Mechatronics Education in Vocational Schools in Turkey and Comparative Curriculum Analysis

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Abstract

In this study, the present situation of mechatronics education as a new developing branch of engineering in Turkey was investigated in Vocational Schools. Mechatronics education has started as a branch education in Middle East Technical University in 1998, later first graduate degree program in Sabancı University, an associate degree in 2001 and lastly as a high school degree in 2003 in Turkey. In the present year of 2010, 29 Vocational Schools in 25 Universities have mechatronics program including a web-based education in Adapazarı Vocational School. The curricula of the mechatronics programs have been studied and significant differences and tendencies have been found after analyzing their curricula. The possible problems of the present situation were discussed and some suggestions about the standardization of this education and the requirement of branch educations were made.

Key words: mechatronics education; vocational schools; curriculum analysis; branch education.

1. Introductıon

The term "mechatronics" was first introduced by a Yaskawa Electric Engineer in 1969 [1]. Although many definitions about this term were expressed in the following years [2], the most widely known one is: The synergistic integration of mechanical engineering with electronics and intelligent computer control in the designed manufacturing of industrial products and processes [3]. In recent years, this synergistic integration that have already existed in the nature of mechatronics has been compatible with market demands together with the rapid developments in computer, microprocessor, power electronics and software technologies, and as a result it has become more and more popular rapidly.

The increasing demand for the products of mechatronics found in every field of daily life stimulated the need for well-educated human resources in this field. Since 1983, Toyohaski University has run a regular Mechatronics Education course in mechatronics engineering in Japan, and in Europe; on the other hand, the beginning of mechatronics education has dated back mid 1980's [4]. The courses of mechatronics engineering at undergraduate and graduate levels as well as vocational training courses are increasing rapidly all over the world [5]. Today, education of mechatronics engineering is given in many countries. There have been many studies over mechatronics engineering, education philosophy [6], curriculum programs [7] and its revolutionary development as a branch of engineering [8] and now mechatronics engineering education has almost been standardized worldwide.

Although mechatronics was introduced to Turkey in 1993, the development in this subject were performed in a quite slow course. In the early 2000, it became possible for mechatronics to be widely known in academic and industrial fields.

Today, mechatronics, even with a limited capacity, has become a kind of discipline in every level of education from high school level to master degree [9]. The education of mechatronics has started in Turkey late after Japan, America and Europe. Though there was a specific development between 1993 and 2010, there appeared no rapid and widespread of mechatronics. The educational experiences obtained on graduate and master degree have been reflected slowly into associate and high school degrees.

The world economy maintaining the change in science and technology on a large scale has focused on the well-educated human resources that will compete in professional field worldwide [10]. While the rapidly improving technology and steadily-changing market conditions require more economical and qualified products, the customer expectations are in demand for more durable and multifunctional products. The expiration date of products has been curtailed because of the rapidly-changing demands of customers and intensive rivalry business [11]. One of the solutions to meet these demands is the mechatronics engineering philosophy. According to the data of 2007, the share of automotive sector in foreign trade which has been developing particularly in recent years in Turkey has reached to 21.3 billion dollars. The rate of this sector in total exportation, on the other hand, has been 20.1% [12]. The growth of industry in Turkey, especially in the field of automobile, has increased the need for well-educated human resources in mechatronics. In the report of mechatronics strategy prepared by The Scientific and Technological Research Council of Turkey (TÜBİTAK) in 2003, it's aimed that by 2022, 500 graduate degree, 200 master and 50 PhD graduates should be employed each year and by 2023 total national income of 25 billion dollars in robotic and mechatronics systems and one million qualified workers should be employed [13]. Though a strategy in general related to researches, graduate and master degree education was determined, there wasn't any study or purpose about Vocational Schools (VSs) and high schools. Whereas, the most important step in educating one million qualified people would be to have technicians graduated from VSs and from Vocational High Schools (VHSs). The schools that can meet the demanded average human resources other than engineers are VSs. The academic studies made on mechatronics education in Turkey are quite limited and the present studies have either reviewed the subject generally or focused on the topics about the education engineering [14, 15]. Gürbüz has carried out probably the most detailed study on mechatronic education in VSs in Turkey made significant suggestions about the system; however has not performed a comparative curriculum analysis not mentioned the latest developments after 2004 [16]. This study discusses the mechatronics comparative curriculum analysis between VSs, necessity of branch education, general problems, solution suggestions, and the development of mechatronics education in VSs.

