Research Change in Transition

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Abstract: This paper presents the process of managing the knowledge of the intellectual capital of research organizations. This KMIS is dealt by an integrative perspective for a dynamic framework. The focus is given to three decisive components-communication, navigation and multicontact relationship that represent the current 'open nature' of knowledge. This perspective increases, through KM, the role of intellectual capital keeping value in a transition towards research change. Foresight thinking represents an enabler to drive this change in public research organization and Science & Technology Foresight Project and Horizon Scanning, as practice perspectives, are reported in this paper. They have an inclusive and engaging nature based on a participatory process with a bottom-up approach and represent concrete actions enabling the research intellectual capital to move fast toward a research change transition considering cross-cutting aspects for increasing impacts related to technological developments. The monitor of constraints and barriers helps to identify short term issues to be assessed and overcome for success of the undertaking.

1 INTRODUCTION

Knowledge capital provides the intellectual basis in science and technology and will impact on industrial change, growth and jobs.

However, this knowledge is not yet routinely and directly captured to contribute creating intellectual capital. The value in encouraging and supporting individuals interested in similar areas of research and in work processes can be beneficial both to individuals and to research organizations. The accumulation of knowledge makes researchers a large and global community. Highly specialized learned individuals in competitive fields represent the intellectual capital in the knowledge economy.

The need is to relate knowledge, social relationships and creativity to develop a "social capital" to enable a transition empowering scientific organizations and people to become reserves and sources for capital. Due to the economic situation and financial contexts, diverging trends in public investments in research and innovation have been continuously addressed (ERIAB, 2014).

It is hence urgent to develop conditions for stimulating researchers to openly discuss major problems arising in societal and planetary contexts, thus exchanging insights and self-preparing to a research approach, which would deliver responsible and knowledge-based solutions (McInerney et al., 2007).

Considering this need, the so-called accumulation of knowledge represents a reserve, a starting advantage for many countries, but a shift to become a source is required in developing the research intellectual resources to create societal prosperity in the web age.

In this context, the current issue is to build the relationship between the development of knowledge capability inside the IC, KMIS and innovation. Knowledge capability is defined by (Alavi and Leidner 2001) as the interior capability of researchers having the potential for influencing future action. The above relationship is carried forward through processes and social activities within research organization.

To implement this relationship, the mix of two purposes is presented: a framework proposing to integrate the emerging components in daily work of IC in research organizations and a KMIS practice perspective introducing social activities such as foresight and horizon scanning within the above framework for a change in research organization.

This mix enables the transition of IC within research organizations beyond the regulated linear forms for knowledge production.

The proposed dynamic framework allows research process to shift from the current linear

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chain -built on funded research projects with tangible results- to include the components of the integrative perspective. In this framework, KMIS processes are developed.

This integrative perspective focuses on three decisive components -Communication, Navigation and Multicontact relationship- that represent the current practices of researchers.

It draws closer attention to the ‘open nature’ of knowledge and increases the capability to develop interdisciplinary R&D. The perspective is freely interlinked with social practices, with community of interest or practice around challenging themes that require a trustful learning development process.

Therefore foresight that includes also Horizon Scanning (HS) is considered a practice perspective to drive the intellectual capital change supporting research transition, as it requires discussions and debates in order to shape the future of societal progress empowered by R&D.

In addition, foresight actions concern long-term thinking and therefore do not interfere with the management of organizations and individuals.

Both foresight and HS provide a practice perspective on top of the proposed framework, as reported in the paper. They are motivated by the need to develop, at organization level, new strategic interdisciplinary directions that require a collective knowledge and a critical mass (Andreta et al., 2013). At individual level, Horizon Scanning activities at small scale are dedicated to create social situations for high level researchers of the research organization to debate, focus advances and prioritize future areas of key technologies through which individual expression may occur.

2 STATE OF THE ART

The overall on-going shift in the relationship between science and society, according to (Beck 1992) main message, rises problems and implications for any industrialised society and requires to find new pathways for science and technology development in this new context.

