7.2 EMERGING COLLABORATION FORMS AND FURTHER RESEARCH NEEDS

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Several international research initiatives and a growing number of practical implementations are helping the consolidation and expansion of the collaborative networks paradigm. New forms of collaboration are emerging in various domains and further research needs are identified. A summary of these trends is presented.

1. INTRODUCTION

A considerable progress in collaborative technologies and systems could be observed in the last five years. Enabling tools and frameworks have been complemented with a better understanding of the collaborative networks paradigm and its implementation requirements. The acquired experiences with earlier application cases drive the development of improved functionalities and governance models.

A variety of collaboration forms are being developed in practically all domains, turning collaborative networks into a pervasive phenomenon. In some cases those developments tend to adopt a terminology that is specific of that domain; often the involved actors in a given domain are not fully aware of the developments in the mainstream research on collaborative networks. For instance, the grid community adopted the term "virtual organization" but focused mainly on the resource sharing perspective, paying little attention to the other aspects involved in collaboration. The European enterprise interoperability community, which was initially focused on the intra-enterprise aspects, is moving towards inter-enterprise collaboration.

On the other hand, there is still some divorce between the engineering and management schools, in spite of the need for a holistic approach. And yet the collaborative networks discipline is steadily consolidating (Camarinha-Matos, Afsarmanesh, 2005). The ECOLEAD project is an example of a large initiative contributing to this consolidation. But dozens of other international initiatives are contributing to advance different aspects of the discipline. As the area progresses new research challenges become, naturally, evident.

Therefore, this chapter intends to illustrate and summarize such trends and identify important future research needs.

2. EMERGING COLLABORATIVE FORMS

As mentioned above, new collaborative forms are emerging in various sectors as a result of the new possibilities offered by technology, the increasing awareness about those possibilities, and the accumulated experiences with the "classic" collaborative networked organizations (CNOs). In some cases these CNOs can be considered as particular cases of previous forms that just emphasize one or two particular characteristics. Other cases show a larger number of specificities and may be considered as new classes of CNOs. The following table (Camarinha-Matos, 2007) shows a number of such forms and their most relevant or distinctive features. Several other features, common to many collaborative forms, may be present as well but the purpose here is to emphasize the ones that are more relevant for each case.

Table 1: New collaborative forms

New collaborative form	Some relevant / distinctive features
1) Joint resource management (e.g. grid / dispersed manufacturing networks, computer grid)	- Pool of resources. - Separate ownership from management – joint (centralized?) management. - Implies continuous awareness of capacities, status, etc. - Needs proper business models (how to pay the owners). - Specialized scheduling policies and access rights management.
2) Collaborative virtual lab	- Combination of organizations and largely autonomous people. - Remote access to (shared) equipment. - Protocols for experiments. - Special visualization techniques and data mining. - Access rights management. - Intellectual property.
3) Inter-modal collaboration (e.g. integrated transportation systems)	- Service composition / multiple service providers. - Tracking, geo-referencing. - Automatic identification. - Link to payment system (bank network).
4) Collaborative e-government / network of governmental organizations	- Provision of integrated services to the citizen (combining lower level services from different organizations). - Very flexible workflow / service composition (e.g. building a house, changing address, etc.). - Service / process planning / "discovery" (adaptation to the situation of each citizen). - Security / privacy. Need for "intermediaries" for service composition assistance.
5) Energy networks management	- Network of producers. Consumers also as (potential) producers (solar energy, wind energy, etc.). - Continuous adaptation to fluctuating demand. - Specialized decision making (for distribution of price, losses, load, etc).
6) (Occasional) crisis management	- Very short window of opportunity. - Large diversity of entities (public, NGOs, private). - Highly incomplete and rapidly changing information. - Geographical dependence. - Limited communications infrastructures.

