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Managing Intellectual Capital in Knowledge Economy

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Abstract. Strategic Knowledge Management considers Intellectual Capital (IC) as roots of all organizations activities. The success of organizations strongly depends on the way they manage all facets of knowledge and skills. Artificial Intelligence brought some methods and techniques for handling intellectual assets of companies, expertise management, knowledge transfer and training. This paper presents an overview of experiences and research in applying artificial intelligence approaches and techniques for intellectual capital management and gives some perspectives for the future.

1 Introduction

Since over two decades the interest for managing intangible assets, including intellectual capital has been grown. However the roots of intellectual capital go far back in the history. David Skyrme [24] mentions seven ages of Knowledge Management beginning in 1970s. The know-how has been shared by doing or by storytelling. In XX century the term of human capital has been probably re-introduced by the economist Theodore Schultz in 1961 [1]. He considers that the investment in human capital is crucial for the economic development and the education has a key contribution. Latter the term of "intellectual capital" have been introduces to cover larger field including patents and documents. Among training professionals, Karl Erik Sveiby [2] defined an Intangible Assets Monitor to drive the management of human capital. Many reports on Intellectual Capital have been published and numerous databases have been implemented [26]. Reports provide static information that should be updated, it is the same for databases; the both are not adapted for smart managing of human resources, especially in the globalization context.

Probably the first effort in applying the artificial intelligence techniques to managing skills in given situation was the application developed for French police [3]. These principles and architecture were reused in larger system for managing security of the Winter Olympic Games [4]. The techniques such as case-based reasoning can also be useful for matching demand and offer (looking for a job or a skill).

Organizations such as OECD [5] have been involved in defining a general methodology for measuring intangible investment since 1989.

The globalization changed the game of economic development. Intellectual capital is said to become an important asset and its assessment and management has turned to

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a priority for the Knowledge Economy. The intellectual capital is among the hot topics of conversations, conferences, magazines, scientific journals, books and reports. However companies and organizations are still measuring their success in term of financial capital and ROI (return on investment). Corporate Social Responsibility (CSR) recommends using local resources; it could trigger a better management of local talents.

This paper presents key references related to the evolution of human and intellectual capital, gives some elements of economic and environmental context and mentions current efforts in evaluating, measuring and managing of intellectual capital. It is followed by a presentation of a method and tools to manage this wealth differently and to stimulate a reflection on the role of this capital in the Knowledge Economy and in the Innovation Ecosystems.

2 State of the art

The issue of intellectual capital is complex. It includes human capital and related relational capital as well as "paper and digital" capital (patents, books, papers, images, drawings…). The management of human capital involves various fields such as management, psychology, economy, sociology, communication, health, wellbeing, intellectual property rights and recently sustainable development. Intellectual capital forms the basis of the successful and sustainable development of companies, cities, regions and countries. Such a development requires the right way of managing the intangible wealth in connection with tangible ones and continuous search and exploring of opportunities.

Numerous publications provide a multidisciplinary view of the subject. According to Theodore Schultz [1], in charge of economic development, the education is the most important in managing of "human capital". Another economist Gary Becker [6] considers education, training, and health as the major investments in human capital.

According to Dixon [9], training, capacity building and learning are key enabling factors for "sustainability" seen as long term ability of individuals and organizations to produce innovations as a reaction and adaptation to changes in external conditions. It is the link between opportunities, projects, addressing the real needs, and building capacity or empowerment that ensures useful learning, innovation and an economically efficient process. Training supports the development of all phases of the project lifecycle (situation analysis, forecasting, planning, implementation and evaluation /measurement of impacts). Trained persons develop skills and produce methods, information and knowledge required for the success of the project. Training, combined with the development and implementation of projects on the local level, allows: i) increasing and mobilizing human and social capital ii) developing new activities and iii) creating interactions leading to collective dynamics to the invention of new rules and standards (institutional capital) needed to integrate new activities in formal economy.

Leif Edvinsson [7] points out the role of intellectual capital in the modern economy and suggests adding to annual reports of firms a part on intangible values.
Stahle and Lin [27] state that having a world database of Intellectual Capital may improve the way it is managed and influence the welfare of related countries.

