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MERGING TECHNICAL COMPETENCES AND HUMAN RESOURCES WITH THE AIM AT CONTRIBUTING TO TRANSFORM THE ADRIATIC AREA IN A STABLE HUB FOR A SUSTAINABLE TECHNOLOGICAL DEVELOPMENT

Abstract: *The Vision of Europe as knowledge-based society is funded on availability and application of knowledge in all segments of European life. Universities, as key provider of knowledge, and industry, as its largest consumer, are two pillows of this vision. Academic Institutions has a double role in provisioning of knowledge: "research" for creation of new knowledge and "education" as dissemination of current knowledge. In this investigation, a four-year cross-border collaboration is described, including strategy, mechanisms and tools adopted for supporting a wider cooperation between universities and industry. Background, challenges and concepts of long-term sustainability are also presented. Furthermore, a general overview of technical outcomes and advances, provided by a research and development joint action, thanks to this international cooperation, is illustrated. A deeper description regarding these technical investigations is proposed in the following articles of this Special Issue on "Wood: an Ancient Material for a Moder*

n Quality"

Keywords: *European Union (EU), Instrument for Pre-accession Assistance (IPA), Cross-border collaboration (CBC), Adriatic, Western Balkan (WB), Higher Education (HE), Research, Innovation, Wood*

1. Introduction

Major efforts have been made by the European Union to increase the fundamental interaction between research, education and innovation, as key driver of a knowledge-based society. Furthermore, the Union recognised that the relationship between the business community and the university, considering its double role as education and research institution, is of strategic importance for a modern vision of future and development. Several "case-studies", made across the whole Europe, have demonstrated an increase of opportunities by "structured business-university partnerships", especially in industrial innovation and social deployment. At the same time, beyond all

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the official aspirations to enlarge the "collaborative friendships" between Industrial and Academic worlds, a genuine and functional networking is something very hard to accomplish everywhere in Europe and, particularly, in the Western Balkans (WB) area. Until the recent past, these territories had been affected by various political, social and economic crises, leading to an high fragmentation of scientific knowledge and deep impoverishment of the productive infrastructure. Nowadays, existing obstacles and divisions have to be rapidly removed to avoid serious delays in innovation and a potential "point of no return" for regional competitiveness. On the other side of the Adriatic Sea, Italian institutions and enterprises are strongly interested in this developing area, as marked by recent industrial investments. Large prominent companies from the Western Europe, especially from Italy (as *FIAT*, *Iveco*, *Magneti Marelli*, *Telecom Italia* and others) find the West Balkan environment profitable for their business, preferring it to other developing countries, but lamenting the infrastructural shortage of technical and educational facilities.

This introductory paper intends to present a partnership, made by 23 different partners/associates over 5 countries, directly connecting 8 universities with 5 public institutions and 10 private subjects, enterprises and consortia of enterprises. This trans-national association, named as *"Adria-Hub - Bridge technical differences and social suspicions contributing to transform the Adriatic area in a stable hub for a sustainable technological development"*, aims to promote and facilitate the contact among Educational and Business galaxies, creating "new channels and methods of communication". The Adria-Hub website (http://www.adria-hub.eu/) includes useful information on the project and its current status of implementation. Considering that public institutions, private consortia inside the partnership acts in the name and for the interests of their public and business associates, it is evaluated that this action impacts directly over more than 120 protagonists of social and economic life in the whole Adriatic region (Figure 1). Moreover, large business associations, like Chambers of Commerce and Public/Private Associations, widely spread methods and outcomes generated in the partnership.

Figure 1. Target territory of the AdriaHub collaborative action

Specifically, Adria-Hub intends to institutionalize relationships and integrations moving on different levels:

1) Political Approach: merging interests and efforts for common purpose, overcoming divisions between populations inherited from past;
2) Educational Evolution: comparing education models and effects, pushing the university curricula toward the needs of industry;
3) Social Action: reinforcing the employment of young people and their correct positioning on the labour-market (according considerations and experiences reported by Antonelli *et al.*, (2009));
4) Implementation of ICT: creating an advanced web-oriented platform to connect data and information all

over the Adriatic region (according to the experience reported by Baghues and Labini, 2009);
5) Workforce Straightening: merging individual skills and industrial needs towards the recruitment of the most appropriate professionals
6) Transfer of Technology: providing industrial needs for technology to the universities as source of innovation (according to results reported by Camillo *et al.*, 2011))
7) Research and Development: forwarding the R&D efforts and capabilities of university partners toward a "business-driven research"
8) Industrial Innovation: focusing resources and attention on a specific industrial sector, the wood processing industry, relevant for the whole area
9) Eco-sustainability in production: developing methods and prototype solutions in respect to environmental and eco-friendly aspects.

