AuToMa
AUTOMATION, TECHNOLOGY TRANSFER AND MANAGERIAL PRACTICES FOR THE GROWTH OF SMES, A BETTER EMPLOYABILITY AND THE PROMOTION OF THE ENTREPRENEURSHIP

Executive Summary

of

AuToMa Learning Methodology

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Introduction

Innovative managerial practices, information and communication technologies, automation methods, robotics systems have changed and are changing processes in manufacturing companies. In parallel also on the scientific and vocational education level the integration of different fields like mechanics, electronics and information technologies (mechatronics) is practiced since years. Nevertheless many, especially small, enterprises have rather conservative approaches to new technologies and thereby miss many opportunities by utilizing improved technologies. SMEs need highly qualified staff, competent in operating with new machines and in managing sophisticated production processes.

"AuToMa - Automation, Technology transfer and Managerial practices for the growth of SMEs, a better employability and the promotion of the entrepreneurship" project (http://automa-project.eu) contributes to the development of high professional skills with specific regard to the fields of automation, innovation and technology transfer and sharing them at national and European level.

The goal of this executive summary is to summarize the developed "AuToMa Learning Methodology" document, available in English on the project website, explaining briefly how AuToMa project can support an innovative and open training approach, considering the two specific learning paths (one more technical and another one more managerial) and the developed knowledge center area (KRIA) focused on specific target groups' needs: future entrepreneurs and students who want to develop business in manufacturing sector; entrepreneurs and employees of SMEs who want to improve their qualification or re-qualify, as well as unemployed people who want to gain initial competences; universities, research centres and VET trainers that want to improve or update their learning curricula. Other beneficiaries are industrial organizations (at local regional, national and European levels) that work on induced activities and public organizations that want to understand how to finance or support manufacturing SMEs or entrepreneurship in general. The European countries involved in the project are: Italy, Poland, Slovakia, Spain and Bulgaria (involving 5 Partners, all of them having relevant experience in these sectors and also in developing transnational projects: 2 universities, 1 public research centre and 2 private companies).

1) The European manufacturing SMEs in automation field

1.1) Analysis of project target groups and needs in manufacturing sector

Continuous innovation has become a key factor in the global competition in order to acquire the additional factors of production and the new value adding processes, which

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are essential to keep a sustainable economy. Innovation and technological development in manufacturing automation, whereas on the one hand require changing operational processes and organizational modalities of work, further changing staff requirements for employees and companies, on the other hand can help to create next-generation of enterprises, able to develop competitive solutions and innovative products. At the same time with innovative manufacturing approaches and methods, can born new professions, new knowledge and skills that will be more and more required to employees, managers and trainers. The ability to produce, manage and perform innovation requires not only scientific and technological knowledge and abilities, but also organizational, managerial, and marketing skills. In this context, it is central to have innovative learning curricula for use of state-of-the-art technologies and this aspect demands to SMEs highly qualified staff. AuToMa project addresses the problem of low and incongruous qualification of students and staff employed in SMEs in terms of automation systems and new technologies. It will give also to employed, unemployed and people that need to be requalified, more opportunities to find a job at national and EU labour markets. These aspects take in account of the role of the lifelong learning in EU (Lisbon Strategy and Europe 2020 Strategy) and will have a strong impact on the international co-operation in the areas of automation, technology transfer and managerial practices. It will give also the possibility to remove the obstacles and the limits of traditional learning and training activities of EU organizations, also not directly linked with the automation, technology transfer and managerial topics.

There have been significant debates about the impact of new ICTs on economic performance and competitiveness in general, and on productivity, efficiency, and innovation in particular. The diffusion of automation can produce new opportunities for SMEs. It overcomes the concept of traditional organization, emphasizes the interdependence between the organization of jobs and technology. Notably, in seeking an explanation for the acceleration in productivity and economic growth experienced in many industrialized countries, many economists have looked at the development, application, and utilization of ICT as a critical factor. Hence, at the firm level, the expectations are of greater efficiency, lower costs, and access to larger and new markets, while governments see the application and use of ICT as generating higher productivity, and competitiveness. This document provides an analysis of automation and innovation fields and try to explain their organizational impact on Small and Medium-sized Enterprises (SMEs). Besides it try to understand what are the main barriers for SMEs with respect to the realisation of their innovative potential and their capacity to create employment (reduced access to external finance, unavailability of wider distribution channels, low internationalisation, etc.). ICT adoption and organizational change are becoming essential for achieving greater industry productivity, lower operational costs, and higher revenues. The close correlation between these dimensions of improved economic performance from ICT and organizational change corresponds well with findings from other studies on the impact of ICT on firm performance. It has thus often been argued that the effective utilization of ICT requires more horizontal organizational structures with greater levels of responsibility for the overall coordination of work placed on the individual employee. It also requires the

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implementation of clearer functional descriptions of tasks. All this often requires a complete reshaping of the organizational structure of the firm where all aspects of the organizational development are consequently given attention. Hence, it is important to note that the firms are going through a period of rapid modernization, emphasizing improved production processes and flexible organizations that can address the needs of the market, as part of transformations of the socio-economic fabric to a market-driven economy. This may in part explain why ICT is combined with other factors, such as new marketing strategies and organizational change. Today there is a strong need to collect more revealing data on ICT utilization and its impact on SMEs, the need for more rigorous analysis of how ICT investment and use affects innovation, and the need for better understanding how this can translate into productivity increasing and enhancing competitiveness. How to correlate SMEs in the internationalisation processes or whether they only function as suppliers in global value chains, dominated by largescale transnational enterprises, is an open question. Without doubt, the current wave of internationalisation is accelerating the diffusion of innovation across manufacturing industries. It is unclear whether SMEs are driven by globalisation or whether they are a driving force in this process.

Automation is particularly important for lowering operational costs and increasing revenue. In addition to identifying the immediate impact of ICT on the economic performance of SMEs, it is possible to identify how firms use ICT to improve their future performance, namely through innovation. ICT is only a minor facilitator of innovation; it only becomes powerful in combination with a number of other complementary factors. The main factors contributing to innovation in SMEs are:

- changes in salary structure;
- training of staff;
- capital investment in equipment;
- organizational change;
- new market strategies.

It is clear that ICT utilization is already having the main impact on economic performance among firms. This is reflected in the findings on the impact of ICT on economic performance, where it is evident that ICT is a substantial contributor to productivity, profitability, and growth. Accordingly, a new marketing strategy is particularly relevant for translating the introduction and use of ICT into the improvement of profitability. This is mainly because the use of ICT together with new marketing initiatives enables firms to strengthen their position in existing markets or enter new markets, thereby improve profitability.

