



## Design of Curriculum for Woodworking CNC Operators in Turkey

### Current Situation Analysis of the Furniture Industry and CNC Operations in Turkey and EU



Erasmus+

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## Introduction

As furniture consumption in the world accelerates each year, it also increases demand on furniture in extraordinary form and conventional production methods started to fail in satisfy this demand. This situation forces producers to utilize CAD/CAM technologies due to opportunities provided with the software – hardware which are improving and changing each and every day, and due to speeding up and easing the process in order to gain a place in the market.

Currently, CAD/ CAM is the term that is used to describe the mutual relation between design and manufacturing with high precision, productivity and customization at any level. When it became apparent that data exchange was possible between CAD and CAM systems, the development of computer-aided CNC programming techniques and languages brought the CAD/CAM philosophy into existence.

Traditional NC machines have been replaced by CNC machines, allowing small or medium-sized manufacturing enterprises to add CAM to their manufacturing environment. The increase in the usage of personal computers also extended the usage of CAM within non-specialist manufacturing environments. As production information could be created and recreated with CAD, CAM techniques have become both easily accessible and easily applicable.

In the last 15 years, universities, various workshops, and on-the-job trainings resulted in the successful learning and teaching of CAD. One particular benefit of CAD training is the achievement of life-long learning activities, which is one of the goals of the Bologna Process. CAM technologies currently hold great potential, are relatively easy to use, and are widely accessible. The same cannot be said for learning, teaching, or use of CAM in various fields. One such case is that of furniture manufacturers and wood-work companies.

The furniture industry, and wood working in Turkey, are important both as standalone fields and/or as part of construction. There is a great size range of manufacturing companies, from very small workshops to large companies. However, they share some common problems, such as the training of operators and designers, in order to cope with the current technologies and being able to use the available technologies to their full potential. The rapid developments of CAM technologies and the capabilities of new CNC's demand advanced techno-skilled operators and force all the actors of these sectors to re-consider training of CNC operators. Hence, ERASMUS+ Project entitled as "Design of Curriculum for Woodworking CNC Operators in Turkey", aims to improve the competencies of CNC operators in woodworking and furniture industries in Turkey. Although required competencies of the sector operators are well defined in all over EU and in Turkey, it is seen that how these competencies should be developed during formal education and on the job training is still an important subject of interest.

In this regard, it is important to picture the current situation of these sectors in EU and in Turkey in order to understand the needs of the industry to be able to frame the training of

CNC operators. Hence, this report surveys CNC industries in EU and in Turkey. In addition, a field survey has been conducted in the woodworking industry in Turkey in a randomly sampled way to comprehend how the actors of the sector consider CNC training.

## CNC Operations and Woodworking Industry in European Union

### Overview of the Industry in EU

According to Eurostat, the EU's wood-based industries cover a range of downstream activities, including woodworking industries, large parts of the furniture industry, pulp and paper manufacturing and converting industries, and the printing industry. Together, some 446,000 enterprises were active in wood-based industries across the EU-27; they represented more than one in five (21.2%) manufacturing enterprises across the EU-27, highlighting that with the exception of pulp and paper manufacturing that is characterized by economies of scale many downstream wood-based industries had a relatively high number of small or medium-sized enterprises.

As evidenced by the Table 1, between 2005 and 2011 the total number of enterprises within the EU-27's wood-based industries fell by 10.9 %. As such, the rate of decline was similar to the manufacturing average (–9.6%). There were declines recorded for three of the four subsectors, with the biggest reduction registered for furniture manufacturing (– 16.7 %). By contrast, the number of pulp and paper manufacturing enterprises in the EU-27 rose by 0.9 % between 2005 and 2011. (Eurostat 2013)

Table 1: Some Indicators for Furniture Industry in EU-27

Activity	Number of Enterprises (1000)		Gross Value Added at Factor Cost (EUR billion)		Number of Persons employed (1000)	
	2005	2011	2005	2011	2005	2011
<b>Manufacturing</b>	2,322	2,100	1,630	1,650	34,644	30,100
<b>Wood-based industries</b>	500	446	152	135	4,388	3,461
Manufacture of wood and wood products	198	183	35	32	1,280	1,020
Manufacture of pulp, paper and paper products	20	20	40	42	730	651
Printing and services related to printing	133	118	41	33	978	790
Manufacture of furniture	150	125	36	29	1,400	1,000



The economic weight of the wood-based industries in the EU-27 as measured by EUR 135 billion of gross value added was equivalent to 8.2% of the total manufacturing in 2011. The distribution of value added across each of the four wood-based activities presented in Table 1 was spread relatively equally, as each subsector accounted for at least one fifth of the total added value generated within the EU-27's wood-based industries in 2011; the highest share was recorded for manufacturing of pulp, paper and paper products (25.6% or EUR 42 billion).

Between 2005 and 2011 the overall level of added value generated within the EU-27's manufacturing sector rose by 1.2 %. The wood-based industries in the EU-27 on the other hand experienced a decline in activity as gross value added fell by 10.9%. Double-digit reductions in activity were recorded for three of the four wood-based enterprises with the largest decline in output recorded for printing and services related to printing (-20.2%). By contrast, the added value generated by the EU-27's pulp and paper manufacturing enterprises rose by 5.7% between 2005 and 2011.

Wood-based industries employed 3.4 million people across the EU-27 in 2011, or 11.5% of the total manufacturing. There were just over one million people employed within the manufacture of wood and wood products and the manufacture of furniture, while the lowest level of labor input (651,000 employees) was recorded for the relatively capital-intensive and highly automated activity of pulp, paper and paper products manufacturing.

As evidenced by Figure 1, a longer time series and fresher data is available concerning the development of employment within the three of wood-based industries. Across the EU-28, manufacturing employment fell by 18.1% during 2000-2013 period, while the largest losses among the three wood-based industries were recorded for furniture manufacturing (30.3% fewer employees). Printing was the least affected sub industry, noting a 2.9% reduction in employment during the 2000-2013 period.

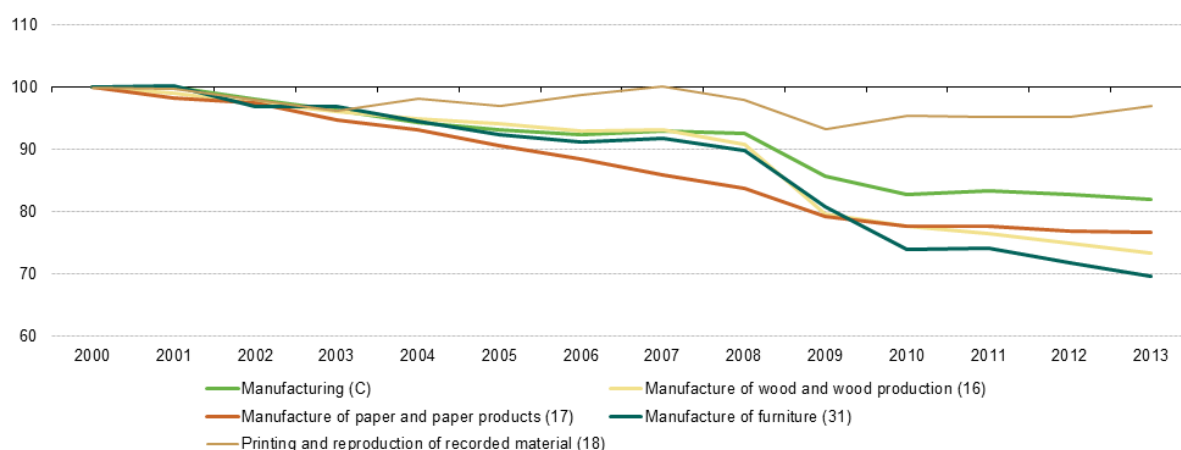


Figure 1: Production Indicators between 2000 and 2013





Figure 1 shows that each of these wood-based industries, similar to most of the manufacturing sectors, experienced a reduction in the respective number of people employed during the 2000-2013 period. The development of EU-28 employment for wood and wood products and furniture manufacturing followed closely the overall pattern for total manufacturing during the period 2000-2008. Thereafter, with the onset of the financial and economic crisis, labor input reductions for these two wood-based industries accelerated at a faster pace than the manufacturing average. Furthermore, having remained unchanged in 2011, there was evidence of a further downturn in EU-28 employment for both of these subsectors in 2013. By contrast, pulp, paper and paper products manufacturing had a more uniform reduction in employment spread across the period 2000-2013, and was relatively unaffected by the financial and economic crisis.

The official statistics are confirmed and contextualized by the European social partners. As reported by the European Confederation of Woodworking Industries CEI-Bois, which represents 380,000 companies generating an annual turnover of EUR 204 billion and employing around 2.1 million workers in EU27, the total production value of the woodworking industries in the European Union (EU) peaked in 2007 with 237 billion EUR. Then, as a result of the global economic crisis, the production value dropped in 2008 and to a greater extent in 2009, amounting to less than EUR 190 billion. Nevertheless, it upturned in 2010 and grew further in 2011 before falling down again in 2012 although slightly by 1.1%, reaching almost EUR 206 billion. (CEI-BOIS 2013)

About the relative importance of the sub-sectors, the 2012 production of the woodworking industry sector was articulated as follows:

- Furniture (NACE 31) : 44%
- Manufacture of products of wood, cork, straw and plaiting materials (NACE 16.2) : 40%
- Sawmilling and planning of wood (NACE 16.1) : 16%

Concerning extra-EU imports, the total EU-28 imports of woodworking products amounted to EUR 21 billion in 2012, reflecting a slight decrease of 1.3% compared to 2011. The sawmill industry experienced the largest decrease of imports (-10.9%) while the imports of woodworking products *stricto-sensu* fell by 2.5%. The value of furniture imports (NACE 31) exceeded EUR 12.3 billion and increased by 2% compared to 2011.

About the relative importance of the sub-sectors, the 2012 extra-EU imports of woodworking products was articulated as follows:

- Furniture (NACE 31): 59.5%
- Sawmilling, planning, impregnation of wood (NACE 16.1) : 15%
- Wood-based panels (NACE 16.21): 9.7%
- Construction elements (NACE 16.23) : 3.1%



- Parquet (NACE 16.22) : 2.2%
- Packaging (NACE 16.24) : 0.9%
- Other (NACE 16.29) : 9.5%

Concerning extra-EU exports, the overall value of EU-27 exports of woodworking products amounted to EUR 23.5 billion in 2012 which was 10.3% more than in 2011 and well above the 2008 peak level of EUR 20.7 billion. In 2012, exports of all sectors and sub-sectors improved. Furniture and woodworking products stricto-sensu increased by 9.7% and 11% respectively. The value of sawmilling, planning and impregnation (NACE 16.1) exports exceeded EUR 4.3 billion. On the other hand, other woodworking industries stricto-sensu (NACE 16.2) reached almost EUR 6.8 billion.