	- Competing operational coordination bodies.
7) Customers involvement networks (kind of living lab)	- Network of manufacturers and customers. - Levels of disclosure of information / levels of involvement. - Guarantee of benefits for both sides. - Communication with customers (non-experts) and impact in product design (by experts). - Regional aspects / preferences / culture. - Involvement of other regional actors (besides the customers) at the end of the chain.
8) Virtual institutes	- Involvement of professors from different institutions to prepare / deliver a course. - (Usually) remote delivery of courses. - Strong support on multi-media and authoring tools. - Intellectual property and business model – a critical issue for sustainability. - Relationship individual (professor) and organization (university) and intellectual property. - Possible combination with virtual lab / remote access to equipment. - Specialized delivery / interaction platforms. - Course management services.
9) Permanent crisis / social care (e.g. supporting homeless)	- Mostly information exchange, some coordination. - Permanent cases (daily) and sporadic (small crisis, e.g. one family needing immediate intensive care). - Mostly based on volunteers – large heterogeneity of qualifications. - Geographic referencing.
10) Collaborative gaming	- Gaming over the net. - Potentially large groups / multiple instances. - Variable levels of "membership". - Formation of teams, organization of competitions. - Rewarding mechanisms. - Additional socialization mechanisms. - Collective intelligence / collective strategy. - Advanced GUI and other user interfaces.
11) Collaborative innovation	- Creation / innovation process (understanding, modeling, drivers). - Support for joint work / tools sharing. - Brainstorming, argumentation, synthesis, etc. - Value identification, intellectual property, rewarding. - Safety / protection mechanisms. - Trust management.
12) Context awareness service provision (i.e. providing services that depend on the context, e.g. location of a mobile customer)	- The actual contributors for a service depend on the actual context of the customer. - Mobile computing, geo-referencing. - Limited communication (in some cases). - Services built on the fly – planning, discovery. - GIS support. - Contexts may be continuously changing (mobile customer). - Identification (of the user), roaming infrastructure. - Business model / payment model.
13) Machine and sensor networks (e.g. networks of robots)	- Intelligent machines or sensorial nodes. - More structured interactions. - Handling errors. - Planning and reasoning techniques. - Machine learning.

As illustrated by these examples, the Collaborative Networks paradigm is spreading to new sectors and application cases. It is, however, necessary to wait until enough experiences are realized so that a proper characterization and classification of these collaborative forms can be made.

Furthermore, as a result of the maturation of a number of new fields, as illustrated in Fig. 1, it is likely that new collaboration forms and new ways of work will also emerge in the near future.

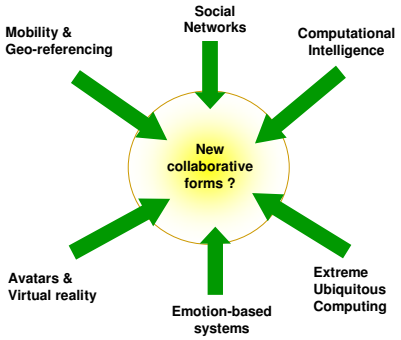


Figure 1 - New synergies in support of collaboration

The integration of concepts and mechanisms originated in these areas may lead to improved collaboration support. For instance, affective computing / emotions-based systems seem quite promising in better supporting geographically distributed communities. Computational intelligence modeling and reasoning mechanisms are likely to induce more advanced decision-support systems for collaborative networks.

3. ACHIEVEMENTS AND FURTHER CHALLENGES

During the last decade a large number of R&D projects have made substantial progress, not only in terms of development of support platforms and tools, but also contributing to a better conceptual understanding and characterization of the area (Camarinha-Matos et al, 2005a), (Camarinha-Matos, 2007). ECOLEAD, an integrated project including 28 partners from 15 countries, with a duration of 4 years, is an example initiative that addressed several key issues of collaborative networks under a holistic perspective (Camarinha-Matos et al., 2005b). The following tables (Tables 2-6) illustrate the current issues and results in various focus areas of CNOs. Further research challenges are also identified. These tables are not complete but only intended to give a synthetic overview of the current state of the art and exemplify further research needs.

Table 2: Status on VO Breeding Environments

Focus area: VO Breeding Environment		
Current issues and results	***Example projects***	***Examples of further challenges***
VBE Reference framework including: - Elements	ECOLEAD, (Virtuelle Fabrik)	▪ Better understanding of collaboration drivers, including principles of interactions, notions of ecosystem and