1.2) Relevant networks and main stakeholders at European level

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To facilitate and support the development and cross-border networking of national knowledge transfer office networks and the work of existing pan-European networks, the EU Commission has launched an initiative that aims at enhancing collaboration on knowledge transfer among the TTOs (Technology Transfer Offices) of large European public research organisations - the "European TTO circle". The TTO Circle includes 25 of the largest research organisations in Europe. The EU needs more innovation to boost its global competitiveness, harness its knowledge base, enhance its economic position and tackle the grand societal challenges of the 21st century. For these reasons, innovation has been placed at the heart of the Europe 2020 strategy for growth and jobs. The Innovation Union flagship initiative stresses the importance of developing mechanisms to strengthen knowledge transfer offices in public research organisations, in particular through trans-national collaboration. Article 181 of the Treaty on the Functioning of the EU encourages the Commission to take any useful initiative to promote coordination with the Member States aiming at i.e. establishing guidelines and indicators, exchanging best practices and promoting monitoring and evaluation. European technology transfer today shows similarities with an emerging industry: many valuable product ideas; a highly fragmented landscape; a lack of critical mass; wide disparities in terms of performances and developing practices. It is anticipated that the next decade will see profound changes in this landscape. Studies have identified the lack of scale as one of the major issues of technology transfer. Given these huge challenges, a necessary step is to bring together the major European public research organisations, so they can play a role in collectively driving changes to this landscape. A main emphasis would be on job creation by supporting the uptake of new technologies in particular by SMEs. In line with the Innovation Union flagship initiative and with the challenges that Europe is facing in mind, the European TTO circle network was established with the aim to bring together the major European public research organisations in order to play a collective role in driving changes to the Technology Transfer landscape in Europe. The European TTO circle partner organisations are leading European public research organisations (PROs) whose prime mission is to perform research. They have agreed to join forces on Technology Transfer to boost innovation in Europe through a set of initiatives, including: fostering the use of their knowledge portfolio; sharing best practices, knowledge and expertise; performing joint activities; establishing informal channels of communication with policymakers; organising training programmes; and developing a common approach towards international standards for the professionalization of Technology Transfer.

1.3) Transferability

Technology transfer is a fundamental step of innovation processes and it is of key interest for companies who want to profit from exchange of innovative solutions and cutting-edge ideas within their technical domain. However, only few companies have integrated technology transfer into their routine business processes. Main driver for technology transfer is to avoid infringement of third parties' intellectual property as well as acquiring technologies of high value contribution to own technical solutions or products. Additionally

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– on a long-term basis – technology transfer opens up the possibility for collaboration in technical development. Technology transfer is to be addressed carefully in term of speed of transactions being performed as well as financial expectations being realized. Substantial contribution is achieved in organizations with broad awareness of technology transfer benefits and corresponding broad support of the whole organization. Technology transfer is a key factor strongly impacting on economic growth both in the short and long term. The access to technology and its usage in economic processes to large extent decides as to the competitive position in the international labour division. Structural changes of the entire economy are almost not possible without an effective technology transfer and well-defined country's innovation system. These two factors led the spectacular (despite current problems) improvement in competitiveness and economic success of the newly industrialised Asian Pacific economies. Technology transfer is a complicated process, which includes several closely related elements like – technology (embodied and disembodied; e.g. subparts / machines, patents / licences) and knowledge (e.g. organisational behaviour). Sometimes transfer technology is being understood in parallel to innovation where the latter embodies of specific knowledge of a product or service. Technology transfer can be defined as a flow between technology owner/holder and technology buyer/user. It enables closing the gap in access to particular technology in different ways: buying, renting, lending or licensing. An important element strictly related to technology transfer is the technology commercialisation – which is a technology transfer with a special emphasis on practical usage of R&D efforts (e.g. closing a licence agreement with patent owner to exploit technology of a specific product design). The scale of diffusion of the transferred technology depends to a large extent on existing technology infrastructure – e.g. the resources of the technical science and R&D potential, industrial production advancement, technology start-ups and technology transfer financing system, instruments encouraging the culture innovation across the country, the scale of the country's openness to foreign competition and production co-operation (at the beginning mainly transnational corporations' channels). Economic level is one of most important factors determining the intensity of technology transfer. In effect, the diversity in the level of quality and quantity of labour factors will be strictly correlated with the potential flow of technology. Technology transfer channels can transfer goods, services and production factors (workforce, technology, capital). In this context investments related to technology transfer are analysed as investments directly related to production (e.g. machinery) and partially related to production (e.g. distribution equipment). Technology supply depends to a large extent on innovation the capabilities of a particular country or the so-called innovation potential. Innovation should be broadly understood as everything, which is considered as a new. Innovation is the result of the practical primary usage of certain idea. It is the embodied in a range of processes or products; thus, we can distinguish process and product innovations. The innovation potential of particular country is the sum of specific macro and microeconomic factors, which encourage the process of innovation like income per capita, R&D, technology infrastructure. Technology transfer indicators can be based on the foreign trade specifics and international competitiveness. In this context, they can include e.g. prices in export, shares in appropriate international markets etc. One of the

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most often used indicators as to the intensity of technology transfer is the technology gap, which can be understood as difference between knowledge and capabilities of a particular country. There are several possibilities to define and measure the technology gap which include comparisons of industries' labour productivity and capital intensities. An interesting indicator is the level of profit generated in a single country by foreign enterprises. The national technology transfer system can consist of several entities. The most important of which are innovators (technology creators), commercialisations (companies) and central government institutions (economic policy).

Technology transfer channels are the medium between particular participants in the process. They include ways of gaining the technology (e.g. buying, lending) and other important factors related to the process (e.g. flow of people, documentation, products, and capital). Technology transfer is conducted through different channels and different entities. Depending on the means of creating and gaining of the technology its transfer can be considered either internal or external. Internal technology transfer is conducted mostly inside a single entity or its affiliates. This entity acts both as creator / innovator and user.
Follow a list of involved subjects on technology transfer and innovation system:

- **Government institutions** (goals and resources of innovation policy; legal affairs)
- **R&D institutes** (basic and applied research)
- **Higher education** (R&D)
- **Financial institutions** (Venture Capital funds, banks, public funds)
- **Technology transfer brokers** (incubators, technology parks)
- **Small and medium enterprises** (technology implementation)
- **Large industry** (technology implementation and export)

1.4) Social impact of automation

Innovation and technology transfer are the key drivers of economic growth in today's world economy. Thus, an appropriate economic policy should concentrate on strengthening these processes throughout the country and easing the flow of information and technology between the main players – innovators, companies, state agencies and financial institutions.
During the last decades, advanced information technologies have become more and more omnipresent to address new requirements and new needs of our "e-society". But, their increasing development and their daily use in our professional and/or personal life impact so much the organisation of technical systems and socio-technical systems, that the traditional relationship between humans and machines, in the broad sense of the term, has been strongly altered. One of the results of this increase in automation and control technologies is the emergence of new behaviours of both humans and machines that involve new balances of the mutual influence between technologies and society and that justify revisiting the traditional vision of the role that automation technologies play in our society.

