

Teaching sustainability to industrial engineering students

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INTRODUCTION

In recent years companies' social and environmental responsibility and good practices for sustainability have gained crucial role in economic recovery. Therefore the issue of sustainability has assumed increasing importance in corporate strategies. Hence, as the sustainable design and production of goods and services are making a significant contribution to the recovery of competitiveness of manufacturing firms, universities must update their curricula to the needs of industrial systems.

As the competing context modifies, the competencies and skills required to young industrial engineers change. Both in industry or in the service sector, they will be called to address issues such as the eco design, the complex world of certifications, the Life Cycle Assessment (LCA) and, of course, the process and product innovation according to the new criteria.

LIUC University has always collected promptly instances from the local production system to educate young managers to actively participate in the renewal of the entrepreneurial culture.

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The educative change focused on the final year of the bachelor program, replacing lectures on industrial technologies with teachings focused on sustainability. As the subject is wide and multidisciplinary, the new courses design concentrated on the sustainability environmental and socio-cultural aspects.

The content and teaching methodology have been defined according to the assessment of the skills that the new engineer must have with facing the sustainability issue in a dynamic and proactive way, while avoiding dealing with the bureaucratic and rituals aspects of certification processes. Then, highlighting the close links between market dynamics, scientific research, both creative and productive processes and the effects that these connections lead on business organizational models was the main purpose to achieve.

To provide concrete examples while teaching, the class focuses on the fashion sector (textiles, clothing and footwear), industry of great economic and social importance in Italy and defined by Dickson et alii [1] "to be warranted". The Italian fashion industry (from processing of fibers to weaving, from finishing to the finished garment) has pointed the reduction of the environmental impact of its processes and traceability of the supply chain between the factors able to restore competitiveness to the system. This trend has prompted new ways of relationship between both business textile and fashion companies with chemical and mechanical textile, called to share the common goal of ensuring fashionable products with a high level of aesthetics and quality but low environmental impact [2].

1 SCENARIO

1.1 The industrial context

With over 500,000 active companies in 2014, Italy has a strong manufacturing industry. However, because of the de-industrialization trend and the effects of the financial crisis erupted in 2008, the Italian industry weakened. The production relocation towards less expensive areas and the trend of outsourcing had great impact as well.

To maintain a prominent position in the manufacturing sector, the Italian companies had to place sustainability among the pillars of its strategy and consider it, therefore, in different business areas:

- R&D and design with the aim of reducing pollutant substances and ecologically unsustainable (eg toxic chemicals used in the process [3]), to improve "green" performances (eg: best primary biodegradability), to measure the environmental impact throughout the life cycle of a product, etc. [4].
- production with the adoption of Best Available Techniques (BAT) for energy conservation, the management of emissions and effluents, reduction and waste management
- in logistics with the development of sustainable supply chains, the use of packaging and supply chain control, as done by Indian producers that evaluated their suppliers on the basis of the gray approach [5].

In addition, the voluntary certification (ISO 14000, Ecolabel, EMAS, etc.) and the actions of social sustainability (eg: interventions to improve the degree of well-being of employees and internal relations, dialogue and support social initiatives of community with which the undertaking relates, etc.).

As single initiatives impacts on other, the multiplicity of corporate actions related to sustainability requires a strong involvement of the management and interaction. These actions have also led to changes which cannot be underestimated in the design of education and training activities.

In this picture emerges, with a specific cultural and economic nature, the textile and fashion (this term the textile, clothing and footwear) industry, characterized by a high rate of product innovation and process and present in Italy with over 85,000 active companies.

As known, in the '80s the Italian fashion industry has acquired international leadership not only thanks to brand creativity, marketing and distribution but also due to the strong connection with the earlier stages of the production chain: tanning, yarn production, weaving, dyeing and finishing. An alliance of industrial creativity aimed at research on materials and processes that got benefit from the contribution of other strategic industries: mechanics, electronics, polymer industry dyes and textile auxiliaries [6], [7].

Fig. 1 depicts the integrated system of the fashion industry.