2. Background and challenges

The Vision of Europe as knowledge-based society is funded on availability and application of knowledge in all segments of European life. Universities, as key provider of knowledge, and industry, as its largest consumer, are two pillows of this vision. Their harmonic action is of vital importance for achieving the proclaimed goals. Academic Institutions has a double role in provisioning of knowledge: "research" for creation of new knowledge and "education" as dissemination of current knowledge.

By a stable process of "transfer of technology", the universities on Adriatic can act as useful Research and Technological Developer, pushing enterprises to overcome the current barriers of innovation and competitiveness. But, separated into small countries, burdened with recent political and economic breakdowns, West Balkan is mainly characterized by a large number of little enterprises which are rarely capable to take advantage of the academic research partners. In addition, usually private companies in the Adriatic area have not enough economic and technical resources to commit joint project with universities. Therefore establishment of mechanisms for cooperation between universities and industry should be done from outside, using predominantly university resources, following successful examples and under leadership of experienced partners. Only creating and powering institutionalized mechanisms able to support a strong integration between University and Business beyond these difficulties, a social and industrial development can be obtained on Adriatic area.

On the other hand, while cooperation in research and development is progressive increasing, collaboration in the field of education is just at a starting point, even if the representative of both sides declared the highest social importance. A limit consists in the fact that Industry has not a clear and complete insight into the educational institutions and procedures. Following previous experiences of Academic-Business integration successfully performed in Italy on 72 Universities by the AlmaLaurea InterUniversity Consortium (details in the official website: http://www.almalaurea.it/en), the collaboration developed an innovative ICT platform, able to collect technical information from selected West Balkan universities and to provide them to the Industry (De Rubertis *et al.*, 2011). The platform was tested on the wood processing industry in the region. Beyond this challenge for a new collaborative approach, other political and economic aspects have to be considered:

1) Italian wood-working machines manufacturers are strong players on WB: technological innovations could have high impact on both sides of Adriatic.

2) Within Bologna Process, all the universities have to move towards flexible and modern curricula meeting needs of the labour market and establishing trustworthy quality assurance systems; the project is in lines with their present efforts.
3) Since Serbia, Montenegro and Bosnia Herzegovina exhibit intentions to join the European Union, regional integrations are expected to have strong local support.

3. General and specific objectives

As wide-ranging scope, this collaboration satisfies a priority regarding the economic, social and institutional cooperation by funding an institutional network between academic, entrepreneurial and business organisations and companies with direct impact on 5 countries and large part of Adriatic area.

But, it also permits to of project specific objectives related to the keys of Research&Development, since the essential aim of this large inter-regional network is to improve the research capacity and the degree of industrial innovation in the whole Adriatic area, implementing a "business-driven" research and educational approach.

A sustainable process of social and economic development has to pass the fundamental steps of:

1) definition of technological challenges and objectives
2) scientific research and growth of knowledge
3) improvements in high education and professional training
4) transfer of technological knowledge and human capital
5) product and process innovation
6) optimisation of life-cycle according to the eco-sustainability.

Following this sequential approach, Adria-HUB network proposes a mechanism for supporting a wide cooperation of universities and industry by:

1) Building a sustainable hub of intellectual/human capital. The hub was based on an innovative ICT platform connecting graduates from 80 universities between Italy, Serbia, Croatia, Montenegro and Bosnia Herzegovina with the demands of companies from those countries as work force (in line with Camillo *et al.*, 2011).
2) Creating a sustainable platform, filling the communication gap between the academic R&D offers of services and the R&D needs in productive sector.
3) Testing the new methodology for cooperation on a selected primary industrial sector as target particularly relevant in the local economies (wood processing) by creation of a list of high-potential innovative companies and selection of a panel of graduates, in order to carry out relevant training activities, and facilitate the transfer of technology between University and involved businesses.

Adria-HUB aims to drive university research toward a common path of innovation, merging the scientific curiosity of researchers with demands of competitiveness from enterprises. As social objective, it promotes the correct positioning on the Adriatic labour market of qualified human resources, facilitating the employment of graduates by merging technical and personal skills (Cimatti, 2016) with industrial needs (Camelli *et al*., 2008). Joining these two complementary aspects, technological know-how and human expertise, a prolific environment for innovation has been realized on the Adriatic area and efficiently offered to large enterprises and SMEs as support for their innovation. Improving research capacity, encouraging transfer of innovation, rising competence levels, reinforcing high educational training, facilitating the

employment of graduates, promoting joint activities and focusing on a key sector are direct outputs coherent with the European and National priorities.