- Typologies - Life cycle - Governance rules - Working and sharing principles	LogNET-LOGICA, VIRTUE PlaNet	leadership, self-organization and behavioral models, models of complexity, etc. ▪ Refined working and sharing principles configurable to different application domains together with practical instantiation procedures. ▪ Business, marketing and branding methods and support services. ▪ Legal frameworks and advanced support services (e.g. practical e-notary services, intelligent negotiation wizards). ▪ Ontology construction dealing with distributed and dissimilar views bridging. ▪ Trust management, providing advanced functionalities for trustworthiness analysis, assessment, and forecasting, based on computational intelligence and qualitative reasoning approaches. ▪ Sound theoretical background modeling support for value systems and methods to determine the added-value of each partner, analysis of alignment of value systems, etc. ▪ Advanced competency management focusing on discovery of new competencies, competency gap analysis, and identification of (emergent) composite competencies. ▪ Analysis and data mining of historic performance data, which has a raising potential as collaboration history data are being collected. ▪ Assessment of members' readiness for collaboration based on other factors than the traditional competency-capacity matching. ▪ Development of advanced graphical visualization methods for key performance indicators of the VBE. ▪ Bag of assets management including traditional documents and knowledge items as well as services and corresponding access and composition methods. ▪ New simulation tools to support decision making, what-if analysis, study of emerging behaviors, self-organizing patterns, etc. ▪ Policies and mechanisms for monitoring and enforcement of the
Value systems and Trust: - Value system concept and elements (conceptual framework, preliminary formalization, benefits network) - Objective trustworthiness evaluation - Basic mechanisms for trust building	ECOLEAD e-Hubs EVCM	
VBE management system, typically comprising: - Membership management - Support information management - Ontology construction and management - Knowledge discovery / data mining - Trust management - Competency management - Bag of assets management - Decision support system	ECOLEAD AerViCO PlaNet	
Network analysis mechanisms such as: - Global network analysis - Profit / benefit analysis and estimation methods - Business models	CODESNET, ECOLEAD, PRIME, (MYCAREVENT), DIMA (Swiss Microtech)	
VO creation framework comprising: - VO creation process - Actors, roles, and functionalities	ECOLEAD SIMCT MAPPER	
VO creation services - Collaboration opportunity finding - Brokering - VO rough planning - Partners' search and suggestion / selection	ECOLEAD, CDVEs	
Negotiation and contracting - Negotiation framework, negotiation rooms - Contract models - Templates - Negotiation protocols (agent-	ECOLEAD LEGAL-IST e-LEGAL SESAM TrustCOM	

based) - e-Notary and electronic institutions		VBE governance principles and rules (including warning systems). ▪ Advanced support for finding collaboration / business opportunities.
Electronic Service Markets	NASCEM	

Table 3: Status on VO management

Focus area: VO Management		
Current issues and results	***Example projects***	***Examples of further challenges***
VO governance principles and models, supporting diverse: - Management styles - Management levels and actors	ECOLEAD PANDA	▪ Advanced support for planning VO governance models. ▪ Simulation and assessment environments to analyze VOs. ▪ Support for more fluid customer involvement with VO creation and operation. ▪ New network-centric performance indicators focused on collaboration. ▪ Mechanisms and tools to determine added-value of each partner, distribution of benefits and losses. ▪ Risk management tools for VOs. ▪ Advanced manufacturing models for diverse distributed collaboration modalities. ▪ Models and mechanisms to generate aggregated performance indicators (e.g. at the dissolution phase). ▪ Policies and mechanisms for VO inheritance and transfer of responsibilities. ▪ New process / workflow models coping with ad-hoc collaboration, complexity and evolvability. ▪ Real-time (virtual) enterprise – the "old" concepts of intelligent supervision acquire new "life" in the context of collaborative networks being necessary to revisit this body of knowledge and extend it, possibly in combination with RFID and sensor networks.
Collaborative process specification and modelling: - (Distributed) business process modelling - Process supervision - Exception handling	ECOLEAD INTERPROD ArKOS ECOSELL AerViCO PANDA	
Performance management mechanisms: - Network-oriented performance indicators (collaboration performance indicators) - Performance measurement - Distributed data acquisition	ECOLEAD, (SCOR) Tool-East PMS-EVE GPM-SME	
Preliminary decision support systems: - Conflict resolution - Risk management - Financial decision making	ECOLEAD GPM-SME	
Principles of VO inheritance: - Lessons learned - Aggregated performance indicators - Transfer of liabilities / responsibilities - Benefits / losses / assets distribution	ECOLEAD	

Table 4: Status on Professional Virtual Communities

Focus area: Professional Virtual Communities		
Current issues and results	***Example projects***	***Examples of further challenges***
PVC conceptual framework, including: - Main concepts	ECOLEAD CSDN	▪ Since this is an emerging concept, it is necessary to progress further in the organizational models, leadership and