OECD [8] highlights the role of human capital in the development and well-being of nations.

Folke et al, [10] propose to develop an "adaptive capacity". The concept has been used in biology and in the context of climate change, but applies to a much broader range of issues. Adaptive capacity developed in poor countries is very strong; it is extremely important capacity to be successful in XXI century. Persons able to adapt and to solve problems using individual and collective knowledge, as well as solutions from the past that work for current challenge, is able to survive and even lead in global dynamics – Mercier-Laurent [11]. Viability theory of Aubin [12] may be useful to control the balance of the ecosystems based on human capital as engine.

According to Charles Savage [13] the 5th generation of managerial methods has to consider knowledge as asset. This statement has been enhanced by Debra Amidon [14] in The Innovation Strategy for the Knowledge Economy. *To know* is the opposite of *to have* attitude cultivated in today world and focus exclusively on quick business. From education point of view the most important is to learn how and what to learn.
These few references cover a large spectrum on human and intellectual capital themselves and the roles they play in economic development and the wellbeing of the nations.

From management point of vie, the connection between Balanced Scorecard and Intellectual Capital is studied [30].

Considering Information Technology (IT) and Information and Communication Technology (ICT), companies have now human resource databases, but in many cases they contain just basis information on employees and are not often updated. There is some tries to use the Enterprise Social Networks (ESN) as a source of information about skills and experience of employees [31]. Pairs certified, usual ESN contain reliable information on expertise of members.

Globalization of economy has contributed to the crisis in developed countries. To face this problem we need more than reports and databases.

3 Economic and Environmental Context

The current economic situation in the developed countries and intensive industrialization in Asia generate new problems and needs – among them we can mention the industrial decline and unemployment in developed countries, exodus from regions to

towns and the emergency of planet protection. In search of the cheapest work force China has become the world factory. Goods travel all around the globe, increasing pollution and amplifying global warming. Asian people are also studying abroad to improve their intellectual capital and sometimes bring it back to their respective countries. However we can also observe growing Diasporas that may influence their origin and adopted countries IC.

In Europe the emphasis is on education and innovation. They are seen as a magic wand to renew industry, impulse growth and job creation. Despite the recommendations of the Lisbon treaty, the impact of education and innovation is still not measured in term of job creation and economic development of the cities, regions and countries. This problem is complex, but with the help of talented people and advanced technology we have in Europe it can be easily solved.

The intensive industrialization from the beginning of 20th century did not taken into account the impact of these activities on livings and the planet - Lenkowa [15], Eckholm [16]. The recent alerts points out the extreme emergency – Arthus-Bertrand [17]. The Earth Summit was launched in 1992 in Rio de Janeiro. Since many others summits discussed the facts, sign agreements, but no action plans are made to change this situation. Business focus society does not change. The Sustainable Development and Corporate Social Responsibility movements focus, among others, on the optimized use of local resources [32].

While companies say to be concerned about carbon and recently about water footprint, less about raw materials, they seem not concern by biodiversity. In reality they still do not manage the human capital; the local skills and know-how are not considered, because of the wrong focus and lack of holistic approach. By consequence skilled people manage themselves and travel to the places their talents are recognized. Despite ubiquitous information and communication technology these movements remain significant even increase.

Public and private organizations have been produced a lot of data using “data thinking” [11]. Data is stored in datacenters producing heat that should be managed; some efforts are now made to explore it [32]. Google and Facebook install them in cold areas (Sweden, Finland in Europe), but despite the efforts to manage the heat system, they influence local ecosystems.

The current trend is to explore data a posteriori and got revenue from the related services. While Google masters exploration of “big data” created on voluntary basis by its users, the other owners of Big Data and Open Data are just thinking about what kind of paid services they can offer. Data mining techniques are available, but mostly statistics are used; however other Knowledge Discovery techniques and tools with AI inside are available since over thirty years now. Knowledge discovery from text may help finding experts, by cross analysis of their written work. Main barrier of effective exploration is the way of thinking and separation between areas.

Technology and in particular AI has a great potential to master the impacts, however these techniques are underused.

