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Web-Based Curriculum Development of a Manufacturing Engineering Technology Programme*

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The aim of this paper is to present the use of the Internet in developing the curriculum of a manufacturing engineering technology programme in Turkey. The programme was implemented in the curricula of 15 two-year colleges over six months to provide seamless progression from vocational high school to two-year colleges and meet the needs of Turkish and global industry. A curriculum development committee, administrative board core group and curriculum development commission were established at the beginning of the project. The roles and responsibilities of the board, committee and commission were determined in January 2002. Members of the curriculum development commission for the manufacturing engineering technology programme were selected: three instructors from two-year colleges, two teachers from vocational high schools, one representative from manufacturing and industry. Two-year colleges, non-governmental organisations, the industrial sector of manufacturing, the chamber of industry and trade and some international vocational and technical educational institutions (USA and UK) contributed to developing a manufacturing engineering curriculum, as well as 14 other developed programmes. A special web page was designed, to provide fast and interactive communication between stakeholders in the curriculum development project and a user name and password were given to each member of the project team to monitor the progress of the project. The curriculum development process was completed on 30 May 2003 and submitted to the Turkish Higher Education Council. It was implemented during the 2002–2003 education year in all the two-year colleges in Turkey.

INTRODUCTION

ENGINEERING AS a discipline has been taught for centuries. Over the years, a standard engineering curriculum has evolved. While accreditation agencies have provided general guidelines, courses were often created and taught by the instructor most interested in the subject area.

Several curriculum design methods have been developed so far. As yet, there is no universal agreement on a methodology for curriculum innovation, renewal, or development and in fact there is significant variation in opinions as to what constitutes a good curriculum [1].

One reason for this lack of a universal methodology is the large number of constraints involved in developing any particular engineering curriculum (e.g. budget, facilities, identification of employer needs, and available faculty time), and the effects of these constraints are almost certain to be different from campus to campus.

The rapid advancements that have been made require adjustments and improvements to the educational programmes. The cyber-world provides effective, efficient and rapid interaction and communication, despite physical distance. Many books and articles have been written about curriculum renewal or developing study programmes.

An ASEE report entitled 'Engineering Education for a Changing World' focused on the need for engineering curricula to keep pace with what faculty, students, parents, alumni and employers will need in a rapidly changing world. The report specified a number of critical action suggestions [1].

Curtis R. Finch and I. R. Crunkilton presented the fundamental principles of curriculum development in their book, *Curriculum Development in Vocational and Technical Education* [2].

The Colombo Plan Staff College issued their book, *Aspects of Curriculum for Technician Education*, in 1987, which described technician curriculum design, curriculum and subject analysis, teaching methods, evaluation and measurement, curriculum implementation, etc. [3].

Web-based educational programmes of 15 two-year colleges were developed over six months in Turkey, with the collaboration of the Ministry of National Education and the Higher Educational Council, as part of the project. The aim of the study was to ensure coherence and coefficiency among the educational programmes. One of those 15 programmes was the Manufacturing Engineering Technology programme.

* Accepted 3 February 2004.

BACKGROUND INFORMATION

The goal of developing the curriculum was to equip students with the knowledge and skills required by the industrial sector, to enable them to interact better with their colleagues, be active participants of socio-cultural activities and make use of technology.

Between 1985 and 1997, a project was funded by the World Bank under the direction of the Turkish Higher Education Council (YOK) to develop a manufacturing engineering technology diploma programme with 20 other engineering technology programmes in two-year colleges, employing Turkish, English and American curriculum development specialists [4].

As part of the project, workshop and laboratory equipment, costing about 100 million USD, was purchased to support the 21 engineering technology programmes. Technical and vocational education continuously has to evaluate engineering programmes such as the manufacturing engineering technology programme [5].

In 1996, after 11 years in operation, it was apparent that the manufacturing engineering technology programme required amending in light of developments in Turkish industry [6].

There were a number of objectives in developing the manufacturing engineering technology curriculum in 1996.

- A core group of instructors was established to work closely with the two-year colleges to design and document a system called Curriculum Development, Monitoring, Evaluating and Renewal (CDMER).
- One 'lead' instructor from the manufacturing engineering technology programme was trained to carry out the tasks related to CDMER.
- Two-year colleges were provided with instructor training and were introduced to the revised curriculum of the manufacturing engineering technology programme. A management system was devised that would ensure CDMER sustainability.
- This study would be a good basis for future curriculum development studies.

QUALITY ASSURANCE SYSTEM AND ACCREDITATION IN TURKEY

In Turkey, there are no quality assurance institutions, assurance such as ABET, QCA and SQA, to provide accreditation and quality. The Turkish Higher Education Council has begun a study of education faculties that train teachers, but this has not yet been completed [7]. In 2001, an article entitled 'A Proposal for a Turkish Quality Assurance Center' was published in the *Journal of Standards* by the author of this article [8].

