE LEARNING ENVIRONMENT IN MECHANICS

the efficiency of the learning process; 3) the development of new types of learning: initial, continuing or lifelong learning in situ or at distance.

In this system each participant has some defined purposes: The teacher should create the course in the multi-media form with all its particular software components; present the course and the applications using multimedia resources; present supplementary explanations during ex cathedra lectures or teleconferences if it is necessary for more difficult themes and to support the teacher-student link; create exercises, problems and knowledge tests; answer to the student questions, makes the student's informational following thread.

The student should: attend the teleconferences and in some cases watch the in situ explanations, courseware demonstration on the computer and study the support text book; do individual work on the personal computer, solve the tests and enter the results into the computer and also navigate the network-cooperative learning system; create individual or group informational network for project development.

MECHANICS ELECTRONIC MANUAL

CHARACTERISTICS OF THE MECHANICS ELECTRONIC MANUAL

The Mechanics Electronic Manual(MEM) is mainly based on multimedia interactive packages. Every package consists in an "electronic" book; a hypertext database and the necessary access software. The "electronic" books offer the main content of the course, many notions, relations or images being connected with explanatory references from the hypertext database.

This "electronic" manual allows also live conferences in the same university, between many universities or for many users in distance learning. By its structure, the electronic course can be adapted to the needs of every particular technical university mechanics curricula.

The features of this system are very useful for life long and distance learning [5], one of our main objectives. The difficulty is that this objective is function of student home-equipment and network-access of learners. However, this can be achieved by the creation of an on-line training network having as main core the Mechanics Electronic Manual.

THE STRUCTURE OF MECHANICS ELECTRONIC MANUAL

The "electronic manual" contains two main modules (fig. 3). The first one consists in many "electronic" books containing the following sections: Rigid Mechanics: Statics, Cinematics, Dynamics, Analytical Mechanics, Mechanic Vibrations with examples of technical applications;

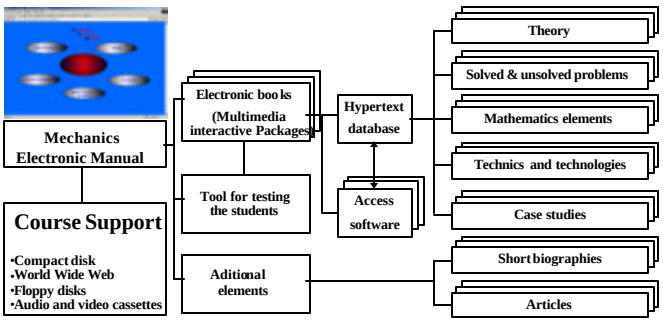

FIGURE 3. THE STRUCTURE OF THE MECHANICS ELECTRONIC MANUAL

Mechanisms Theory: Structure, Kinematics, Kinetics of Plane Mechanisms; Introduction to the Mechanics of a Continuous Medium; Mathematical elements reference.

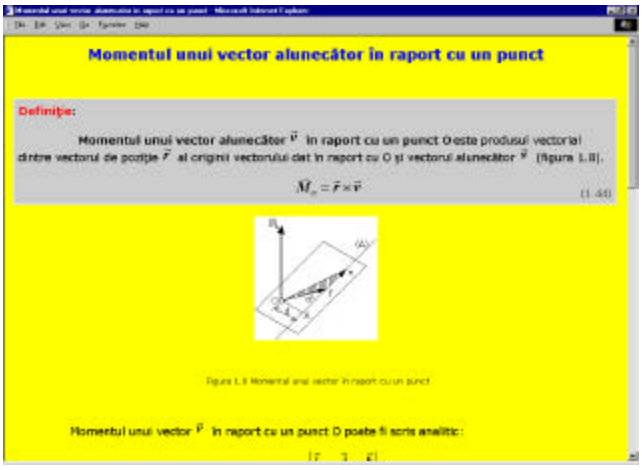

FIGURE 4 . EXAMPLE OF "IN EXTENSO" THEORY

There is "in extenso" theory(fig.4), abstracts, applications, solved and unsolved exercises, measures tables, warnings and frequently encountered mistakes with comments, real time tests and a very important part containing frequently asked questions and comments. There are also explained the possible mistakes that professors have encountered in student's examination. In the data base hypertext there are syntheses of general solving methods for main applications and examination subjects.

Logical schemes or templates for sequential solving accompany the applications.

The MEM contains also some interactive application for the most significance types of problems(fig.5). These programs are designed as conversational systems and allow the solving of various applications, for each type of problem (either with the whole group or individually) [2]. The programs are composed by a set of problems, graduated by purpose and difficulty.

When running in application mode the student can either select an existing problem file or create a new one. The applications use an interactive way of communication with the user by menus, commands and toolbars; all computational and management functions are just a click away. First, the student will type in input data using a Data browser dialog box. The user can navigate through the data and view the intermediate results. During this period the students maintain the contact with the teacher who follows the progress and gives them advice.

Final results are available by menu commands that will display dialog boxes containing numeric results. On-line help is available through help index and keyword search; the applications also benefit from a context-sensitive help engine that will display help as you work along.

