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TOWARDS A GENERAL THEORY OF CHANGE

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THE EMERGENT POWER OF WEB-PLATFORM FOR ENHANCING ECOSYSTEM INNOVATION

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The growing symbiosis between the development of ICT and the development of innovation processes in enterprises is evidenced by the proliferation of a large number of websites based on the concepts of open innovation, collective intelligence and knowledge sharing. In this paper we want to suggest how the basic concepts of complexity theory and business and innovation ecosystem can inspire and guide the design of a web platform to support innovative and collaborative process of European SMEs. More specifically, we have highlighted the power of modularity (Baldwin and Clark, 2000) towards the design of new products, services and business models, which potential has been already only partially exploited. The innovation led by an eco-systemic vision and the systemic assumption of the modularity principle are therefore proposed as the self-organization and self-poiesis enablers of collaborative network.

Keywords: complexity theory, innovation ecosystem, modularity principle.

1 Introduction

The COLLECTIVE project aims at developing an ICT operational platform supporting each phase of the innovation process (foresight, creativity and design) and the creation of communities of firms and users (bottom-up approach) collaborating and feeding innovation ecosystems [3,4]). The growing symbiosis between the development of ICT and the development of innovation processes in companies is evidenced by the proliferation of a large number of web platforms based on the concepts of open innovation, collective intelligence and knowledge sharing. However what the Collective project is trying to achieve is to solve the major constraints of small medium enterprises (SMEs) concerning innovation issues by:

- proposing self-organizing communities of firms and users as the new organizational unit for managing the innovation process in a collaborative way;
- increasing the amount of cognitive diversity that firms (or groups of) will be able to gather and manage
- considering and feeding the innovation ecosystems that will emerge through the ICT-platform as a digital idea-space [16]. Moreover Ogle [16] proposes nine laws governing the idea spaces that have been arisen from complexity theory concepts such as self-organization, emergence, edge of chaos, fitness, etc. (see Appendix A).

In this paper we want to suggest how the basic concepts of complexity theory and business and innovation ecosystem can inspire and guide the design of such an ICT-platform. The paper is organized as follows. In the initial part of the first section we will

provide a review of the most interesting concepts and issue concerning open innovation, collective intelligence and business and innovation ecosystems. In the second part we will propose modularity as a powerful concept enabling the self-organizing of collaborative networks of firms and users. Then we will suggest some managerial implications that could help in designing and developing an ICT-platform that wants to represent a digital agorà for collaborative innovation for European SMEs.

2 Literature review and theoretical development

2.1 Nurturing an open innovation and collective intelligence oriented culture

The closed innovation paradigm is slowly and inevitably crashed by four main factors of erosion [5,9]. The first one appeared in the late '90s thanks to a generalized increase in investment in so-called venture capital markets, when the most qualified members ran away from many large companies, attracted by start-up emerging and innovative companies. The second factor is related to the concomitant increasing availability and mobility of skilled workers. In this context, companies that were strongly oriented to a high internal support for R&D ran a serious risk of losing the intangible capital and knowledge created and stored inside. The third factor is closely related to progressive decoupling between research and development. In order to find a solution, companies included a decoupling buffer to separate the two functions and to create a real storage "shelf" for ideas/solutions from the research until the development function would be able to use and enjoy them into the market. Some ideas and projects accumulated on the shelf during the time found necessarily 'channels and alternative ways' to reach the market, alternative ways so as to advance outside from the company's boundaries. The last erosion factor is an increase of skills and capabilities of external suppliers, able to propose an offer of materials, components and systems, in terms of quality and quantity, equal or even greater than what they can offer by using only internal resources. The action of these four erosion factors in addition to other context phenomena, such as the reducing of time to market for many products/services, the reducing of the life cycle and the expansion of knowledge, caused the decline of the logic of closed innovation and the breaking of the virtuous circle of closed innovation [5]. The increased investments in research and development may develop new ideas and projects, that if not supported by management can induce some employees to open new start-ups to bring them to the market, rather than place them on the shelf. The successful start-up generally does not reinvest on R&D or new discoveries in the short time, but look outside for new technologies to market, while the company which had initially contributed to the technological discover does not derive any profit from the initial investment in R&D.