The engineering programmes of 5 out of the 77 universities in Turkey were accredited by ABET between 1985 and 2000. The programmes are developed by the faculty staff with the approval of the college administrative board, then they are submitted to the university senate. The programmes approved by the university senate are implemented. This is the first project that has addressed standards and quality assurance and it was implemented in all two-year colleges as a result of cooperation between the Turkish Higher Education Council and the Ministry of National Education, industry in Turkey and other stakeholders.

During the development of the programmes, some courses were defined as compulsory and some as electives during the second-year fall and spring semesters. With the College Administrative Board's approval, the names of the courses can be changed, without changing the course hours and credits, according to the requirements of the individual college. Elective courses provide the flexibility to develop a programme.

CURRICULUM DEVELOPMENT STUDIES IN 2002

After five years, in 2001, it was decided to develop the engineering technology programmes in the two-year colleges in Turkey. There are currently approximately 330,000 students studying on 296 diploma programmes at 439 two-year colleges in Turkey. These students were placed on various courses according to their university entrance exam results. Law number 4702 (2001) states that vocational high school graduates will be placed on courses at two-year colleges without having to take a university entrance exam. The placement decision will be made according to criteria such as graduation degree, graduation date, etc. Students are provided with handbooks and relevant information regarding transition criteria. The main aim of developing the curriculum was to ensure continuity within and among the courses run by vocational high schools and two-year colleges.

The Ministry of National Education and the Turkish Higher Education Council decided to develop the 15 selected two-year college programmes. The 15 selected programmes comprise 60% of the two-year college students in Turkey. Manufacturing Engineering Technology is one of the 15 selected courses. Approximately 30,000 students attended manufacturing and mechanical engineering technology programmes (similar to the Associate of Applied Science Degree in the USA) in the 2002–2003 education year in Turkey.

METHODOLOGY OF CURRICULUM DEVELOPMENT

The curriculum development process is generally designed in three stages.

Stage 1. Planning the curriculum:

- determining general criteria and planning timetables, responsibilities and the roles of the board, committee and commission;
- preparing and designing a web page outlining the curriculum development process; and
- collecting and assessing two-year colleges and employment-related data.

Stage 2. Establishing curriculum content:

- analysing the curriculum content;
- identifying curriculum objectives and goals and determining content; and
- setting up a feedback mechanism.

Stage 3. Implementing the curriculum:

- writing the content of the courses;
- assessing the developed curriculum; and
- checking the curriculum content by means of the feedback mechanism.

The curriculum development process is outlined in Fig. 1.

The job descriptions of the curriculum development committee, the administrative board, the core group and the curriculum development commission were formulated by the chair of the curriculum development project. Representatives from two-year colleges, vocational high schools, graduates of two-year colleges, chambers of commerce, unions, the Ministry of National Education, the Higher Educational Council and non-governmental organisations dealing with technical and vocational educational issues, employees and employers of the related sectors took part in the development of these programmes.

Roles and responsibilities

The roles and responsibilities of the established board and commission were described [9].

Curriculum development committee

This committee consisted of the chair of the project, the head of specialist commissions, the head of two-year colleges, who had extensive experience in curriculum development and effective and efficient interaction with the industrial sector, two representatives of the business world, and curriculum specialists. The committee met when requested by the chair to discuss the issues on the agenda, as well as to monitor the progress of the project and ensure coordination among and between commissions.

Curriculum development commissions

These commissions consisted of six specialists, four of whom were from two-year colleges and two from vocational high schools and industry. Representatives of the manufacturing sector, instructors from two-year colleges and teachers from vocational high schools attended the meetings. The head of specialist commissions was appointed by the chair of the project, taking into account the opinion of the members of the commissions.

Progress

The curriculum, which was initiated in January 2002 and completed on 30 May 2002, and developed by the curriculum development committee in accordance with the agenda and principles and legislative constraints of the curriculum development process, was presented by the administrative board to members of the curriculum development committee and the commissions.

The Internet was utilised to share ideas and receive contributions from outsiders and members as well. The two-year college instructors, the vocational high school teachers, industry representatives and the curriculum specialists had the opportunity to review the coursework on the Internet at all times.

All stages of the curriculum development process were monitored by relevant industrial sectors and stakeholders and they passed on their suggestions and opinions about the curriculum development process and content of the courses to the head of the commission and the chair of the project.