4. Coherence with cross-border strategies

Entering in details, this cooperation appears to fit several aspects, specified for EU strategy of developing, as stated below:

- Establishing a fruitful institutional network of cooperation on Adriatic by a partnership of 8 universities (*Bologna, Kragujevac, Belgrade, Nis, Rijeka, Podgorica, Banja Luka*), 2 research centres, 7 associations and other 6 high-qualified organizations from 5 countries.
- Reinforcing the institutionalized cooperation between research bodies and private companies: 4 associations, representing all industrial fields, and 4 prominent enterprises (involved as associated partners and supporters without any direct profit). Several SMEs have confirmed their interest in project outcomes.
- Promoting joint research activities between enterprises and universities, developing partnerships for innovation;
- Developing of competitive and cooperative mechanisms to guarantee private funds to the most promising groups of researchers, as a simple and direct way for the enterprises to access the studies and results of the R&D performers.
- Creating an international technological platform on Adriatic, made by public and private research performers, specialized in wood processing and powered by an exclusive multidisciplinary know-how on conceptual and aesthetic design, advanced materials, numerical simulations, virtual manufacturing, machining technology, drivers and controls.
- Supporting and facilitating advanced research activities, focusing resources and institutional attention on a specific field of research, (wood industry and eco-sustainability), selected for the large economic and social impact on the Adriatic area.
- Fostering mobility of researchers between research institutions by organizing more than 50 person-weeks of one-way and two-way exchange of staff;
- Fostering recruitment of high profile researchers by enterprises: during a pilot project, 15 young researchers were hired by universities, educated on specific aspects of wood industries, and allocated into enterprises during different project phases, guarantying a complete transfer of know-how (Cimini and Girotti, 2011);
- Creating scientific and technological networks in the Adriatic area for exchange of information, data and experiences on research and innovation by developing of two different ICT platforms: “Workforce Platform” and “R&D Service Platform”, to respectively collect data on graduates’ skills and R&D expertise of researchers.
- Reinforcing the regional clusters of excellence and supporting the creation of an interregional “production chain” -aesthetic design in Belgrade, mechanical design in Kraljevo, numerical optimization in Kragujevac, diamonded tools in Pesaro, machine tools in Rimini, control of machines in Bari, manufacturing innovative

materials in Forlì/Cesena, ecofriendly utilization of wood for housing in Ravenna.

- Providing a wide dissemination of outputs by 5 professional associations (Chambers of Commerce and similar institutions).

5. Coherence with the relevant EU policies and horizontal issues

This action fits several issues of Gothemburgh/Lisbon strategy as stated below:

1) The 2006 Spring European Council identified four priority areas under the renewed Lisbon Strategy where the first and key one is "investing more in triangle of education, knowledge and innovation". Specific requests were directed to enforce the cooperation between University and Industry as "the appropriate way" for a stable human development of the Union.
2) As direct consequence, all the Adriatic countries developed national and regional policies to respect Lisbon strategy according to the particularities of their social and economic situation. Specific limitations regarding the current state of development had to be taken into account for Western Balkans (WB) countries.
3) An Action Plan "Strategic priorities and initiatives for development of information society" has been adopted by Serbian Government (announced on 9.10.2006 "Official Gazette" no.87/06) acting as driver for the other Balkan countries. Along with others topics, it emerges: "a. Subsection 5: Strategic priority: Develop access to ICT infrastructure; b. Subsection 7: E – Education; Strategic priority: 1. Build educational system adapted to the needs of information society; 3. Foster research and development; Initiative: Foster collaboration with research institutions from developed countries and participation in EU and international research projects. Objective: To strengthen national research capacities, improve quality of research, enhance knowledge and skills of researchers and prevent "brain drain".
4) In December 2008, the Conference "Towards an Information Society for the Western Balkans", co-organized by the two European projects SCORE and WBC-INCO.NET with the support of the European Commission, held in Belgrade, and hosted by the Serbian Chamber of Commerce, has addressed ICT stakeholders and Ministries from the WB Countries.
5) In 2005, EC launched five-year strategy "i2010 - A European Information Society for growth and employment" as a package of policies aimed at harnessing the potential of ICT to drive innovation and productivity in Europe.
6) In 2007, the European Commission published "Integrated Guidelines For Growth And Jobs! (2008-2010)" where Promote a lifecycle approach to work and Improve matching of labour market needs.
7) Stability Pact - Electronic South Eastern Europe Initiative "eSEE Initiative" launched Agenda+ for the Development of Information Society in SEE 2007-2012 with defined priorities for Information Society development for Western Balkans: Further development of a Single SEE Information Space; Strengthening Innovation and Investment in ICT Research and. Education; Achieving an Inclusive Information Society.