The phenomenon of social innovation is a step forward exploring available resources. Internet and mobile applications offer services connecting people having special capacity to offer with those who need this kind of services. Business models of social innovation are just emerging.

The appropriate management of human capital and the education of knowledge cultivators will certainly bring a contribution to planet ecosystems protection.

This challenge is among the most important of the 21 century. It is vital to understand what we have locally and what we need. The intellectual capital should be managed in connection with others tangible and intangible assets of companies and organizations, of cities, of regions and countries using a combination of holistic and system approaches – Mercier-Laurent [11].

As the basic component of Intellectual Capital is Human Capital, we focus on its smart management.

4 Managing Human Capital

While some thinkers state that the human capital is the most important asset, only few are measuring and managing it. The most important barriers in managing intellectual capital is the lack of focus, following trends, lobbying but also ignorance, selfishness, egocentrism, wrong focus and the way of thinking. Internet offered an easy way of producing data and information and amplified one way communication. Increasing number of various services users produce books, articles, pictures and videos, without listening to the others.

The are a plethora of various databases and "big data", built using traditional information processing methods, as a very limited number codes for professions[1], taking into account only traditional ones. Pole d'Emploi (national center for employment) and other public initiatives in France are supposed to help people in finding jobs, but their efficiency is very low, because they are not using the appropriate methods and tools.

Some methods for measuring human capital are available, such as Mediolanum Asset Management[2] method or those of Sveiby [2]; they are not largely used.

With the quick progress of technology and artificial intelligence, computers are able to process natural language instead of codes. This open programming approach allows including in real time new professions that appear every day.

There are also a lot of valuable papers and electronic reports about intellectual capital containing key information and complex charts. They are very useful to know the current status, but they are static, rarely updated and can not be used for supporting a dynamic process of IC management.

[1] for example all information services are coded 721Z

[2] http://www.maml.ie/

For someone looking for a local know-how, it is not easy to find quickly a right person. Some social networks such as Viadeo in France or LinkedIn are trying to connect talents and those who are looking for. Google is certainly among the most efficient search engines, but its business model introduces an important "noise" (and intellectual pollution) due to the advertisement system management.

Human capital may be represented and managed using advanced technology.

One of the first applications of competency management was the hybrid system for long-term and short-term capacity management of French police (Gendarmerie Mobile).

4.1. Managing Gendarmerie mobile workforce

Developed in 1989, this application was conceived to allow the short-term management and long-term planning of human resources.

For over 25 years this application is still operational and innovative compared to current methods for managing human capital. The intellectual approach is those of "knowledge thinking", while most of human capital managers use "data thinking" and scoreboards as decision support.

The Mobile Gendarmerie (in French: *Gendarmerie Mobile*) is a subdivision of the French Gendarmerie. Specific anti-riot units of the Gendarmerie were established at the beginning of the 19th century. The name of Gendarmerie Mobile (GM) was given in 1921.

Mobile gendarmerie[3] is a workforce of 17,000 men who ensure the missions of maintaining and restoring order and operational defence of the territory. Their missions are following:

- Riot control and order recovering
- Monitoring the territory and its dependencies
- Guarding sensitive locations such as embassies, airports, railways stations, etc.
- Defending the territory, providing reinforcements to the departmental Gendarmerie
- Conducting external operations

The management of GM workforce consists of:

- Allocation of the appropriate teams for a given mission
- Know and follow the activity of all units (groups and squadrons).

There are permanent missions, such as custody of the Embassy and specific ones, such as crisis management. The permanent missions are planned in advance and change periodically, against the specific missions require management to task - it

3 http://www.gendarmerie.interieur.gouv.fr/fre/Notre-Institution/Nos-composantes/Gendarmerie-mobile

comes to identifying qualified people and located near of intervention place to perform actions.

The architecture of developed solution is presented in Figure 1.