According to literature in intellectual capital, the definition of knowledge meeting the research intellectual resources is to focus knowledge as a the interior capability of researchers having the potential for influencing future action (Alavi and Leidner 2001; Carlsson et al. 1996).

In KM literature, (Swan 2007) pointed out the issues in the relationship between KM and innovation introducing the perspective of production, process and practice. These reflections studies on rethinking KM as a plurality of techniques, methods and epistemologies are collected in (McInerney et al., 2007).

Recent studies, still in draft publications, describe difficult times for science and technological organizations and prospect a clear need for rapid transformation and research change of their intellectual capital to keep together public costs, value and the quality of life achieved in years of scientific development (ERIAB, 2014). Previously, the transformation in the perspective of Science 2.0 was proposed by (Burgelman et al., 2010). However, it is not yet known how to support this transition and its related processes and research runners help themselves engaging in foresight initiatives. Foresight is a well-known area that has given support to various types of intervention for transformation purposes as reported below.

(Georghiou et al., 2008) demonstrate how, since the last decade of the last century, foresight has been strongly linked to public policies. During that period five generations of technology foresight were developed to respond to both stakeholders and multi-level policy, involving national, regional and local frameworks (Taylor, 2004). Debating foresight with implications for policy and decision-making at general level is considered a relevant activity by the European Commission, enabling experts to think and share technological perspectives and suggesting implications to complement potential development for economic growth (EC and JRC, 2008). Various contributions find a relationship between foresight and the increase of societal participation extending the concept of stakeholders beyond private or institutional organisations to communities. The role of these communities is to develop Future-Oriented Technology Analysis (FTA) reflecting their interests in new emerging contexts and to make use of shared methodologies.

Recent literature in foresight debates on the integration of quantitative and qualitative approaches. This is addressed in detail by (Haegeman et al., 2013) who propose a taxonomy for methodological combinations across current FTA practices. Of particular interest in this paper is the analysis of common ‘misconceptions’ such as ‘subjectivity’ which becomes a barrier especially in qualitative processes involving scientists.

Furthermore, the reported Epistemology-Skills-Trust cycle indicates the need to adopt mechanisms for the capturing of intellectual scientific knowledge.

The authors point out weaknesses and introduce ways to reduce the distortion, for instance through the 'legitimacy of the person making the judgement'. With regard to participation from institutional stakeholders, foresight has been considered an instrument for political participation on medium-long-term planning perspectives, capable of influencing priority-setting and political agendas (Gieseke, 2012).

In the foresight studies literature, the maturation of foresight through growth processes is a result of contributions given to overall S&T development, through technological forecasting, horizon scanning and scientific/technological prospective studies including broader social and economic perspectives.

Recently, due to the economic transformation, foresights concentrate on innovation and on drivers of change STEEP (Society, Technology, Economy, Environment, Policy) and on decisive, strategic factors analyses. Multiple stakeholder classes are required for this foresight and this stresses the 'collective ability to shape the future'. In particular, it is acknowledged that the use and impact of forward-looking technology analysis for policy and decision making can be successfully led by institutional governmental organizations taking into considerations dominant criteria for success (Calof and Smith, 2008). Interviewed practitioners from different countries include social and economic dimensions in technological development and innovation systems. Among the features of foresight success, Calof and Smith identify the existence of a national-local academic receptor and training capacity during the start-up phase.

Foresight is also considered supporting strategic intelligence for policy decision-making (De Smedt, 2008; Montalvo et al., 2006). It was noted that to respond to innovation policies, foresight needs to meet the demand of future-looking scenarios regarding the overall changes of cultural and societal aspects (Cagnin and Keenan, 2008). In order to enable decision-makers to better understand and cope with the complexities and uncertainties of the continuously changing patterns of innovation, foresight practices increased mobilisation and coordination of different stakeholders as well as personalised delivery of insights and analysis to key players at group level. Ends, in literature foresight is shown as a tool, stimulating a 'change of direction'.