Moreover Dahlander and Gann [7] highlighted two other factors. The increasing globalization that characterizes our times which lead also to a strong division of the work. The dissemination and use of new technologies, especially the informatics, allow to develop and to test new types of collaboration, overcoming geographical distances and

finding solution to many problems. In this context the paradigm of open innovation emerges. The corporate boundaries become porous, transparent, allowing the exchange between internal and external ideas and technologies; the research projects born within a company, thanks to R&D function, may follow an internal way to supply the current market or they can reach the market through an external way, creating new opportunities outside current business, generating an additional value. It is also possible an opposite way: external stimulus and opportunities can be absorbed and used within the corporate boundaries [5,21]. The concept of 'not invented here' (NIH) has been reappraised, but considered as a hub of innovation strategies of many companies. Thus, the firms deliberately open its boundaries interacting with other subjects (firms, institutions, universities, etc.) establishing two main collaboration channels: vertical or horizontal (see Figure 1). The vertical collaboration channel refers to the collaboration between a SME and all possible actors of its value chain: with the upstream stakeholders (n-tiers suppliers) or with the downstream stakeholders (dealers, customers, etc.). The horizontal collaboration channel regards the alliances, cooperation and interactions that the SME can start with actors that do not belong directly to its value chain, for example universities, research centres, technological poles, public institutions, experts, consultants, companies from other industries, and eventually competitors.

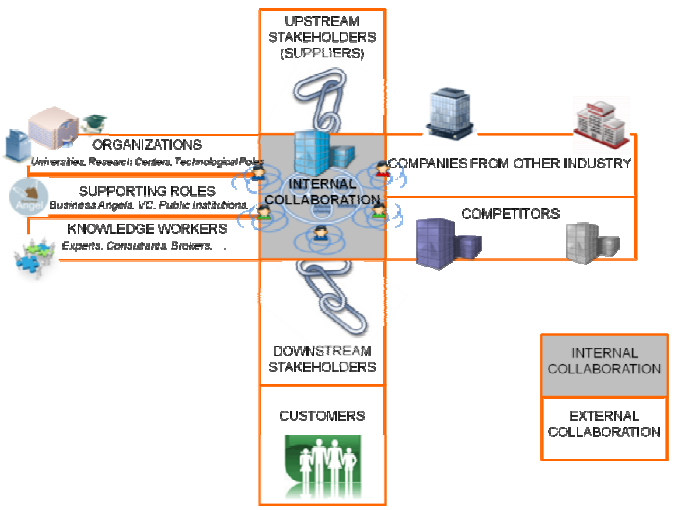

Figure 1. Horizontal and vertical collaboration channel in Open Innovation approach.

We identified a set of dimensions for analyzing the open innovation approach (see Figure 2). The first dimension is related to the subjects/actors involved. The second dimension refers to the concept of platform that supports the innovation process, both in organizational and in ICT perspective. The third dimension concerns the inclination towards sharing the value generated. The last dimension considers the sustainability of the approach over time. The closed innovation paradigm deals with the view of firms as self-

sufficient 'castles', with very restricted communication going outwards to other companies or universities. The innovation is pursued through internal research and development (R&D) by means of ICT tools that enhance internal collaboration and value sharing. The sustainability over time is conditioned by the ability to maintain the virtuous cycle described by Chesbrough. The open innovation paradigm has some relevant differences if we consider medium-large company (MLE) or small-medium enterprise (SME). Large companies that adopt open innovation approaches have been progressively studied by scholars and practitioners. The main characteristic is related to having porous boundaries that let the company being connected on the outside with other companies and universities. As pointed out in the Procter & Gamble case, it is proper to speak in term of research, connection and development (R&C&D). In this view, ICT tools places a strategic role in supporting and in enhancing the connection between the large company and the outside world, mostly composed by SMEs or stand-alone brilliant inventors, lead users or creative people. The value sharing flow is mainly directed inside the large company, that is fathoming and interested in acquiring from the outside ideas, technologies and opportunities for increasing its competitiveness. The sustainability over time is shaped by the ability to reach and introject new contributions avoiding the risk of assuming unbalanced power relationships.