THE USE OF THE WEB PAGE

The home page of the website, illustrated in Figs 3 and 4, has served as an important means of developing the education programmes. A password and user name were issued to all the 133

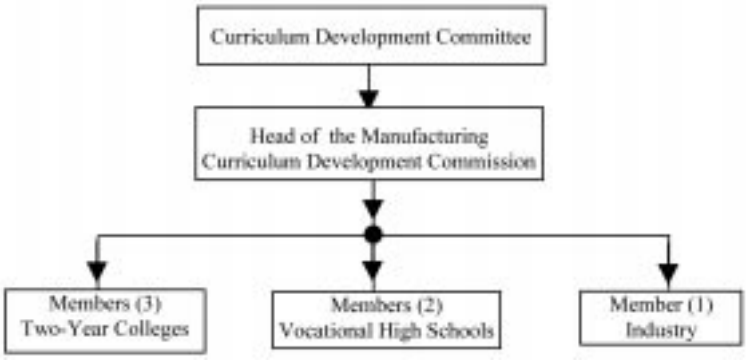

Fig. 1. Organisational structure of the curriculum development commissions.

members in order that they could access the Internet site (Fig. 4).

The head of the project was the sole authority regarding the design of the web page and the issuing of passwords. As well as the design of the home page of the project, a website was constructed for the 15 curriculum development commissions and a user name and password were given to each member of the project team. The head of each commission was responsible for entering and updating data. The members of all the curriculum development committees were able to observe the progress of the other commissions. A password and user name were given to other stakeholders in the project to observe the curriculum development studies. The head of the project and curriculum development specialists were able to monitor the curriculum development process or intervene when necessary. In the development phase of the project, ideas and recommendations were requested from two-year colleges, industry and graduate students and various questionnaires were administered to the aforementioned party members. The data were announced and were then made public in the curriculum development commission section of the Internet site.

The Internet site, as shown in Fig. 4, consists of the following elements:

Home Page. This is the first page of the curriculum development project Internet site after accessing the site with a user name and password.
Send Messages. This is used to send short messages to related commissions or to the head of the project.
Send File. This is used to send files to related commissions or individuals.
List of Messages. This shows the list of all messages sent previously.
List of Files. This shows the list of files prepared and numbered previously.
Change Password. This is used to change passwords if needed (this can only be done by the webmaster of the project).
Announcements. This is used to display any announcements made by the head of the project and the curriculum development commissions.
Other Commissions. This element can be used to view the studies of the other commissions. However, no change can be made to the data.
Useful Links. Connections are provided to over 30 international Internet links relating to curriculum development to allow the members of the committees to access relevant data. The sites to benefit initially were ABET (especially the Engineering Technology programme), QCA, SQA and the Minnesota State University and Colleges System (MnSCU). The contact details of the commission members can be seen on the right-hand side of Fig. 4.
Help. This explains how to access and use the data on the site.
Message. This is used to send messages to commission members.
Index. This shows the headings of all the files and data on the commission's Internet site.

The contacts of the programme development board members and principals, the developed programmes, the aims and targets of the project and the calendar of curricula can be seen on the home page of the project (Fig. 3).

Advantages of web-based curriculum development

A special web page was designed for fast and interactive communication between members of the manufacturing engineering technology curriculum development commission, instructors in the two-year colleges, graduates of two-year colleges and representatives from industry. Everybody was able to observe the progress of the curriculum development studies and could sent their opinions and suggestions to commission members. Five meetings were held to discuss and assess the curriculum development studies. Some advantages of a web-based curriculum development process are as follows:

- Technology-based team study
- Less bureaucracy
- Interactivity
- Studying in a virtual environment
- Ability to access the data easily and continuously
- Horizontal–vertical–diagonal communication
- Flexibility
- Transparency

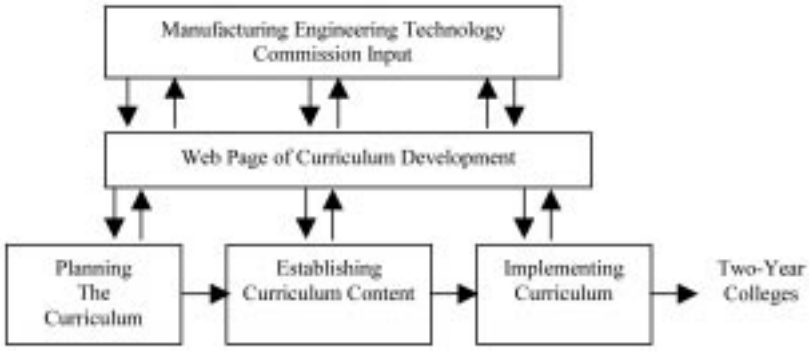

Fig. 2. Curriculum development process.