The second module of MEM represents a tool for testing the students: As stated above, the application can also run in a fundamental mode called "test mode". When runs in test mode, the student will be prompted to enter his identification data (that is name, first name and group ID) and will no longer have access to the computational routines of the program, and will have to enter the results. Then, using a selectable way to appreciate the student's knowledge level, the application will write into the selected student database the test results.

The teacher, using the Student Database Manager application, can then have an overall or detailed impression about his students. The Student Database Manager allows the professor to examine each students' record, which contains a history-like recording of what the student has done at the test, and, if necessary, change the appreciation.

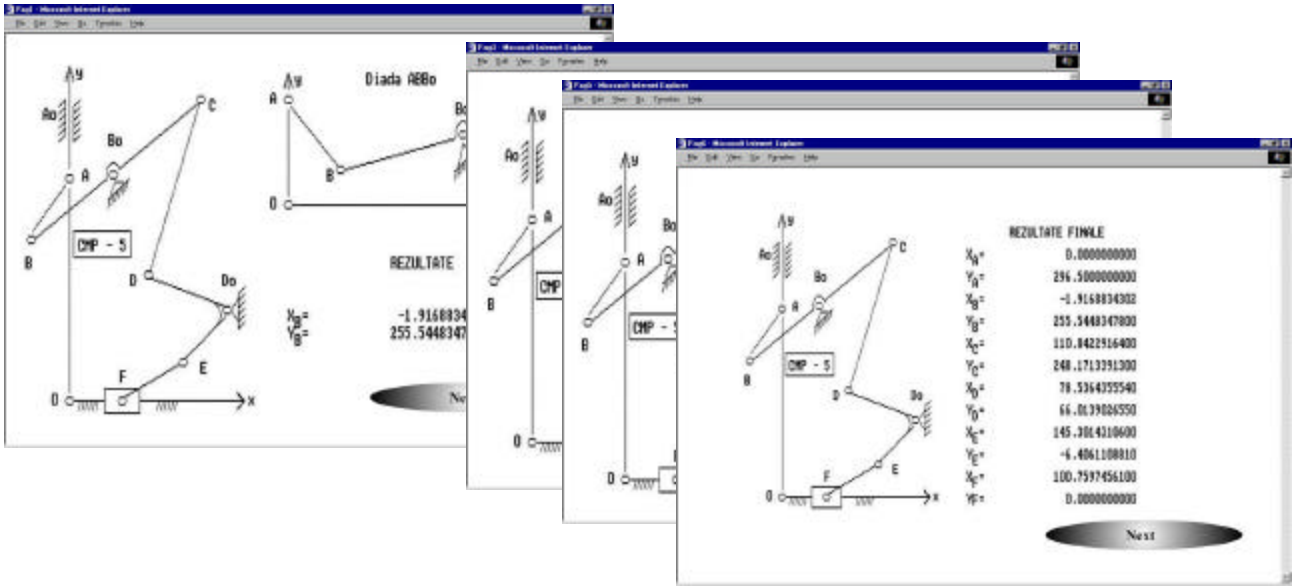

FIGURE 5. EXAMPLE OF MEM INTERACTIVE APPLICA TION

Figure 6 shows the data needed by the application before entering the test mode. The computer asks for a problem file (which can be hand-written or generated with the Problem Generator), a student database file, a code that allows only the teacher to stop the test mode and a method for analyzing the students' answers.

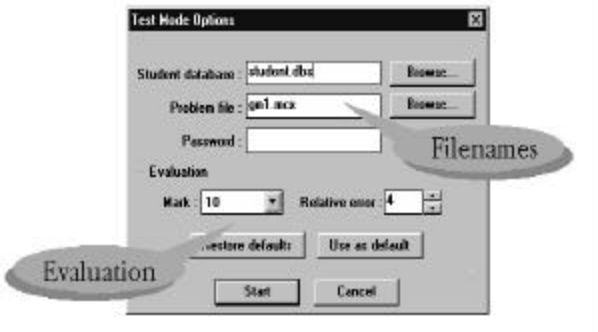

FIGURE 6. PERIODIC KNOWLEDGE TEST

MECHANICAL CAE TRAINING MODULE

Computer aided engineering technics play a crucial role in many engineering fields. Particularly in mechanical engineering excellent tools to deal with a large amount of various information have been developed. This is a very dynamic domain, with many changes in the software packages. Almost all firms recognize that mechanical CAD/CAM/CAE technology is the mainly tool to maintain profitability and competitiveness on the market.

In the educational process we are forced to take in consideration on one side the new industrial environment and on the other side the new communication technologies. This idea means a new educational methods for accumulate the knowledge and for developing skills for using the new engineering software packages. Mechanical CAD/CAM/CAE technology is considered to be the backbone of the whole development product cycle. So it is mainly necessary students be prepared to manipulate a large amount not only of engineering knowledge but computational technics too.

The Interactive Learning Environment in Mechanics we have developed at our university allows to the students to use both MEM for theoretical aspects of some problem and dedicated software packages for CAD/ CAM/CAE technology in an integrated environment.