More in detail, in regard to the relative importance of the sub-sectors, the 2012 extra-EU exports of woodworking products was articulated as follows:

- Furniture (NACE 31): 52.8%
- Sawmilling, planning, impregnation of wood (NACE 16.1) : 18.4%
- Wood-based panels (NACE 16.21): 12.6%
- Construction elements (NACE 16.23) : 8.4%
- Packaging (NACE 16.24) : 2.1%
- Parquet (NACE 16.22):1.8%
- Other (NACE 16.29) : 4.1%

## Observations on the Sector by Other Institutions

CEI-Bois remarks that employment in the woodworking industries declined by 1.3% in 2012, still exceeding the 2 million threshold. The decrease of employment took place primarily in the furniture sector (-2.5%) while employment remained rather stable in the woodworking industries stricto-sensu (-0.1%). Within the woodworking industries stricto-sensu, a slight drop of employment was observed in the other woodworking industries (-1%) while employment progressed by 2.4% in the sawmill sector.

About the furniture sector specifics, the European Trade Union Confederation - ETUC remarks in particular:

- The sector is restructuring and moving towards more efficient, sustainable and innovative production.
- New competition from outside Europe (mainly China) has put pressure on competitiveness in the sector (as referred in Aris' report)
- Rising energy prices increase production costs, while intense competition in the sector does not allow the passing on of the costs to the final products; thus profits and employment could suffer (as referred in Aris' report)



- The evolving market for wood, with a rising demand for wood energy as well as possible market growth in the use of wood in construction due to 'green building', may result in a price increase (as referred in Aris' report)
- New products in line with lifestyle changes and eco-furniture arise to meet growing consumer demand for environmentally friendly items (natural materials combined with innovative design) (as referred in Aris' report).
- The general trend in wood industry is a decrease in occupations, but there are substantial differences among regions, which reflect level of mechanization and potential for increased productivity (as referred in Aris' report).
- The principal markets being the advanced countries, there is an industrial transfer to less developed economies, threatening the sustainability of the furniture industry in Europe (as referred in Aris' report).
- The furniture industry traditionally is a wood-based industry with recent trends to use new materials as an alternative to wood (e.g. concrete products, durisol, rice, straw, coconut) and moves towards fair-trade and environmentally sustainable wood (as referred in Aris' report)
- Deforestation, illegal logging, inefficient use of resources, pollution and irresponsible use of waste are major threats, which may exacerbate the negative effects of climate change (as referred in Aris' report)
- Tight indirect regulation on the sector's activities including the VOC Solvents Directive (of particular importance to the sector), the IPPC Directive, the REACH Regulation and the Waste Framework Directive. The European Union Timber Regulation 995/2010 (EUTR) (2013) aims at greater transparency in timber trade practices and the eradication of illegal wood products on the European market.

Regarding furniture sector employment and demographic situation and trends, ETUC also remarks that even though the production of furniture is labor intensive, the sector employs a rather low share of young employees. In 2012, 8% of the workforce in the EU furniture sector was under 25 years old, 2% below the average share in the total EU economy and, due to the crisis, the share of young employees in the sector decreased by 4% in 2008-2012, as shown in Figure 2. (ETUC 2012)



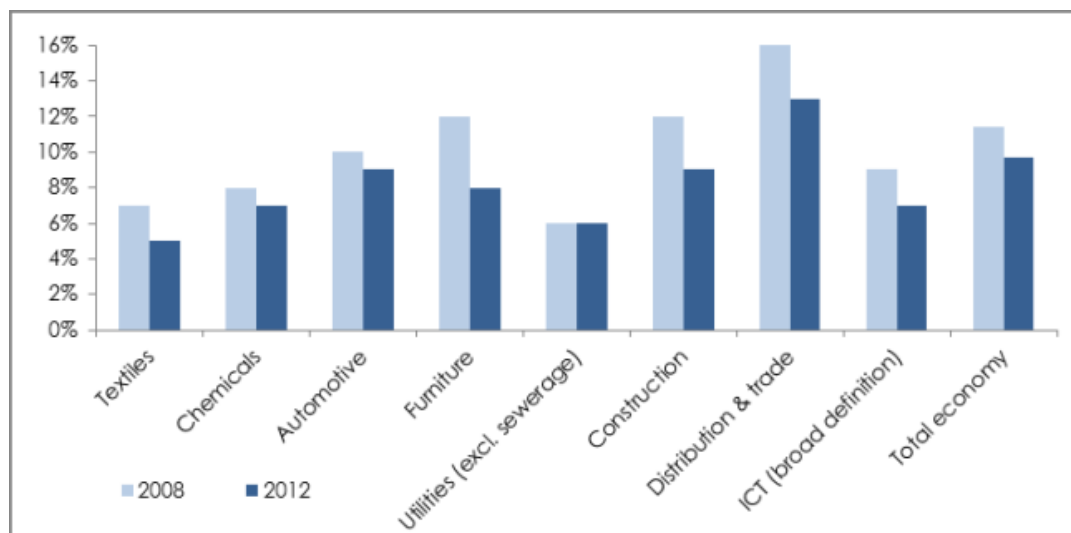


Figure 2: Young Employee Share in the Total Industry Workforce, 2008 And 2012

ETUC also stresses that, prior to the crisis, young employees exceeded the number of older employees in the sector, however, by 2012 older employees already dominated, as shown by Figure 3 and Figure 4. (ETUC 2012)

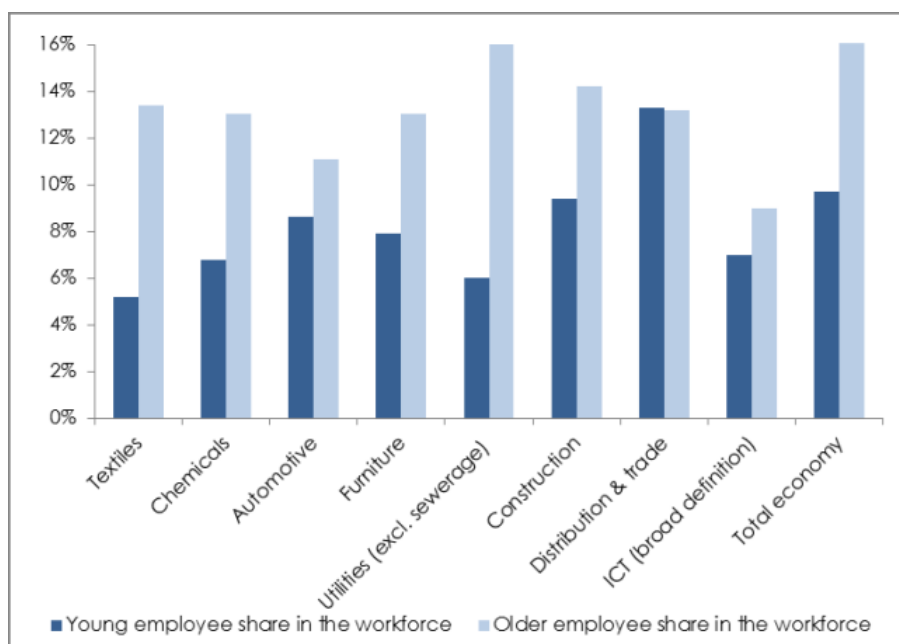


Figure 3: Young and Older Employee Share in the Total Industry Workforce, 2012

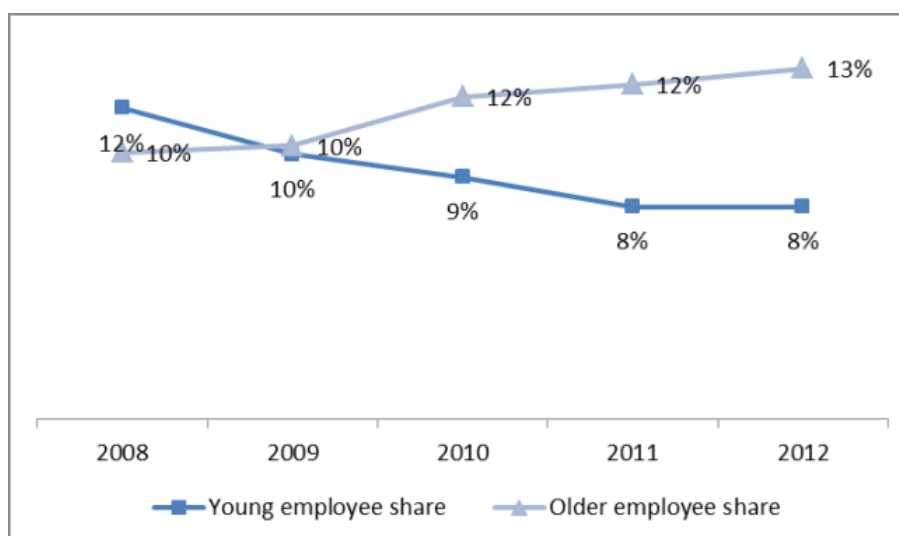


Figure 4: Young and Older Employee Share in the Furniture Industry Workforce, 2008-2012

About gender issues, ETUC also remarks that male employees strongly dominate both the young workforce and the total workforce.

However, the male prevalence in the young workforce is especially high – in 2012 the male share of the sector’s young workforce reached 84% (male share among the selected sectors was higher only in the construction sector), as evidenced by Figure 5. (ETUC 2012)

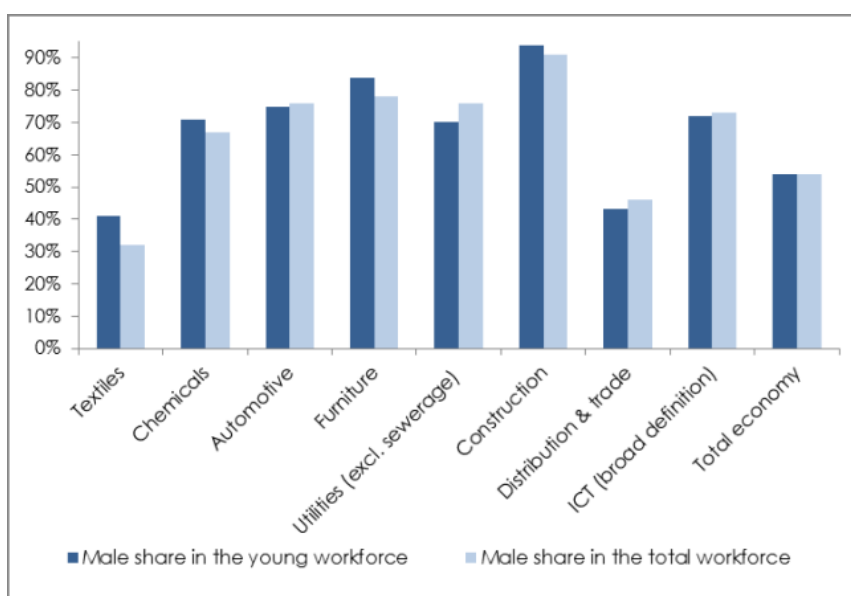


Figure 5: Male Share in the Industry Workforce, 2012

ETUC also remarks that, according to Eurostat data, the furniture sector in the EU is unsafe for young employees. 17% of total non-fatal accidents at work happen to them – 4% more than

average in the EU economy, as evidenced by the Table 2 below. This was the highest indicator among the diversely considered sectors. (ETUC 2012)