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In this perspective, the knowledge of the relationships between humans and technologies allows further research activities so as to encompass all issues and topics of the social impact of automation technologies. All actions aim to address aspects of the relation of automation to social environment through the application of the potential of advanced technologies to the full benefit of humans and organizations. But, the study of these aspects implies to enlarge the traditional setting of both control sciences and social sciences to a more holistic approach in order to cope with the increasing complexity of integrating technologies and human behaviour within socio-technical systems and society in large. Thus, important themes that are emerging are:

1. e-Automation and Human Capabilities
2. Collaborating e-Intelligence and Human Skills
3. Balancing e-Learning and Face to Face Education and Training
4. Ubiquitous e-Automation
5. Safety
6. Secure and Ethical e-Society
7. Management of e-Technology.

1.5) Employability in the automation field

It can generally be assumed that the employment effects of an innovation depend on its type (Peters, 2006). If a higher market share is achieved due to a new product, the input of capital and labour can be increased, and the firm achieves a higher value added. The substitution of a presently marketed product by a new one can also trigger off this effect if the firm's competitiveness can thereby be increased (employment-creating innovations). Process innovations and organisational innovations, on the other hand, normally aim at decreasing costs by reducing labour input to generate the same output (labour-saving innovations). However, as the introduction of new products is in reality generally only possible in combination with new production processes, a systematic separation of the employment effects of different forms of innovation is empirically difficult. Nevertheless, Greenan and Guellec (2000) show that industries in France, where process innovations were predominant during the survey period, suffered net losses in employment, while industries in which product innovations were predominant achieved net gains in employment. Employment effects of innovation also seem to be dependent on the technological level of an industry. Blechinger and Pfeiffer (1999), using data from the manufacturing sector of OECD countries between 1970 and 1991, showed that an increase in labour productivity generally went hand in hand with a decrease in employment (with the exception of Japan, where, despite above-average productivity gains, an increase in employment was observed) – whereas for high-tech and medium-high tech industries an employment increase could be registered (see also Lettmayr et al., 1997). A number of studies exist on the subject of firm-size specific employment effects of innovation. For instance, Cesaratto et al. (1997) analysed data from Italian SMEs. Innovative enterprises generated an annual employment increase of 0.28% during the survey period of 1990–1992. Non-innovative enterprises reduced their workforce in this period by 0.45% per year.

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This result is also supported by evidence of positive indirect employment effects on SME innovations. It should be noted, however, that the above-mentioned differences are related only to the number of employees, not to the number of hours worked. The only exceptions are SMEs within a range of 20–199 employees. For this group of enterprises, a positive correlation was observed between both the number of employees and the number of hours worked and the innovation activities of an enterprise. These results were confirmed by a study on SME ranging from 6 to 249 employees in Italy's manufacturing sector during the period of 1998–1999 (Sheikh and Osterholzer,2001). Innovative SMEs experienced an employment increase well above the SME-average. On the other hand, SMEs which reduced their R&D activity also reduced their workforce. A positive correlation between innovation and employment in Italian SME is always confirmed.

1.6) Quality of education and lifelong learning

Especially for the automation field the planning and design of quality learning contents is very important. Their value has to be considered particularly for e-learning courses oriented to the identified target groups of Erasmus+ projects. For these reasons in AuToMa project two learning paths, including specific learning contents, has been planned to improve technical, managerial and transversal skills for managers, technicians and students. This is the main reason because the project will focus the contents development on two paths: one more technical and the other one more managerial. For the e-learning delivering, the design and development of structured training materials must be self-contained and able to be used everywhere. An instructional design model defines the activities that guide AuToMa learning contents development.
The main developed features regarding the learning materials are:

- modularity: each of the modules will be designed independently allowing easy adaptations of the program. The advantage of having a modular learning program is that the training contents can be easily adapted to the specific needs;
- competence based: this approach allows participants to advance, basing their ability to master a skill or competency at their own pace regardless of environment. This method is tailored to meet different learning abilities and can lead to more efficient participant's outcomes;
- activity based: compared to traditional teaching activity-based, education is proven to be more successful in terms of understanding and applying the learning content, especially with a multidisciplinary background of the training;
- participant-centred: this teaching method shifts the focus of activity from the teacher to the trainees. These methods include active learning, cooperative learning, and inductive teaching and learning;
- output-oriented: this teaching approach is directed towards the learning achievement of the participants. This could be reached through competence orientation and education standards (mostly available in formal learning).

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Several reflections considered in AuToMa project regard the following aspects:

- A needs analysis influenced by key characteristics of the target groups (e.g. their previous knowledge and skills, geographical provenience, learning context and access to technology);
- Specific learning needs and job-related skills identification;
- A set of the best learning objectives required to achieve the general and high-level courses objectives;
- A set of instructional, media, evaluation and delivery strategies useful for AuToMa learning goals;
- Contents development collecting all the required knowledge and information identified by Partners;
- Storyboard development: integrating instructional and media elements;
- Courseware development: developing media and interactive components, producing the course in different paths;
- Web delivery of content elements by a learning platform that learners will easily access;
- Evaluation of knowledge and skills acquired by participants;
- Certification procedure, at the end of the two learning paths that will be available for participants.

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1.7) Educational gaps and emerging training needs for SMEs

Internet of Things in manufacturing allows to have distributed sensors that communicate between them and a "head office" to monitor and control data such as: asset status (for example physical variables and failure states) or locating people (just thinking about issues related to work safety). IA and digital manufacturing enable also to take advantage of production data to track product progresses and traceability by being able to understand at any time where a given good is, whether it is being produced or from a customer. These are therefore technologies that increase the efficiency of the production that seek to "relocate intelligence" to the same plant that, thanks to proper data management, may be able to "optimize" independently, under the supervision of an expert. With RFId (Radio Frequency Identification) sensors, for example, it is possible to know exactly where the production chain is located and to intervene in the event of malfunctions, thus avoiding production stoppages and ensuring greater plant availability. Additionally, the ability to trace components in production has a significant impact along the logistics chain, enabling to reduce inventory stock and to provide timely delivery of component delivery requirements even in automatic mode, thus making the entire supply chain more efficient.
Big Data, on the other hand, can be used for predictive maintenance. Thanks to the collected data by the sensors installed on the machines, the company is able to trace the maintenance interventions (part, position, service life and number of malfunctions) and to deduce where the defect is focused, thus improving the product quality. In addition, data collection can allow the company to predict any breakdowns, thereby alerting the customer in advance with important impacts in terms of improving the use of the good and its security. The development of robots will also enable the country system to increase its competitiveness, enabling easy process automation. There are also many potentialities of Artificial Intelligence application: from optimizing product quality to decision taking.
3D printing, ultimately, enables not only prototypes to be realized, where this technology is already widely used, but also and above all modified unique pieces or designed from time to time based on specifications that vary for each realization.
The benefits of 3D printing are many: eliminating waste from production, producing more complex parts, increasing precision, and decreasing weight, reducing the time it takes to produce a prototype. In addition, 3D printing enables to customize customer's needs or needs faster by responding to an increasingly popular customization trend.