6. Coherence with national strategies

The network moves inside the national strategies of the Adriatic territories as stated below:

1) In 2006, (as already mentioned in 3.3.2) in accordance with Lisbon Strategy, Serbian Government launched the "Strategy for Development of an Information Society of Serbia" focusing on growth and employment by a Information Society policy.
2) Serbian Government is paying significant attention on using IC Technology in HE (Higher Education) area, as a part of its long-term objective of joining the European Union (EU). A number of changes still need to be made in order for the.
3) One of the objectives of this Strategy is "to clarify roles, build public-private partnerships, and facilitate participation by all stakeholders".
4) SCORE Project, within FP6 programme issued: "ICT Research Priorities for Serbia, 2007-2013", as the outcome of an initial consultation with a group of 20 experts from Serbia which set out the future ICT research priorities for Serbia.
5) In May 2008, study was done by EC DG, "Social protection and social inclusion in the Republic of Serbia". Executive summary states that one of the most important issues that should be addressed in the cooperation with the EU Agencies, international partner organizations and experts is Introduction of a reliable information system.
6) Other WB countries are following this roadmap of actions. The Council of Ministers of BiH adopted the Policy, Strategy and Action Plan for Information Society Development in Bosnia and Herzegovina. The Strategy covers the period 2004- 2010. However, a number of important projects were planned, but most of them have started or do not have funding secured.
7) In January 2009. Bosnia and Herzegovina has launched State Agency for Higher Education, Development and Quality Assurance located in Banja Luka, to be guided by ERA principles. Agency has been established with Framework Law on Higher Education (Official Gazette of BA No. 59/07), in order to set clear, transparent and accessible criteria for accreditation of higher education institutions. Within the Framework Law on Higher Education it is stated that HE shall be based on: academic self-governance, openness of the university towards the public, the citizens and the local community, respect for European humanistic and democratic values, and harmonization with the European higher education system, the concept of lifelong learning, interaction with the community and the obligation of the university to develop social responsibility of students and other members of the academic community.

7. Added value of the cross-border cooperation

Two elements led to development of concept that is employed in the action: first, serious obsolesce of innovation activity in contemporary Western Balkans industry in comparison to competition, and the second, their inability to be competent partner to universities at the moment.

Urgency of action, which is needed to correct the obsolesce, requires swift approach with application of proven mechanisms which are existing in developed parts of Adriatic region. In that meaning, the project is to be considered as transfer of technology from developed to undeveloped parts of Adriatic region. The fact that, regarding mechanisms for cooperation between universities and industry, whole countries of Western Balkans belong to undeveloped part of Adriatic region, makes them incapable for quick solution of the problem within their borders, and calls for support from abroad.

Therefore, swift and efficient solution of the problem of lack of efficient cooperation between universities and industry in Western Balkan countries can be sought only in development of international project. That project has to include partners from developed parts (Italy) for their expertise and experience, and West Balkans partners as local implementation partners and future beneficiaries of outcomes of the project.

It is not expected that, within national limits of small countries, a stability of demand and supply on innovation, research and development market can be achieved. Therefore, substantial improvement of employment of existing potentials and optimal selection of human and knowledge resources can be achieved through an internationally available database of resources able to provides an opportunity for levelling the market's offer and demand (a general analysis on the graduates job mobility is available in Bacci *et al.*, 2008).

8. Methodology approach

A virtual triangle of Education-Knowledge-Innovation bridging the Adriatic shores has been realized by:

1) Exporting to the WB of the *AlmaLaurea model* for storing information of graduates. Besides a database (DB) of CVs, this innovative approach consists of: developing of common modes & methods to acquire and store data on professionals' skills; implementing a ICT DB and entering CVs by the University partners; setting-up new criteria for classification, certification and ranking of CVs according to entrepreneurial needs; defining techniques for a regular updating of information, finding the best strategy for selling data. Improvements in respect to the current AlmaLaurea platform consists of: integration of data from different countries, use of new languages for interfaces, new techniques for ranking (see "Adria-Hub platform for graduates and enterprises", 2014);
2) Merging Italian and West Balkan previous experiences in industrial research & transfer of technology by development of an integrated platform for classification of services in research and technology. Instruments, technical capacities, previous experiences of collaborative researches and ongoing projects are available for insight through an innovative platform for R&D services. A interface guides users through the scientific expertise of Universities towards a highly customized proposal of research, focused on the industrial need for innovation;
3) Pilot Projects of industrial interest were defined based on the demands outlined by the entrepreneurial partnerships by a regular "*call for ideas*". Further, a "call for partners" was launched, searching for additional (economic or technological) support between the WB and Italian enterprises. Technical projects were limited to the "world of wood" and its

industrial "supply chain", with specific attention to every technical solution providing eco-sustainability.