*Table 2: Share in Non-Fatal Accidents, Young Employees, 2010*

Sectors	Share in total non-fatal accidents
Textiles	8%
Chemicals	10%
Automotive	12%
Furniture	17%
Utilities (excl. sewerage)	7%
Construction	16%
Distribution & trade	17%
ICT (broad definition)	12%
<b>Total economy</b>	<b>13%</b>

Regarding employment trends, ETUC stresses that in 2010, the furniture sector employed approximately 3.73 million workers in the EU33, and that from 1995 to 2010 employment was decreased by 0.27% annually due to on-going technological upgrading. However, it is projected that during the 2010-2025 period total sectorial employment is likely to decrease slower (by 0.14 % annually) and in 2025 is expected to reach approximately 3.65 million workers. As a result, between 2010 and 2025 the sector may lose approximately 80,000 jobs. The shift in sectorial employment is likely to be caused by a complex set of trends including the increasing prices of raw materials, strong global competition and the strong market power of furniture retailers (as referred in Aris' report). This reduces producers' profits and decreases the attractiveness of the sector. Moreover, employment is shifting from Western Europe to Eastern and Central Europe, in addition, basic manufacturing activities are being subcontracted and outsourced to third countries (as referred in Aris' report)

The sector might also be affected indirectly by greening actions. For instance, recycling of materials or remanufacturing of furniture might increase cost-efficiency and thus boost the sector's profits. Remanufacturing saves significant volumes of fuel and raw materials (as referred in Aris' report)

About developing skills, ETUC remarks that the sector relies on medium- and low-skilled employees, taken together, medium/low-skilled employees accounted for 85% of the sector's labor force in 2010. Between 2010 and 2025, it is projected that up-skilling would take place, but its impact on the composition of labor force skills is not likely to be that significant compared to other selected sectors. (ETUC 2012)

With regards to the future replacement demand, the industry is mostly likely to look for medium-skilled employees, but low-skilled labor is expected to be in demand as well. In 2010,



most jobs were in the category of craft and related trades workers, with medium level skills. Besides, in the future craft and related trades workers are still likely to constitute the core of the workforce in the sector. The demand for other craft and related trades workers was the highest in 2010. Moreover, the occupation is expected to remain crucial for the sector between 2010 and 2025 as well.

The undergoing restructuring in the sector is projected to increase the demand for managers, ICT professionals, industrial designers, sales and marketing employees, supply chain managers and plant and machinery maintenance and repair staff, and decrease the demand for laborers and skilled handicraft workers (as referred in Aris' report)

Besides a number of other key factors, environmental regulation and the demand for ecological products and the use of non-traditional materials are viewed as important determinants of skills' development in the sector. Logistics' knowledge becomes increasingly important too, since distribution is one of the most important strategic levers for furniture manufacturers to succeed in new globally emerging markets (as referred in Aris' report)

The general trend in the EU-15 countries is towards fewer hand workers and more supporting staff like managers, architects, engineers, other professionals and office clerks and secretaries.

In the newer EU Member States the share of wood processors and textile, garment, pelt and leather processors may increase significantly (as referred in Aris' report)

Social skills (such as communication, language and intercultural), creativity and innovation, understanding of suppliers' and customer needs, management skills (planning, flexibility, process optimization, quality management and strategic skills) are likely to be required in the future.

Table 3 (as referred in Aris' report) shows four different scenarios assuming different types of production specialization. Employment is projected to increase only under the scenario of global markets with a high degree of customization. In the case of greening, the most important skills are projected to be design, ICT technologies and sales' skills.

Table 3: Skill Development Scenarios Based On Future Production Specialization

Local mass production	Global mass production	Local customization	Global design and customization
<ul style="list-style-type: none"> <li>• Current trends.</li> <li>• Further measures to protect the position of EU producers.</li> <li>• Production along traditional lines.</li> <li>• Further mechanization and automation would diminish the labor factor (EU15).</li> <li>• The industry fails to renew itself and would not be able to cater to the demands of an increasingly segmented market.</li> </ul>	<ul style="list-style-type: none"> <li>• Traditional approach to furniture design and manufacturing.</li> <li>• Open markets speed up the processes of delocalization, outsourcing and the growth of global furniture value chains.</li> <li>• Dominance of few large companies.</li> <li>• The European sector would concentrate on design, logistics, integration of the production chain and marketing.</li> </ul>	<ul style="list-style-type: none"> <li>• Relatively low levels of international competition.</li> <li>• Important role of consumers in design and customization.</li> <li>• An increasingly segmented market of different types of consumers.</li> <li>• Customers' involvement in design and adaptation, using web-based tools.</li> <li>• Tailored high-value, high-quality production.</li> <li>• New systems of production organization like lean manufacturing and mass customization.</li> </ul>	<ul style="list-style-type: none"> <li>• A wider variety of customers would be served through mass customization on global scale.</li> <li>• Internet, web-based design tools, advanced logistics and systems of quality control.</li> <li>• Rapid manufacturing, virtual prototyping and a higher degree of automation.</li> <li>• Customers have a higher degree of freedom in customizing their furniture.</li> </ul>
Decrease in employment	Employment reductions in the EU-15 and possible gains in the NMS based on lower labor cost.	Decrease in employment	Little increase in employment
Skills: Supply chain managers.	Skills: ICT professionals; Production managers; Sales & marketing; Supply chain managers; Plant and machinery maintenance and repair staff.	Skills: Managers. Industrial designers, Sales & marketing.	Skills: Managers. ICT professionals, Industrial designers, Production managers, Sales & marketing, Supply chain managers, Plant and machinery maintenance and repair staff.

ETUC concludes that since the furniture sector in the EU33 is experiencing restructuring, the current trend of negative employment growth may change in the future. However, at the moment the sector requires additional employees only to replace those leaving the sector (a total additional workforce requirement for 2010-2025 is approximately 1.5 million). Greening would not have a direct effect on the sector's jobs, but indirect effects might be significant, ranging from raw material price increases, material innovations to new types of consumers.

As for the young employees' prospects, the sector is expected to employ mostly medium and low skilled employees. Therefore, young people (with less experience) are likely to have better chances of finding a job in the sector, especially if they have received special training in crafts,



design or sales. If the sector is successful in restructuration, then more highly-skilled employees would be required with knowledge of legislative/regulatory issues, languages, ICT, marketing, technologies and product development. However, the key problem for the sector is the poor working conditions of the young employees. Thus, it is unclear whether young employees would be willing to work in the sector in the future.

Other interesting data and information about the situation of the EU furniture market are also provided by the very recent research “The EU Furniture Market Situation and a Possible Furniture Products Initiative” (CEPS 2014) : “One quarter of the world’s furniture is produced in the EU. Furniture remains one of the most fragmented manufacturing sectors in Europe. In 2010, about 940,000 European workers were employed in approximately 130,000 firms. SMEs account for over 70% of total added value, of which a sizeable share is represented by small companies and micro-enterprises. In 2010, the sector’s production amounted to around EUR 83 billion with a value added of nearly EUR 29 billion. Germany, Italy, Poland and France ranked among the top 10 furniture manufacturers worldwide, and held a combined share of 17% of the world production and almost 60% of the EU production. Moreover, the EU Single Market has resulted in a very high degree of business-to-business trade integration across the Member States both in terms of firm specialization and product differentiation. With over 500 million inhabitants, the EU accounts for roughly one quarter of the global world furniture market. Depending on the economic cycle and on increases in the housing stock, per capita furniture consumption in the EU can be as high as 1.5-2% of total household purchasing power domestically.

The furniture market has traditionally been very cyclical and is sensitive to the economic conjuncture. Indeed, the furniture industry has been one of the most severely hit by the recent economic downturn. After a peak in 2007, total industry production has decreased by more than 14% and total sector employment decreased by 20% between 2007 and 2011. This has accelerated an underlying restructuring process common to other low-tech industries such as clothing and textiles. Commitment to open trade and globalization also impacted the EU furniture market in a notable way over the last decade. Since 2000, the EU has substantially increased its extra-EU imports of furniture from EUR 5 billion to EUR 10 billion. Most of these imports are based on price competition and come from low-labor cost countries. China alone accounts for about 60% of the EU imports in furniture. Against this background, the competitive response of the European furniture industry centered around further quality upgrading, although this has occurred at different strengths and levels across the various segments of the industry. Yet, and despite the recent and strong reduction in workforce, furniture remains by all standards a labor-intensive sector.

## Fundamental Problems of the Sector in EU

While the EU furniture industry has so far remained competitive worldwide, it has increasingly faced problems in signaling the quality and sustainability of its products at home and in using these features as a competitive advantage against foreign competitors. In the long run, this shortcoming has the potential to erode some of the industry's factors of strength and its competitiveness. In particular, the consumer is often no longer in a position to recognize quality adequately. This development stems, among others, from the use of new retailing formats where information on product quality that consumers can recognize and react upon is not necessarily conveyed or easy to find. Moreover retailers might not always have incentives to display such information, as this can go against their marketing strategies.

Essentially, three problems affecting the provision of information on furniture product characteristics were identified:

1) The existence of an informational failure caused by the presence of information asymmetries between manufacturers, retailers and consumers of furniture products, particularly for product features that cannot be easily verified by consumers prior to the purchase (e.g., durability of use, environmental friendliness of the production process, hazardous substances contained in the product)

2) Misaligned incentives along the value chain that make it more difficult for manufacturers and retailers to agree on "quality signaling" strategies, with negative repercussion on the competitiveness of some EU manufacturers and the availability of unbiased and comparable product information for consumers;

3) A potential regulatory failure generated by the adoption of various mandatory or voluntary schemes at the national level to address this informational gap. While the first two problems emerged as being a concern (to different extents) for several stakeholder groups that responded to the public online consultation (i.e. the existence of an informational failure was reported more strongly by consumer associations and associations representing manufacturers; misaligned incentives along the value chain were reported mostly by manufacturers and their associations), the impact of a potential regulatory failure stemming from the coexistence of various schemes at the national level appears more limited.

Under the light of the above, the general objective of a possible EU furniture products initiative is enhancing the competitiveness of the EU furniture industry by establishing a level playing field in the EU consumer market. This general objective can be further specified and leads to different specific and operational objectives, and namely:

1. Improve market transparency and raise consumers' awareness about quality features when purchasing furniture. This objective leads to two operational objectives:



- a. Increasing the quantity and quality of information on the features of furniture products provided to consumers before purchase;
  - b. Increasing consumers' awareness of and willingness to pay for the quality features of furniture products made in the EU
- 2. Support a coherent approach to the provision of information on furniture characteristics across the EU. This leads to the following operational objectives:
  - a. Lowering administrative and compliance costs, thus eliminating actual and potential obstacles to intra-EU trade;
  - b. Favoring economies of scale in quality signaling and therefore improving overall visibility of quality labels in the market.