In particular, the main training requirements for managers and entrepreneurs are oriented to:
• dialogue and contamination between different sectors and chains;
• adapting the business model to technological change;
• ability to retain the skills that make up the company's assets and the ability to learn the new skills required by the evolution of technology;
• ability to monetize research;
• designing a business plan for innovation and market analysis projects as well.

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For operational levels, however, the issue of employee training is divided into three different axes:

• know-how;
• being able to be creative thinking, being proactive, being available to move to other markets (so-called soft skills);
• know how to use, to keep up with the change in new technologies.

This specific know-how has to be provided by Universities and schools and where it is lacking it can be completed with practical activities. There are, however, no specific training paths for the size of being able to be, so often companies organize internal paths.

Among the main skills to be trained, other innovative managerial capabilities that need to be adopted in training curricula are:

• Lean thinking;
• Transversally, multidisciplinary and lateral thinking;
• Propensity to change and international vision;
• Problem analysis and problem solving;
• Ability to read and apply technological trends;
• Ability to systematise and share knowledge within the organization by learning from its own mistakes
• Settling the enterprise learning;
• Ability to generate new ideas;
• Ability to work effectively on orders and manage efficiently the time;
• Adopt a product and process orientation.

In addition, it is necessary to tackle the problem of the generational transition of employees whose performance decreases with age. In this case, they also have the skills to interfere with a different culture.

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2. Context analysis in Italy Partners' countries

Automation and technology provide great new opportunities for innovation by supplying hitherto untapped sources of knowledge. At the same time, innovators, entrepreneurs and traders must be able to connect to both consumers and sources of capital to fuel their growth - new ideas must be developed in tandem with the rise of new needs on the part of real customers and supported with financing and business services in order to ensure the commercial realization of these ideas. A wide range of factors, including both macro- and microeconomic conditions, have an effect on the supply and demand of innovation. Intellectual property rights, the financial market structure, human capital and investments are some of the factors determining the pace of innovation worldwide, and countries must be equipped with sufficiently developed conditions on all levels if they want to capture the benefits arising from the knowledge-based economy. Almost two thirds of SMEs in Italy do not even know what the term Industry 4.0 means. The SME segment is the backbone of our economy and, with it, our prosperity. 99.7 percent of all VAT-paying companies in Italy are SMEs. They make up 38.3 percent of total revenue generated by the Italian economy and the contributions of their employees pay almost two thirds (64.9 percent) of the social security benefits that our country pays out every single month. The future of Italian industry is dependent on these companies successfully riding out the fourth industrial revolution – no more, and no less. Missing the industrial automation boat by failing to digitize products and production will rob manufacturers in the SME segment of their international competitiveness. Italy is one of just a few industrialized countries that have successfully retained their standing as major manufacturing nations, despite the dramatic changes in recent decades. We can keep it that way. In fact, if we identify the changes ahead early enough, this could even prove to be an advantage for our competitiveness. But time is running out for SMEs to tackle the topic of industrial automation and position themselves at the forefront of the change movement. Just a handful of small and medium-sized companies have already recognized Industry 4.0 as an opportunity to boost competitiveness. They are working flat out to get themselves ready for the connected, fully automated age with cutting-edge products.

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2.1 State of the art of automation in Italy

a. Relevant networks and main stakeholders

The overall strategy of the Italian Government continues to focus on implementing a modern industrial policy - concentrated on factors and not on sectors - which takes account of the specific dimensional characteristics of the production system: it is a well-known fact that SMEs hold an important position in the Italian production fabric, not only as a percentage of the total number of enterprises, but above all in terms of their contribution to employment and GDP. However, they continue to be penalised by delays in investment and in recovering productivity. Their central role is confirmed by the numerous initiatives undertaken in favour of Micro-SME's over recent months, by enhancement of the Central Guarantee Fund and also by the numerous and carefully structured actions in favour of the ecosystem of innovative start-ups and SMEs, ranging from simplification of the balance sheets of small enterprise to the measures aimed at assisting the start-up of new business activities. A well-functioning European innovation ecosystem for start-ups and scale-ups plays an increasingly important role in underpinning prosperity, jobs and growth. As the recent European Commission Communication Europe's next leaders: several studies highlight that European start-ups currently survive beyond the critical phase of 2-3 years, with even fewer growing into larger firms. This requires policy attention at all levels: local, regional, national and European. The recent economic debate rightly returned the challenge of productivity to a central priority, alongside the dimensions of the enterprise. In fact, although it is true that small enterprise in Italy has a lower average productivity and less propensity for internationalisation and innovation compared with other countries, it should also be emphasised that the size of firms is not enough in itself to explain the weak performance of the Italian economy. Many studies (Banca d'Italia, Istat, MET study centre) highlight how the question of low quality enterprise is an overarching aspect with respect to the size of enterprise and how even the smallest firms may have an excellent ability to compete on the market. The key issue is therefore the propensity of the entrepreneur to take a modern path towards growth and consolidating competitiveness. This change can only be triggered by creating the right external conditions to encourage it, such as improving the tax situation, by creating a taxation system which rewards those who invest, particularly in research, development, know-how and innovation; reducing energy consumption, particularly for firms operating in the most energy intensive sectors; modernising funding for enterprise, by creating a more well-structured supply, which is less bank-centric and more capable of giving access to the open capital market to SMEs as well; improving both tangible and intangible infrastructures, by investing in ultra-broadband based on a fibre to the factory model, and also by undertaking initiatives which act on internal company factors, such as overcoming the paradigm of family capitalism, in which management of enterprise is mainly family-run. The challenge the Government faces therefore relates to four main issues: how to ensure more favourable taxation for enterprise, how to encourage capitalisation and financial consolidation of enterprise