- Actors and roles - Life cycle - Typologies - Business drivers and interaction with other organizational forms - Main processes		coordination principles. ▪ Specific value systems and appropriate IPR are needed, both for pure PVCs and PVCs embedded in VBEs. ▪ The legal framework needs to be further developed as well as the interactions with other organizational forms (interactions of the PVC as a whole or interactions of its individual members). ▪ New "life support" institutions (e.g. new forms of social security) need to be developed to cope with the volatility of the working conditions. ▪ Appropriate ethical codes need to be developed, namely for PVCs spreading over different geographical regions. ▪ Advanced process models adjusted to new collaboration / working modalities. ▪ Advanced competency management (similarly to VBEs). ▪ Advanced collaboration platforms supporting mobility / pervasive computing, multiple virtual rooms, etc. ▪ New affective computing / emotion-based models and support tools for collaboration environments. ▪ Collaborative problem solving integrating mechanisms for distributed brainstorming, argumentation, avatars management and virtual reality, delegation, etc. ▪ Mechanisms for determination of members' added-value and distribution of benefits and losses. ▪ Advanced trust and reputation management mechanisms focused on professional collaboration. ▪ Practical negotiation, e-contracting, and virtual team creation support. ▪ Better understanding of the collaboration drivers (behavioral models, self-organizing principles). ▪ Handling multi-cultural issues in collaborative product / service design. ▪ Measuring added-value and benefits of collaboration on design. ▪ Methods for collaborative learning in design. ▪ Computer-aided creativity support.
Basic PVC business model, analyzing: - Value objects and metrics - Business strategy - Legal, social, ethical, and societal issues	ECOLEAD CSDN	
PVC organization and processes - Legal / informal structures - Governance principles and processes - Value-adding processes	ECOLEAD	
PVC management system, including: - Membership management - Documents and knowledge management - Basic collaboration tools - Virtual teams creation	ECOLEAD AREITO network OASIS	
Virtual Teams management	ECOLEAD	
Collaborative problem solving - Negotiation, argumentation, consensus building, task decomposition and distribution, … - Conflict / dispute resolution	(ECOLEAD) (SciencePeer) (Modelling Space)	
Collaborative engineering platforms (for collaborative or concurrent engineering as a particular case of PVC) - Design tool sharing and encapsulation - Shared access to computational facilities, experiments, labs and prototyping facilities - Collaboration support - Knowledge sharing and collaborative learning - Digital manufacturing - Joint IPsharing and protection - Standards for technical	e-COLLEG VIVACE ACTIVe3D-Build	

product data exchange (e.g. STEP).		

Table 5: Status on ICT infrastructures

Focus area: ICT Infrastructures		
Current issues and results	***Example projects***	***Examples of further challenges***
Service Oriented Architecture (SOA) orientation established as the main approach for integration of distributed services	ECOLEAD ITSIBus ATHENA INPREX	▪ In spite of the growing importance of SOA approaches, there is a need for better standardization and design methodologies. Other aspects include: Services' semantic annotation (focused on collaboration), dynamic ("on the fly") service combination, intelligent planning, search, and integration of services, soft matching methods, etc. ▪ Sustainable business models for the infrastructures (one of the main current obstacles for the development of the area). ▪ Absorption of emerging computing paradigms. ▪ Grid computing has been trying to be a kind of "bandwagon" that collects / integrates ideas from other areas but still offers a limited conceptualization of VO and corresponding business model. Nevertheless it includes some potentially useful mechanisms for resource management and collaboration between the two communities could be useful. ▪ As the area of mobile computing, WiMax, new mobile devices and infrastructures is developing, it is necessary to identify / create new opportunities for new pervasive collaborative environments. ▪ RFID (radio frequency identification) may enable better real-time management in production and logistic networks for which a holistic approach is needed. ▪ The Multi-Agent Systems area continues to be promising from a conceptual perspective but there is a need for more robustness in development environments for widely distributed systems.
Security infrastructures including: - Basic security mechanisms - Authentication mechanisms - Responsibility policies	ECOLEAD TRUSTCOM DyVOSE	
Distributed workflow / business process modeling and execution engines	WIDE CrossFlow	
Distributed information exchange and sharing mechanisms: - Federated systems - Standards for information exchange - Web-based document management systems	PRODNET II MASSYVE	
Interoperability principles and approaches for integration of legacy systems	ATHENA ITSIBus INTEROP ECOLEAD	
Base collaboration services: - CSCW - Document management - Forum, chat, billing, etc.	ECOLEAD	
Agent-based approaches: - Agent-based enterprise modeling - Agent-based infrastructures - Agent-based simulation - Mobile agent infrastructures	TeleCARE, SteelNet Global Automation Platform	