## Research Elements about the Relevance on CNC in Furniture

### Operations in EU

Even if the literature about CNC in furniture operations is much more limited compared to the sectorial economic and occupational situation and trends, and to the strategic development perspectives of the sector, accessible and existing data and information confirm the importance of CNC in furniture operations of woodworking industry in Europe. According to the studies, the technological innovation from the computer numerical control of machine tools, to the highly automated end-to-end component design using computer-aided design (CAD) and computer-aided manufacturing (CAM) programs will shape the future skills required in the sector.

The survey study held at enterprise level "Study of Wood Sector - Research Report on Skill Needs" (Training 2008) indicates two important and relevant outcomes on the use of contemporary production and information technologies and innovations.

Firstly, the respondents widely relates the technological innovations that will influence the company development for the enterprises active both in the wood manufacturing and furniture manufacturing sub-sectors, with modern technological equipment and the automation of the manufacturing process.

Secondly, answers of the respondents indicates that diffusion of the use of information systems both in wood and furniture manufacturing sub-sectors, getting faster, crucial and more popular with the emergence of manufacturing planning and management software as well as integrated computer aided design, engineering and manufacturing software.

Coherently, according to the same interview's questions which tries to define the "Future Skills" required by the sector, the Lithuanian study evidenced that the skill change with regard to the jobs in the wood sector not only will be determined by the customer expectations,



increase in raw material and energy resource prices; but also and particularly by the implementation of the new tools in manufacturing. In the future, the companies aim to increase the productivity of their work by making the manufacturing process automated and by modernizing work methods. Explicitly, more advanced equipment will require well qualified staff in terms of working with software machinery, conducting their maintenance and programming the machine itself.

It is also forecasted that, quality requirements of the goods will grow and therefore the knowledge in the quality management principles will be necessary to all employees. As a result, learning and teaching skills will gain more importance among the qualification of the specialists and workers.

These previsions about the diffusion of the computer numerical control of machine tools, and of the highly automated end-to-end component design using computer-aided design (CAD) and computer-aided manufacturing (CAM) programs within furniture industry, as well as the forecasted growth of related skill needs, seem confirmed and even exceeded within the 2015 European and global furniture sector, as highlighted by recent analysis and studies both at extra-EU ( Research and Market 2015) and intra-EU level (Teischinger 2012)



## CNC Operations and Woodworking Industry in Turkey

### Overview of the Industry in Turkey

Woodworking industry has an important role for Turkey as one considers the number of businesses and the employments it create. In Turkey, although the number of large-scale companies remarkably increases, the industry is typically composed of SMEs, which mostly face the challenge of having low technological level and insufficient well-trained technical staff. The increasing number of large-scale companies leads to boost the share of the production based on automation. Furniture industry, which has one of the highest employment capacity in Turkey, is distributed all across the country to cities and counties. Economic and social developments in Turkey after 1980's, fast housing and urban transformation in last 10 years increased high quality, functional and modern furniture demand especially in big cities and these advances gave acceleration to sector and country economy.

Enterprise numbers and employment numbers in furniture sector steer with ups and down concerning the years. Between 2005 and 2013, the furniture production in Turkey had an increase of 67.9%, doubling the growth of the average manufacturing industry production in the same period. It is stated that the increasing productivity (production per capita) of the furniture industry reached 46.3% while the ratio was 13.6% in the whole manufacturing industry. The production was above the employments during this period, which gave rise to the significant ratio of productivity.

The number of enterprises in the furniture industry is 10% of the enterprises in overall manufacturing industry. However, it can be analyzed that, in Turkey, furniture industry allocates less in terms of the number of employee and financial turnover.

*Table 4: Some Indicators for Furniture Industry in Turkey*

Year	Enterprises	Employee	Production Value (Million TRY)	Value Added (Million TRY)	Investment (Million TRY)
2006	35,854	106,807	7,322	1,525	772
2007	32,994	106,407	8,150	1,795	642
2008	34,438	115,898	9,811	2,067	445
2009	34,427	97,105	8,436	1,899	429
2010	31,089	120,580	10,486	2,362	662
2011	35,883	140,772	14,074	2,860	826
2012	39,036	159,246	15,963	3,461	903

(TÜİK 2012)

With respect to 2012 values, 159,246 employees are present in 39,036 enterprise/businesses in furniture industry. The ratio of sector employment to overall employment is 5.09% whereas the ratio of number of businesses to overall production is 11.59%. In last seven years, employment in the sector has a significant increase from 106,000 to 159,000 and number of



enterprises increased from 35,000 to 39,000. The decrease in the number of enterprises in 2007 and 2010, and decrease in the number of employees in 2009 are attention grabbing. Number of employees per businesses in furniture production is 4.07% and far below the overall production average (9.2%).

The capacity utilization ratio slightly decreased between 2011 and 2013 as declared in the Turkish Central Bank's (TCMB) reports. Furthermore, the ratio is stuck around 70% for the last ten-year period (Table 5). (TCMB 2014)

Furniture production has capacity utilization of 71.6% in 2006. However, there is a decrease in present capacity utilization ratios with respect to previous year in 2007, 2008, 2009 and 2012. The highest ratio of capacity utilization is reached in 2011. With respect to evaluation of last 8 years, capacity utilization of 70% is observed while it is still under the overall production capacity utilization of 75%.

*Table 5: Production and Capacity Utilization Ratio*

	2006	2007	2008	2009	2010	2011	2012	2013
<b>Furniture Industry Production (Percent Change)</b>	-1.9	26.8	12.8	-7.4	4.8	22.1	-8.9	10.8
<b>Manufacturing Industry Production (Percent Change)</b>	7.2	6.7	-1.5	-11.3	14.4	9.2	2.0	4.0
<b>Capacity Utilization Ratio of the Furniture Industry (%)</b>	71.6	70.9	68.5	66.9	70.4	72.6	69.8	71.4
<b>Capacity Utilization Ratio of the Manufacturing Industry (%)</b>	81.0	80.2	76.7	65.2	72.7	75.4	74.2	74.6

(TCMB 2014)

In accordance with the values of last 8 years, it is remarkable that the sector is operated with a capacity utilization ratio of 70%. Fluctuating and decrease dominant course of capacity utilization despite the increase in production volume and monetary value presents negative nonoccurrence. Present capacity utilization ratios of the sector is below the country ratios which are competed against. This situation causes insufficient return of the investments made.

Number of people employed for research and development activities in production industry by the year 2012 is 332 in total. Expenses for research and development has a tendency to increase throughout the years and in 2012, it is TRY 13.8 million. 12.4 million of these expenses are employment based expenses and TRY 1.4 million is used for investment expenses including hardware and alike. Expenditure data regarding research and development indicators are present in Table 6.

Table 6: Number of Patents, Trademarks and Design Registries for Furniture Production

Employment Indicators	Years							
	2009		2010		2011		2012	
	Furniture Industry	Overall Industry	Furniture Industry	Overall Industry	Furniture Industry	Overall Industry	Furniture Industry	Overall Industry
<b>Researcher</b>	164	13.085	142	13.242	103	16.036	106	17.433
<b>Technician</b>	154	7.371	137	8.120	207	9.348	180	10.309
<b>Other Support</b>	107	2.989	89	3.226	53	5.301	46	3.592
<b>Total</b>	<b>425</b>	<b>23.445</b>	<b>382</b>	<b>24.588</b>	<b>363</b>	<b>28.781</b>	<b>332</b>	<b>31.334</b>

(TÜİK 2012)

Istanbul Chamber of Commerce announced that “Number of people employed as part of R&D activities in the manufacturing industry of furniture is 315 as of 2013. R&D employment in the industry is observed to be reduced following 2009, while cost of R&D activities has increased over the years, measuring at 15.7 million TRY in 2013. 14.4 million TRY out of this amount covers employment-based current expenditures while investment cost is equal to 1.3 million TRY.” (Istanbul Sanayi Odası 2015)

Table 7: R&D Expenditures in Furniture Industry (Million TRY)

Current Expenditures		Investment Expenditures		Total
Personnel	Other	Accoutrements	Permanent Facility	
7,814,157	5,056,263	2,353,247	185,000	<b>15,408,667</b>

(TÜİK 2012)

Design registries, trademark registries and number of patents in the sector are important parameters for production with high added value, innovation and branding. Accordingly, number of patents obtained in 2000 in furniture industry is 52, trademarks obtained is 200 and design registries is 402. In overall production, number of patents obtained is 720, trademarks is 10,736 and design registries is 1,679.

In 2013 number of patents obtained is increased to 137, trademarks obtained is increased to 2633 and design registries is increased to 1719. Even though there is a remarkable increase observed for the sector, it can be concluded that the numbers for developed countries cannot be reached. It is considered that the continuity of these parameters, which have tendency to increase in last years, with acceleration will have positive influence on the competition of sector in both national and international market.

Table 8: Furniture Consumption and Its Relation with Production

NACE KOD	Furniture Production and Consumption Equilibrium (Million TRY)						
31	Years						
Furniture Production	2006	2007	2008	2009	2010	2011	2012
Production	7.322	8.150	9.811	8.436	10.486	14.074	15.963
Consumption	7.064	7.798	9.217	7.820	9.810	13.357	14.612
Consumption ratio	96,4	95,6	93,9	92,6	93,5	94,9	91.5
Average of last 7 years	94.05						

(TÜİK 2013)

With respect to the data provided in Table 8, 94% of the furniture produced in the country is consumed in domestic market. It can be stated that change of consumer habits and needs, increase of level of income effects consumption and directly reflected to production. With respect to MUSİAD's report (MUSİAD 2013), it is claimed that the consumers' rate of replacing furniture is increased. It can be stated that this tendency is a factor effecting furniture consumption.

In 2013, furniture export in Turkey is approximately USD 2.23 billion and exported to 203 countries. In 2012, export is done to 215 countries with the value of USD 1.9 billion. Increase of export value despite the decrease in number of countries makes sense and it is remarkable that 85% of the export is done to first 25 countries. When export is evaluated generally, while there is 18% increase in 2011, 22% increase in 2012; there is an increase of 18% in 2013. First 5 countries in the list with respect to monetary value did not change and are Iraq, Libya, Germany, Azerbaijan and France.