In order to discuss the open innovation approach in SMEs some premises and clarifications are needed. The discussion about the concept of open innovation in SMEs has been relatively understudied from major traditional schools of thought [13]. Firstly, open innovation is more easily analyzed in large firms, as SMEs have a lower capacity in accessing external resources and they could arrange fewer assets to be able to exchange technology [15]. Secondly, SMEs are using more cues and stimuli from the outside than large firms, and they consider alliances, networks and other forms of cooperation as a natural means to extend their technological skills, often only to implement outsourcing agreements mainly with large corporations [13]. Finally, the SMEs consider external resources as means of access to marketing and sales channels in the later stages of the innovation process (marketing), while the open innovation is more focused on the early stages of innovation [22]. In this respect, the value sharing flow is mainly directed outside the company, towards a partner able to monetarily recognize the technological step gained. Thus, in efforts to achieve open innovation, large companies are focused more in R&D and SMEs focused on marketing, because while many of LEs can count on technological superiority, the other often lack capacity terms of production facilities, marketing channels and general contacts that permit effective market introduction of innovation [15].

Zara [24] claims that an *intelligent* enterprise stands on three inseparable and complementary pillars: *collective intelligence* (quantity[1] and quality of intellectual cooperation), *knowledge management* (quantity and quality of knowledge) and

[1] The author argue that quantity has to be interpreted as "best suited to the situation and needs of the organization".

information and collaboration technologies (quantity and quality of software, hardware and networks facilitating relational and information flows).

			INNOVATION APPROACHES		
			AS IS		
			Closed Innovation	Open Innovation	
				Large enterprises	Small Medium Enterprises
DIMENSIONS OF ANALYSIS	1) Subjects		Firms as 'castles'	Firms with porous boundaries	Innovative High-Tech Firms and Start-ups
	2) Platform	Organizational	Internal R&D	R&Connect&D	R&D&Connect
		ICT – Intra-firm	For internal collaboration	For internal collaboration	(rare)
		ICT – Inter-firm	/	For external connection	For external connection
	3) Value sharing		Internal flows	Mostly incoming flows	Mostly outcoming flows
	4) Sustainability		Ability to maintain the virtuous cycle described by Chesbrough	Avoiding the risk of assuming unbalanced power relationships	Sustaining technological and financial growth

Figure 2. Dimension of analysis for open innovation (as is and to be) in large and small-medium enterprise.

More specifically collective intelligence is the intelligence of harmonious connections that foster relationships and cooperation [24]. Malone, Laubacher and Dellarocas [14] of the *MIT's Center for Collective Intelligence* propose a sort of genome model for studying the building blocks or "genes" of the collective intelligence. Four fundamentals questions are linked to the dimensions that are important in designing any system for collective action: *Who?* The subjects involved and to be involved; *What?* The goal that has to be reached; *Why?* The motivation for participating and collaborating; *How?* The process by which to reach the goal.

The potential answers to each of the four key questions are the different types of genes that could be used to build and characterize a collective intelligence system.