Figure 2. Platform access page for CV storage (by graduates) and selection (by enterprises)

9. Results and outputs

As general outcomes, a transnational network between Higher Education Institutions (HEIs) and Entrepreneurial Organisations was founded, on which companies (or other social players) can easily find needed information (like information on: degrees, competences and skills, graduates' CVs, training courses, R&D services performed by HEIs, scientific know-how, practical solutions of technical problems, etc) Djapic *et al*. (2016).

Tangible outputs were:

- one new DB of WB graduates, containing a large number of CVs from the WB Universities (more than 10.000 CVs), creating a platform for recruitment of high skilled staff (Figure 2);
- build up IT connection among the new WB graduates platform and the existing AlmaLaurea DB in order to integrate and exchange information (the Italian DB currently stores more than 1.55 million of CVs of graduates), thus creating information linkages among the Adriatic basin;
- public recommendations and guidelines on "Matching graduates' skills and employability with industrial innovation needs", directed to national and regional policy makers, but also to University management, with the aim to increase the relevance of education and training programmes according to Bologna Process and industrial needs, with special attention to the wood industry (Engelberg, 2016);
- a DB describing expertise and R&D services that Adriatic Universities are able to provide to enterprises;
- public recommendation and guidelines on "*Bridging University-Business Gap on Collaborative Research*" directed to national and regional policy makers;
- a budget equivalent of 25 man-years, targeted to employ and train new researchers (70% from WB area), engaged on industrial projects;
- more than 20 new jobs in research groups or enterprises created as final output of transfer of technology process;

- a prolific environment for innovation and economic development on Adriatic region;
- new scientific know-how, technical expertise and early prototypes for a sustainable wood processing.

Nevertheless, and probably more relevant respect to the contest of this investigation, were the technical projects, market oriented, that were realized in a close collaboration between University and Enterprises.

10. Cross-border cooperation

Activities and objectives were specifically planned to realize three joint cooperation systems, as stated below.

- Joint development: the action was successfully completed by an intensive cross-border integration. Partners from 20 different provinces shared objectives, results, output, activities. AlmaLaurea shared its exclusive know-how regarding how to efficiently implement and manage a large database; by this platform, the Universities offered a unique enter door to access a huge amount of professional information on their graduates. Adding, the several promising groups of researchers merged their expertise with the aim at offering to enterprises an integrated platform where solutions of technological problems could be found;
- Joint implementation: the project's activities show a close relation and collaboration between cross-border partners in terms of content (like new means and methods to improve: high education; institutional integration; applied research; university-enterprise connection, transfer of technology; industrial innovation, etc.), planning and timing. The high technological level of pilot projects (described below) demonstrated the primary quality of outcomes.
- Joint staffing: to avoid duplications of functions and wasting of human resources, several joint groups were created with trans-partnership's roles either for general aspects (like management, scientific supervision, promotion) or for "real" joint R&D activities, inside the technical tasks (Figure 3).

Figure 3. Joint implementation of technical projects by joint training and staffing

11. Technical action

The framework of technological know-how and human capacities were directed to foster the regional clusters of excellence and support the creation of an interregional and integrated "production chain" consisting of aesthetic design in Belgrade, mechanical design in Kraljevo and Rijeka, numerical optimization in Kragujevac, tools production in Pesaro, machine tools production in Rimini, electronics in Nis, control of machines in Ravenna and Montenegro, manufacturing and testing of innovative materials in Forlì, wood technology in Bologna. Focusing on wood use and processing, the action aimed at creating conditions for advances far beyond the actuality and the perspectives of the wood industry development in the countries of the Adriatic region (as detailed by Dimic and Pavlovic, 2016). Special attention was paid to technical solutions improving eco-sustainability and efficient use of resources, acting on complementary aspects like:

1) modifying the approach to design with "eco-efficiency" as a key-driver for design of solutions;
2) virtual machining to foresee and optimize the industrial process;
3) using innovative materials to raise performances;
4) accurately controlling the dynamic response of machines;
5) developing a better way to use cutting tools;

This *Special Issue "Wood: an Ancient Material for a Modern Quality",* reporting a synthesis of R&D efforts and main technical results, aim at representing a relevant proof of the capability of the Academia to perform "business-driven research", focusing resources on specific industrial needs. Technological outcomes were evaluated in consideration of their real implementability respect to the industrial environment and University factually assessed respect to its role of "source of innovation".