Table 9: Furniture Export With Respect to Countries

2014	2013	Years (USD)					Performance	Share
		Name of the Country					%	
		2011	2012	2013	2014 August	2012 - 2013	%	
1	1	IRAQ	286,447,623	396.202.880	455,149,461	306,557,338	15	20.3
2	2	LIBYA	17,494,230	167,211,289	237,097,610	144,274,271	42	10.6
3	3	AZERBAIJAN	108,470,135	131,495,049	166,777,149	110,067,839	27	7.45
4	4	GERMANY	168,836,852	152,839,224	143,940,092	96,320,328	-6	6.43
5	5	FRANCE	91,390,124	85,444,360	105,689,976	80,485,137	24	4.72
6	8	RUSSIA FEDER.	49,109,839	59,346,904	100,774,616	59,217,444	70	4.50
7	7	TURKMENISTAN	76,133,454	61,209,556	87,962,455	62,114,023	44	3.93
8	6	SAUDI ARABIA	42,622,461	66,676,562	84,099,719	79,543,627	26	3.75
9	9	ENGLAND	40,776,546	49,672,190	57,597,146	42,165,128	16	2.57
10	10	NETHERLANDS	56,552,284	53,155,514	46,351,419	30,931,692	-13	2.07
11	11	U.A.E.	18,267,312	20,864,737	41,028,799	25,454,485	97	1.83
12	12	U.S.A.	26,822,602	30,335,122	38,946,611	41,280,539	28	1.74
13	13	ITALY	34,100,350	30,344,907	33,895,412	23,779,975	12	1.51
14	14	IRAN	110,754,208	71,527,314	31,354,938	25,059,182	-56	1.40
15	17	GEORGIA	28,539,695	32,126,202	30,891,035	23,017,583	-4	1.38
16	16	ISRAEL	23,299,555	23,419,348	30,506,365	23,734,155	30	1.36
17	15	KAZAKSTAN	19,552,230	24,317,979	30,221,023	18,910,436	24	1.35
18	21	ROMANIA	19,489,484	18,535,895	27,977,666	33,473,136	51	1.25
19	17	AUSTRIA	25,474,875	22,634,247	25,392,503	14,988,118	12	1.13
20	18	T.R.N.C.	22,526,384	21,512,284	24,036,693	16,424,491	12	1.07
21	19	EGYPT	14,034,612	20,493,500	23,176,014	15,952,170	13	1.03
22	20	SPAIN	15,264,377	11,946,444	22,353,441	17,892,702	87	0.99
23	22	BELGIUM	25,439,710	24,620,794	22,053,544	16,382,902	-10	0.98
24	23	ALGERIA	13,828,285	14,271,911	18,827,133	19,992,460	32	0.84
25	24	QATAR	9,656,755	11,375,405	18,765,599	9,77,545	65	0.3
Total of the List		1,323,746,017	1,614,314.364	1,904.466,419	1,337,696,706	18	85.11	
Total of 203 Countries		1,658,376	1,898,570	2,237,246	1,600,330,218	18	100.0	
Annual Change (%)		18	22	18	-			
World's Furniture Export				170,524,239,000	-		1.30	

(TÜİK 2014), (Trademap 2014)

In 2013 year, Turkey got a share of 1.31% from the world furniture export with the USD 2.24 billion export and is in 15<sup>th</sup> rank. Turkey manages to continuously and gradually increase its share from total exports made in world market. For import, Turkey is ranked 28<sup>th</sup> with USD 968 million volume. In 2012, there is a decrease with respect to previous year but got a share of 0.60% by continuing the tendency to increase in 2013. Import and export share of Turkey in World classification is considerably low.

Table 10: Turkey's Import-Export Share

Years	Export (USD billion)			Import (USD billion)		
	Turkey	World	Turkey's share	Turkey	World	Turkey's share
2009	1,153	112,204	1.02	537	115,649	0.46
2010	1,414	131,922	1.07	738	134,037	0.55
2011	1,658	149,127	1.11	941	147,783	0.63
2012	1,898	159,713	1.18	817	150,845	0.54
2013	2,237	170,524	1.31	968	159,954	0.60

(Trademap 2014), (Trademap 2014), (TÜİK 2014), (TÜİK 2014)

Turkey's balance of trade of furniture sector have a positive course since 2001. Sector, which is having deficit between 1997 and 2000, has foreign trade surplus by years with the net exchange income, which is measured with difference of export and import of final products since 2001. Sector became USD 1.2 billion in only 2013 and in last 17 years, net exchange surplus is USD 4.5 billion. With respect to these values, sector is one of the rare sectors which does not give foreign trade deficit in countries which Turkey has foreign trade relation.

However, it can be stated that especially garden/outdoor furniture which are conveyed from China and Far East countries and which don't have common usage before, caused increase of export of furniture to Germany and Italy.

Even though Turkey remains in the first 12 with 1.65% share in production and 1.54% share in consumption in the world furniture production and consumption in 2013, trade remains low in terms of volume.

Table 11: Turkey's Share of Production – Consumption in the World

Years	Production (USD billion)			Consumption (USD billion)		
	Turkey	World	Turkey's share (%)	Turkey	World	Turkey's share (%)
2009	3.8	352	1.07	3.5	340	1.02
2010	4.7	341	1.37	4.4	353	1.24
2011	6.2	376	1.64	5.4	403	1.46
2012	7.1	434	1.63	5.9	421	1.40
2013	7.4	446	1.65	6.8	440	1.54

(Csil 2013), (TÜİK 2012)

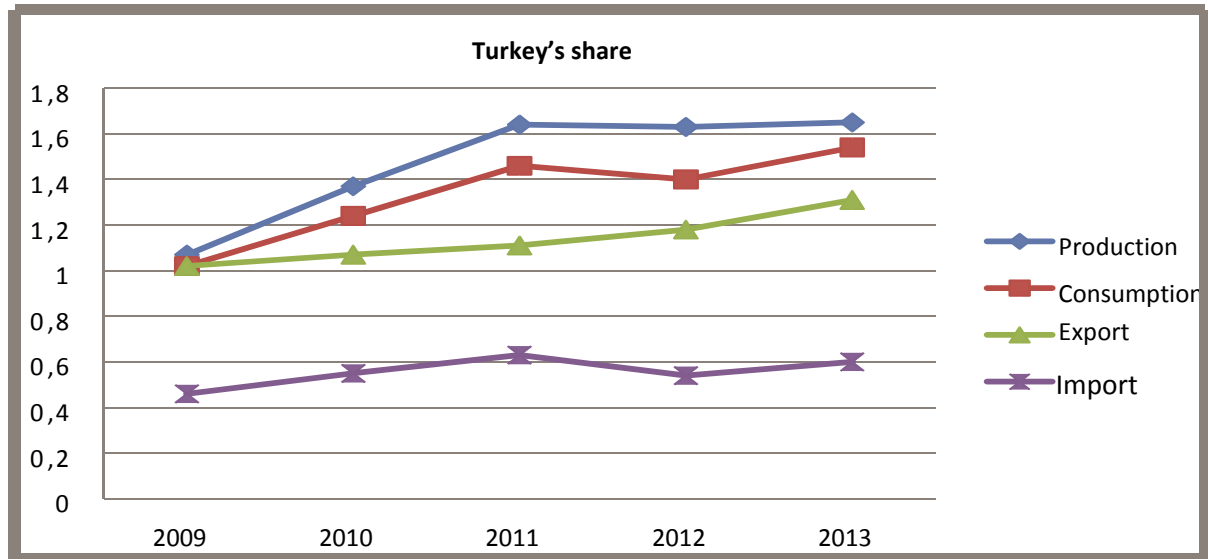


Figure 6: Turkey's Share in World Furniture Trade Share

Turkey has a positive trend in World furniture trade in production-consumption values between 2009 and 2011. However, in 2012 and 2013, it is in decrease and fixed. Export trend is in a significant increase. However, performance in import is fluctuating.

While Turkey produced furniture worth USD 3.8 billion, USD 3.5 billion of this is consumed in domestic market in 2009. With respect to the shares got from production, share of 1.07% increased to 1.65% and for consumption 1.02% increased to 1.54%. With respect to 2013 values, production and consumption is increased approximately twice. Turkey is among the first 12 countries with the highest production-consumption values in World furniture market.

### Sector's Perspective of the Industry

In order to understand the view of businesses in the sector to woodworking industry, project leader IKOOR as one of the leading companies in this industry as well as one of the proactive members of sector associations shared a report on the current situation in woodworking industry as summarized below.

In Turkey, most of the companies operating in furniture sector are composed of workshop type, small businesses which are working with traditional methods. Furniture manufacturing with traditional methods has never lost value but factors such as the ones listed below caused increase of investment in the fields of furniture and decoration especially in last 10-15 years. Some of these factors can be listed as follows:

- Urbanization
- Increase in population
- Increase in level of income

- Advance in fashion and esthetic values
- Increase of export share of foreign market

By means of these factors, labor intensive manufacturing in the sector went towards automation based mass production.

Handcraftsmanship is always valuable in furniture manufacturing. However, with the factors stepping in, aid of technology is required. Manufacturers speeds up their investments in the technology and automation by realizing the requirement of employing such technologies in the conditions of competition affecting time, craftsmanship and quality.

Like in any other developing countries, advanced manufacturing technology in CNC field is employed in furniture sector in Turkey. It is known that majority of the companies employing this technology is composed of medium and big sized companies. Even though companies having CNC machines improved their manufacturing and investment capacities, they have to use their CNC machines more actively and effectively in order to compete with other developed countries.

In the period which CNC machines are newly employed in Turkey, furniture staff, who are employed in furniture manufacturing industry which is a labor intensive sector, are trained with the trainings provided by the companies (producer/distributor) which the CNC machines are purchased from in order to be able to use CNC machines. However, it is seen that operators joining short term training provided by producer/distributor companies and not having technical/computer knowledge background, are not productive enough for enterprises in long term manufacturing programs. This process showed various developments proceeded periods. Firstly, companies already employed qualified staff in their facilities who are able to use traditional machines, also employed them in furniture sector as CNC operators. In periods after that, it is seen that graduates of vocational high schools, especially with computer literacy are preferred. It is known that staff who are engineering based and graduated from university are employed as CNC operators in order to obtain much effective results. This rough transition period is tried to be relieved with the support of umbrella organizations which many of the companies in the sector is affiliated with.

### Fundamental Problems of the Sector in Turkey

Problems and solution proposals took place in agenda of government for years. Fundamental problems are determined, solutions are proposed and solutions are searched with authorized organization and institutions in 9. Development Plan, 10. Development Plan and TOBB reports for last 10 years. Fundamental problems which are becoming chronic in years are given in



2013 TOBB Furniture Council Sector report in detail and summarized with the titles below. (TOBB 2014)

- 50% - 60% black economy in the sector,
- Product duplication and aperty,
- Public loads increasing cost,
- Problem of insufficient local raw material,
- Deficiency in furniture vocational education,
- Problem of logistic support,
- Problems encountered in foreign market,
- Problems encountered in customs,
- Problems encountered in trade aimed at neighbors.

Tackling with aforementioned problems and increasing international competitive power are mandatory for Turkey to be able to get the highest share from global furniture market, which is expected to reach USD 500 billion in 2020. Furniture sector determined 2023 for the targets on the horizon. Sector aims to achieve USD 25 billion production, USD 10 billion export and to be one of the top 10 furniture producers in the world as well as one of the top 5 in Europe by 2023.