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through a more efficient allocation of capital to industrial applications, how to promote investment in innovation, digitalisation and internationalisation and how to make it more profitable for small and medium-sized enterprise to abandon investment strategies, market strategies, financial structures and governance which are frequently unsuitable for maintaining competitiveness and productivity. A greater focus on innovation is one of the key features of Horizon 2020, but I believe there is more we can do to support our top innovators who have the ambition, resilience and capability to create and capture new markets. This will be all the more important as Europe's current industrial strengths are likely to be disrupted in the coming years by digital technologies and business model innovations taking place at the intersection between different sectors, technologies and disciplines. The main subjects that are involved in the automation eco-system are: Offices for company support, employment agencies, local development, associations, government bodies, VET networks, trade and industrial associations, industrial organizations, types of institutions – universities, and companies Universities, industrial associations, professional and teaching networks, research centers, business communities, national Chambers of Commerce, professional networks on automation, business communities and industrial associations, etc. Enterprise Europe Network; future entrepreneurs and students who want to develop business in manufacturing sector; entrepreneurs and employees of SMEs; VET trainers, manufacturing SMEs' managers, people employed in SMEs, technicians, administrative staff and trainers/consultants, students, Universities and Higher Education Institutions, Research and Technology Centers. Italy provides a favourable environment for the establishment and the development of innovative companies. Several public agencies are involved on the automation environment, especially the MISE (Ministry of Economic Development), MEF (Ministry of Economy), Banca d'Italia, Istat, AGID (Italian Agency of Digital Italy). A great deal of work has already been done, from deregulation of non-bank channels of business funding to the tax measures aimed at encouraging investment in renewing capital goods (so-called Super-depreciation) or innovation (such as tax credit on R&D and the Patent Box), without forgetting that technology renewal and digitalisation of the manufacturing system is a cornerstone of the "Industry 4.0" strategy recently introduced by the MISE through the wide range of measures included in the 2017 Budget, to name but a few. These are important processes of development in regulations which will not only encourage the most dynamic and best-equipped firms to invest in digitalisation, but also move the inefficient ones from situations of inertia and non-productivity and thus relaunch the entire Italian production system. The implementation of Italian regulations is supporting the ecosystem of innovative start-ups and SMEs, and it will provide a strong support to SMEs by the impact of various measures on the Italian production system.

b. Context analysis of the innovation adoption and technology transfer

Innovation adoption is best represented by a process of multiple stages through which an individual pass, from first awareness to continued use of the innovation. According to main managerial literature (e.g. Hall and Khan, 2003), innovation results from a series of

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individual decisions to begin using the new technology, decisions which are the result of a comparison of benefits and costs of adopting the new invention (demand and supply-side perspectives). From the demand-side there are two main conditions for innovation diffusion: being aware of the new technology and being able to use and adapt the new technology (what is referred to in the literature as absorptive capacity of the firm, region or country), and the profitability of adopting the new technology (depending on the price, on the expected returns, and on the level of risk). Therefore, from the demand side perspective, several factors such as the user's investments in human capital and R&D, user's organizational innovation, size and market features are among the main ones for explaining innovation diffusion.

We can identify two main drivers of innovation diffusion: supplier's R&D and innovation (the capability of firms to improve their technology, provide users with complementary products as well as to reduce the technology costs) and supplier's financial means (to be able to adapt the new technology and to inform potential users). *Technology transfer* is the process by which existing knowledge and capabilities developed under public R&D funding are used to fulfil public and private needs. It is the sharing of knowledge and facilities among public institutions and private organizations to increase productivity generate new industry, improve living standards and public services. Technology transfer from public research institutions can occur either by natural mechanisms such as scientific publications, training of students or continuing education of engineers already working in industry or by specific measures. The specific mechanisms will always be based on Intellectual Property policy of the public institution and must involve, during the discussion with private partners, specialists as such specific items like cost evaluation, patents, licenses, confidentially agreement, etc. will be considered and negotiated. Technology transfers requires effective contacts between suppliers and users. Interactions between users and suppliers are required for innovation diffusion to occur. These relationships support two distinct kinds of exchange between suppliers and users: exchanges of tangible assets (products and services) and exchanges of intangible assets (ideas that are not freely accessible to everyone). Technology transfer, i.e., a transfer of knowledge from universities to industry, has gained considerable attention in recent years because knowledge produced in universities can spur business innovation, foster competitiveness, and promote economic and social development. Over the past decade, there has been increasing political pressure in many European countries to transfer research findings to the market and to strengthen the linkage among universities, industries and governments. In this context, several European universities have added a new mission to their agenda. In addition to the traditional teaching and research activities, they are pursuing a higher interaction with society by bringing research results to business. In the last years, university-industry relationships have become an important subject due to the essential role played by technological progress in the economic development of countries. From a theoretical point of view, several studies have shown the close relationship between investments in research and innovative activities of universities and the economic growth of specific territories. Indeed, the strong linkages between universities and a country's production system encourage the process of technology transfer and the commercial use

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of the research results. For this reason, the European Union has implemented a series of measures to promote the adoption of research findings in the real economic and social context, strengthening the linkages between universities, industries and government. As a starting point for enhancing this link, specific mechanisms have been devised by universities. In particular, technology transfer offices (TTOs) have been created to stimulate and encourage the dissemination of the research outcomes, translate them into practise, and facilitate their interrelations with the other two agents of the innovation systems: industries and government. Joseph Schumpeter is often mentioned as the first economist having drawn attention to the importance of innovation, defining five types of innovation ranging from introducing a new product to changes in industrial organization. The Oslo Manual clarified the definition of the two more technical definitions but still it appears that "innovation" is not easy to define precisely. In 1999 in his key note address Mills gave some simple definitions:

1. Science: how to understand things;
2. Technology: how to do things;
3. Management: how to get things done;
4. Creation: bringing into existence;
5. Invention: devising something new or a new way to do things;
6. Innovation: turning an idea into income.

David Archibald considers that innovation is a science and explains what innovation and creativity means by these simple formulas:

1. Creativity = Idea + Action

By this, Archibald means that the 'idea' is just the beginning and to truly create something you have to take action starting from the idea. Accordingly, you must do something to bring the idea into reality to create something new.

2. Innovation = Creativity + Productivity

In reality, the sequence is: get an idea, test or prototype it, produce a finished item and bring it into use. In the case of artists this corresponds to: get inspiration, sketch it, put it down on canvas, and finally exhibit the work. For many businesses, the ultimate goal is for the idea to produce profit. In this case innovation must come from ideas that lead to sales.