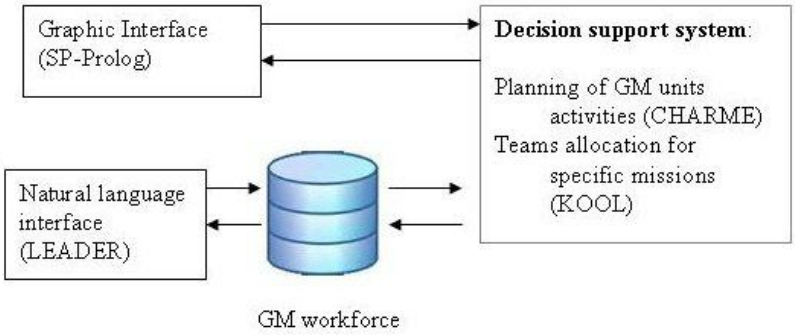


Figure 1 ARAMIS system for Management of skills and know-how of Mobile Gendarmerie [3].

The hybrid architecture of ARAMIS decision support system is composed of following modules:

- Graphic interface written in SP-Prolog
- Database contains information on police skills, know-how and experience, their location, the tasks completed and in progress and planned leave as well.
- Support system for planning ongoing activity of units. The permanent missions module implemented in constraint programming language CHARME[4], takes into consideration the skills needed to perform a given task, precedence constraints (conducted missions and locations) and the number of units required. The use of CHARME is justified by the combinatorial character of this problem: over 100 squadrons split into groups, more than 100 types of missions, each lasting between 15 and 120 days, more than 20 features to consider, eight months of activity to plan. The system allows simulations to achieve optimal planning and quick rescheduling by performing minimal changes.
- Expert systems (KOOL[5]) for short-term resource allocation for specific missions such as the visit of a foreign president or ORSEC plan[6] deals with the characteristics of the mission to be performed, the ability to perform a given task, the availability of units and verifies the proximity of these groups. The allocation process

[4] CHARME - the first constraint programming language developed by Bull CEDIAG from the research results of the European Computer Research Center (ECRC), Munich

[5] KOOL – Knowledge representation Object Oriented Language, developed by Bull CEDIAG

[6] ORSEC plan - French generic emergency plan in case of disaster, when the local means are not sufficient

requires knowledge of domestic regulations specific for the mobile gendarmerie. An example of rule:

If there are no units available, and
it is a vital and urgent mission (life-threatening, major damage),
close and short duration,
then allocate the team currently being trained.

The expertise of this project was reused for another resource allocation system for the Winter Olympic Games (OG) in Albertville, 1992.

4.2. Resources for security management during the Olympic Games

For the needs of the Olympic Games in Albertville, 1992 the above described system was extended and integrated to overall OG management systems, presented in Figure 2. The main objective was the optimal resources allocation for permanent missions a well as for specific missions in crisis situations, such as avalanche, transport accident, blocked road etc.

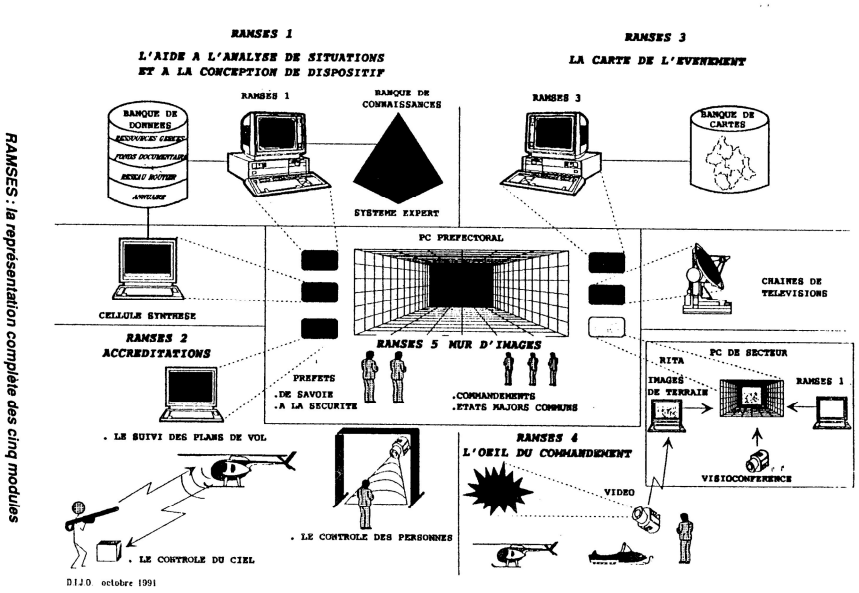


Figure 2. Ramses – Integration to existing command and security control system [4]

Context
1600 km2 of high mountain area, thirteen Olympic sites, over one million of spectators, 1200 tourism coaches and 150 helicopters. Risks to manage are those of High Mountain and of accidents du to significant road-rail-air traffic, crowd gathering.