- Subjects: *crowd* (activities can be undertaken by anyone in a large group who chooses to do so); *hierarchy* (when someone in authority assigns a particular person or group of people to perform the task).
- Incentives and motivation: *money* (the promise of financial gain); *love* (people can be motivated by their intrinsic enjoyment of an activity, by the opportunities it provides to socialize with others, or because it makes them feel they are contributing to a cause larger than themselves); *glory* (the desire to be recognized by peers for their contribution);
- How-Creation Process (the actors in the system generate something new): *collection* (the items contributed by members of the crowd are created independently of each

other); *contest* (one or several items in the collection are designated as the best entries and receive a prize or other form of recognition); *collaboration* (members of a Crowd work together to create something and important dependencies exist between their contributions);

- How-Decision Process (the actors evaluate and select alternatives): Group decision (inputs from members of the crowd are assembled to generate a decision that holds for the group as a whole) - *voting*; *averaging (*average the numbers contributed by the members of the Crowd); *consensus* (all, or essentially all, group members agree on the final decision); *prediction market* (people buy and sell "shares" of predictions about future events); Individual decisions – *markets* (each member of the crowd makes an individual decision about what products to buy or sell); *social network* (crowd members assign different weights to individual inputs on the basis of their relationship with the people who provided them and then make individual decisions).

After a deep study on collective intelligence, Schut [19] found some properties of the collective intelligence, distinguishing between *enabling* and *defining* properties.

The enabling properties are those that if available, let collective intelligence to emerge; the defining ones are those that characterize and 'define' the system as a collective intelligence one. The first enabling collective intelligence properties is *adaptivity*. According to Schut [19:133], "to adapt literally means 'to fit to', usually referring to (necessarily) changing one's own structure to deal with one's environment. In our context, this means that either an individual changes itself if necessary or the whole system changes itself. The former implies the latter, but not necessarily the other way around". Adaptivity can happen on the local level, the individual one, and/or at the global level, the whole system one. The second enabling properties, *interaction*, means that a complex system must be analysed not only at the individual behaviour level but also at the interactions level that occur within individuals. The third enabling properties are *rules*. Schut [19:134] argues that "the most fundamental form of describing the behaviour of an individual (or whole system) is to use rules. Such rules are implications between inputs (observations) and outputs (actions)".

Moreover, the first defining collective intelligence property is *global-local*. The local level concerns the individuals in the systems, while the global level is related to the system as a whole. The second defining collective intelligence property is *randomness*. Shut [19] highlights that complex systems intrinsically have some element of randomness due to their moving on the edge of chaos where they face both a chaos-disorder side, and a structure-order side. The third defining collective intelligence property is *emergence*. Shut [19] uses the following working definition, coined by de Wolf and Holvoet: "A system exhibits emergence when there are coherent emergents at the macro-level that dynamically arise from the interactions between the parts at the micro-level. Such emergents are novel with respect to the individual parts of the system." [23]. Thus emergence is a concept that concerns going from the local to global aggregation level.

The fourth defining collective intelligence property is *redundancy*. This means that the same knowledge and information are represented and spread in a number of different places in a system and shared in a number of individuals (but not everybody). The fifth defining collective intelligence property is *robustness*. The system has to be robust against malfunctioning and attack from the outside. Shut [19] highlights that this property is closely linked and enhanced by redundancy.

Zara [24] suggests a process to let collective intelligence emerge. The first step is to foster a cooperation culture in the organization, overcoming resistance and distrust. The second step is to build a progressive know-how about the collaboration inside the organization, adopting specific training in order to strengthen the collective intelligence culture established within the first step. The final step is related to the retrieval of the tools that could support collaboration, both software and hardware, enhancing the growth and fattening of the social network dimension inside the organization.

2.2 *Ecosystem Perspective: towards business and innovation ecosystems*

Chesbrough [6] also poses some challenges for open innovation, referring to the 'what' (product/services vs. business models) and 'how' (closed vs. open innovation) companies should address new way to open their boundaries to become more innovative. The key challenge concerns the adoption of an open innovation approach (changing the 'how') towards a new business model (changing the 'what'), that the author claims is related to foster and nurture ecosystem innovation. Adner and Kapoor [1] confirm this view arguing that the model that seems more appropriate to represent the reality where we are going towards it is the one of "Innovation Ecosystems". More specifically they argue that the success of an organization depends not only from its ability in facing and resolving internal technological challenges regarding the innovation process, but also from the efforts of the actors involved in such a process that are part of the external environment and surround any firms and from the way the firm relates itself with this technological partners [1].