More recently, (Van der Gießen and Marinelli 2012) reported the multiple functions and the role of European and national policy workshops. Yet, in past literature, (Eriksson and Weber 2006) suggested that adaptive foresight were developed at the crossroads of foresight and adaptive strategic planning. Innovation is seen as increasingly complex, interdependent and uncertain and therefore in need of broad and multi-disciplinary exploration and participation. establishing a close relationship between foresight, decision-making, innovation and new technologies. Particularly they highlight the capitalisation of the accumulation of knowledge with the aim of delivering insights on the maturity of knowledge and planning for knowledge options in a later stage.

A relevant aspect in the literature for a transition to a research change regards the evolution of initial foresight panels involving only a few experts (De Smedt, 2008). These have been superseded by large extended and interacting communities, formed by stakeholders and key players. They actively participate and progressively align their expectations to shape the future (EFP, 2012; Eriksson and Weber, 2006; Futman Project, 2003).

All these elements mark important steps in the evolution of design of complex economic and industrial scenarios. This continuous process of collecting stakeholders' knowledge through different contexts is called 'integrative planning'. It defines the combination and mapping of available insights for future developments emerging from different groups of stakeholders and experts and mass interviews conveyed into 'packages of information' that are published as policy briefs for decision-makers, summarising possible and alternative options and solutions.

In the same area, to bridge the gap between research and industrial demand, starting from the futuring of next generation industrial technologies in order to assist the industrial transformation, a full cycle-oriented methodology -rolling programme- was proposed to relate results from future-oriented activities such as Foresight, Roadmapping, Implementation and Monitoring (FRIM) (Paci and Chiacchio, 2008). This methodology can enable participants to assess and prioritize those enabling technologies for implementation of research and development projects within the EU 7FP as proposed by (Paci et al., 2013). In the last five years, foresight for research and innovation represents a relevant social process. It was intensified and supported through funded projects (covering different objectives such as Global Europe, Pashmina, NEEDS etc) by the DGs of the European Commission and foresight studies carried on by the EU Commission Joint Research Centre (JRC, 2013) in order to collectively shape a strategic frame for the EU policy strategy that envisages both industrial as well as social benefits.

In this stimulating thinking, the sketch contested science delivered by the EU foresight project VERA visions, presents a pessimistic narrative that gives the deep motivation why research change is needed (VERA, 2013).

(Di Bello and Andreta 2013) provide some initial guidance for industrial competitiveness in Horizon2020 towards an integrated planning framework for key enabling technologies. These enablers drive innovation and growth in the economy and society in a global Europe (EU, 2012) in the frame of the Grand Challenges as depicted by the EU Horizon 2020 programme.

Considering digital initiatives, recent developments and the toolkit available in looking at digital futures have been described by (Accordino 2013) with regard to the EU Commission web platform Futurium in order to strengthen and support the social networking aspect together with the global dimension.

3 INTEGRATIVE PERSPECTIVE

In the business perspective, intellectual capital is formed by four separated elements covering different roles: innovation capital, human capital, structural capital and customer capital.

In the research perspective, the intellectual capital covers multiple roles with the four elements establishing a flexible relation with the related research organization structure. It is interesting to observe the distribution of these different roles during the research process, currently oriented to funded project implementation in a linear chain, within three main steps:

- Innovation capital in Accumulation of scientific and technological knowledge in terms of papers, patents and knowledge stratification.
- Human capital and structural capital are together in Segmentation which is tied in the organization structure, based on the research infrastructure and tied in the net of scientific core competencies.
- Customer capital in Multiplication that refers to public-private collaboration models and to funded projects efforts.

Therefore, research performance is oriented to achieve project results limiting adaptive and flexible behaviours and implies reflections on how to feed, manage and increase the 'open nature' of knowledge. A more comprehensive and dynamic framework for research process will be useful to understand how to move forward and which orientations are to be taken to stimulate intellectual capital to interdisciplinary thinking. This framework introduces an integrative perspective to combine the current process with three decisive components for research change affecting today and in the future how knowledge could be shared and accessed: Communication, Navigation and Multicontact relationship (Figure 1). KMIS is embedded in this integrative perspective for a dynamic framework.