Specifications

The system must be able to handle multiple crises simultaneously and allow the rapid response. Each site must be equipped with decision support system. A central command-control system must handle all crises even outside the local level. The system must manage the allocation of all types of security units, such as Police, Firefighters, Chasseurs Alpins (the elite of mountain infantry of the French Army), CRS (*Compagnies républicaines de sécurité*[7]**)**, and others, in record time and in sufficient quantity.

System architecture

This system, built up from the expertise of more than 60 specialists, supports the decision maker in analyzing the situation and composing appropriate and available resources and teams for intervention.

The RAMSES 1 expert system, shown in Figure 2, analyzes the situation; suggest the actions and the all types of resources needed. The topographic display module locates the close resources available. In the case of necessity to manage simultaneously multiple crises the Optimization Module chooses optimal solution.

These three modules interact with the database including information on the human and other resources, traffic, weather conditions, accommodations, risky locations, the directory of civil security, and others.

The Olympic area was split into seven sectors, each placed under the responsibility of a sub-prefect controlling the overall security system. The Central Command Post take decisions when local resources are insufficient.

Such a decision support system may be useful in many cases.

Another way of managing talents is simply to know them. The easiest way is to display a content of human resource database. Sur, to provide a real help, it should be up-to-date and updated in real time.

4.3. Know what we have

A concept of “knowledge trees” have been introduced by Michel Autier and Pierre Levy [18] and implemented in tools as Ginko (Trivium) and Selva (Ligamen), offering graphic representations of individual and collective skills as a tree.

The Figure 3 illustrates the skills of 10 people: the trunk represents common knowledge, branches the specialties, and leaves the unique skills. Such an image provides information on everyone’s ability and helps to decide if the unique skills represented by the leaves are strategic.

[7] Republican Security Companies

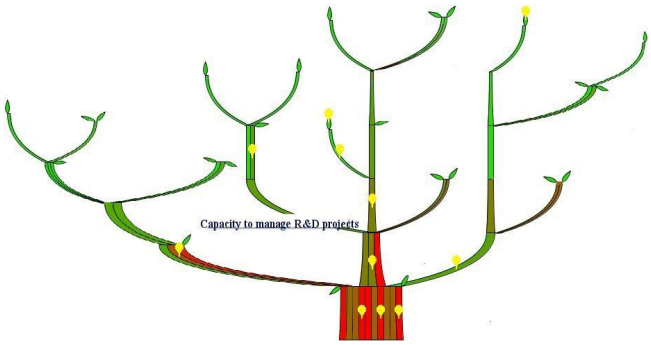


Figure 3 “Knowledge tree” created using the Ligamen software (http://www.ligamen.fr)

The part to the far right of the trunk, as well as the triple branch, indicate the position of a person in a group. Such visualization facilitates the identification of skills and helps to detect the lacks in relation to a required profile, which can be filled by training. Thus, we can build the competency tree of a company, city or a region and reason backwards: what projects can we achieve with such intellectual capital? We then need to search for the skills in a neighbouring region or “rent” them to a partner.

In the international context and within a networked enterprise, it would be better to manage skills with a holistic perspective - on regional, national and international levels. This intangible wealth can grow through continuous learning from interaction with the environment, according to corporate strategy. However it is necessary to define some rules for information updating and validation – who can/should update or who validate this update? Is the up-date allowed in real time or periodically?

The training department is in charge of making this capital grow and generating value from it. It is involved for now, because in the global Knowledge Management approach all knowledge cultivators are constantly learning things in function of current needs and their own ambitions.