2. An overview of mechatronics education in Turkey

The exploration for mechatronics education in Turkey has started in 1993 [17]. Since then, Middle East Technical University (METU) has been holding international meetings of "International Mechatronics Designing and Modeling Study". Besides since September 1994, METU has been publishing an international journal about mechatronics named as "International Journal of Intelligent Mechatronics: Design and Production" [14]. Since 2010, mechatronics education in Turkey has been continued on master, graduate, associate and High School degrees (Table 1). Engineering graduate and master degree education in Erciyes, Sabancı, Kocaeli and Bahçeşehir Universities, engineering graduate education in Yıldız, Fırat, and Atılım University, mechanical engineering as a lateral branch in METU, master degree in Science Institute of Bogazici University, Istanbul Technical University (ITU) and Dokuz Eylul University, Erciyes University, graduate degree of mechatronics teaching in Technical Education Faculties of Marmara and Suleyman Demirel Universities have been continued. While there is a program of mechatronics on an associate degree in 29 VS, one of which has a distance learning education, there is an education of mechatronics in Balgat (Ankara), Çayırova (Kocaeli), and Hürriyet (Bursa) Anatolian VHS since 2003-2004 education periods [18]

3. Vocational Schools and Mechatronics Education in Turkey

The position of VSs in the education system of Turkey is after the high school and before the graduate degree (Figure 1). In two-year VSs, there is totally four semesters of education. With the law no 4702 put into effect in 2001, it was aimed for the consistency of vocational and technical education in secondary school to be reduced to 60% like in developed countries. In Turkey, there is a variety of programs over 300 in more than 600 VSs and these schools admit almost 200,000 students each year [20]. The primary student source of VSs is Vocational High Schools (VHS). In accordance with the new law introduced in 2001, the students graduated from VHSs are admitted to VSs, by "Higher Education Council Student Selection and Placement Center" (ÖSYM) considering certain criteria, without having an exam. The graduates of VSs can make vertical transfer into graduate programs with an exam prepared by ÖSYM if they intent [19-21].

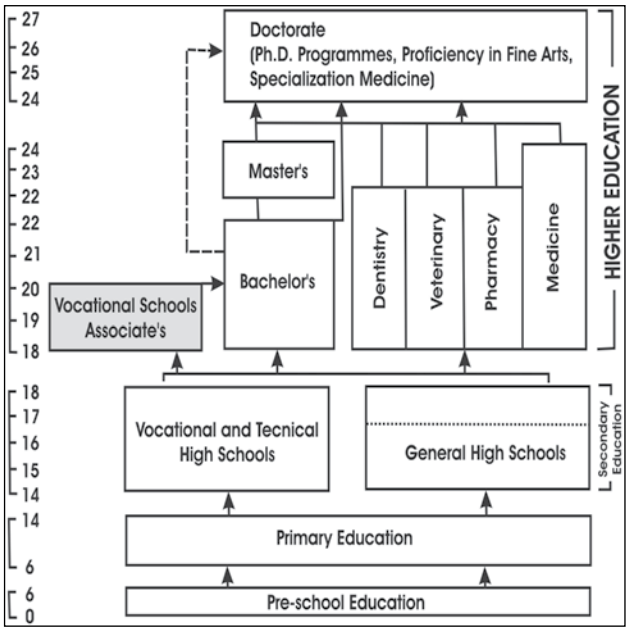

Figure 1. General Structure of the Turkish Educational System [19]

Before the undergraduate education of mechatronics started in Turkey, VSs had programs of electrics, electronics, computer and machine independent from each other. The first experiences

Table 1. Mechatronics Education as graduate, master, associate and high school level in Turkey