Table 6: Status on the theoretical foundation for collaborative networks

Focus area: Theoretical Foundation		
Current issues and results	***Example projects***	***Examples of further challenges***
On a modeling basis: - Identification of modeling approaches and tools developed in other disciplines but with potential applicability in CNOS - Initial attempts to combine different modeling approaches - Preliminary consolidation of concepts	ECOLEAD, THINKcreative VOSTER	▪ More rigorous and formal models of the base concepts. ▪ Development of base theories of collaborative networks. ▪ Exploration of soft modeling and qualitative reasoning in addressing complex decision-making problems in CNOs. Examples include, value systems, trust, risk management, readiness and preparedness to join a CNO, etc. ▪ Validation of the ARCON framework. Namely in the case of emerging collaborative forms. ▪ Revision and extension of ARCON. ▪ Elaboration of reference models for specific cases / classes of CNOs. ▪ Further development of the behavioral dimension, namely exploration of the emergence and self-organization principles. ▪ Identification and characterization of the mechanisms that motivate and sustain collaborative behaviors.
Modeling framework: - Some attempts to extend enterprise modeling frameworks (e.g. Zachman, CIM-OSA, GERAM) to CNOs - Some attempts to extend supply chain frameworks (e.g. SCOR) to CNOs - ARCON, a comprehensive framework covering both the Endogenous Elements of a CNO (Structural, Componential, Functional, and Behavioral dimensions) and the Exogenous Interactions (Market, Support, Societal, and Constituency dimensions)	GLOBEMEN ECOLEAD	
Reference modeling: - Preliminary attempts to define reference models for virtual organizations - First stage of ARCON reference model for collaborative networks	VOSTER ECOLEAD	

The following sections illustrate some of the challenges in the context of specific application areas.

4. CASE 1: PRODUCT / SERVICE FOCUS AND CUSTOMER INVOLVEMENT

During the 1990s there was a considerable effort worldwide focused on product and process modeling. A major stream was represented by the activities around the

STEP standard. Logically, contemporary research on virtual enterprises also embedded a strong focus on the exchange of product models and related technical data among the participants in the collaborative network. In the current decade, however, the product / service do not appear to be explicitly in the center of attention of many projects. For instance, ECOLEAD quite intensely focused on the organizational and governance aspects of the collaborative network and the product or service got somewhat less attention.

It is now important to refocus the research attention, revisiting the aspects of distributed product / service design and development, and consequently align the corresponding process models, governance and organizational structures of the collaborative networks.

Current trends in mass customization have highlighted the need to take into account the preferences, specificities, and constraints as well as the assets of the target market regions. In fact there are plenty of examples of failed cases of manufacturing projects due to the lack of proper customization, especially related to intangible products and services. To access different markets, large companies possess enough resources to install local branches, able to address the local specificities. SMEs and micro enterprises however, can only compete for such markets through collaboration. Furthermore, in addition to the need for involvement of local enterprises, it is important to extend the collaboration process to selected customers and lead users - a form of focused living lab environment. In fact, the classical corporate boundaries have recently begun to blur and the value chain is loosing its attributes, and being replaced by a web of fluid and flexible relations. In this context, customers are becoming an important part of the value creation, offering new possibilities to increase operational efficiency as well as to define strategic uniqueness through innovation.

The role of the customer is changing from a pure consumer of products and services to a partner in the value creation process, i.e. consumers become pro-sumers and co-designers (Hippel, 2002), (Reichwald *et al*., 2005). Empirical studies find that innovation by customers tends to be concentrated on lead users of the products. In some cases the innovation comes from expert users (e.g. sports users can suggest / design completely new products fitting their specific needs), in which case the process goes far beyond simple customization to even radical "first" product type innovation. Many publications have analyzed a diversity of case studies and the related economics of co-innovation. Several of these empirical studies show that innovating users often choose to freely reveal their innovations to other users and to manufacturers as well. Some reasons for this behavior (Hippel, 2002) include: 1) Often not practical to benefit from intellectual property via either licensing or secrecy (even if innovators should wish to do this). 2) Much intellectual property does not qualify for protection. 3) Gains can be obtained by reputation. 4) Other gains can be achieved through earlier market realization of solutions to users' needs. It is however unclear the evolution of this situation if more and more customers get involved in the process.

A large number of empirical studies are reported in the literature on involvement of customers in the innovation process (Reichwald *et al*., 2005). Most of this work however merely covers the descriptions / enumerations of cases, adding only little contribution to the needed systematic definition of processes, structures, and drivers

involved. Fig. 2 (inspired from Berger *et al*, 2005) summarizes the main characteristics of many of these cases found in literature.

The current challenge is to enable *collaborative innovation* involving a network of SMEs (manufacturers, designers, etc.), interfacing different entities and customers. Unlike previous works focused on interactions between one company and its customers, it is necessary to address the much more challenging scope of customer involved networked collaboration and co-innovation, as shown in Fig. 3.