The training department could also manage the transmission and preservation of the essential knowledge and know-how of retiring, especially when this is the knowledge of a long-life and a strategic product for the company. Collaboration between several professionals facilitates the skills management.

4.4. How to find the right profile

When we know what we have and what we are looking for, one of artificial intelligence techniques - case-based reasoning [19] could be very helpful. The built-in analogy engine works by matching demand (*I am looking for*) and offer (*base of existing skills and know-how*) to find instantaneously the profile we want, if such a profile is

registered. If not, a set of similar profiles that could be adapted to the expected ones by training is proposed to the user. We can imagine a World Knowledge Base including Talent Bank equipped with such an engine. The principle is presented in Figure 4.

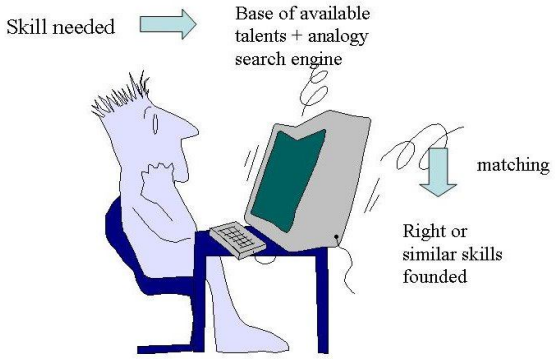


Figure 4 Principle of case-based reasoning applied to matching offer and demand [28]

The user asks for a given profile using appropriate interface, the analogy engine retrieve from the talent bank the right profile if it exists or close to what is asked for. The user can decide the best person having the needed competency. If he/she decide to hire someone with similar profile to demand, this person can be trained to improve his/her capacity; the case base should be updated to serve for future matching.

Each company, organization, city, region and country can use such a tool for smart competency management.

5. From Talent Management to Organizational Strategy

The various methods for measuring the value of human capital of a company, city, region or country may provide the information on what we have. The same information can be explored to plan the future development - what new activities and companies may be created from existing IC. This purpose is illustrated in Figure 5.

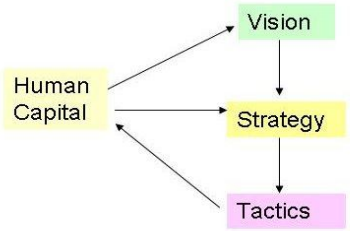


Figure 5 Human capital dynamics

A company/city/region need to elaborate a clear vision for the future. At this point the skilled persons able to envision it are needed. This vision will be “translated” into corporate (organizational) strategy and a tactics (actions to achieve the strategic goals). The intellectual capital of professional working on accomplishing various tasks grown and the new knowledge and capacity should be taken into account at strategic level. It may also influence the vision.

To go further, it is vital to consider the relations between the smart IC management and the sustainable success of a given organization. It involves several ecosystems that can be balanced to ensure such a success. An example of such ecosystems is shown in Figure 6.

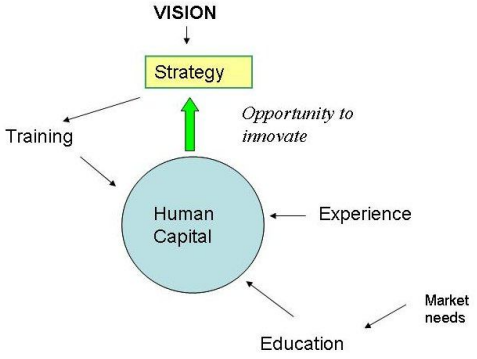


Figure 6 Ecosystems of Human Capital

Current organizational strategy is decided at top management level and considers HR just as a workforce serving to achieve the goals. The question: How we can innovate better exploring our talents?” is not asked. Educational programs are defined by Ministry of Education without taking into consideration the future market needs in term of skills. There are many new skills needed and many are obsolete. The communication and knowledge of each component of these ecosystems is a vital element for preserving the balance, be successful and avoid unemployment.

5 Skills for the Future

Today educational system produces the traditional professionals. Many of them face the difficulty in finding job in their region or country. The most audacious travel for job; change country, language and continent. They have to adapt to new conditions and to new culture.