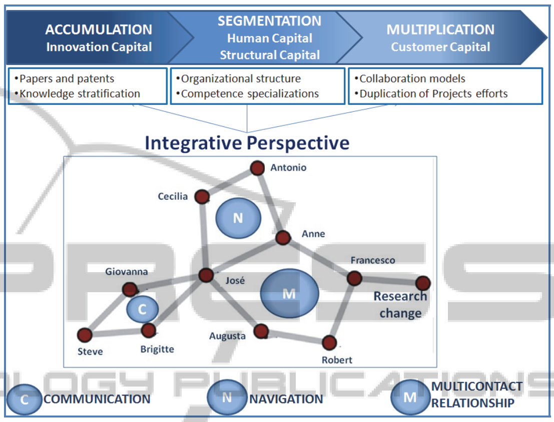

Figure 1: Integrative perspective for a dynamic framework of research intellectual capital.

This perspective integrates the four elements of the intellectual capital dragging and placing them in three decisive components to empower the research process with dynamic behaviours (Figure 2).

Communication has the role of enhancing trusted confidence, adding value to Accumulation built on publications of papers and patents and knowledge stratification, dragging the innovation capital to stimulate a more proactive behavior.

Navigation with multiple channeling has the role to overcome the Segmentation of organizational structure and competence specializations, dragging human and structural capital to promote interdisciplinary thinking.

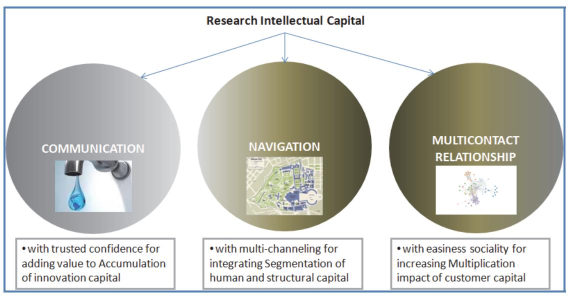

Figure 2: Decisive components for research change.

Multicontact relationship with easiness sociality has the role to increase the impact of Multiplication, dragging the customer capital to increase to promote the exploitation of collaboration models and projects results.

The integrative perspective for research change is driven by societal needs and foresight thinking is the essential enabler for the transformation of research organizations. This perspective facilitates more adaptive and flexible approaches to make research valuable for society.

4 PRACTICE PERSPECTIVES

Practice perspectives for knowledge and innovation are mentioned in the literature as emerging areas to encourage learning and innovation within communities of practices (Schatzi, 2001; Swan, 2007). Foresight thinking represents an enabler to drive this change in public research organization. Foresight and Horizon scanning can be considered practice perspectives that add insights to the understanding of the fast dynamics of knowledge, dedicating closer attention to the social activity of research communities. Foresight and horizon scanning support the understanding of technological trends, of complex issues, of strengths and weaknesses as well as expectation from society and companies that will drive the societal progress in next 20-30 years. The practice perspectives proposed are related to two initiatives carried on with research groups.

They represent practices built on top of the integrative perspective in order to improve the intellectual capital of research communities and to activate a social activity characterized by the research environment.

The practices respond to the need of establishing forward looking activities to address future emerging S&T paradigms to anticipate and increase impacts. They aim to develop the imaginative capability of researchers to envisage interdisciplinary solutions, building and implementing a societal driven vision contributing to a responsible and sustainable socio-economic development.

The objective of these practices is to accelerate the shift from project team or individual practice of accumulation of knowledge to collective practices that involve researchers to analyse strategic choices, exploit networked collaboration and build new solid and durable contacts across high-tech specialties within the organization and at global level. This in particular targets to activate dynamic processes to form a critical mass within research organizations that want to act as a key receptor in the knowledge economy.