- Parallel study
- e-administration, e-observation, e-supervision
- Economical

Decisions taken by the curriculum development administrative board

The curriculum development administrative board took a number of decisions to maintain harmony and order between the various programmes. These were:

- The basic skills and knowledge to be acquired by the students should be identified.
- There should be continuity and contingencies within and among the content of each subject.
- The curricula of two-year colleges, approved by international quality and accreditation councils or boards, should be reviewed and common features of these curricula should be identified.
- The weekly class hours should be 24 at a minimum and 28 maximum.
- A minimum of four and maximum of eight hours should be allocated to elective courses during the third and fourth semesters. The number of elective courses should be a minimum of two and a maximum of four in the second year.
- Class hours should be a minimum of two and a maximum of four.
- The theoretical element of each course should constitute 30–40% of the course, whereas the practical component should be 60–70%.
- Mathematics, Basic Science, Computer Usage, Communication, Management Knowledge, Sports–Arts, and Cultural courses should be integrated into the curriculum.
- The goals and objectives of each course should be identified at the course outset.
- Recommendations in regard to methodology, evaluation and assessment should also be identified at the course outset.

CURRICULUM DEVELOPMENT PROCESS OF MANUFACTURING ENGINEERING TECHNOLOGY

The curriculum development commission of the manufacturing engineering technology programme consisted of three or four representatives from two-year colleges, two from vocational high schools, and one from industry. From these six members, one of the most experienced was elected as the group leader and one as the reporter.

The commission presented the six-month schedule to the curriculum development administrative board. The curriculum development process then started at the beginning of January 2002.

- First the commission reviewed the existing manufacturing technology programmes at the two-year colleges and vocational high schools.
- The results of the 74 graduates of the participating two-year colleges were analysed by questionnaire specialists.
- The manufacturing engineering technology curriculum of some two-year colleges in the USA accredited by ABET were reviewed [10].
- The manufacturing engineering technology curriculum of the two-year colleges developed by SQA and QCA in the UK were reviewed [11, 12].
- The proposed curriculum was displayed on the Internet so that instructors and representatives of the industry and other stakeholders could express their opinion and make suggestions.

In accordance with the recommendations made by stakeholders, the name, hours and content of courses in the manufacturing engineering technology programme were changed three times. The curriculum development process was initiated in April 2002. The content of courses was written within two months by the commission.

The curriculum thus developed was presented to the Turkish Higher Educational Council in June

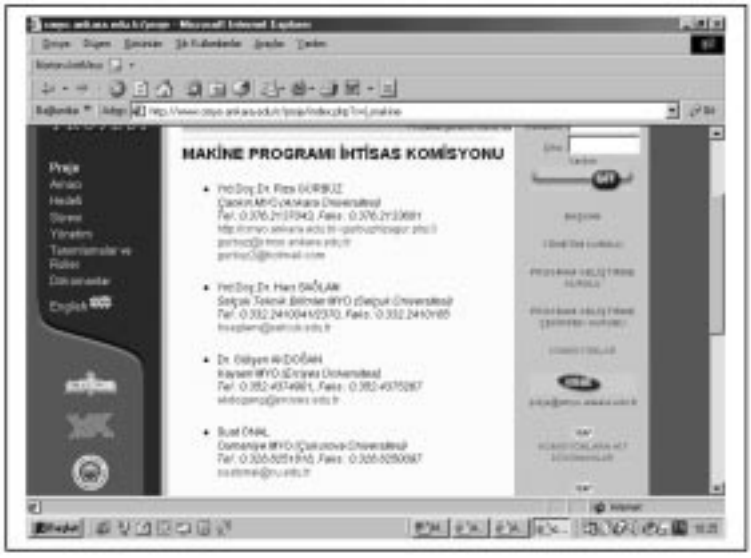

Fig. 3. Internet site of the manufacturing programme development project in Turkish.

2002 by the chair of the project and implemented in the 2002–2003 academic year.

EVALUATION AND FEEDBACK OF THE RECOMMENDATIONS AND QUESTIONNAIRES

The contact facilities were open to college teaching staff, industry and graduate students throughout all the phases of the developing programmes. Based on the recommendations and responses to the questionnaire by committee members, some courses names, credits and contents were altered. The commission members and questionnaire specialist examined the recommendations and questionnaires and the results of the evaluation were announced on the project Internet site.

A database was developed to accommodate all the data obtained from the questionnaires and to avoid conducting data queries manually, which would be a complex process considering the large amount of data. A spreadsheet was used to generate a series of tables and figures to examine the basic features of the variables [13, 14].

In the survey questionnaire, the two-year colleges, industrial sector and graduates of manufacturing engineering technology programmes stated which subjects they thought were a part of their programme and production field and specified the knowledge and skills gained by the students on a scale of one to five.

Table 1 shows the structure of the survey questionnaire on manufacturing engineering technology. Table 2 demonstrates the average depth of knowledge and skills that participant programmes accorded to each of seven categories.