3. Profitable Innovation = Innovation + Marketing

In general people, following Schumpter proposals, consider innovation as resulting from technology transfer or through the development of new business concepts. It can be technological, organizational or presentational. There is now a good understanding of the links between research and innovation, with the research laboratory being the starting point. This model is sometimes called the "linear model" of innovation. Nowadays, people have started to look at others forms of innovation that are less dependent on research and they speak of second, third generation of innovation policy or sometime of the network innovation model but at any rate the direct link innovation-research must be kept. According to the definition given by The London Development Agency, innovation is the

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successful exploitation of new ideas and is a vital ingredient for competitiveness productivity and social gain within businesses and organizations. It appears clear that innovation occurs when businesses introduce new products or services to the market place or adopt new ways of making products or services. The innovation process is a combination of various activities starting from research but including design, market investigation, process development and may also include organizational restructuring, employee development, etc. Innovation implies creativity and dynamism that will benefit the company and result in a higher standard of living. However, as a conclusion it must be kept in mind that measurement of innovation is likely to be very difficult.

c. Tax policy and financial incentives

In the last years several incentives were delivered in Italy to increase industrialization and automation. On average, neither tax measures nor (direct) financial support for R&D were perceived sufficient to encourage firms to engage in the use of automation. Forty-two percent of all enterprises even indicated that existing tax measures discouraged them to engage in automation usage. For only 10 percent of all firms, public financial support was perceived sufficient to encourage automation usage. A significant majority of SMEs support the statement that taxation discouraged the adoption of automation. The majority of the SMEs confirm that public financial support was insufficient to support R&D, diffusion and uptake of automation. These findings are consistent with other levels of satisfaction with government intervention in, amongst other things, ICT regulation. In that sense, they are revealing of the governments' attitudes towards automation. However, another correlation can be established, namely with GDP per capita and available public funds to support industrial policies, thus revealing (inherited) material boundaries to proactive automation policies. Accordingly, for the new EU member states in the survey, streamlining some of the EU structural funds towards innovation and stimulation of automation will be highly appropriate in light of previous relevant experience. Use of international loans can also be an option although many of those are seen as too expensive in light of the financial capabilities of the countries at this stage. About 44 percent of the SMEs specified that the current education system delivered adequately trained personnel to engage in automation usage and 28 percent stated that the system delivered inadequately trained personnel. Compared to existing staff skills and training of firm personnel, which for 69 percent of all firms appeared sufficient to support the uptake of automation, newcomers to the labour market still have a learning trajectory to go through. In all countries, the education system is positively evaluated as adequately preparing for automation usage by a significant but moderate majority of SMEs. Figures on education deviate from the traditional pattern with regard to the government's role in promoting automation. For obvious reasons, automation policies are not the only factor affecting this score, which is dependent on overall levels of pedagogical quality as well. Most of all the speed of response of the educational system in the surveyed countries is still insufficient to accommodate the dynamism and the requirements of the businesses. This stem, in part, from the weak relationship between the business and education and

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R&D communities. It is the obligation of the government to create an environment that stimulates this relationship and hence makes the educational system more adaptive and flexible to the requirements of the businesses. For 38 percent of all enterprises, government provision of online electronic services made it more attractive to engage in automation usage. Yet even more firms did not know or stated that government online e-services did not apply (altogether 49 percent). Curiously, almost 13 percent of the firms stated that government online electronic services made it less attractive to engage in automation usage. National differences in the appreciation of e-government services as a stimulating factor for the uptake of automation in the economy correlate relatively well with other governmental efforts to stimulate automation. However, overall levels of appreciation are significantly lower than for other factors, indicating that the provision of online services is a relatively weak stimulus for the uptake of automation services in the business community. Private programs to raise awareness of the utility of automation in firms and private demonstration programs did on average contribute more to improve automation usage than public programs. Almost 21 percent of all firms indicated that private awareness raising and demonstration programs were not sufficient. In other words, they could be improved. The world economy has undergone a number of profound changes over the last decade. These are reflected in concepts such as “the new economy”, the “learning society”, the “information society” and the “knowledge-based economy”. Some of the expectations created in the process fell flat to the ground at the turn of the millennium, as the business cycle turned, equity valuations – not only of the high-tech sector but much more broadly – came tumbling down around the world, as flows of foreign direct investment dried up, and multilateral trade negotiations turned sour. On the other hand, there are a number of on-going developments the effects of which are not easily quantified, such as rapid quality improvements in a number of industries, and an expansion of new service sector segments where productivity is hard to measure. In fact, associated with the knowledge economy, the mounting difficulties of measuring economic growth and welfare are masking the accelerating rise of new determinants of economic performance, of the competitiveness of nations and of the prosperity of people around the world. The fundamental change that is underway is linked to the collapse in the costs for diffusing and making use of information (Casalino N., 2012). This leads to a massive expansion in the availability of codified data. There is the potential for new technologies and for knowledge on how to access markets, partners, suppliers, etc. to be diffused worldwide, to any corner of the world, in a way never seen before. As a consequence, international trade is increasingly tilted towards products with high skill- and technology-content. Similar observations are easily made at industrial- and firm-level where areas intensive in technology and skill are on the increase. There are many opportunities associated with the rise of the knowledge-based economy – both for countries and companies. SMEs, in particular, have the opportunity to make use of new information and communication technologies (ICT) to broaden their international contact with both customers and partners. However, the ability to make use of the new opportunities is not a given as new skills are needed, as are organisational changes. New means of establishing trust over the internet have to be mastered. More than anything else, firms and individuals

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around the world need to be able to innovate, that is, develop and implement new commercially viable ideas. As new determinants for economic growth are appearing, increased focus is put on the role of innovation. In the European Union, the past decade has seen an increasing focus on promoting innovation as a driver of national (and European-wide) competitiveness. From this action plan, programmes focused on promoting innovation within and between member countries were formed, primarily within the EU's Programmes for research and technological development. For instance, the current Horizon 2020 (H2020) is focused on creating an internal market for science and technology in order to foster scientific excellence, competitiveness and innovation through the promotion of better cooperation and coordination between relevant actors at all levels. The hopes and expectations for European competitiveness have been raised. The growing weight of, and policy emphasis on, innovation and knowledge as drivers of competitiveness and growth in Europe puts particular and increasing pressures on many of the new EU member states and the candidate countries, including any other countries that are generally not considered to be at the forefront of knowledge creation or innovative capacity. After the financial crisis, EU continues to undergo a massive economic stabilisation programme. Struggling against widespread perceptions of political corruption and lack of transparency, the EU has taken long strides towards improving and maintaining political and economic stability, and addressing the ever-increasing demands of the knowledge-based economy. Through a number of strategic and vision-setting chapters, as well as several ambitious programmes, the EU has been able to prove its resolve and begin turning the tide of public opinion. Yet there are still a number of hurdles ahead. It has a clear possibility to rise to meet the challenges and seize the opportunities emerging with a globalised, knowledge-based economy and thus ensure a continued rise in the well-being of its people. Alternatively, if the necessary conducive conditions are not put in place, the EU faces the very real risk of falling behind, and thus seriously endangering the progress it has achieved so far. This would happen at a time when its neighbours, partners and competitors in Europe, Asia, and Latin America, among others, are rapidly improving the mechanisms for reaping the benefits of the knowledge-based economy. A slow-down or failure to establish the appropriate framework conditions for a knowledge-based economy would neither aide EU's prospects being on its own, nor facilitate its integration. Following this line of argument, the challenges that the EU is facing with regard to its basic economic and political foundations are arising at a time when stability in these areas is becoming an ever more important prerequisite for stimulating investment and encouraging innovation. The EU's leaders need to continue their efforts to stabilize the political and economic macro environment in order to establish confidence and encourage investment. Yet this is only the first step; the EU must also succeed in addressing a number of challenges on the micro level. Rather, the competitive advantage of a country is dependent on multiple, interdependent factors – not least of which include its leaders' ability to act on issue areas in a coordinated and collaborative fashion. Thus, the EU's ability to address the challenges of establishing a stable political and economic environment, setting-up the appropriate framework conditions to in still confidence in the business environment, and catalysing

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innovation in the economy is dependent on a concerted effort of multiple actors, working across sectors or domains in a systemic, inclusive and transparent manner.