Engineering Education		**Technical Education Faculties**
Sabancı U [a,b] Kocaeli U [a,b] Bahçeşehir U [a,b] Ortadoğu Technical U[c] Erciyes U[a,b] Yıldız U[a]	Atılım U [a] Bogazici U [b] Istanbul Technical U[b] Dokuz Eylul U [b] Fırat[a]	Marmara U [a] Suleyman Demirel U [a]
Vocational Schools		
Adnan Menderes U Soke Afyon Kocatepe U Bolvadin Ahi Evran U Kırşehir Bahçesehir U Balıkesir U Edremit Celal Bayar U Soma Çanakkale Onsekiz Mart U Çan Dokuz Eylul U Izmir Dumlupinar U Gediz Gaziantep U Gaziantep	Gaziosmanpasa U Turhal Gediz U VS Gaziosmanpasa U Zile Giresun U Şebinkarahisar Inönü U Arapgir Kadir Has U Karadeniz Technical U A. Kanca Kastamonu U Kırklareli U Technical Science Kocaeli U Gebze	Kocaeli U Karamursel M. Kemal U Iskenderun Namık Kemal U Nevşehir U Hacı Bektaş Veli Sakarya U Sakarya Sakarya U Adapazarı [DE] Selçuk U Kadınhanı Faik Içil Selçuk U Eregli Uludağ U Technical Sciences
High School Education (Anatolian VHSs)		
Balgat (Ankara)	Hurriyet (Bursa)	Çayırova (Kocaeli)

*[a] GRADUATE EDUCATION [b] MASTER EDUCATION [c] BRANCH EDUCATION DE: Distance Education *All informations from The Turkish Higher Education Council, Turkish Ministry of National Education [19] and the web sites of the related universities. ** U stands for University.*

Table 2. The chronology of Mechatronics Education of VSs in Turkey

Year	School	
2001	Kocaeli University Gebze VS,	Sakarya University Sakarya VS
2002	Gaziantep University Gaziantep VS, Gaziosmanpaşa University Turhal VS	Namık Kemal University Tekirdağ VS
2003	Sakarya University Adapazarı VS (The first internet-based distance learning program of Turkey started in)	
2004	Gaziosmanpaşa University Zile VS, Kocaeli University Karamürsel VS	Giresun University Şebinkarahisar VS
2005	Uludağ University Technical Science VS, Selçuk University Eregli VS and Kadınhanı VS.	
2006	No new Mechatronics program.	
2007	Dokuz Eylul University İzmir VS, Balikesir University Edremit VS,	Çanakkale Onsekiz Mart University Çan VS, Mustafa Kemal University İskenderun VS.
2008	Bahçeşehir University VS, Kastamonu University VS, Karadeniz Technical University A.Kanca VS.	Celal Bayar University Soma VS Kadir Has University VS,
2009	Adnan Menderes University Soke VS, Ahi Evran University Kırşehir VS, Gediz University VS, Kırklareli University Technical Science VS,	Afyon Kocatepe University Bolvadin VS Dumlupinar University Gediz VS Inönü University Arapgir VS Nevşehir University Hacı Bektaş Veli VS

aiming at mechatronics undergraduate education were observed in the programs of 'Control Systems Technology' (CST) where the basic courses were Electric, Electronics, Control and Computer. The chronology of Mechatronics education of VSs is in Table 2.

While the number of mechatronics program in 2001 was two and student quotas were 55, this number increased to 29 including distance learning programs and student quotas increased to 2415 in 2009 [20]. It can be estimated that, in view of the intensive interest and demand for mechatronics and the need of the sector, these numbers will increase more and more. Although Mechatronics undergraduate education started in 2001, there is internet-based distance learning in only one of the 21 schools which have still been maintaining their education. While Adapazarı VS of Sakarya University, which started its distance learning program in 2003, admitted 300 students during the early years, in 2010 this number has reached to 700. In this program the services such as textbooks, CDs, internet access packages are provided by a standard education fee.

The courses are given on internet by computer animations and simulations. In a 50 student imaginary classes, students can ask questions by means of e-mails, forms, and chat programs, receive special help and take assignments. At the end of the first semester, students get condensed campus training for fifteen training days and consolidate their knowledge. Moreover, the students get a training of thirty days at the end of the third semester and consolidate their practical knowledge. There is a summer school for students who fail some of the classes. The students of this program who have the same rights like those of organized education are entitled with the degree of "mechatronics technician" [17].

4. Curriculum of Mechatronics of Vocational Education

The main problem related to the educational curriculum of VS is to what degree the courses of Electrical-Electronics, Machinery, Computer and Control forming the sub-components of Mechatronics reflected in the course plans. The other issues can be listed as follows: the difference in the courses of theory and practice, and the differences between total course credit and teaching hours.