The results of the questionnaire administered to the 74 manufacturing engineering technology graduates during the last five years were as follows:

- More emphasis should be placed on practice in labs and workshops.
- The number of hours allocated to information technology computer-aided design, computer-aided manufacturing, and CNC technology should be increased.
- Lack of knowledge in quality control measurement and engineering material testing and analysis should be addressed.
- Knowledge in the engineering materials order and national and international standards of engineering materials should be enhanced.
- There should be courses in the field of 'industrial automation technology'.

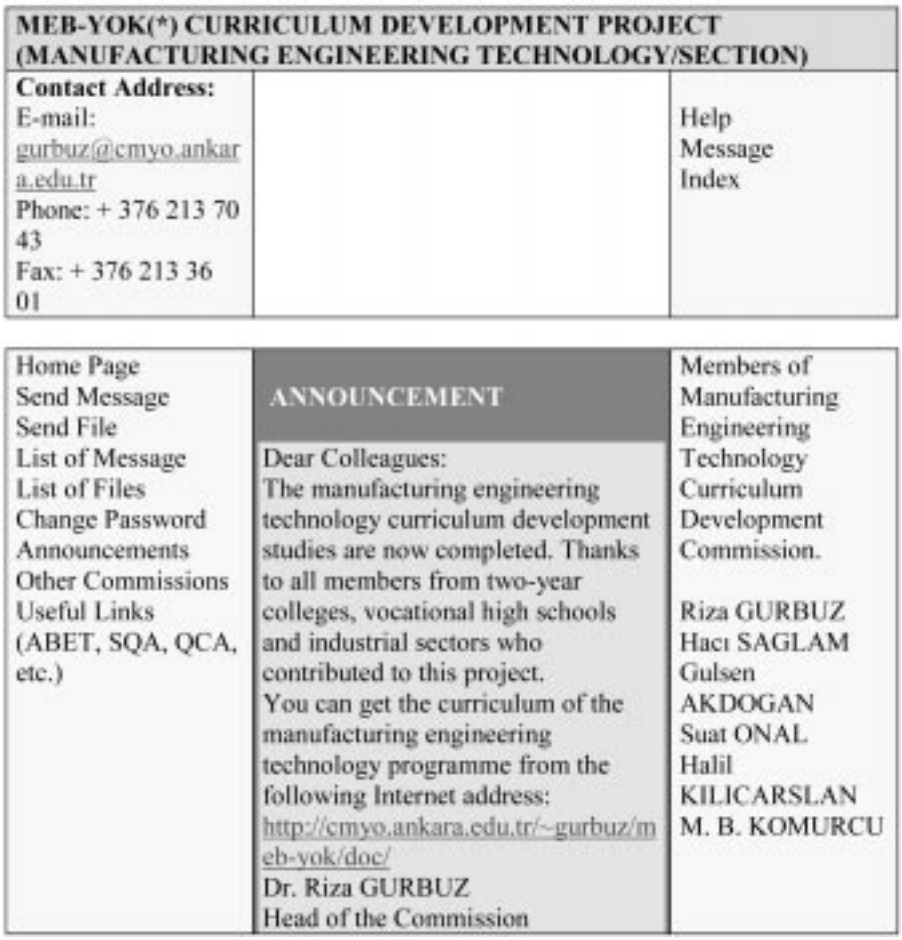

Fig. 4. Internet site of the manufacturing engineering technology commission.

Table 1. Structure of the survey questionnaire

No.	Title	Description
1	Contact information	Information and contact details for industrial institutions, chambers of commerce, unions, graduate students and two-year colleges
2	Background information	General information about the manufacturing engineering technology programme and developing technologies
3	Assessing existing manufacturing programme	Filling in the questionnaires and sending them to the curriculum development commission by electronic mail or fax
4	Expectations of stakeholders in the manufacturing curriculum development process	Identification of important structures of the manufacturing engineering technology programme and expectations of the stakeholders in the project
5	Influencing standards	Identification of importance of certain standard of curriculum
6	Assessing courses and curriculum	Analysis and assessment of the developed curriculum of the manufacturing engineering technology programme
7	Conclusions and the latest assessment of the curriculum	Assessing the latest curriculum and sending suggestions and proposals regarding the curriculum to the commission