12. Contest

These industrially oriented projects regarded very different aspects of wood sector, but all of them considered as strategic for the general scope of improving the level of technology in target companies in terms of:

- *Eco-sustainability design*: considering aesthetical and functional design of wood products and equipment for wood processing focusing the technical requirements on the aspect of eco-sustainability (e.g. reducing loss of draft materials, energy and time for processing, packaging, weight, etc., but also increasing the lifetime, the use of recyclable materials, etc.). Innovative design concepts and tools, largely spread in other sectors, but not in wood industry, were used for visualization of variants of concept design; evaluation and valorisation of variations according to functional-aesthetical criteria; detailed development (CAD/CAM) and presentation of solutions, rapid prototyping (RP) activities.
- *Virtual Manufacturing* (VM): represents an integrated computer based model for product design and manufacture process simulation, as well as rapid manufacturing of rapid prototyping (RP) and reverse engineering (RE). This integration was applied with the aim to optimize design of products and processes by selection of materials for new products and process conditions and their tuning. It permitted to reduce lead times, time-to-market costs, manufacturing costs, tool costs, material costs, increasing the final quality and life of the product. Several activities were performed to introduce the approach of VM into the wood processing sector in the

Adriatic area proposing them VM innovative tools and methods.

- *Light materials for tool machines*: tools machines were mainly evaluated by customers for cost, accuracy and productivity. All the parameters were strongly influenced by materials used for structural and nonstructural parts (as guides, bearings and other mechanical supports). Reducing weight, saving draft materials and energy for movements, transportation, etc., directly impacted on sustainability of this industrial sector. Lighter materials, as special plastics or even innovative wood based composites, investigated in the University, are currently at a level of development able to be profitably used in designing and developing of ready-to-market solutions for a more sustainable manufacturing plant.
- *Improving dynamic behaviour of wood machinery*: Dynamic stiffness of machine tools is limited by first natural modes of their mechanical structures (usually between 10 and 30 Hz) that are excited mainly by inertial forces. To reduce these vibrations, manufacturers have to impose severe limits on jerk and maximum accelerations: in terms of productivity these limits translates in a longer cycle time (up to 15-20%). Goal of this part of activity was the development and application of an innovative control technique based on high-performance accelerometer sensors able to improve the machine tool performances in terms of cycle time reduction, higher productivity and a better exploitation of energy
- *Tracing and monitoring of tools*: increasing efficiency of cutting tools of a tool machine is a direct way to reduce losses (materials, energy, and waste products), increasing competitiveness. Some technical solutions are already implemented with success in heavy machinery but these innovations rarely reach factories. In this action, a platform for tracing back and monitoring tools' degradation was developed. Methods to predict reliability using statistical data were defined and used to foreseen fails reducing effects. A cost-effective strategy for maintenance was planned according to the fundamental parameters of process increasing the eco-sustainability of wood processing.

13. Practical examples

Several interesting examples of practical results achieved thanks to this network of collaborations are available inside this Special Issue or in similar publications. For instance, talking about the use of wood in building construction, in Allacher *et al*. (2016) the sustainability of timber structures respect to other traditional materials is compared demonstrating how wood, especially when properly engineered, can represent an high-class solution in a large number of applications. This usability is also highlighted in Pozza *et al*. (2016) where the high performance offered by wood in seismic improvement, especially of historical heritage, is detailed. At the same time, Ceccotti *et al.* (2016) compare traditional and modern wooden building types by an experimental characterization in static and seismic conditions. It is evident how special treatments on wood, together with several technical solutions (e.g. in design) can transform this natural resource in an extremely advanced material: we are now talking about *engineered wood*, a material able to compete with many others, as plastic composites, as detailed in several investigations. In particular, in Zivkovic *et al.* (2016) a way for improving the

mechanical properties of wood based composite materials by physical and chemical treatments are presented, while, in Fragassa *et al*., 2015, similar improvements are realized by an "hybridization" with cellulose fibers in traditional composite fiber reinforced polymers. Both studies demonstrated the general interest for applications including unconventional materials with properties in the middle between what already available on the market.