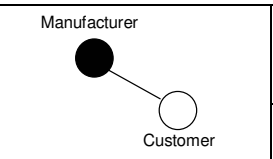
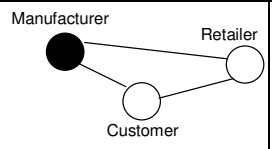
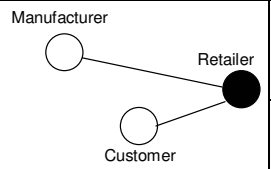
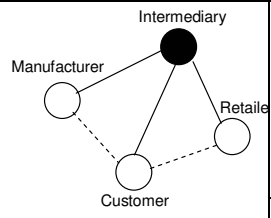
 *Customer-direct collaboration*	+	▪ Lower transaction costs ("design it yourself") ▪ Absorb weak market signals by direct interaction wit customer ▪ Single contact – no confusion about responsibility
	-	▪ Requires new skills for the interface with customer ▪ Combination of standard products with co-designed ones brings extra internal complexity ▪ Needs further contact points (high investment on interaction systems)
 *Manufacturer-driven collaboration*	+	▪ A retailer can provide closer physical and information proximity to customer ▪ Retailers can bundle customer interactions, reducing internal complexity on manufacturer's side ("buffered mode") ▪ Customers more used to deal with retailer ▪ Customers still "see" the manufacturer
	-	▪ Lower level of customer information absorbed by manufacturer ▪ Retailers may have low level of education, lacking needed knowledge for these interactions – require training & incentives
 *Retailer-driven collaboration*	+	▪ Retailers can realize individualization needs faster ▪ Retailers may upgrade their offerings in line of service-orientation (more motivation)
	-	▪ More difficult information absorption by manufacturer ▪ Although retailers learn the needs, often do not have the motivation to convey this information along the chain ▪ Retailers must manage new issues (e.g. product design, manufacturability, etc)
 *Intermediary-based collaboration*	+	▪ Investment on the "interaction system" made by the intermediary ▪ Third party to balance interests between the manufacturer, the retailer, and the customer – better sustainability ▪ Intermediary may gain core competencies in configuration, selection, and assisting customer – higher performance, lower cost
	-	▪ Difficult to effectively transfer absorbed information to other actors ▪ Requires the intermediary to have strong understanding of the value chain and how to seamlessly integrate all partners – difficult since he has no product and no customer ▪ Additional transaction (communication) costs ▪ When the broker also works with other competitors, there are barriers in sharing information.

Figure 2 - Forms of customer involvement (adapted from Berger *et al*, 2005)

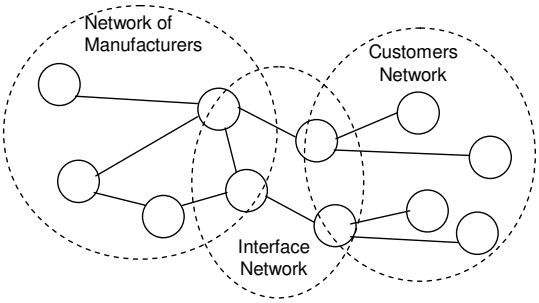


Figure 3 - Customers' involvement in a CN

Early attempts to involve customers in the product creation / innovation process, as tried by single enterprises (Salkari et al., 2005) while having the merit of putting the customer in the center, ignored many of the interaction difficulties (e.g. the knowledge/ language gap) between the customer and the manufacturing experts.

Future systems should aim at giving the customer, as well as the involved enterprises a new role, i.e. making them partners within a co-creation / co-innovation network, as illustrated in the diagram on Fig. 4. The co-innovation network comprises a network of enterprises (designers, manufacturers, brokers, etc.) merged with a network of (lead) customers, that is supported by an adequate collaboration platform and infrastructure. The interaction gaps that represented big obstacles for an effective involvement of the customers, are to be overcome through an adequate organizational structure, as well as the supporting technology, leading to a synergetic innovation ecosystem.

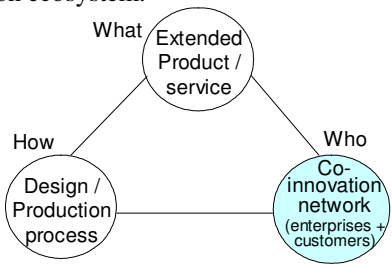


Figure 4 - Customers as part of a co-creation network

Clearly, different perspectives are to be considered at creation stage and operation stage. However, as identified by previous practices, the main current challenges for an effective establishement of a co-innovation network are related to its creation stage.The notions of digital factory / digital manufacturing and corresponding tools can play an important role here in order to facilitate the involvement of all stakeholders in the process of producing economically viable solutions. Once adequately integrated / adapted to the collaboration platforms, such tools can help in reducing the problems of the language gap and contribute to support the more and more needed ultra-short development times.