It is, moreover, very crucial for the industry to reach high standards in products, production and processes. Harmonization of legislations and standards of the furniture industry throughout the membership process to the European Union is essential for Turkey. In this aspect; ISO 9000 Quality Management System, ISO 14000 Environmental Management System, OHSAS 18000 Occupational Health and Safety Management System certifications have to be imposed.

The industry challenges with insufficient number of qualified employees, their commitment to the job and finding proficient workmen. The incompetence drops quality and efficiency. It is essential to create well-trained and skilled labor force with ability to adapt itself rapidly to the latest technological developments. Unfortunately, it is ascertained that the vocational schools graduates deficient number of students for the needs of the industry.

### Field Study on Furniture Industry in Turkey

Turkish woodworking and furniture industry is an ever-growing industry for which standardization, quality assessment become more and more important with the increasing rate of export and increasing number of contractors working in abroad. Yet the diversity of the scale of companies and their available technology as well as the profile of the CNC operators in terms of their education is one of the major challenges of these industries. Moreover, rapid developments of the machining technologies easily outdate the skills of the operators resulting in inefficient use of even available CNC's in hand.

In addition to picturing the woodworking industry in Turkey, a survey which is given in Appendices is prepared and shared with some sector companies via OMSIAD which is the umbrella organization of wood working companies in Turkey. The survey does not aim to provide a statistical data but aims to understand how the sector understands CNC education, whether they have it and the typical problems that they encounter with. The analysis of the answers shows that CNC education in general has different problems with respect to owner and operator. The results of the survey is as follows;

When number of staff employed in companies is examined, 37% of the 19 companies employs 11-50 staff, 32% employs 51-100 staff and 26% employs 100-500 staff. In the 32% of the participant companies there is 1 CNC machine whereas 21% have 2, 21% have 5 and 16% have 3 CNC machines. In the 26% of the companies there are 3 CNC operators, 21% have 1, 21% have 2 and 16% have 4 CNC operators.

For the training of CNC operators, 63% of the companies consult distributor firms when needed; 5% consult once in 6 months; 5% consult once in 3 months. Only 4 operators get CNC training when needed and 1 operator gets training once in 6 months from producer firm. 1 company states that operators in their company gets CNC training when needed and 1 firm states the operators in their company gets CNC training once in 3 months from a private educational institution.

In regard with the evaluation of training instructors, 10 representatives state that the instructor is specialized on specific CNC machine models; 6 representatives state that instructor has mastery on all CNC machine models; 3 representatives states that the instructor doesn't have any certificate regarding the specific issue; 3 representatives states that the instructor doesn't have instructor certificate.

While 37% of the member firms don't have any problems regarding the trainings; 58% complain about high training fees and again 58% complain that the distributor firms do not serving on time. 1 participant states that they don't have time for education of their CNC operator.

In regard with the operators' capacity to use CNC machines; 47% of the firms evaluate the level of operators as good; 42% state as intermediate; only 2 firms think that their operators are capable of using CNC machines at full capacity (high).

In regard with enterprises' satisfaction of the investment made on CNC machines; 63% of the participant firms grade good; 21% as very good; 11% as intermediate. Only 1 firm declares negative opinion (low). CNC stock of the participant enterprises can be seen in Table 12.

Table 12: CNC Stock of the Participant Enterprises of the Field Survey

BRAND	NUMBER	YEAR
HOMAG	5	2010 and later (majorly) The oldest CNC utilized is made in 1998. The newest CNC utilized is made in 2014
BIESSE	20	
IMA	1	
AES	1	
NETMAK	1	
OTHER	BUSELOTTO, TENWOOD, BRAD, WITAP, CIBEN, ALBERTI, FIMPOWER, EASTERWOOD VS.	

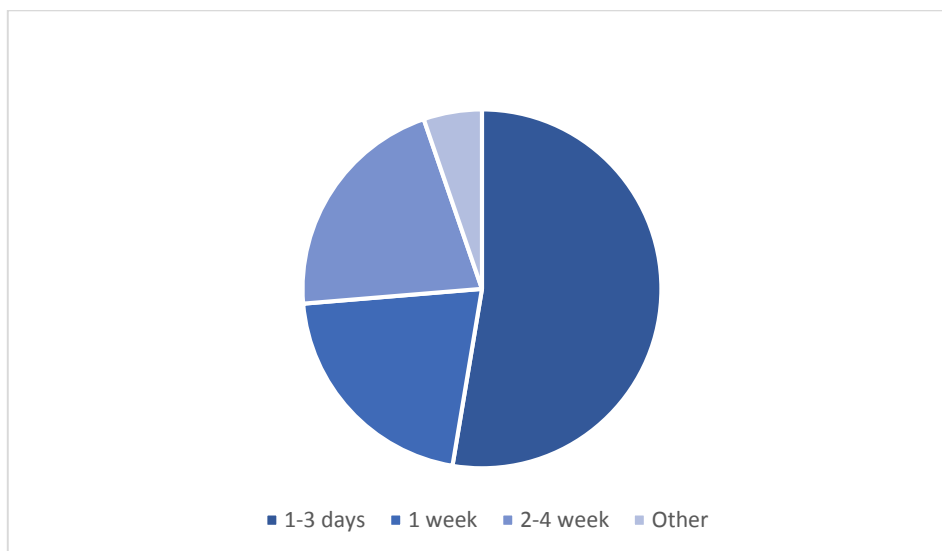
Another survey is conducted to be able to understand the current situation of educational level of CNC operators in the industry. The total number of participants is 22 and the age of ten participants is between 25 and 34, eight participants is between 35 and 50.

Ten of the participants states that they graduated from vocational high schools while six of them graduated from regular high schools. It is noted that only two participants have a bachelor degree. **Only 77 percent of the operators states that they ever trained on CNC** via;

- Short term in-company trainings (7 of the participants)
- Trainings of CNC suppliers (12 of the participants)
- Trainings of CNC distributors (18 of the participants)
- Trainings of private educational institutions (1 of the participants)

It is noted that the duration of these trainings is mostly around 1 to 3 days and the longest training is only 4 weeks as can be seen in Figure 6.





*Figure 7: Duration of the Trainings of Participant Operators*

18 participant operators indicate that they get help from distributors when they face technical problems during CNC operations. 8 participants consult CNC suppliers, 8 participants take support from in-company resources and another 8 of them use internet to solve the problems while 4 operators state that they cope with the problems via trial-and-error approach and only 6 operators utilize the user manuals.

In regard with the problems encountered during the use; 8 operators evaluate the solution found in internet as useful (1 operator as very good, 7 operators as good) whereas 10 operators issue negative opinion (low) for the solutions available in internet. All of 18 operators states that they encounter linguistics problems while searching for a solution on Internet.

While 32% of the operators do not find user manual of a CNC machine useful (none), 27% of the operators find it poor and none of the operators evaluated as very useful.

Regarding the utilization of the all features of the CNC machines; 45% of the operators answer as good; 32% answer intermediate; 14% answer as insufficient. Only 1 operator has the opinion of all features of the CNC machine is utilized very well.

The reasons of the operators who answer as insufficient for the features of the CNC machine is distributed as: 15% answer as not being able to access the supporting documents; 13% as not getting CNC machine specific training and 40% answer as other reasons.

Survey is conducted in order to understand the view against the vocational education of sector rather than presenting a statistical data. In this regard, it is observed that operators do not find the trainings sufficient and the troubleshooting skills remain insufficient.





In addition to the questionnaires conducted in the scope of the project, results of the questionnaire conducted by Çukurova Development Agency (ÇKA) and Turkish Statistical Institute (TÜİK) grabs attention. In this questionnaire; Businesses in Çukurova Region are asked that “In which machinery they would invest if they had the chance?” As the Figure 8 indicates, only 19% of them invest in CNC machinery that may be utilized for most operations with more precision and speed. This simply implies that the majority is not aware of the opportunities of CNC machining in production. (ÇKA 2014)

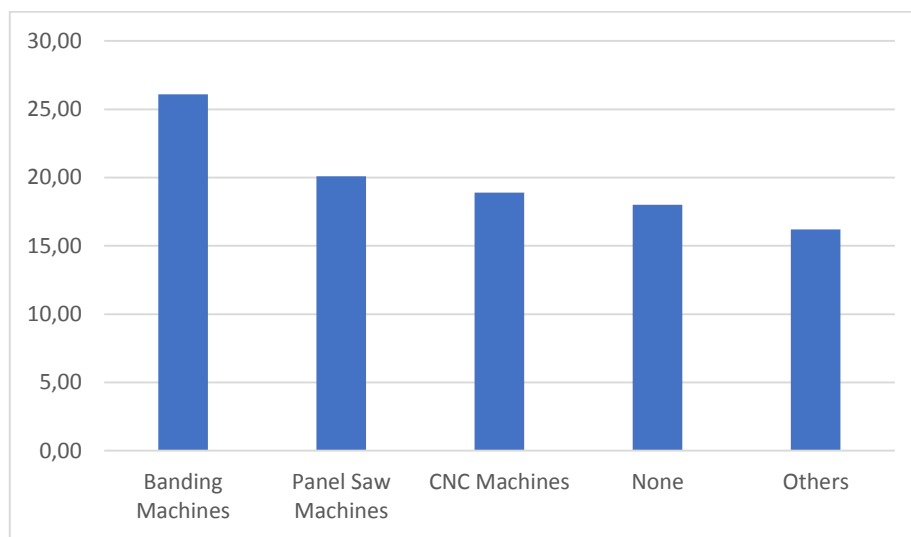


Figure 8: ÇKA-TÜİK Furniture Industry Questionnaire

## Comparison of EU and Turkey in Terms of Woodworking Sectors

So far, this study presents the actual cases of wood based sectors of both EU and Turkey with a special emphasis to woodworking and furniture sub-sectors. Important statistics, problems, future projections, with possible solutions and road maps are discussed. Although very detailed information on both EU and Turkey are presented in the scope of this study, exact data matching cannot be achieved due to the absence of overlapping information. But still, to a certain extent, a comparison which is structured on similarities and differences can be made between two in order to indicate certain discrepancies, sectorial gaps and sectorial needs, from the vocational training point of view. Throughout this comparison, indicators and statistics related to EU27 are assumed as the actual case of the EU.

Latest comparable statistics (2011) show that enterprises active in wood-based industries across the EU-27 represents nearly 6% of manufacturing enterprises across the EU-27, while in Turkey, the number of enterprises in the furniture industry is 10% of the enterprises in overall manufacturing industry. Between 2005 and 2011 the total number of enterprises within the EU-27's wood-based industries fell by 10.9 % while in Turkey such a big difference cannot be seen. However, sector employed approximately 35,000 more workers, resulting in an increase of nearly 30% despite the global economic crisis. During the same period, manufacturing average of furniture manufacturing declined 16.7% in EU whereas in Turkey production rate increased from approximately from EUR 5.1 million to EUR 7.8 million.