There is still not a standard or specific approach regarding the course programs in the mechatronics associate's education. When we have a look at today's schedule, we can see that there are specific course programs in each school concerned with mechatronics education, including serious differences with other schools. The most important factor about these differences is that the programs are not set up according to a certain plan and standard. When the detailed analyses of course programs were made, it was observed that these mechatronics undergraduate programs had serious differences depending on the school.

4.1 Total teaching hours with theoretical and practice rates

In 2010, there have been 29 VSs continuing mechatronics undergraduate education and a VS giving a distance education (Table 2). In analyzing the course programs, 22 schools giving their course schedules on internet pages were examined. This number seemed sufficient to make a general assessment. In Table 3, course schedules of 22 mechatronics programs and one distance learning education program were compared. The course schedules of schools during four semesters were examined including optional courses and theirs predominance percentages in the whole course plan were estimated together with the theoretical and practical teaching hours. In this comparison, the percentage rates of theoretical and practical courses in the course schedules of schools were also estimated.

According to Table 3, the total teaching hours in the course schedules of schools vary between 92 and 125 hours, however credit hours vary between 63 and 113 hours. In the education system of Turkey, industry expects that VSs become practice-based schools [21, 22]. In the current table, practice rates vary between 13.46% and 40%, and these

Table 3. Four Semester Total Weekly Course Hours

	Vocational Schools and Mechatronics Programs	Theory Hours	Theory %	Practice Hours	Practice %	Total Hours	Credit Hours
1	Adnan Menderes University Soke VS	76	79,79	23	23,23	99	99
2	Bahçeşehir University VS	88	77,19	26	22,80	114	113
3	Celal Bayar University Soma VS	82	77,36	24	22,64	106	104
4	Çanakkale Onsekiz Mart University Çan	88	70,40	37	29,6	125	109
5	Dokuz Eylül University İzmir VS	82	70,08	35	29,92	117	100
6	Dumlupinar University Gediz VS	74	84,09	14	15,90	88	88
7	Gaziantep University Gaziantep VS	-	-	-	-	-	104
8	Gaziosmanpaşa University Turhal VS	84	73,68	30	26,31	114	112
9	Gaziosmanpaşa University Zile VS	86	78,89	23	21,10	109	106
10	Inönü University Arapgir VS	79	73,83	28	26,16	107	103
11	Kadir Has University VS*	46	57,50	34	42,50	80	63
12	Karadeniz Technical University A.Kanca	89	78,76	24	21,24	113	99
13	Kastamonu University VS	81	81,00	19	19,00	100	89
14	Kırklareli University Technical Sciences VS	83	74,77	28	25,23	111	111
15	Kocaeli University Gebze VS	85	79,44	22	20,56	107	96
16	Kocaeli University Karamürsel VS	88	78,57	24	21,42	112	96
17	Nevşehir University Hacıbektaş Veli VS	64	69,56	28	30,43	92	92
18	Sakarya University Sakarya VS	75	81,52	17	18,47	92	92
19	Sakarya University Adapazarı VS [DE]**	75	81,52	17	18,47	92	92
20	Selçuk University Kadınhanı Faik İçil VS	90	86,53	14	13,46	104	97
21	Selçuk University Ereğli VS	90	86,53	14	13,46	104	97
22	Uludağ University Technical Science VS	63	60	42	40	105	84

** Only course credits are given in the internet sites. **DE: distance education*

Table 4. Distribution of Courses According to the Disciplines

Electrical and Electronics	Computer and Controls	Mechanics and Design
- Measurement - Circuit Analysis (DC /AC) - Electronics - Digital Electronics - Electrical Machines and Control - Power Electronics - Sensors and Transducers - Electromechanic Control - Computer Aided Electronics Circuit Design	- Fundamental Computer Technologies - Computer / Visual Computer Programming - Computer Aided Data Acquisition and Control - Automatic Control / Process Control - Process Measurements - Artificial Intelligence / Fuzzy Control - Programming Logic Controllers - Microprocessors / Microcontrollers	- Materials - Mechanics - Static and Dynamics - Thermodynamics - Computer Aided Manufacturing [CAM] / CNC Machines - Computer Aided Design [CAD] - Pneumatics and Hydraulics - Mechanical Science and Components - Mechanical System Design - Energy Management - Engineering Science

Interdisciplinary	General Sciences	Culture
- Introduction to Mechatronics - System Analysis and Design (Projects) - Robotics - Mechatronic Practices - Mechatronics System Design - Bio-mechanic - Fault Detection in Mechatronic Systems - Servo Systems	- Mathematics - Physics - Scientific Principles of Technology	- History of Ataturk Principles and Reforms - Turkish Language - English - Sports / Fine Arts - General and Technical Communication - Quality Management Systems - Management Administration - Human Rights - Labor Law

Table 5. Percent Weight of Mechatronic Course Programs according to disciplines.