Table 2. Programme curricula and depth of knowledge and skills

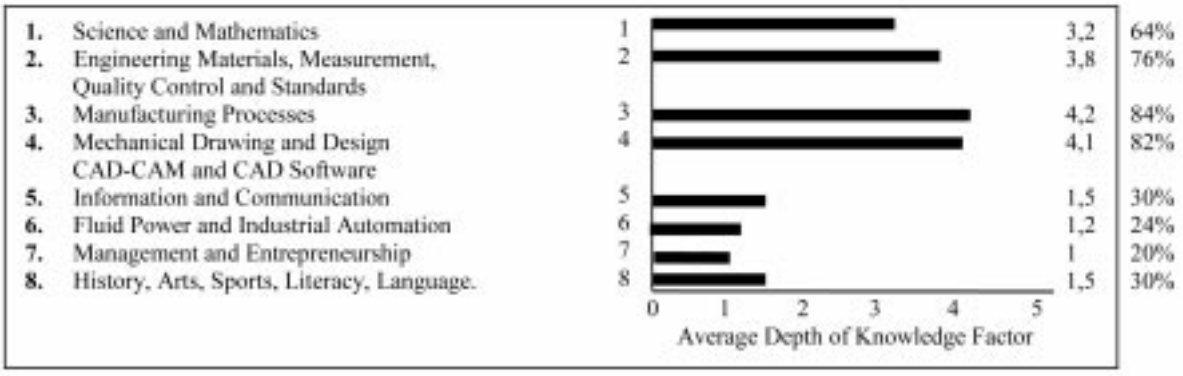

Table 3. Results of the curriculum assessment survey by instructors, employers and graduates

Assessment Manufacturing Curriculum	Instructors Survey	Employers Survey	Graduates Survey
Science and Mathematics	4.27	3.92	4.06
Measurement, Quality Control and Engineering Materials Standards	4.44	4.61	3.48
Manufacturing Process	3.96	4.41	3.67
Mechanical Drawing and CAD–CAM and CNC	3.77	4.15	4.29
Information Technology and General Communication	3.75	4.16	3.92
Fluid Power and Industrial Automation	4.09	4.69	4.75
Management and Entrepreneurship	4.16	3.35	4.35
History, Arts, Sport, Literacy and Language	3.92	4.76	4.33
Average Assessment of Curriculum	**4.78**	**4.64**	**4.52**

5 = Very satisfied
4 = Satisfied
3 = Neutral
2 = Dissatisfied
1 = Very dissatisfied

Table 4. Percentage rate of the main subjects in the developed curriculum of manufacturing rngineering technology programme in two-year colleges

Main subjects on curriculum	Course hours of main subjects	Percentage main subjects
Science and Mathematics	23 hours per week	19%
Measurement, Quality Control and Engineering Materials Standards	17 hours per week	14%
Manufacturing Processes	18 hours per week	16%
Mechanical Drawing and CAD–CAM and CNC	22 hours per week	19%
Information and Communication Technologies	6 hours per week	5%
Fluid Power and Industrial Automation	8 hours per week	6%
Management and Entrepreneurship	6 hours per week	5%
History, Arts, Sports, Literacy, Language*	18 hours per week	16%
Total	**118 hours per week**	**100%**

*History, Arts, Sports, Literacy and Language courses are compulsory for all the higher education courses (including two-year colleges) in Turkey. Some are electives.

- Material testing and Quality Control courses should be implemented as practice courses designed in accordance with the expectations of the manufacturing industry.

Table 3 shows the results of the curriculum assessment survey and Table 4 shows the percentage rate of the main subjects in the developed programme.

The results of the questionnaires administered to 17 employers were as follows. Students should:

- be equipped with the basic knowledge and skills required by the profession;
- be able to take responsibility and obey ethical rules;
- be able to use a computer at least at a basic level;
- be able to work cooperatively;
- be able to keep up to date with technological advances;
- have knowledge about engineering materials, quality control and standards;
- be able to speak, write and understand English or other international language at a basic level; and
- be furnished with the necessary knowledge and skills about CAD–CAM software and CNC machines.

The results of the questionnaire administered to 38 two-year college instructors were as follows:

- The existing manufacturing engineering technology curriculum complies with the needs of the Turkish industry (18%).
- The curriculum should be revised in accordance with technological improvements (82%).

In which fields is there a need for revision? (Identify the first three fields)

a. Information and computer technology, CAD–CAM and CNC technology.
b. Testing methods of engineering materials and quality control of production.
c. Providing flexibility in the developed programme via elective courses.

Would you like to contribute to the manufacturing curriculum development studies?

a. Yes (75%)
b. No (12%)
c. NA (3%)

What is your opinion about the web-based manufacturing engineering technology curriculum development process?

a. Perfect (97%)
b. Disagree (1%)
c. NA (2%)

What should be the features of graduates of the manufacturing engineering technology programme

Listed below are the features that we should expect in manufacturing engineering technology graduates from two-year colleges. Graduates should be able to:

- read drawings and prepare clear, dimensioned scratches of machine parts;
- plan and control production activities;
- evaluate the feasibility of a chosen method of manufacturing engineering technology;
- demonstrate knowledge of the fundamental principles of basic science and manufacturing engineering technology;
- select and specify materials for manufacturing applications;
- utilise 2D–3D modelling CAD systems and create mechanical components, generate assembly designs and machine them using general purpose machines or CNC machines;
- demonstrate knowledge of the fundamental principles of engineering mechanics and strength of materials;
- apply standard testing techniques approved by national and international standards and perform quality control and inspection of products;
- utilise computer-controlled machines (CNC) and software packages such as CAD–CAM; and
- transfer the CAD programme to CNC machines, controlling, uniting and machining work parts on CNC machines.