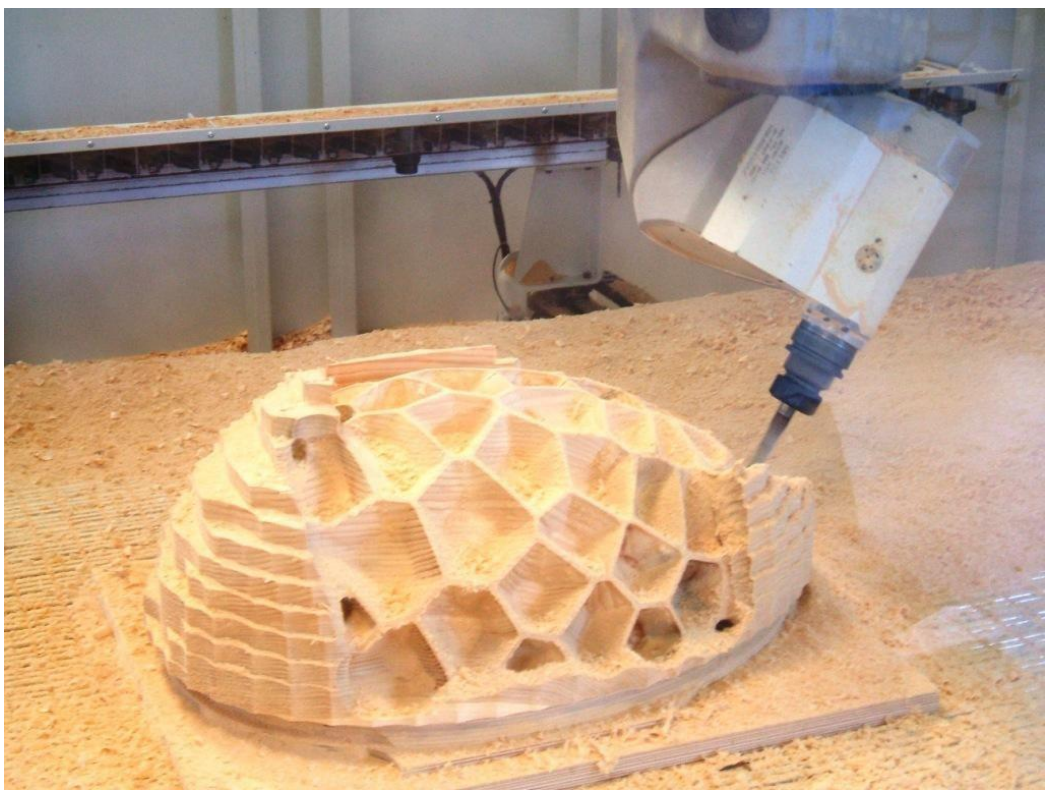

Figure 4. Production of complex geometry by woodworking [Courtesy SCM Group]

These materials, labelled sometimes as "green composite materials", have to provide adequate performances (e.g. resistance, durability, lightness), but also a reasonable level of eco-sustainability (both in terms of "ingredients" and processes). Whatever ancient or modern it is considered, this material has to be manufactured in accordance with the highest levels of productivity. It means that, as happened in other industrial sectors, only a proper strategy, including concepts of Total Quality (TQ) and Life Cycle Costs (LCC), permit to improve the level of wooden products, including the related processes, in the way to assure their stable success on the market (see Fragassa, Pavlovic *et al.* (2014) for a similarity with automotive sector). In line with this, Vujovic *et al*., (2016) propose a potential application of the intelligent agent-based system in the wood industry for process rationalization and products improvements. In Lucisano *et al*., (2016), several advanced solutions for design of high-precision woodworking machines are detailed. They range from the definition of an appropriate base with the aim at maximizing the stability by frame-pavement

connections, to the implementation of devices able to provide a perfect feedback control on spindle (and, then, on machining) by electrical signals on magnetorheological materials. It also reports, better detailed in Fragassa *et al*. (2016). about changes in metallurgical processes with the aim at producing a specific cast alloy for frames, able to reduce the transmission of vibration by internal damping properties. Finally, several aspects on cutting tools are investigated. These studies are mainly focused on validation or optimization of tools parameters in accordance with specific working conditions. Finite Element (FE) analysis are, then, compared with experiments tests, but also with theoretical models (as in Zigulic *et al*., 2015).

An accurate definition of cutting models is something under investigation since several decades, and far beyond a definitive solutions, especially in the case of anisotropic materials as wood surely is. At the same time, a practical guideline aiming at the correct definition of tools requirements in accordance with specifications from process was realized inside the project and discussed in Fragassa *et al*., (2015). The choice of the "best cutting tool" does not only deal with factors as precision, productivity, etc., but also affect relevant aspects of machining as equipment maintainability and, even, personal safety (Pavlovic *et al*., 2016). Additional investigations are on-going, especially regarding an integration between CAD, CAD and CAM tools for reducing lead time in new products, boost the productivity, even in the case of complex geometries (Figure 4).

References:

Adria-Hub platform for graduates and enterprises (2014). Retrieved from: http://international.almalaurea.it/adriahub/ Accessed: 01/2016.

Antonelli, G., Camillo, F., Cammelli, A., di Francia, A., Ghiselli, S., & Sgarzi, M. (2009). Graduates' employment and employability after the "Bologna Process "reform. Evidence from the Italian experience and methodological issues. *International Conference on Development of Competencies in the World of Work and Education*. Ljubljana, Slovenia: DECOWE, 24-26.

Bacci, S., Chiandotto, B., & Di Francia, A. (2008). Graduates job mobility: a longitudinal analysis. *Statistica*, *68*(3), 255-279.