	Vocational Schools and Mechatronic Programs	Electric-Electronics %	Computer & Control %	Mechanics & Design %	Inter disciplinary %	Fundamental Sciences%	Culture %	Total %	Branch %	Culture & Fundamental Sciences %
1	Adnan Menderes University Soke VS	26,49	18,80	20,51	5,13	10,26	18,80	100	70,94	29,06
2	Bahçeşehir University VS	24,78	15,93	17,69	11,5	7,08	23,00	100	62,92	37,08
3	Celal Bayar University Soma VS	21,70	16,98	16,04	11,32	11,32	22,64	100	66,04	33,96
4	Çanakkale Onsekiz Mart University Çan	23,20	14,4	22,40	11,20	9,60	19,20	100	71,20	28,80
5	Dokuz Eylül University İzmir VS	28,77	17,26	17,26	15,83	5,75	15,10	100	79,15	20,85
6	Dumlupinar University Gediz VS	28,00	24,00	21,00	9,00	4,00	14,00	100	82,00	18,00
7	Gaziantep University Gaziantep VS	25,40	20,50	13,93	12,03	9,84	18,03	100	72,13	27,87
8	Gaziosmanpaşa University Turhal VS	25,00	27,94	13,24	4,41	8,82	20,58	100	70,60	29,40
9	Gaziosmanpaşa University Zile VS	16,24	20,51	18,80	11,96	7,69	24,79	100	67,52	32,48
10	Inönü University Arapgir VS	19,15	25,53	22,70	12,77	7,09	12,77	100	80,14	19,86
11	Kadir Has University VS	30,00	28,75	12,50	10,00	3,75	15,00	100	81,25	18,75
12	Karadeniz Technical University A.Kanca	30,97	21,24	13,27	10,62	7,96	15,94	100	76,01	23,90
13	Kastamonu University VS	21,00	18,00	30,00	4,00	8,00	19,00	100	73,00	23,00
14	Kırklareli University Technical Sciences VS	25,71	17,14	25,71	6,67	7,61	17,14	100	75,25	24,75
15	Kocaeli University Gebze VS	16,41	21,64	11,20	26,86	5,22	18,66	100	76,12	23,88
16	Kocaeli University Karamürsel VS	26,68	23,21	16,07	10,71	8,04	14,29	100	77,67	22,33
17	Nevşehir University Hacıbektaş Veli VS	27,27	23,64	12,72	4,54	8,18	23,63	100	68,18	31,82
18	Sakarya University Sakarya VS	11,54	17,30	25,00	8,65	8,65	28,85	100	62,50	37,50
19	Sakarya University Adapazarı VS	11,54	17,30	25,00	8,65	8,65	28,85	100	62,50	37,50
20	Selçuk University Kadınhanı Faik İçil VS	10,84	28,33	22,5	10,00	8,33	20,00	100	71,67	28,33
21	Selçuk University Ereğli VS	10,84	28,33	22,5	10,00	8,33	20,00	100	71,67	28,33
22	Uludağ University Technical Science VS	25,16	37,74	7,95	7,95	7,95	13,25	100	78,08	21,20

rates increase 23.90% on average. It is seen that the rate of some schools giving face-to-face education is below the rate in distance learning. The rate in the number of courses in formal education program and distance learning program in Sakarya University is the same. Same difference is seen in Zile and Turhal VSs of Gaziosmanpasa University. This situation can be considered as richness, but in the future it can lead to graduates who have the same associate degrees but have much more different level of education Table 3.

4.2 Mechatronic courses in terms of disciplines

To study the extent to which these components in arranging course schedules are effective, the courses taught were analyzed in six categories. These are: Computer and Control, Electrical and Electronics, Mechanics and Design, Interdisciplinary, General Sciences and Culture. The courses in Interdisciplinary category are composed of courses that cannot be completely classified and that are in the intersection of different disciplines in terms of mechatronics concept. The course programs of VSs are shown in Table 4 according to these six categories. Also, the percentages of these categories within the whole course plan are indicated in Table 5. In this analysis, no division of optional and compulsory courses is made and the course schedules are viewed as general.