5. CASE 2: NETWORKS OF MACHINES AND SENSORS

The growing diffusion of computational power and sensorial systems in

manufacturing equipment, combined with the integration of real-time and computational intelligence functionalities, are giving machines an increasing level of intelligence and autonomous decision making capabilities.

On the other hand, the participation of enterprises in dynamic (and temporary) networks requires agile adaptation to each new scenario, namely in terms of its manufacturing capabilities, processes, capacities, etc. The processes of change have been addressed mostly at the level of business process re-engineering and information technology infrastructures. Little attention however has been devoted to the changes needed at the manufacturing system level although the shop floor suffers a continuous evolution along its life cycle. A non-agile shop floor seriously limits the global agility of a manufacturing company even if its higher levels are agile. A particularly critical element in a shop-floor evolution process is the control system. Current control/supervision architectures are not agile because any shop floor changes require programming modifications, which imply the need for qualified programmers, usually not available in manufacturing SMEs.

The above needs and the new levels of intelligence and autonomy of equipments suggest that a collaborative networks approach can be adopted in the design of new manufacturing systems. The potential similarity between the dynamic adaptations at shop-floor level and the formation of consortia regulated by contracts in networked enterprise organizations was first identified in (Barata, Camarinha-Matos, 2003), work that also made a first feasibility demonstration. The problems a company faces in order to join a consortium are, to some extent and at some abstraction level, similar to the shop floor dynamic adaptation / re-configuration problem. The proposed approach is therefore to use the mechanisms and principles developed to support the enterprise integration into dynamic enterprise networks as inspiration for a new generation of agile shop-floor systems and the design of new mechatronic components.

Sensor networks are also becoming more relevant in practical applications. For instance, in environmental protection, a large number of sensors measuring environmental parameters such as temperature, pressure, concentration of chemicals, etc., and with embedded computational power can be organized in a network of cooperative autonomous sub-systems. In manufacturing sites and other large facilities (e.g. airports, ports, and large public buildings) networks of sensors can be implemented for monitoring of errors, attacks, optimization of energy consumption, etc. Each sensor in the network can do some amount of computation and communicate the raw and/or processed data to a central computing facility or intermediate integration nodes for further processing and integration with other data.

Although the interactions among nodes in these contexts tend to be more structured that in the case of networks of organizations, it is expected that structural, functional and behavioral models of inter-organizational networks can inspire new solutions here. Artificial intelligent techniques and particularly computational intelligence (soft computing, genetic computing, etc.), machine learning, federated systems, planning, and decision making are expected to provide the base implementation tools. Like in inter-enterprise networks, the outcome of machines and sensors networks is more than the sum of its parts. For instance, a complex pick-and-place skill may become available when a robot and a flexible gripper work together. This skill results from a proper combination of more elementary skills provided by the two individual manufacturing components. Therefore, principles of

emergence, both in terms of manufacturing / perception skills and behavior need to be properly identified, understood, and modeled.

6. CASE 3: ACTIVE AGEING SUPPORT

It is widely recognized that Europe's population is ageing and with ongoing improvements to health and welfare, life expectancy is progressively increasing. It is foreseen that by 2020, people over the age of 60 will constitute 25% of the number of people in Europe. It is thus timely for Europe to reassess the understanding of such terms as ageing and retirement, and questioning the assumptions as to work, happiness, leisure, community involvement etc. with respect to old age.

The current understanding of elderly as a dependent stage of life no longer coincides with the way society is developing at the outset of the 21st century. The concept of "*active ageing*" provides a more appropriate understanding of the later phase of life given both social and technological trends and outlook for the future. One significant challenge is thus to enable older people to continue participating in and contributing to economic and social life – where they wish to do so – and to reduce social isolation and exclusion.

Many senior citizens across Europe, as they reach the age of retirement, desire to remain engaged in economically and socially productive activities. Indeed, their knowledge and experience is a critical asset to the future development of European society. In fact, this desire to remain active and to use their professional skills for the benefit of the wider community is the driving force behind the emergence of what has now become recognized as the "*silver economy*". However, many elderly citizens, following retirement, quickly become marginalized as they feel discarded by a society which often fails to recognize their worth, and to appreciate and benefit from it. They are often seen as a cost burden rather than a resource, capable of value creation. This feeling of exclusion creates a vacuum in the life of the elderly citizens which can affect their health and well being. The critical challenge for society in this aspect of the active ageing process is to create an ICT-supported environment in which elderly citizens do not feel excluded, but rather have a chance to use their knowledge and expertise in a meaningful way by making a valued contribution to the communities in which they live.