The first practice presents the Science and Technology Foresight Project (STFP) launched in 2013 by the National Research Council of Italy (CNR) and the Trieste Area Science Park Consortium (AREA), with the support of the Ministry of Education, University and Research (MIUR) as an open bottom-up participatory process. The scope is to build a community of researchers and a networked collective knowledge to overcome disciplinary boundaries.

The practice perspective describes the approach to new interdisciplinary S&T areas for research development of next generation technologies in the medium to long term tackling societal problems related to health, food, environment and energy challenges.

The network dimension - in particular - is considered a fundamental enabler of interaction and interconnection ensuring inclusion of learned and sound popular opinions. Benefits are for individual participants, for the research communities, and for the research organizations that covers the role of national-local receptor - as observed by (Calof and Smith 2008). The first practice perspective on Foresight focuses the Interdisciplinary Thematic Groups.

4.1 Foresight S&T Thematic Groups

The CNR foresight Thematic Groups (TGs) are the core engine of the project aiming to provide new insights for the collective understanding exploiting the collective intelligence of researchers through a participatory process and a bottom-up approach.

Focusing on urgent problems related to the Grand Challenges -food, health, environment and energy- each Thematic Group highlights a specific S&T topic: Nano for sustainable food, Personalized medicine, Intelligent traceability for environment, Smart storage for future energy.

Referring to the topic, each TG carries on specific activities and searches contributions from high level international experts to consolidate the related background document with references to available sources.

Each TG holds a foundation seminar regarding the selected topic to validate the background document, inviting previously interviewed participants who also actively contributed to develop the topic. The seminar purpose is to improve and to deepen the knowledge confrontation, to identify gaps in knowledge, to point out obstacles, to identify needs for more and better education as well as for more funding, and to outline market potential and social acceptability for activities and products. The output of the seminar is a draft of a roadmap describing the most promising areas for investment in research dealing with multiple Key Enabling Technologies (KETs) areas as described in the Pillar LEIT of Horizon2020 Programme and in the final report of the High Level Group on KETs (2011).

The first foundation seminar in December 2013 covered the topic Nano for Sustainable Food. 'Sustainability' has been identified as the main challenge and 'Nanotechnology' the key enabling technology.

Health TG, held in May 2014 the seminar on personalized medicine covering the theranostic area for technologies development.

EnvironmentTG will debate next November the topic 'Intelligent traceability for Environment' investigating promising areas for R&D.

In addition, among the TGs, specific S&T areas of common interest are under consideration to focus on future research aspects that require a convergence of perspective and a synergy across knowledge stratification. An example of this TGs' collaboration was sought in the occasion of the last International workshop "Eco-sustainable Food Packaging Based on Polymer Nanomaterials" (Bartolucci et al., 2014).

In particular in food packaging, nanomaterials (NMs) play already an important role (Table 1). Benefits in the future would result from further development of intelligent and active packaging and a better synergism with other converging or emerging technologies. This future research development would be advisable in order to reduce the current environmental impact. Furthermore in medium and long term, packaging will be integral part of the food chain and research on this need is to be encouraged.

Table 1: Challenges that can be addressed through the application of nanomaterials in the food sector.

Health	Safety	Bio-Economy, Security
Packaging Distribution Storage	- Better food chain management/surveillance through: - Match durability with product shelf life -Tracking - Intelligent Traceability for environment	Control of Waste Environmental Impact through: - Biodegradable packaging - Better food chain management - Bacterial/Spoilage detection - Longer shelf life

Among the fundamental understanding, is the researchers' awareness that the introduction of NMs, especially in the food sector, is accompanied by reluctance since it is difficult to evaluate their hazard on the environment and on human health. Building on this and investigating the advances, the security regarding Health, Environmental and Safety, encourages researchers to support the development of discussion on core cross-cutting aspects such as appropriate analytical methods for the characterization and quantification of nanomaterials and nanoparticles within a life cycle framework, necessary for toxicological evaluations.