Bagues, M.F., & Labini, M.S. (2009). Do online labor market intermediaries matter? The impact of AlmaLaurea on the university-to-work transition. *Studies of labor market intermediation*, University of Chicago Press, 127-154.

Camillo, F., Conti, V., & Ghiselli, S. (2011). *Representativeness and evaluation impact issues concerning the use of databases with self-selection effects: the case of the AlmaLaurea system*, Mimeo.

Camillo, F., Ghiselli, S., & Conti, V. (2011). *Integration of different data collection techniques using the propensity score*. Almalaurea Working Papers 34. Bologna. Retrieved from: http://www2.almalaurea.it/universita/pubblicazioni/wp/pdf/wp34.pdf

Cammelli, A., Guerriero, A., Ralli, F., & Sgarzi, M. (2008). *AlmaLaurea recruiting and placement services: for the benefit of universities, graduates and companies*, EUNIS.

Ceccotti, A., Massari, M., & Pozza, L. (2016). Traditional and modern wooden building types: static and seismic characterization. *International Journal of Quality Research*, *10*(1), 47-70.

Cimatti, B. (2016). The enhancement of "Soft Skills" as a way to increase employability and competitiveness. *International Journal of Quality Research*, *10*(1), 97-130.

Cimini, C., & Girotti, C. (2011). *Factors contributing to participation in web-based surveys among Italian University graduates*. Almalaurea Working Papers 35. Bologna. Retrieved from: http://www2.almalaurea.it/universita/pubblicazioni/wp/pdf/wp35.pdf

De Rubertis, S., Pollice, F., Ciavolino, E., & Ricciardelli, A. (2011). *The incidence of regional factors on "competitive performance" of universities*. Almalaurea Working Papers 37. Bologna Retrieved from: http://www2.almalaurea.it/universita/pubblicazioni/wp/pdf/wp37.pdf

Dimic, M., & Pavlovic, A. (2016). Actuality and the perspectives of the wood industry development in the countries of the Adriatic region. *International Journal of Quality Research*, *10*(1), 131-142.

Djapic, M., Lukic, Lj., & Pavlovic, A. (2016). Technical Product Risk Assessment: Standards, Integration in the ERM Model and Uncertainty Modeling. *International Journal of Quality Research*, *10*(1), 159-176.

Engelberg, S. (2016). Educating for Quality in the Wood Industry: Some Words of Caution. *International Journal of Quality Research*, *10*(1), 89-96.

European Union (2013). *IPA Adriatic CBC Programme website.* Retrieved from http://www.adriaticipacbc.org/ 01/2016

Fragassa, C., Minak, G., & Pavlovic, A. (2016). Investigating the fracture toughness of cast iron. *Tribology in Industry*, *38*(1),

Fragassa, C., Pavlovic, A, & Massimo, S. (2014). Using a Total Quality Strategy in a new Practical Approach for Improving the Product Reliability in Automotive Industry. *International Journal for Quality Research*, *8*(3), 297–310.

Fragassa, C., Santulli, C., Sljivic, M., & Pavlovic, A. (2015). Improving Performance and Applicability of Green Composite Materials by Hybridization. *Journal of Contemporary Materials*, *4*(1), 35-43.

Fragassa, C., Zigulic, R., & Braut, S. (2015). *Effect of Design Parameters in Circular Saw Blades*. In: Proc. 8th International Congress of Croatian Society of Mechanics. 29 Sept – 2 Oct 2015. Opatija, Croatia.

Lucisano, G., Stefanovic, M., & Minak, G. (2016). Advances Design Solutions for High-Precision Woodworking Machines. *International Journal of Quality Research*, *10*(1), 143-158.

Ongaretto, E., Pozza, L., & Savoia, M. (2016). Wood as high performance material for the seismic improvement of historical heritage. *International Journal of Quality Research*, *10*(1), 17-46.

Pavlovic, A., & Fragassa, C. (2016). Analysis of flexible barriers used as safety protection in woodworking. *International Journal of Quality Research*, *10*(1), 71-88.

Vujovic, A., Krivokapic, Z., Jovanovic, J., & Grujovic, R. (2016). Possibility of application of the intelligent agent-based system in the wood industry. *International Journal of Quality Research*, *10*(1), 193-204.

Zigulic, R., Fragassa, C., & Skoblar, A. (2015). A nonlinear vibration model of the woodworking band saw. *In: Proc. 8th International Congress of Croatian Society of Mechanics*. 29 Sept – 2 Oct 2015. Opatija, Croatia.

Zivkovic, I., Pavlovic, A., & Fragassa, C. (2016). Improvements in wood thermoplastic composite materials properties by physical and chemical treatments. *International Journal of Quality Research*, *10*(1), 205-218.

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