4.3 The differences in course programs

According to Table 4 and Table 5, none of the course distributions of the current mechatronics undergraduate programs have a consistency of 100% with each other, except for Sakarya and Adapazarı VSs of Sakarya Universitry and Kadınhanı and Eregli VSs of Selcuk University. On contrary, though Turhal and Zile VSs of Gaziosmanpasa University belong to the same university, they have different course schedules. The differences in course schedules can be summarized as follows:

- Titles of courses that have the same content, teaching hours, theory and practice classes
- The weekly course schedules and credits of schools
- Compulsory main courses
- Optional courses
- Courses given in different teaching semesters

5. Mechatronics Branch Education

In Turkey, branch education has not been applied in mechatronics associate degree yet. The students who have an education with different courses and programs and graduate from 29 different VSs have the same professional title and associate's degree. In a study on mechatronics VS education in Turkey, a course schedule was suggested for the branch of Mechatronics-Manufacturing [16]. In the suggested program, it is seen that 61.66% of the courses are theoretical and 38.33% of them are applied courses. When the lessons in the suggested program are classified as shown in Table 5, their distributions according to scientific branches are; Electric – Electronics 11.66%, Computer and Control 21.6%, Mechanics and Design 28.33%, Interdisciplinary 5%, Natural Sciences 10%, Culture 23.33%. 66.67% of the lessons is vocational, 33.33% of them is Cultural and Natural Science lessons.

Following the same classfification as in [16], three major tendencies can be found according to data in Table 5. The classification method is to group the courses in their categories (Electrical and Electronics, Computer and Control and Mechanical and Design), and then calculate their distribution percentages and the result is shown in Figure 2. Here, the category name which has higher percentage is the tendency category of the mechatronics programs.

According to the Figure 2, the branch tendencies can be grouped into 3 categories. There is only one exception; Kırklareli VS has a balanced program between Electrical-Electronics and Mechanical and Design branch. The major three categories and the included schools are;

- **Electrical-Electronics:** Soke, Bahçeşehir, Soma, Çan, Izmir, Gediz, Gaziantep,Kadir Has, A.Kanca, Karamürsel, and HacıBektaş Veli VSs.

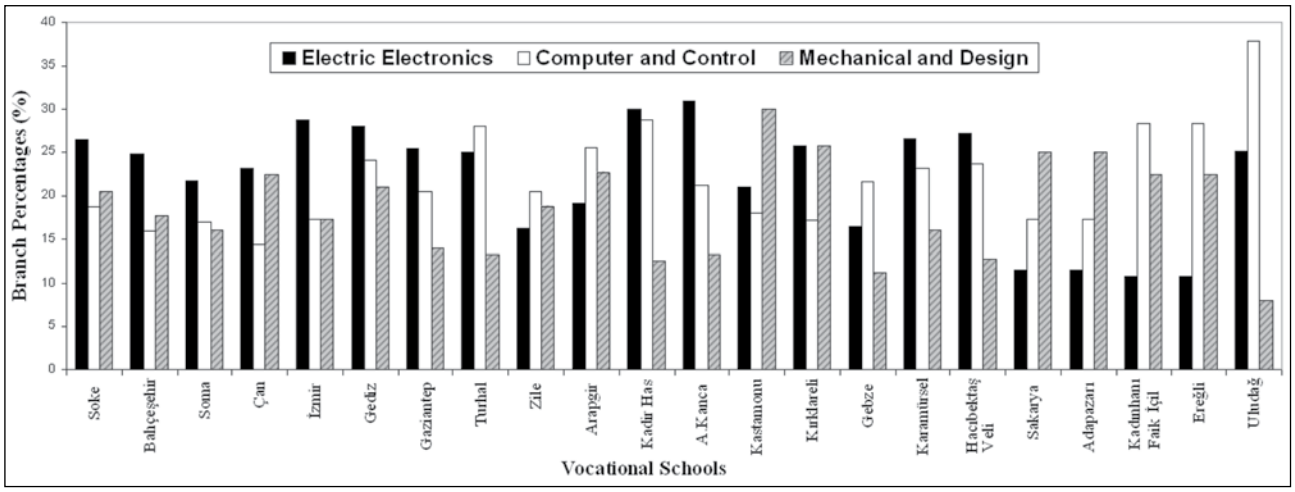

Figure 2. Percentages of branches in Mechatronic Programs of Vocational Schools according to Table 5.