Collective internal discussions and with international experts enable to debate advances in this research areas, the development of intelligent hazard strategies for risk assessment and subsequently the issue of risk reduction. Social acceptance is key to the adoption of a new technology in market driven strategies. In this context, new forms of packaging, including packaging with interactive labelling, could provide a good starting point for the introduction of NMs. In the transformation of research, a process of change requires a community of researchers sharing an overall approach with better information, transparency and willingness to communicate with stakeholders and the public - which is a requirement to be continuously addressed.

4.2 Web Platform

Social connectivity plays a key role in the involvement of scientists and experts from academia, government and the private sector. For a convergence among IC, KMIS and innovation, web systems are geared toward enabling users to share meaning in discussions and to capture some of their knowledge to form a collective knowledge crossing boundaries (Alavi and Leidner, 2001)

The CNR foresight project has developed a webplatform (http://www.foresight.cnr.it) as the enabler for this collective knowledge. The webplatform represents the operational infrastructure of the STFP net, enhances transdisciplinary knowledge sharing and ensures connectivity and real time exchange.

The Foresight webplatform characterizes the STFP innovative approach to foresight. It is composed by sections such as topics discussion, contributions, document repository, management and administration. This tool is subject to changes to respond to the needs of the thematic groups. The aim of the tool is to ensure a networking environment designed for researchers engaged in the foresight process.

5 HORIZON SCANNING

The second practice perspective describes the experience based on Horizon Scanning (HS) - which is an activity distinct but often related to foresight drawing a closing attention to the Navigation component in the integrative perspective.

The described practice aims to help researchers - with excellent knowledge background and apical research positions- to work together looking to future emerging directions in a broader view. Researchers are intensively involved in the daily management of specialized groups to achieve specific scientific artefacts and have a lot of interactions at any level.

The scope is to overcome the segmentation currently in place in organizational structure due to competence specializations and to manage the fragmentation related to Navigation.

Therefore, the HS practice represents a practice that is built on the "materiality" of the research work but represents also an investment into a social activity for identifying new and emerging trends and issues and to focus on developments to deal better with an uncertain and complex future.This practice has important implications for KMIS for research and innovation as it reveals the propensity to transform knowledge and working habits to overcome the silo-thinking.

The experience reports about the DMAIC-HS method developed (Paci, 2011). and applied to a working group of CNR high-level researchers. The method DMAIC-HS is constituted by five steps that are:

- Design = problem recognition for development of future technologies and/or innovation actions to meet societal challenges.
- Measure = the overall appraisal of the outstanding quality of S&T compliant with the trends towards the future.
- Analyse = the analysis is to be performed with a qualitative methodology based on intensive-information experts workshops. The output aims to develop synergies among processes and to weight the relative importance to influence strategic and innovation choices for industrial developments and market changes.
- Improve and Control/Monitor = the analytics exploit the discussions held in a push/pull forward-looking areas to develop case studies testing the qualitative methodology.

The Discussion and Prevision Group, formed by CNR Chemistry Department researchers, is the current practice to overcome the specializations in chemistry (macromolecular, bio-sensor, bio-catalysis, plastic materials, DNA, ...).

Horizon scanning is therefore finalized to internally debate and prioritize future developments focusing issues, promoting interdisciplinary across several scientific and technological domains to facilitate horizontal learning and thus overcoming verticality and linearity of thinking processes.

6 SUPPORTING TRANSITION

To support the transition in the integrated perspective, it is useful to catch in a dynamic way the emerging situation at individual and organizational level. To this understanding, good practices provide qualitative information. Researchers participating in CNR S&T Foresight give and exchange contributions regarding interdisciplinary field of societal interests. This is a novelty in research activity as the project aims at building a collective knowledge, a transparent process and a free space.

Therefore, researchers need to adapt their linear behaviour to fully participate in the foresight process to overcome emerging barriers and silo-thinking adding value to their knowledge.