COMPARISON OF THE DEVELOPED PROGRAMMES WITH THE PREVIOUS ONES

The rapid development in technology requires education programmes to be revised every 3–5 years. A comparison of the current and previous programmes follows:

- There were no changes in the basic courses on offer (such as basic science, mathematics, manufacturing technologies, engineering materials, hydraulics and pneumatics, quality control), but their content was partially changed.
- This is the first time that the second year (autumn and spring terms) of the two-year colleges has included a minimum of four and a maximum of eight hours of elective courses.
- Continuity and integration were achieved between the high school and two-year college education programmes.
- Details of the aims, targets and evaluation criteria of each course were outlined in an education programme handbook.

CONCLUSIONS

The Internet is an integral part of today's world. Curriculum design and development procedures have to be carried out based on the latest technological developments. Programmes have to be revised or abandoned depending on the needs of users. Coordination is essential between and among educational institutions, industrial employers, government training offices, educational foundations, unions and chambers of commerce, but it would be expensive and impractical to have all parties meet frequently.

Table 5. Manufacturing Engineering Technology Associate of Applied Science Degree (AAS)

FIRST YEAR

Semester: Fall

Course	C/E	Hours per Week			Credit
		Total	Theory	Application	
Turkish Language I	C	2	2	0	2
The Principles of Ataturk and History of Revolution I	C	2	2	0	2
Physical Education	E	1*	0	1	–
Arts	E	1*	0	1	–
Language I	C	4	4	0	4
Mathematics I	C	4	3	1	4
Scientific Principles of Technology	C	4	3	1	4
Computers I	C	2	1	1	2
Manufacturing Processes I	C	4	3	1	4
Mechanical Drawing I	C	4	3	1	4
Manufacturing Technology I	C	2	1	1	2
Total		28	22	6	28

Note. 1 hour theory is 1 credit, 1 or 2 hours application is 1 credit. Total course hours per week must be a minimum of 24 and a maximum of 28.
C = Industry-based learning (six weeks) in summer term.
E = Elective.
* Optional.

Semester: Spring

Course	C/E	Hours per Week			Credit
		Total	Theory	Application	
Turkish Language II	C	2	2	0	2
The Principles of Ataturk and History of Revolution II	C	2	2	0	2
Physical Education	E	1*	0	1	–
Arts	E	1*	0	1	–
Language II	C	4	4	0	4
Mathematics II	C	4	3	1	4
Engineering Science I	C	3	3	0	3
Computers II	C	2	1	1	2
Manufacturing Processes II	C	4	3	1	4
Mechanical Drawing II	C	2	1	1	2
Materials Technology I	C	3	2	1	3
Manufacturing Technology II	C	2	1	1	2
Total		28	22	6	28

Note. Turkish Language, Principles of Ataturk and History of Revolution and Language courses are compulsory for all colleges and faculties in Turkey.
C = Industry-based learning (six weeks) in summer term.
E = Elective.
* Optional.

Table 5. (*Continued*)

SECOND YEAR

Semester: Fall

Course	C/E	Hours Per Week			Credit
		Total	Theory	Application	
General and Technical Communication	C	2	1	1	2
Engineering Science II	C	4	3	1	4
Manufacturing Processes III	C	4	3	1	4
Machine Science and Elements	C	4	3	1	4
Materials Technology II	C	4	3	1	4
Computer-Aided Design I	C	4	3	1	4
Machine Design	C	2	2	0	2
Total		24	18	6	24
Elective Courses*		4	2	2	
Electro-Mechanical	E	2	1	1	2
Entrepreneurial	E	2	1	1	2
Computer-Aided Design (Packet Programme)	E	2	1	1	2
Manufacturing Technology III	E	2	1	1	2
Other Electives**					
Average Total		28	20	08	28

* Two courses must be selected.
** Elective courses can be renewed according to the needs of local industry or development of industry.