Between 2005 and 2011, the overall level of added value generated within the EU-27's manufacturing sector rose by 1.2% (EUR 1.630 billion to EUR 1.650 billion) While, furniture industry declined from EUR 36 billion to EUR 29 billion and increased from EUR 1.1 billion to EUR 1.6 billion in EU and Turkey respectively. Positive case of Turkey for that indicator cannot be explained with a single reason but possible factors can be improvements in the technology used in the industry, innovations, patents, wide spreading automated production processes and Turkey's increasing trade relations with luxurious product demanding markets.

The most recent data available about total production and international trade rates of the furniture industry of both EU and Turkey are presented in the Table 13

*Table 13: 2011-2012 - Comparison of EU and Turkey in Terms of Production and Foreign Trade*

	EU			Turkey		
	2011	2012	Change (%)	2011	2012	Change (%)
<b>Production (million EUR)</b>	91,001	90,000	-1.1	7,800	8,900	12.4
<b>Imports (million EUR)</b>	12,059	12,300	2	735	638	-13.2
<b>Exports (million EUR)</b>	11,249	12,340	9.7	1,297	1,484	14.4
<b>Employment</b>	1,013,171	1,000,000	-1.3	140,800	159,250	13.1

As can be seen in the previous table, between 2011 and 2012, production rate of the furniture industry of EU decreased 1.1% while during the same period, production rate of furniture industry in Turkey increased 14%, which is nearly similar in terms of magnitude. Same rates can be seen in employment statistics, which is a result of the increasing production rates.

Between 2011 and 2012 in contrast to 2% increase in imports made in EU, approximately 13% of decrease in imports to Turkey can be seen. However, during the same period export rates of both EU and Turkey increased approximately 9.7% and 14.4% respectively. In 2012 difference between imports and exports are nearly same for EU however, Turkey exports nearly 2.5 times as much that it imports, which also emphasizes the importance of wood based products and furniture sector for Turkey.

In Turkey, wood-based industries have a larger share in the overall manufacturing sector, compared to EU. It can be remarked that, for Turkey's economy, wood-based products have a greater importance. Increase in Turkey's employment rates for the sector shows that, wood working industry has a great potential for decreasing the unemployment rates.

When the furniture industry in EU and Turkey are examined in detail, it can be seen that same positive and negative factors affect the economics of the sector.

Both sectors copes with the competitive global actors with lower labor costs like China. It is inevitable for customers to prefer cheaper products even if the material and labor quality is far below. Besides, rising energy prices force enterprises to increase final prices of the goods, competitive prices offered by producers with lower labor costs, prevent the increase of the prices of the goods produced both in EU and Turkey, Which also forces enterprises to decrease labor force or/and their profits.

General tendency of building green, -which may require use of wood as a building material-, greening action and increase in the demand for wood as an energy source, especially with the increasing energy prices, throughout EU and Turkey results in the increase of the raw-material

cost. Together with the rising raw-material costs; climate change, deforestation and interconnected governmental regulations enforce industry to increase efficiency on use of the material. Moreover, industry is forced to offer more eco-friendly products with innovative designs, new materials as well as modernized and automated production processes from design idea to final product.

However, offering of new, innovatively designed products together with the state-of-the-art production processes and modern automated machinery and software aided design and manufacturing already started to outdate the existing skills of the labor force, which is currently based on hand craftsmanship. Future projections shows that in the near future, sector will require not only a labor force with higher techno skills but also a labor force capable of conducting necessary self-learning, problem solving and troubleshooting activities. In order for labor force to carry the sector to a higher level to compete with the low-priced and low-quality products, quality assessment knowledge and related skills should be improved.

Labor intensive and labor dependent situation of furniture industry is highlighted by the studies conducted by trade unions, business associations and academic institutions. Competitive conditions in the sector also increases the importance of labor force, in terms of both craftsmanship quality and cost.

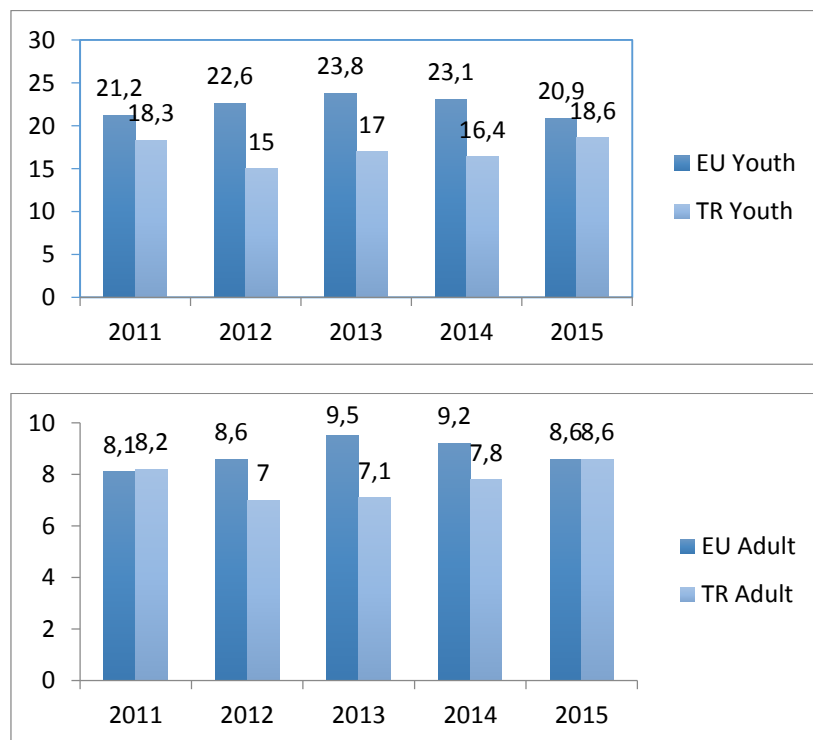


Figure 9: Comparison of Adult and Youth Unemployment Rates of EU and Turkey by Eurostat.



As presented in Figure 9, according to data obtained from Eurostat, in addition to adult unemployment, youth unemployment, which is also an important issue both for EU and Turkey is approximately 22% and 17% respectively. With a larger potential of learning, bringing of youth employees to the labor market of furniture industry, which is already in demand of low and mid-skilled employees, will definitely be advantageous both in terms of usability of the aforementioned labor force in the long term and overcoming possible future problems that may arise due to low skilled youth and youth unemployment. However, as mentioned before, current fragile economic state of both EU and Turkey is a disadvantage for youth employees. Statistics show that for most of the enterprises, first action to be taken in case of an economic recession, is decreasing the labor costs, which most of the time results in increasing rate of youth unemployment (as in the case of global economic crisis between 2006 and 2011) as young employees are relatively inexperienced. Also during the recovery of such cases, lack of experience prevents youth workers from entering the labor market. As a solution, youth employees can be equipped with contemporary techno skills, which will ease their efforts on finding job and as a result, to decrease youth unemployment both in Turkey and EU.



## Remarks and Conclusion

The literature survey on CNC operations in EU and in Turkey is presented in this report. It is seen that although CNC operations in woodworking and furniture industry in EU is more limited compared with other CNC operations, yet it is very competitive and sector develops new policies and strategies to be a global stakeholder. In addition to this, it is clearly seen in

Table 3 that woodworking sector in EU is developing future scenarios which are the basis of sector strategies and projections. However, even in this clear framework, the role of training of operators is not explicitly targeted.

Woodworking and furniture industry in Turkey is a blooming industry and not only the investment in this sector but also the income is increasing each year but not as much as it is aimed. The survey on Turkish sector shows that one of the major problems is inefficient use of existing capacity and thus relatively low turnover in the sector. Therefore, it is necessary for Turkish woodworking and furniture industry to develop new policies and strategies as in EU in order to compete globally. In this sense, it is important for this sector in Turkey to develop similar scenarios for future as in EU and it is necessary to include training in future scenarios in order to be a global actor in the market.

The comparison of the sector survey in EU and in Turkey shows that CNC operations in EU is well documented and the situation is clearly outlined. On the other hand, although this sector has an important contribution to Turkish economics, sector still needs a more detailed picture in order to develop new strategies. In this regard, the comparison of the sector in EU and in Turkey may not provide a precise and intelligible information in order to understand the present situation in terms of capacity, income, turnover etc., but both reports highlights the following issues

- Woodworking and furniture industries need clear policies and strategies in order to compete globally
- The efficient use of CAD/CAM in these industries is still a problem
- The investment on CNC's and the turnover are not fully compatible
- The skills of CNC operators are expiring very quickly due to rapid developments on CNC technologies
- The training of CNC operators is a major subject since most of the CNC machines are used under-capacity

The furniture industry, and wood working in Turkey, are important both as standalone fields and/or as part of construction. There is a great size range of manufacturing companies, from very small workshops to large companies. However, they share some common problems, such as the training of operators and designers, in order to cope with the current technologies and being able to use the available technologies to their full potential.

It is evident that rapidly changing and evolving technologies in CAD/CAM field and CNC technology in particular, forces companies and operators to update their knowledge and adapt to new technologies. This survey shows that woodworking and furniture industry is getting more and more important and the share of the sector is increasing both in EU and in Turkey. The success of the sector depends on the quality of the material, available



technologies, diversity of designs and their implementation, marketing. Aside these well-known factors the production quality which is not only dependent on the technology but on the skills of the operators plays a crucial role. Hence, training of operators in formal or informal way should be one of the major targets of the sector.

In this context, a new system of education/training is required for operators and designers to cope with the current technologies and being able to use the available technologies to their full potential enabling efficient turnover of the investment and utilization of the hardware at its full potential. As a result, it is evident that the new system shall satisfy the needs of trainees by including learning objectives such instillation of self-learning, being able to observe analyze and troubleshoot. In second report of the present Erasmus+ project, meta-analysis of CNC education in both Turkey and Europe is done to determine the lacking parts of the CNC education system.