6.1 Barriers and Contrasting Opinions Role

KMIS and innovation in the context of the proposed dynamic framework need to consider the difficulties in transforming knowledge and practices. It is considered then interesting to observe from the current experience some aspects, representing the "inertia" that emerge immediately from the current experience among researchers of research organizations such as National Research Council of Italy. They represent a slow down signal of social processes in research which should be monitored during the perspective practices.

Indeed, at the end of the practices, this issue vanishes and the final results consist of objects producing policy briefs, notes following validation workshops etc. With this aim, an in-house analysis has been carried out on the behaviours of researchers in the participatory process within the S&T Foresight Project. This monitoring helps to identify short term issues to be assessed and overcome for success of this undertaking.

Emerging short-term barriers often occur in project meetings and in follow-on discussion. In wide participatory process, resistance and polarization of opinions frequently occurs.

Motivational climate, friendly relationships, team spirit and self-motivation, retreat for meeting outside organization premises represent also short term features to be addressed and researchers need to consider them as key requirements for a successful participatory process.

Other relevant issues are related to feeling of uncertainty, risk analysis, self-learning, tendency to close shops and excessive filtering; these issues require to be turned into new capabilities of the research work. In addition, work overload often occurs and researchers' extreme specialization inhibits the participation. The mix of networked and personal approach in many cases supports to take care of personalized approaches and to resolve issues.

Through the web platform, contrasting opinions - emerging in this web-communication- exchange complement the scientific and technological knowledge and skills possessed by the researchers.

The dynamic and interactive network is capable of contributing with continuity, creativity and responsibility and the participatory process reinforces the intellectual capital to react to complexity. The complementary approach to this regards experts' interview on S&T developments across disciplinary borders related to the four selected topics described earlier. World experts' interviews represent a source of information regarding future developments. The identification and selection of experts to be interviewed is an important and specific activity often derived from horizon scanning. Aim of the interview is the validation and exploration of S&T areas with impacts onto different domains. During the interview, which also establishes a friendly climate, each international expert is invited to freely express his point of view discussing the future S&T of current technologies and Frontier research arguments in the next 10 years.

7 CONCLUSIONS

An interdisciplinary approach to science and technology is core in the current industrial and societal transformation. Science and technology include other dimensions such as society and environment which represent driving forces for the global EU economy. The research change transition looks at cross-cutting aspects such as development of collective knowledge, awareness of ethical issues, users and societal acceptability, analysis of benefits, business planning and skill sets, assessment of risk. All of them influence the development of proper research policies highlighting aspects for increasing impacts related to technological developments. Research intellectual capital, therefore, is an important asset for industry and society under a continuous process of transformation since year 2000. Public research organizations and innovative enterprises should consider managing and improving their intellectual capital through an integrative perspective.

Research intellectual capital holds a proactive role in the dynamic framework described in this paper. The decisive components Communication, Navigation and Multicontact relationship- allow to the transition overcoming the physical limitations and facilitating the expansion of knowledge flows, making research change possible to include cross-cutting aspects.

In Italy, CNR S&T Foresight Project has been launched to initiate the research change transition. It facilitates bottom-up researchers interactions within a community, with the aim to stimulate the development of a collective intelligence at interdisciplinary level to foster societal driven future ideas and solutions.

To support the strengthening of the international dimension, governmental organisations from outside Europe and international organisations are planning similar pathways planning coordinated foresight actions.

CNR S&T Foresight Project was invited to join the meeting of the Global Foresight Network (GNF) for future collaboration among members to discuss and exchange experiences in horizon scanning and foresight practices. The ambitious goal is to develop new approaches and activities enabling the research intellectual capital to move fast toward a progressive research change.

Going back to Beck's message, science and society need to overcome barriers and consider impacts of R&D in a wider perspective. This R&D will support industries and Country economies to change products, processes and organisations thus facing resources scarcity, energy efficiency, eco-innovation and climate change for a sustainable future and economic growth.

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