- **Computer and Control:** Turhal, Zile, Arapgir, Gebze, Kadınhanı Faik İçil, Ereğli and Uludağ VSs.
- **Mechanical and Design :** Kastamonu, Sakarya and Adapazarı VSs.

6. Discussions

The present problems were discussed and some recommendations were concluded. They are;

There is a different understanding and application of mechatronics education in different vocational schools. This situation causes the students to be trained with the same professional name, but with different educational level and variety. This will also bring about discussions related to the term 'Mechatronics Technician'. These data show the necessity and obligation of standardization in Mechatronics undergraduate education.

Mechatronics associate's education started in 2001 in Turkey is gradually becoming widespread. If the industrial condition of the regions and the basic facilities of universities are not taken into consideration while opening new mechatronics programs, it is likely to have problems of employment and quality in further steps.

Unless sufficient financial and educational sources provided, it will become difficult to train and graduate Mechatronics technician suitable for the expectations of industry [22].

Mechatronics associate's education has started in Turkey in 2001. Although the significant increase of the school count and student quotas between the year 2001 and 2010, these developments are still insufficient for the Turkey as a developing country [23]. The aim is to have one million employees in mechatronics field in 2023 [13]. The count of mechatronic programs of VSs and their student quotas must be increased to achieve this aim.

There are significant differences between theoretical and practical hours, and also weekly course hours and credits if the course curriculum of mechatronics associate's education were researched. Also, there are significant differences in the distribution rates of the courses forms the subdisciplines of mechatronics. After all these data are examined, it appears that there are two main tendencies in the mechatronics associate's education as electrical – electronics and mechanical (manufacturing) branches. It is clearly seen that branch education has needed in VSs, otherwise the students come from different programs get different kind of knowledge and experience during the mechatronics education in VSs but will get the same associate's degree despite their differences and this situation will cause unpredicted problems in the future.

As an application based education, practice hours are very important in VSs, hence the theory and practice course hours in curriculum must be close to each others.

7. Conclusion

In this study, the development process of mechatronics programs of vocational schools was analyzed between the years of 2001-2010. Curriculum compatibility existence and the level of the compability of the mechatronics programs of vocational schools were examined. As a result of studies conducted, presence of three important disciplines was determined: electric-electronic, Computer and Control and Mechanical and Design. These disciplines are also the fundamental disciplines taking place in the definition of mechatronic. It is thought that disciplines of electric-electronic and mechanical and design are the main characters giving direction to mechatronic programs. The third discipline computer and control can be said to be an element combining the disciplines of electric-electronic and mechanical and control equally and not to be able to become a main character. Today's curriculums are not optional and according to curriculum each school has a unique mechatronic definition. A previous study supports the formation of optional curriculum in associate degree programs. [16]. our study also supports formation of two-optional curriculum [24]. And in the light of all these information we reached some results which we consider to be beneficial to do in the future. These are;

- A Turkish Mechatronics Education Platform should be established in order to have a common specific mission and strategy for extending this education from high school level to master degree for a robust mechatronics educational development in Turkey.
- The professional and educational standards of mechatronics technician must be determined on a national level that compatible with the international standards and the curriculum of the schools must be in parallel with these standards.
- Curricula must be reviewed and updated through a dynamic structure for certain periods according to technological changes, industrial demands, and regional needs. The curriculum varieties for the regional and industrial needs must be provided by the well defined optional courses without changing the main structure of the existing curriculum and this also gives an opportunity to meet the new developments on the technology.
- VSs must perform two mechatronics branch educations as Electrical and Electronics branch and Mechanical and Design branch according to their own facilities. In the transfers of students from high school to VSs who are encouraged to attend mechatronics programs, the ones graduated from Machinery department must be encouraged to VSs giving Mechatronics-Manufacturing Branch Education and the ones graduated from Electrics-Electronics department, on the other hand, must be encouraged to VSs giving Mechatronics-Electrics/Electronics Branch Education.

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