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d. Best practices (2 successfully technology transfer cases and related managerial practices in SMEs)

ORGANIZATION NAME AND WEBSITE OF THE SME

Robotech Srl
http://www.robotechsrl.com

CONTACT PERSON FOR THE BEST PRACTICE

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DESCRIPTION

Robotech was founded in 2004 as a spin-off company of the Scuola Superiore Sant'Anna (public university in Pisa), namely of the formerly known ARTS Lab (now Institute of Biorobotics). ROBOTECH combines expertise and passion for robotics, automation and electronics, for the purposes of both education and entertainment (edutainment) and for domestic and professional applications, but always geared towards improving and optimising the interaction between man and machine.

STATE OF DEVELOPMENT AND IMPLEMENTATION

ROBOTECH debut was the launch of a humanoid robot designed and created for the commercial market: the i-Droid 01 by De Agostini, which perfectly embodies the company edutainment spirit, with business and culture in mind.
Not surprisingly, the company was voted best European performer in 'technology transfer' for this product.
Since then robotech has developed many other projects, with the same aim of applying the expertise of its founders and researchers in bioengineering, biorobotics, biomedical robotics, humanoid robotics and personal robotics to the market for personal and business use.

FIELD OF APPLICATION

ROBOTECH holds the world record for developing the first completely autonomous system for urban door-to-door garbage collection with real users: the Dustcart robot; one of the italian innovations selected for expo 2010 in Shanghai. ROBOTECH designs and develops service robots for a variety of applications, such as the Dustclean robot for automatic street sweeping (another italian innovation selected for expo 2010 in Shanghai and finalist at the Living Labs Global Award in 2012) and the Hydronet robot for water monitoring (which was tested during the salvage operation for the wreck of the Costa Concordia).

MAIN ADVANTEGES ON THE MANAGERIAL PRACTICES AND THE EMPLOYABILITY

ROBOTECH is one of the main player on electronic or mechatronic/robotic projects; ROBOTECH has the expertise, reliability, speed and passion to design, prototype, test and engineer totally customised products. The close-knit and highly specialised ROBOTECH team has developed and honed its skills over time, and can interpret customer requirements, combining functionality and robustness with an economically sound product. They involve experts in inventing innovative solutions, combining quality and cost.

PATENTS AND ECONOMIC EXPLOITATION

For further information about the innovative technology and the new managerial practice please contact:

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AuToMa
AUTOMATION, TECHNOLOGY TRANSFER AND MANAGERIAL PRACTICES FOR THE GROWTH OF SMES, A BETTER EMPLOYABILITY AND THE PROMOTION OF THE ENTREPRENEURSHIP

TechOnYou personalized electronics

ORGANIZATION NAME AND WEBSITE OF THE SME

TECHONYOU Srl
http://www.techonyou.com

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DESCRIPTION

TechOnYou S.r.l. was founded in 2008 as a spin-off of the Unversity of Cagliari. It is a technology-based company, whose main interest is in the development of innovative systems for medical monitoring and healthcare, robotics and biotechnologies. Technological skills of TechOnYou mainly address two sectors: on one hand, latest generation sensors, based on Organic Semiconductor Electronics (better known as Plastic Electronics). In this case, the final goal is the production of sensing systems based on plastic materials, suitable for different non-conventional applications and feasible with low cost technologies as, for instance, ink-jet printing. On the other hand, our competence is centered on the design of multiple function electronic systems that include signal processing, conditioning and communication modules.

STATE OF DEVELOPMENT AND IMPLEMENTATION

TechOnYou S.r.l. aims at exploiting innovative materials as polymers and plastics to realize low cost electronic devices to be integrated in non-conventional applications, in several fields as Wearable Electronics, Personalized Health, Robotics and Biotechnologies. TechOnYou also has a long experience in design of multiple functions electronic systems. These two parallel aspects allow TechOnYou to be a high-tech company that aims to provide personalized innovative solutions for wearable electronics and biomedicine.

FIELD OF APPLICATION

The KeepInTouch developed solution allows patients to measure and transmit, one or several times per day, their physiological parameters to be monitored such as blood pressure, weight and, if necessary, glycemia. A correct monitoring of weight variations within the day is very important for a proper treatment of patients with cardiac insufficiency, since a sudden increase of the weight is usually related to an increase of body liquids, indicating on one hand the disease evolution, and/or on the other, if the employed therapy has to be immediately modified.

MAIN ADVANTEGES ON THE MANAGERIAL PRACTICES AND THE EMPLOYABILITY

The telemedicine system division work on several innovative projects based on a specific project management approach. The data acquisition and transmission to the remote health center for patient's pressure, weight and glycemia measuring is very sophisticate. The patient can use the remote control coloured buttons of the decoder in order to transmit the already made measurements to the remote health center. At the same time, the interactive application is directly run on the decoder from the selected TV channel; no action from the patient is required

PATENTS AND ECONOMIC EXPLOITATION

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Glossary

activity based management approach to management that aims to maximize the value adding activities while minimizing or eliminating non-value adding activities. The overall objective of ABM is to improve efficiencies and effectiveness of an organization in securing its markets. It draws on activity based-costing (ABC) as its major source of information and focuses on reducing costs, creating performance measures, improving cashflow and quality and, producing enhanced value products

automation technique, method, or system of operating or controlling a manufacturing process by highly automatic means, as by electronic devices, reducing human intervention to a minimum

benchmarking the measurement of performance against best practice as a means of setting goals for improvement - applied by firms to business processes (e.g. within their sector), or by national or regional policy-makers (e.g. in relation to support for the creation of à new technology -based firms)

best practice the methods and achievements of the recognised leader(s) in a particular field

business angel a particular type of informal investor, usually a successful entrepreneur, who is willing to invest in high-risk, high-growth firms at a very early stage, and adds value by supplying hands-on business advice

cluster a grouping of large companies, of small and medium-sized enterprises and universities or large public research institutions operating in a particular sector and region - designed to stimulate innovative activity by promoting intensive interactions

commercialisation the process by which the results of research projects are converted to marketable products or services, either by the inventors or by third-party developers

community patent a single affordable patent offering a guarantee of legal certainty for the protection of an intellectual property rights throughout the European Union - long-standing proposals for such a patent remain blocked by certain Member States

entrepreneurial innovation a market-oriented approach to innovation policy which addresses not only the suppliers and immediate users of new knowledge but also indirect beneficiaries, end-users and intermediaries

entrepreneurship training courses, especially for researchers and university students, designed to equip them to commercialise new knowledge by founding their own spin-off companies