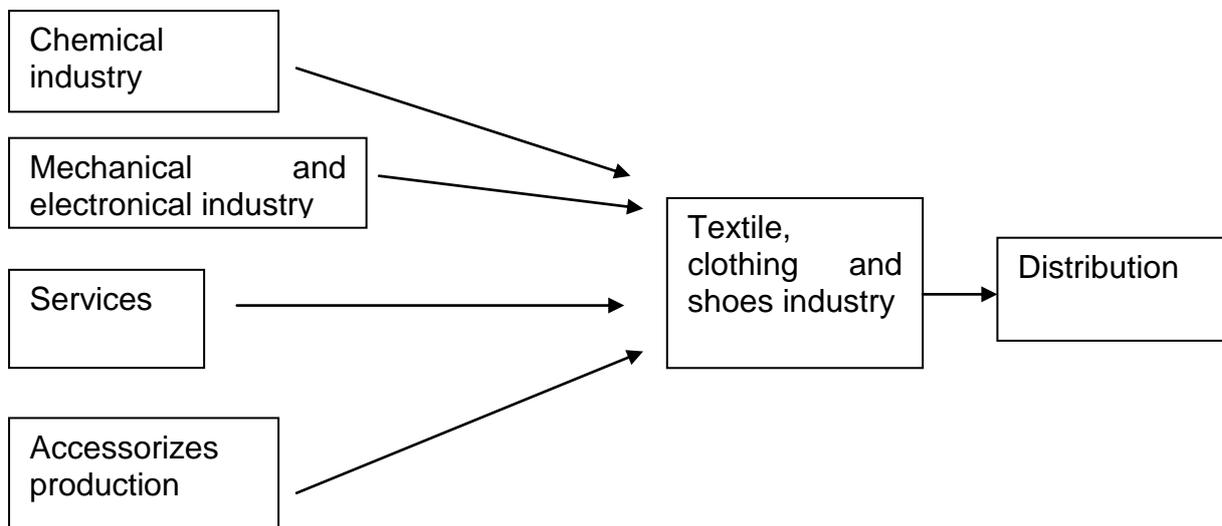


Fig. 1. The fashion industry integrated system

The environmental impact of dyeing, finishing and textile and leather craftsmanship and leather is particularly relevant and it is the reason why the industry is subject to severe restrictions. The effects of certain chemicals (dyes and auxiliaries) on the quality of the natural environment and human if exposed to prolonged contact are known. The complaint of the fashion industry as a cause of environmental disasters emerged to public attention as a result of the complaint of Greenpeace campaigns aimed to push the global fashion brands to eliminate from processing 11 classes of toxic chemicals. The issue has aroused interest particularly in Italy, home of major fashion brands and the supply chain of materials location. The decision of many brands to sign the commitment Detox Greenpeace launched a cascade process [8], [9]. Each of the companies asked then its suppliers to subscribe to the Chapter technicians which commit the company to not use toxic substances with a definite advantage for the environment. Equally impactful was the tragedy of the Rana Plaza in Bangladesh in 2013 that saw the death of over 1,300 textile workers engaged in

the manufacture of garments for international brands including some Italian. Such events force the think about outsourcing, supply chain management and traceability of processes based on the criteria of transparency and social equity. Such an industry, so discussed in int environmental impact, seemd the best to introduce students to the many facets of sustainability.

1.2 Industrial engineering in LIUC

LIUC university was born in the 90s on a specific instance of the Lombard production system: to train young technical managers able to renew the entrepreneurial culture of innovation, according to continuous organizational and technological change.

To a large extent the industrial engineers graduates from LIUC find employment at manufacturing enterprises of small and medium sized (SME) or at consulting firm for SMEs. The growing attention that, in the last years, firms, especially from the fashion industry, devote to the culture of environmental sustainability is an important fact that the university has to consider in supporting specific initiatives with upgrading skills of the new engineers to fit the new requirements.

For the instructional design of such initiatives LIUC has used the approach that can be summarized in the following steps:

- economic scenario, technological and social analysis,
- competencies and skills required of future managers identification,
- content and teaching methodologies consistent and innovative identification,
- experimental teaching,
- results evaluation.

In the case of corporate sustainability isworth noting that is the result of an integrated approach that involves multiple factors (internal and external) and various functions / areas of corporate decision-making. Industrial engineers, thanks to the knowledge and interdisciplinary methodologies acquisition, will then have the ability to relate with different areas of business skills.

The decision of carrying out the teachings on sustainability in industrial processes has cut the interest on the part of the business system that is believed to grow more significantly in the coming years.

2 SUSTAINABILITY TEACHING

The course, open to students of the third year of the bachelor, arises as central objective:

- introduce students to the topic of sustainability in its full meaning, highlighting the logical political, economic and social factors that underlie it,
- reflect on the dynamics of the market and consumer trends oriented to favor green products and socially responsible,
- identify the ecological and social commitment of the company topics enhancement of its products and services,

- know the methodological tools that companies can take to identify their weaknesses and improvement actions,
- examine the function of certification systems and the effectiveness of communication of sustainability.

As previously said, the issues have been developed using the fashion sector as an example. The textile and fashion industry is a field of study of great interest because it was among the first sectors to give strategies to reduce the use of hazardous substances and reduce energy and water consumption, representing mainly, the first, one of the main cost items of the financial statements of companies.