## References

- Research and Market. 2015. "Global and Chinese CNC Machine Industry Report 2014." Dublin. <http://www.researchandmarkets.com/reports/2896349/global-and-chinese-cnc-machine-industry-report>.
- Altin, Recep, and Osman Yalçın. 2011. "VET reform in Turkey: the key of ECVET." Edited by Liliane Volozinskis. *ECVET Mag Magazine* 19-22. Accessed May 11, 2015. [www.ecvet.team.eu](http://www.ecvet.team.eu).
- Aris. 2015. "Literature Survey of CNC Operations in EU." Umbria.
- CEI-BOIS. 2013. "Demographic Changes in the Woodworking Industry." Brussels. [http://www.cei-bois.org/files/Brochure\\_Demographic\\_Changes\\_-\\_final\\_version\\_EN.pdf](http://www.cei-bois.org/files/Brochure_Demographic_Changes_-_final_version_EN.pdf).
- CEPS. 2014. "The EU furniture market situation and a possible furniture products initiative." Brussels. <http://www.ceps.eu/publications/eu-furniture-market-situation-and-possible-furniture-products-initiative>.
- Csil. 2013. "WORLD FURNITURE OUTLOOK, 12th edition of the Seminar." Milano.
- ÇKA. 2014. "Mobilya Sektörü Araştırma Raporu."
- ETUC. 2012. "Furniture - Visionary Analytics." Brussels. [https://www.etuc.org/sites/www.etuc.org/files/Furniture\\_12-08\\_fin.pdf](https://www.etuc.org/sites/www.etuc.org/files/Furniture_12-08_fin.pdf).
- Eurostat. 2013. "Manufacture of wood and wood products statistics - NACE Rev. 2." Luxembourg. [http://ec.europa.eu/eurostat/statistics-explained/index.php/Manufacture\\_of\\_wood\\_and\\_wood\\_products\\_statistics\\_-\\_NACE\\_Rev.\\_2](http://ec.europa.eu/eurostat/statistics-explained/index.php/Manufacture_of_wood_and_wood_products_statistics_-_NACE_Rev._2).
- Istanbul Sanayi Odası. 2015. "Mobilya İmalatı Sanayi." İstanbul. [www.iso.org.tr](http://www.iso.org.tr).
- MUSIAD. 2013. "Dayanıklı Tüketim ve Mobilya Sektörü Raporu." İstanbul. [www.musiad.org.tr](http://www.musiad.org.tr).
- n.d. "Small and Medium Sized Wood Businesses Opportunities and Challenges for a Sustainable and Regional Development."
- TCMB. 2014. *Kapasite Kullanım Oranı-İmalat sanayi (Ağırlıklı-NACE REV.2)*. Ankara: Türkiye Cumhuriyeti Merkez Bankası.
- Teischinger, A. 2012. "Small and Medium Sized Wood Businesses Opportunities and Challenges for a Sustainable and Regional Development." University of Natural Resources and Life Sciences - BOKU, Vienna. [https://bismarck.nymc.hu/fileadmin/dokumentumok/palyazat/tamop421b/IntConference/Papers/Articles/PDF/Teischinger\\_SmallAndMediumSizedWoodBusinesses-OpportunitiesAndChallengesForSustainableAndRegionalDevelopment.pdf](https://bismarck.nymc.hu/fileadmin/dokumentumok/palyazat/tamop421b/IntConference/Papers/Articles/PDF/Teischinger_SmallAndMediumSizedWoodBusinesses-OpportunitiesAndChallengesForSustainableAndRegionalDevelopment.pdf).
- TOBB. 2014. "Türkiye Mobilya Ürünleri Meclisi Sektör Raporu." Ankara. [www.tobb.org.tr](http://www.tobb.org.tr).
- Trademap. 2014. "International Trade Center, Trade Statistics, Exports." 2001-2013 International Trade in Goods Statistics by Product Group.
- Trademap. 2014. "International Trade Center, Trade Statistics, Imports 2001-2013 International ."

Training, Methodological Centre for Vocational Education and. 2008. "Study of Wood Sector - Research report on skill needs." Vilnius. [http://www.kpmc.lt/Skelbimai/SEK\\_EN/EN-Medz.%20sekt.%2008.07.30.pdf](http://www.kpmc.lt/Skelbimai/SEK_EN/EN-Medz.%20sekt.%2008.07.30.pdf).

TÜİK. 2012. "Araştırma geliştirme göstergeleri, ISIC-REV.3 No:3611-3614." Bilgi İşlem Merkezi Veritabanı, Ankara.

TÜİK. 2014. *GTİP 4'lü, Ülkelere Göre Mobilya İhracat Değerleri*. Ankara: Türkiye İstatistik Kurumu.

TÜİK. 2014. *GTİP 8 ila 12'li Maddeler Bazında Ürün Gruplarına göre Mobilya İthalat Değerleri*. Ankara: Türkiye İstatistik Kurumu.

TÜİK. 2013. *Yıllar itibari ile Türkiye mobilya üretim ve tüketimi*. Ankara: Türkiye İstatistik Kurumu.



## APPENDICES



Appendix 1:  
Questionnaire for CNC Operators/Users

*Name of the Organization: . . . . .*

*Member of Non-governmental/ Vocational Organization: . . . . .*  
.....

*City you live in: . . . . .*

**A. General**

**1. Age**

☐15-19 ☐20-24 ☐25-34 ☐35-50 ☐50+

**2. The most recently completed school**

☐Primary ☐Secondary ☐Open High School

☐High School ☐Vocational High School

☐Open Plan Schools ☐Associate Degree

☐Undergraduate ☐Graduate/PhD ☐Student

**3. If you are a student, specify your degree**

☐ Open High School ☐ High School

☐ Vocational High School ☐ Open Plan Schools

☐Associate Degree ☐Undergraduate ☐Graduate/PhD

**Gender**

☐Female ☐Male

**4. For how many years are you working for this sector?**

☐0-1 ☐1-5 ☐5-10 ☐10+

**5. For how many years are you working for the company you are employed in?**

☐0-1 ☐1-5 ☐5-10 ☐10+

**B. Questions regarding CNC use**

**6. Did you specifically get a CNC training?**

☐Yes ☐No

7. If your answer to question 7 is yes; where and for how long did you get your training? (Can be marked more than once)

Training Institute	Duration					Satisfactoriness				
	1-3 days	1 week	2-4 weeks	1-3 month	Continuous at certain intervals	None	Low	Average	Good	Very good
Vocational High School										
MEB Courses										
Municipality Courses										
Academy										
University Courses										
In-house Training										
Producer Company										
Distributor Company										
Special Training Institutions										
Other (.....)										

8. Do you get a new training for a CNC machine that you are using or the first time?

☐ Yes ☐ No

9. If your answer to question 8, who and for how long this training is given? Do you get any vocational competence certificate?

Training Institute	Duration					Competence Certificate	
	1-3 days	1 week	2-4 weeks	1-3 months	Continuous at certain intervals	Yes	No
In-house Training							
Producer Company							
Distributor Company							
Special Training Institute							
Other (.....)							

10. When you encounter problems, how do you troubleshoot? (Can be marked more than once)

- ☐ By getting help from producer company
- ☐ By getting help from distributor company
- ☐ By getting help from internet medium
- ☐ By getting help in-house
- ☐ By getting support from a friend
- ☐ With trial error method
- ☐ By looking at user manual

11. *If you use internet medium, is it beneficial for your troubleshooting?*

- ☐ Low ☐ Average ☐ Good ☐ Very good

12. *Do you have language problem especially while searching internet for troubleshooting with CNC machine you are using?*

13. ☐ Yes ☐ No

*Is your CNC Machine User Manual helpful for you?* ☐ None ☐ Low ☐ Average ☐ Good ☐ Very good

14. *Do you think you can use CNC machine at its full potential?*

15. ☐ Low ☐ Average ☐ Good ☐ Very good

16. *If you think you are using low potential, what are the reasons of this? (Can be marked more than once)*

- ☐ Not getting CNC specific training in the purchase of the machine
- ☐ Not refreshing present CNC knowledge
- ☐ Not getting sufficient support while using the machine
- ☐ Not having qualified labor force
- ☐ Not being able to access appropriate assistive documents
- ☐ Other ( . . . . . )

17. *What is the brand, model and production year of the CNC machines you are using?*

Brand	Model	Year
Homag		
Biesse		
IMA		
Morbidelli		
AES		
TTMak		
Makser		

<b>Toskar</b>		
<b>Netmak</b>		
<b>Elfamak</b>		
<b>EuroCNC</b>		
<b>Other</b> (.....)		





Appendix 2:  
Questionnaire for CNC Producers/Distributors



3. *If the language of training materials is not Turkish, do you present by translating to Turkish?*

☐ Yes ☐ No ☐ Partially

4. *How do you assess the success of trainees?*

☐ We don't

☐ Via exams

☐ With respect to the result of exemplary application

☐ Other ( ..... )

5. *Apart from the training given, do you give support via telephone or internet?*

☐ Yes ☐ No

6. *Who prepares the training material?*

☐ In-house ☐ Main Producer

☐ Other ( ..... )

7. *Does the training material show differences with respect to trainee groups?*

☐ Yes ☐ No

8. *How the training of trainers are provided?*

☐ Via software company

☐ Producer company

☐ In-house training

☐ Special Training Institute ( ..... )

☐ Other ( ..... )

9. *Which software do you use in CNC machines?*

☐ Wood wop

☐ Mastercam

☐ Alphacam

☐ Top solid

☐ Cabinet Vision

☐ Biesse works

☐ Xilog plus

☐ IMOS

☐ Cute Rite

☐ Other ( ..... )



Appendix 3:  
Questionnaire for Companies Using CNCs

*Name of the Organization:* .....

*Year of Establishment:* .....

**Field of Activity:** .....

**The City which the Organization is Active:** .....

**Member of Non-governmental/ Vocational Organization:** .....

**Position in the Organization:** .....

**1. Age**

☐ 15-19 ☐ 20-24 ☐ 25-34 ☐ 35-50 ☐ 50+

**2. The most recently completed school**

☐ Primary ☐ Secondary ☐ Open High School

☐ High School ☐ Vocational High School

☐ Open Plan Schools ☐ Associate Degree

☐ Undergraduate ☐ Graduate/PhD ☐ Student

**3. If you are a student, specify your degree**

☐ Open High School ☐ High School

☐ Vocational High School ☐ Open Plan Schools

☐ Associate Degree ☐ Undergraduate ☐ Graduate/PhD

**4. Gender**

☐ Female ☐ Male

**5. Number of employees in your company?**

☐ 1-10 ☐ 11-50 ☐ 51-100 ☐ 100-500 ☐ 500+

**6. How many CNC machines do you have?**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Other(.....)

**7. How many CNC operators do you have?**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Other (.....)

**8. How, in which intervals and durations CNC education of these operators are given?**

Training Institution	Duration						Not repeated
	When in need	At certain intervals					
		3 months	6 months	1 year	2 yil	Diger	
Distributor company							
Producer company							
Special Training Institute							
Other (.....)							

**9. Mark the ones which are valid for the people (trainers) giving training to your company?**

- ☐ Trainer is the permanent staff of the company giving training only giving trainings.
- ☐ Trainer is called abroad for the training
- ☐ Trainer is specialized on specific CNC machine types and/or models
- ☐ Trainer have control on every CNC machines
- ☐ Trainer has trainer certificate regarding the subject
- ☐ Trainer is an expert CNC operator who doesn't have trainer certificate

**10. Which one of the options listed below are the problems encountered during the trainings?(Can be marked more than once)**

- ☐ I don't encounter problems
- ☐ Price of training fees being too high
- ☐ Distributor company not providing support timely
- ☐ CNC operator not having time for training
- ☐ Other

**11. Do you think your operators can use CNC machine at its full capacity?**

- ☐ Low ☐ Average ☐ Good ☐ Very Good

**12. Does the investment made to CNC machine meet your expectation?**

13. ☐ Low ☐ Average ☐ Good ☐ Very Good

**14. What do you want to offer for the enhancement of efficiency for use of CNC machines in the sector? .....**

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