European patent a mechanism for the protection of à intellectual property rights in multiple signatory states on the basis of a single application to the European Patent Office (EPO) - has the same legal effect as a national patent in each of the designated states, so protection is not uniform

exploitation see commercialisation

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governance (of innovation) issues related to the involvement of stakeholders - scientists, industry, consumers and public authorities - in the process of innovation policy design, implementation and evaluation

incubation "one-stop" delivery of business support services for new firms, often linked to a university or large public research institution - traditionally, the package includes inexpensive accommodation, but virtual incubation is becoming more common

indicators quantifiable factors which serve as proxies for underlying behaviour of interest to policy-makers or others- a country's high-tech patent applications per million population is one indicator of its innovative capacity

industrial liaison office (ILO) a unit within a university or a large public research institution which interacts with industrial users of its intellectual property, for example, by negotiating licensing agreements - ILOs are also well placed to support spin-offs since they have close research and business links

informal investors often the only available source of finance for high-tech start-ups - they include entrepreneurs' friends and families, and business angels

innovation the conversion of new knowledge into economic and social benefits - now acknowledged to take place as the result of complex long-term interactions between many players in an innovation system

innovation expenditure defined by the Community Innovation Survey as business spending on the full range of innovation activities - in-house R&D, outsourced R&D, machinery and equipment linked to product and process innovation, acquisition of patents and licenses, industrial design, training, and the marketing of innovations

innovation finance all of the sources of finance available to high-tech start-ups in their early stages of growth - includes seed capital funds, informal investors, banks and venture capital funds

Innovation Relay Centre (IRC) network Europe-wide networks of local technology brokerage agencies, specialising in support for transnational à technology transfer

innovation system the local, regional or national environment for innovative activity - in addition to companies it includes the research base, innovation finance, business support services and schemes, and the networks through which these components interact

innovative firm / company defined by the Community Innovation Survey as a firm that has introduced new or improved products, processes or services within the previous three years

intangible assets that part of a company's real worth formed by its staff and their skills, knowledge and creativity - fundamental sources of wealth and value in a knowledge-based economy (see also tacit knowledge)

intellectual property (IP) the original inventions and proprietary knowledge of a company or an individual

intellectual property rights (IPR) defined rights to the exclusive exploitation of à intellectual property granted by a national or supra-national authority - most commonly, patents, trademarks and industrial designs

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initial public offering (IPO) the "flotation" of a company through the open sale of its shares in a stock market - the conventional exit route for early investors such as à business angels and à venture capital funds

knowledge base the accumulating sum of knowledge on which the advance of a particular industrial sector relies - includes not just codified knowledge but also à tacit knowledge and knowledge embedded in plant and equipment

large public research institutions (LPRI) publicly-funded bodies, usually specializing in a particular scientific field - together with universities, they are the main components of the research base of a regional or national innovation system

lifelong learning continuing education, including in company schemes - an essential means of accelerating assimilation of new technologies

"linear model" of innovation an over-simplified (and largely discredited) view of innovation in termsf simple transfers of specific technologies from the research base to industry - now superseded by the à "systemic model" of innovation

managerial practice method or technique found to be the most effective and practical means in achieving an objective while making the optimum use of the firm's resources

mobility in the context of innovation, mobility refers to the temporary transfer of skilled staff between industry and the research base, between regions, and between scientific disciplines, and to schemes to promote such transfers

new technology - based firms (NTBF) a spin-offs and other high-tech start-up companies

open coordination a method for spreading best practice in the field of national policy-making in order to achieve convergence on EU goals, based on benchmarking, target-setting and à peer review

peer review the exchange of tools, methods and experience between policy-makers on the basis of information about relative performance

research and development (R&D) creative work undertaken systematically to increase the stock of knowledge and its application - includes basic research, applied research, and experimental development

research base a region's or country's universities and large public research institutions - the academic science and technology resources from which its industry draws new knowledge

seed capital seed capital funds invest relatively small sums in start-ups at the earliest stage, often to finance feasibility and market studies - many universities and large companies have established dedicated seed funds to stimulate à spin-off activity

small and medium-sized enterprises (SME) an SME is defined by the European Union as an independent company with fewer than 250 employees and either an annual turnover not exceeding 40 million or a balance sheet not exceeding 27 million

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spin-off/spin-out a new company established to à commercialise the knowledge and skills of a university or corporate research team

start-up a newly formed company

supply chain a large company, its primary and secondary suppliers and contractors - innovation spreads relatively easily along supply chains (see also cluster)

"systemic model" of innovation recent understanding of innovation takes account of its dependence on complex, on-going interactions between many individuals, organisations and environmental factors - research and development is no longer viewed as the "source" of innovation but as one of a number of essential elements

tacit knowledge a knowledge that has not yet been codified, but remains embodied in researchers and in companies' owner-managers and key employees (see also intangible assets)

technology audit a formal method for evaluating a company's technology assets and requirements

technology-based firm includes not only companies operating in high-tech sectors but, increasingly, technology users in traditional manufacturing and service sectors

technology brokerage a professional service offered by the innovation relay centres, involving the national or transnational matching of technology assets in one company or research centre to technology requirements in another

technology foresight the process of assessing the future needs and opportunities for the economy of a region or country, in the light of technological and market trends

technology transfer the transfer of technology or know-how between organisations through licensing or marketing agreements, co-development arrangements, training or the exchange of personnel

technology valley a large scale à cluster, normally supported by a national or regional policy initiative, in which a critical mass or industrial and research activity in a particular field leads to self-sustaining innovation-led economic development - Silicon Valley is the classic case

university-industry interface open and continuous interaction between industry and the research base is now acknowledged to be a critical element of the innovation system - universities are adding the diffusion of knowledge to their traditional missions of education and research (see also industrial liaison office)

utility model a registered right for technical inventions, entitling the owner to forbid third parties from exploiting an invention - more flexible and less onerous than a patent, but lasting for a shorter period

venture capital high-risk, high-return investment - venture capital funds are essential as a means of financing the rapid growth of new technology-based firms

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