CAE implementations are not smooth and problem-free. In fact, keeping up with changes in technology is one of the biggest problem in implementing CAD/CAM/CAE technology. This is closely followed by integrating technology with engineering practices and training existing personnel.

The Mechanical CAE Training module of the ILEM package (MEM) aims two goals: First – to offer a technical support for the students who must develop their ability to apply teoretical knowledge using the power of computer aided engineering tools Second – this module is a very useful instrument for continuing education of the personnel from various companies who should refresh their knowledge with the latest CAD/CAM/CAE technology in mechanical fields.

This module is based on a multimedia interactive package. The modul for CAE training (fig.7) has both a theoretical part and a exercise part, which allow to the to learner to practise teoretical knowledge.

On one hand the "electronic" technical support offers the basis of CAE technics particulary for mechanical

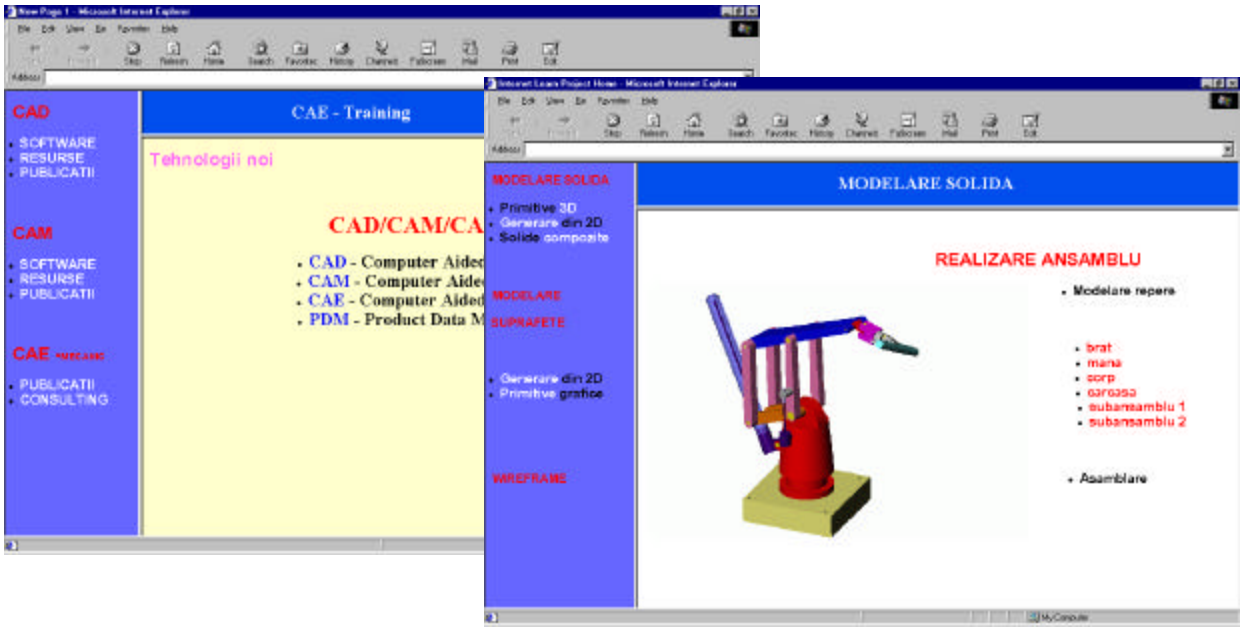

FIGURE 7. MECHANICAL CAD/CAM/CAE TRAINING MODULE.

domain. On the other hand this module contain a practice section which help the learner to exercise the acquired knowledge, following step by step the instruction that allow him to realise 2D and 3D models for mechanical parts. The software that were used for the practice section is SolidWorks (fig.7).

Theoretical part offers informations about CAD/CAM/CAE technics, terms, notions so that the user can familiarize with the new technologies (fig.7).

CONCLUSIONS

In the age of globalisation we assist at a "sliding" from traditional education to online courses, to international distance education, to virtual university.

The ILEM presented this paper represents a modern and more efficient learning instrument in mechanics and associated disciplines. It comes to support the point of view mentioned above, offering some advantages like:

- The development of this system will introduce a very useful tool for long life and distance learning process in Mechanics: more efficient for university and inter-universities courses, very easy using from different site of work (university, library, student-home etc.
- The increasing number and the variety of applications analyzed at the application classes or during personal study lead to a better comprehension of the analyzed themes. This allows the teacher and the students to achieve some synthesis debates on many examples. We obtain an efficient individual work at university or home for students.
- The system is designed in a flexible manner offering a high level of adaptability and expandability, due to the variety of the elements contained in the hypertext database.
- CADCAM/CAE technology is clearly seen as a competitive advantage by many of industrial products manufacturers. The huges CAD/CAM/CAE investments, can justify by a simple reason: to stay competitive. But implementations are not smooth and problem-free. In fact, keeping up with changes in technology is one of the biggest problem in implementing CA D/CAM/CAE technology.

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