Taking advantage of current technology, a number of initiatives have been launched in several regions to establish virtual communities that try to help elderly to remain active and involved. These communities although playing a beneficial role, namely in terms of "socialization", are quite limited in several other important aspects, e.g.

(a) They lack modeling the evolution of the elderly's behavior and adapting to the emotional state of the elderly, and therefore cannot provide any effective support (so much as needed in this phase of life).
(b) They lack adequate mechanisms for interaction with the economic system and therefore face big difficulties in making use of the potential contributions of retired professionals, even when they would be wiling to volunteer such contributions.

To exploit these issues and elaborate a strategic roadmap focused on innovative solutions and ensuring a balanced post-retirement life-style, a new European project

(ePAL - extending Professional Active Life) was launched recently. As a guiding case study in the ePAL project, an existing virtual community of retired professionals is used. Members of this community provide, on a voluntary basis, help in assessing the viability plans and initial business plans for launching small and micro enterprises. One such specific network that will participate in the ePAL has been created in the region of Andalusia in Spain and consists of approximately 300 retired professionals.

In general, small start-up companies cannot support the costs of such specialized analysis help. The governmental organizations also can only give partial help. On the other hand consulting companies can usually provide analysis methodologies that help with the problem diagnosis of such entrepreneurial projects, but often do not provide much advice on how to find suitable solutions to the identified problems. Applying their life time gained experience, expertise, and wisdom, retired professionals in interaction / collaboration with public institutions, can provide a valuable help contributing to the development of the economic tissue in their region and otherwise. However, in order to be effective, this process requires involvement of a variety of actors including: the target beneficiaries, i.e. the small and very small enterprises, the (regional) entities involved in supporting the economic developments (governmental organizations, chambers of commerce, etc.), consulting companies specialized in SMEs, and other support institutions, e.g. financial institutions.

Each member of the retired professionals' community has specific knowledge in a particular field, while often an adequate solution for the problems of every start-up company requires a proper combination from multiple fields. Therefore, virtual teams of elderly professionals can be engaged on providing the assessment and advice to each specific case. On the other hand, the retired elderly may not have the possibility or even interest in doing the necessary field work (e.g. the problem diagnosis and identification, characterization of the situation, etc.) and therefore it is necessary to create synergies with other (economic) actors that perform that role.

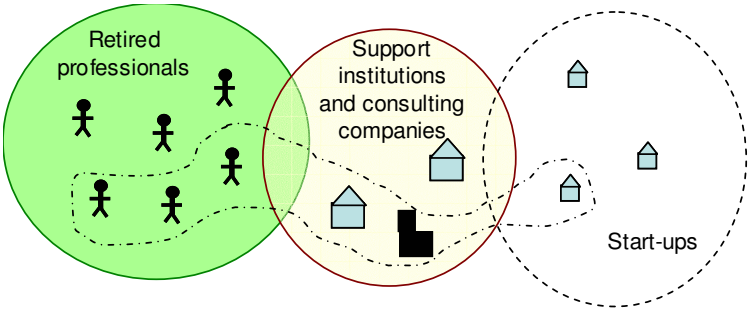


Figure 5 - Hybrid network to advice start-ups and small companies

At present there is a "gap" between the "potential" valuable help that can be provided by elderly professionals and the need for assistance and consultancy raised by the economic system, especially in the context of scarce resources at SMEs and start-ups. The challenge is for ICT-supported specialized virtual communities that (i) *reduce the geographical barriers* – supporting limited mobility, (ii) *allow flexibility* - not necessarily synchronous collaboration, (iii) *enhance establishing links with other retired professionals in similar circumstances* – finding new " (*electronic*)

pals", and (iv) *facilitate the integration and interaction with other stakeholders* in the socio-economic system.

7. CONCLUSIONS

The discipline of collaborative networks and particularly the collaborative networked organizations are going through an expansion and consolidation process, as shown by the large amount of conceptual results, support tools, and developed pilot demonstrations and applications during the last years.

As the area progresses, and especially as a result of the enlarging application base, new research challenges are being identified. Collaborative networks are nowadays applied in a large variety of sectors, including industrial manufacturing, services, logistics and transportation, energy management, education, agribusiness, government, research, elderly care, etc. Three examples presented in this chapter illustrate some of the challenges faced in these diverse application areas. The paradigm is becoming a pervasive phenomenon with a great potential. Further research and development shall materialize this potential.

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