2.1 The contents

The content of the course recall four main subjects developed in four teaching modules. The first was dedicated to raising awareness of the issue of sustainability. In this module ecological problems -deriving by climatic changes, environmental disasters due to industrial activities and the effects of these on human health- are discussed. The economic effects related to the increase in world population and the scarcity of resources essential to life people (water and raw materials) as described in causes of the state of severe poverty for millions of inhabitants is analysed. To complete this module, with the aim is to give students the widest possible view of sustainability, especially in light of its historical events, the history of the industrial system from the second half of the 900 is presented as inherent to the evolution towards a model business-sensitive recognition of workers' rights, the conditions of hygiene and safety in the workplace certification systems to improve the quality of the system and to better manage the risks with precautionary actions. Through a brief overview, the main contributions to the determination of the theory of sustainable value, a decisive factor for industrial competitiveness, is discussed.

The second module of the course is dedicated to the textile and fashion as explanatory scope of the concept of industrial sustainability. The contents are primarily the tools to design and implement a sustainable product. The design of goods through eco-design and evaluation of the load of CO₂ equivalent are proposed to the students as a way to approach design so that the productions have less environmental impact. How to perform the life cycle assessment (LCA) of the product, from the raw material to its transformation to the impact caused by the use of the asset and its disposal at the end of life, is explained in relation to specific cases of the fashion cycle. The product evaluation in light of voluntary certification systems completes the picture. The production process from raw materials to packaging of clothing are then taken into account from the energy and water consumption and the supply chain point of view. Discharges and emissions are considered not only to provide students with a basic level of understanding of a complex technological process but also for identifying the contribution and potential of the most significant innovations in respect of the various legislative frameworks.

The third module concerns the relationship between companies and stakeholders. The company is defined as an open system that compares with other production systems, with administrative entities, political, social and cultural rights. The dialogue and the ability to understand instances of different subjects allow the company to be proactive specially in a context strongly marked by new information technologies and their popular power. Given these relationships, space is also given to communication. Many brands and companies operating in a business to business market are heavily involved with their social and environmental strategies. The role of technical communication, information and emotional is therefore particularly important in the

strategies of industrial competitiveness when it comes to sustainability. This part of the program also has the purpose of learning the importance of avoiding greenwashing and to provide, on the contrary, information traceable and objective [9].

With the aim to provide students with elements to design your own professional future in function of a theme now unavoidable as sustainability, the last part of the course deals with the role of the engineer in the management of sustainability. Specific consideration is therefore given to the role of the engineer as a professional able to identify, in complex flows of information, priorities and factors of advantage for the company making the organization more effective.

2.2 Teaching methodology

In the present academic year, the course was provided for the first time. It is preferred, therefore, a teaching methodology with traditional lectures supplemented by meetings with experts able to bring current and interesting case histories. Students were encouraged to visit the exhibitions and participate to conferences dealing with the addressed issues, to develop their own reports which were then the subject of classroom presentations, keeping the thread which question the quality of economic development, the involvement of the system industry and the need to adopt preventive behaviors and compensatory.

For next year the active participation of students, divided into working groups, is meant to increase. They will be asked to develop projects and propose the results in a presentation collegial. With reference to a specific theme (e.g.: the evaluation of the energy content of a product), the members of the working group will have to simulate the role of the various functions involved and present and discuss the results of their work with all colleagues.

A work that will allow students to experience a business approach based on the synergy between different functions in a logical problem solving.

3 CONCLUSIONS

The main reason why the issue of sustainability was introduced in Industrial Engineering bachelor curriculum was the finding that the green economy opens up new and interesting employment opportunities in European countries and not only in the renewable energy sector or purification [10]. The growing attention in production systems to issues of sustainability requires, in fact, skills to address the eco design methodologies, systems and voluntary certification of the LCA. A company committed in reducing the environmental impact of its products and processes must take also actions on raw materials, technologies, production processes, marketing and logistics acquiring information and simulating alternative solutions to those standards. The relationship between sustainability, research and innovation is, in fact, more and more narrow.

We believe strongly that young industrial engineers can acquire an important role in this scenario. At the moment in Italy are not yet fully operational training models aimed at preparing new engineers with interdisciplinary skills such as those described. This first year teaching on sustainability in LIUC to bachelor students is a first step in a larger development. We will therefore continue on this path, and we hope to devote to sustainability, within the academic year 2016-2017, more than an entire semester of bachelor. Teaching presented will then cover, in depth, energy

and water purification processes. It will also be possible to program targeted internships for students in enterprises engaged in initiatives to reduce the environmental impact of production processes and to achieve green products.

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