As mentioned before, our future depends on our capacity to adapt, to detect opportunities, to collect necessary skills and knowledge and to transform them into economic values, in balance with ecosystems. It also depends on the rapidity of our deci-

sion making, on our risk taking ability in a dynamic environment, and on our ability to use the computer, regardless of its form, as an intelligent assistant. The latter facilitates an innovation without boundaries between fields (out of the box thinking).

Facing the affluence of information and solicitations, a new skill is required – the innovation know-how. This is the art of finding and exploiting strategic information and of gathering momentum and developing the knowledge and skills essential to the success of this enterprise, which is innovation in its entirety.

These skills are numerous – from the management of ideas and people to the implementation and commercialization [11].

Although Europe has a long innovation tradition since the industrial era, globalization has changed the odds. The factors such as the slowing down, the obsolescence of some sectors and the emergence of others, as well as the relocation of activities, influence active knowledge and skills. The lack of interest expressed by youths in scientific studies will lead to a shortage of engineers. Some skills are disappearing with retirements, which are sometimes accelerated by the economic crisis. Knowledge capitalization approaches are saving a part of the strategic and "sensible" skills, but these initiatives are quite rare and are often initialized too late.

The European document Putting Knowledge into Practice (European Commission 2004) specifies that the lack of skills, notably in the fields of sciences, engineering and ICT, is a challenge for European education. Another publication, Innovate for a Competitive Europe (European Commission 2004) advises companies to learn how to transform the absorbed knowledge into action. Such an innovation dynamics combines the knowledge and skills in value creation. Kolding et al 2009 describe the skills we need to acquire to face the post crisis era in Europe. The authors are convinced that the ICT skills are the most important, but they did not mention what approach to ICT and to computer programming should be used. Figure 7 shows the EU vision of ICT skills needed for the future.



Figure 7 European Union vision of the skills for Future [29]

Is it really enough to develop just ICT skills to build a successful Europe?

Companies training departments need to focus on the transformation of today capacities good for industrial economy to those that are essential for Knowledge Economy. The progress can be measured using for example the trees of knowledge software, or other that may help.

6 Conclusion and Future Works

Some approaches presented above may seem old, but apparently there are no new intellectual approaches for human capital decision support systems. All available works in this area describe “Intellectual Capital Reports”, mainly paper, database and scoreboards. The users of Organizational Social Networks consider themselves innovative. Consequently, human capital professionals, as well in companies as in public organizations, still do not have efficient tools for measuring, growing and effective using of this capital.

To build a sustainable future we need more than data base, reports and dashboards, we need a disruptive innovation in the way we build, evolve, maintain and manage the human capital.

We need a new educational system, having the ambitious task of changing mentalities and values, to educate a culture of knowledge cultivators and to increase imagination and creativity. Main challenge of education is to teach how to learn, the curiosity,

adaptability, capacity of solving problem with limited resources and to undertake and succeed collectively. This education is based on exchanges, listening and respecting the others opinions; an education for all, to learn from nature, from the past and from differences, in which technology and means of communication have a significant role to play.

We need to use the power and "intelligence" of computers and other connected devices. When programmed using "knowledge thinking", they can bring a significant helps in storing, updating, displaying, matching and finding the relevant elements of human capital.

Computers in all forms should be programmed to work in synergy with their users in am to help them in the tasks computers are better than humans. The same logic needs to be applied for robots and drones design, for connected object and internet of things. Games have a special role to play in long-life education – to provide knowledge by playing instead of having boring lectures.

We need to create synergy between educational programs and local needs and link them to a dynamics vision for the future.

New metrics could be: boldness, imagination, associations (links making), and capacity to find and use the appropriate knowledge, mental flexibility, knowledge and ecosystem thinking, capacity to transform ideas in value and to envision the future. The estimation of 5D impacts of resulting activities – economic, technologic, cultural, social and environmental, could be added to measure the progress.

Such a wise management of intellectual capital, supported by electronic "intelligent" assistants and appropriate measure of progress is essential for the development of companies, regions and countries.

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