Semester: Spring

Course	C/E	Hours Per Week			Credit
		Total	Theory	Application	
Computer-Aided Design II	C	2	1	1	2
Computer-Aided Manufacturing	C	4	3	1	4
Quality Assurance and Standards	C	2	1	1	2
Non-Destructive Testing (NDT)	C	2	1	1	2
Management and Manufacturing Control	C	2	1	1	2
Hydraulics and Pneumatics	C	4	3	1	4
System Analysis and Design	C	4	2	2	3
Advanced Measurement Technologies	C	2	2	0	2
Quality Control	C	2	2	0	2
Total		24	16	8	23
Elective Courses*		4	2	2	
Computer-Aided Manufacturing (Packet Programme)	E	2	1	1	2
Servo-Proportional Control	E	2	1	1	2
Heat Treatment Technologies	E	2	1	1	2
Management of Energy	E	2	1	1	2
Other Electives**					
General Total		28	18	10	27

Note. 1 hour theory is 1 credit, 1 or 2 hours application is 2 credits.
* Two courses must be selected.
** Elective courses can be renewed according to the needs of local industry or development of industry.

With a web-based curriculum development project, discussion and interaction among the abovementioned parties were easily achieved. The administrative board core group and the curriculum development committee were able to meet three times and the curriculum development commission managed to meet five times.

The documents, both printed and on CD, were produced for use by the two-year colleges. The developed curriculum includes a list of laboratories, resources and course materials for each branch.

Approximately 300 programmes of two-year colleges will be revised and updated in accordance with the needs of the industrial sector over the next few years. There will be 20–40 main programmes and related branches. It is firmly believed that these programmes can be successfully implemented if the necessary resources are made available.

One of the 15 educational programmes developed by the Ministry of National Education and the Turkish Higher Education Council was manufacturing engineering technology. There are approximately 300 000 students studying in the 297 programmes at the 439 two-year colleges in Turkey; 98 two-year colleges run manufacturing and mechanical engineering technology programmes and 10 025 student enrolled in the manufacturing engineering technology programme in the two-year colleges in 2002–2003. One of every 12 two-year college students is studying on the manufacturing engineering technology programme in Turkey.

The curriculum that has been developed can fulfil the needs of Turkish and global industry in the near future. It will need to be revised or renewed in three years.

To ensure that the manufacturing engineering technology programmes are effective and efficient, the two-year colleges need to have the necessary workshops and labs. The manufacturing engineering technology curriculum development commission has identified nine workshops–labs and the equipment and machines to be provided in them. A list was included in the manufacturing curriculum book and on CD and the Internet.

The most important element of the educational programmes is the instructor. Instructors should keep up to date with technological advances and strive towards professional competency.

All the students enrolling in the two-year colleges are vocational high school graduates. Continuity and integration between their programmes were almost achieved. Some students were able to transfer to the manufacturing and mechanical engineering faculties of the Minnesota State Universities and Colleges Systems (MnSCU) and some faculties and colleges in the UK. Negotiations are under way for students to transfer to manufacturing or mechanical engineering faculties in the UK and other countries as well. It could be said that curriculum development is moving from the national to the international arena.

REFERENCES

1. D. E. Beasley and D. J Elzinga, *Curriculum Innovation and Renewal*, ASEE conference, session 3567 (1996).
2. R. Finch and J. R. Crunkilton, *Curriculum Development in Vocational and Technical Education*, Allyn and Bacon, USA (1999), p. 23.
3. L. S. Chandra (ed.), *Aspects of Curriculum For Technician Education*, CPSC, Singapore (1987), pp. 11–36.
4. R. Gurbuz, S. Balci and K. Maria, Technical and vocational education in Turkey: Co-operation between two-year college and selected industries, *International Journal of Vocational Education and Training*, USA (2000), pp. 23–31.
5. R. Gurbuz, Designing and developing VET curricula of two-year colleges for Turkish and global industry: A case study in Turkey, International Conferences of Engineering Education (ICEE), session 7E6–9, Norway (2001).
6. G. Inan and I.Gedya, Curriculum development, monitoring, evaluation and renewal in technical training colleges, International Symposium, Turkey (1996), pp. 36–49.
7. Official web page of Turkish Higher Education Council, (YOK), Standards and Accreditation in Teacher Education in Turkey, http://www.yok.gov.tr/english/acr2/contents.html
8. R. Gurbuz, A proposol for a Turkish quality assurance center, *Journal of Standards*, **470** (2001), pp. 85–88.
9. Official web page of Ministry of National Education and Turkish Higher Education Council for curriculum development project of two-year colleges, Turkey (2002), http://www.cmyo.ankara.edu.tr/proje/arsiv/
10. Official web page of Accreditation Board of Engineering Technology (ABET), *Engineering Technology Accreditation*, http://www.abet.org/tac1.html
11. Official web page of Scottish Qualifications Authority (SQA), http://www.sqa.org.uk
12. Official web page of Qualifications and Curriculum Authority in the UK (QCA), http://www.qca.ac.uk
13. S. P. J. Sackett and G. P. Nelder, Developing advanced manufacturing engineers for European competitiveness, ASEE Conference, session 3263, 1997.
14. C. W. Somerton and D. G. Somerton, CQI for mechanical engineering education: A two-year experience, ASEE Conference, session 2266.

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