In the ecosystem perspective, two main important roles and strategies are played by the *keystone* and the *niche player* [12]. Keystone player holds a central but powerful hub position in the business network, but generally only a small part of that network. It is able to improve the overall health of the ecosystem by creating and sharing value with its network, by sharing information, intellectual property, and physical assets – from tools to interfaces, and from customer contacts to manufacturing capacity. Niche players has the "capacity to increase meaningful diversity through the creation of valuable new functions, or niches. […]. These 'edge firms' are vital to the health of the ecosystem because they are the locus of precisely the kind of meaningful diversity that we believe is essential to its robustness [...] they represent the bulk of the ecosystem and are responsible for most of the value creation and innovation" [12:133]. The authors affirm that "*keystones shape what an ecosystem does, whereas niche species are what it does*" [12:77].

Iansiti and Levien [12] suggested two fundamental aspects to be considered by firms that want to build a business ecosystem:

- *Product architecture* defines how the firms settle boundaries between products, technologies and between themselves. In an ecosystem it is core to define a common platform that could be accessed by the members of the ecosystem.
- *Integration capability*: defines how organizations collaborate sharing capabilities and technological components.

More specifically, a product platform is composed by a set of solutions available to the members of the ecosystem through different access points or interfaces. It is a collection of established technologies and standards that are useful to simplify transactions and operations within the ecosystem and that supply an efficient framework for value creation and for its division. The product platform contains a bundle of the most important functionalities delivered to the members of the ecosystem, both:

- *Implementations*, proprietary approaches to solve problems in the underlying technologies on which an ecosystem is built,
  and
- *Interfaces*, the visible incarnations of the solutions reached with implementation. They are access points, visible expression of what a platform does and they settle the utility of the underlying technologies.

An example of how business ecosystem perspective is used to foster the competitive advantage of a network of SMEs firms is Coral CEA[2]. It assists companies of all sizes with the commercialization of the next generation of information and communications technology: Communications-Enabled Applications (CEA). Coral CEA aims to represent the keystone organization of a Business Ecosystem. It provides 'out-of the room' technology, enhances partnering processes, and brokers deal flow to the advantage of its members. The Coral CEA ecosystem is anchored around a not-for-profit company with five founding members (IBM, Nortel, Carleton University, Eclipse Foundation and The Information Technology Association of Canada).

Eisenmann, Parker and Van Alstyne [8:3] define a *platform-mediated network* as "comprised of users whose transactions are subject to direct and/or indirect network effects, along with one or more intermediaries that facilitate users' transactions". Through the *platform*, users employ in common the set of components and rules. "*Components* include hardware, software, and service modules, along with an architecture that specifies how they fit together [11]. *Rules* are used to coordinate network participants' activities [2]". To this category belong standards, protocols, policies, and contracts. Moreover the authors provide a clarification of the concept of 'open' platform: "A platform is 'open' to the extent that: 1) no restrictions are placed on participation in its development, commercialization or use; or 2) any restrictions - for example, requirements to conform

[2] www.coralcea.ca/.

with technical standards or pay licensing fees - are reasonable and non-discriminatory, that is, they are applied uniformly to all potential platform participants [8:1]. Furthermore they highlight four key and distinct roles related to a platform-mediated networks. Besides the two users groups, which are divided into demand-side (*end users*) and supply-side (suppliers of components), an essential role is the platform provider, which provides a first point of contact for the user. The platform sponsor has no direct contact with users but has an important role as it holds the rights to change the technology on which the platform is built, it defines all the components and the rules and it decides who may join the network as a provider or as a user.

Eisenmann, Parker and Van Alstyne [8] argue that, referring to a given platform, each of these roles may be closed or open. They notice the need to specify and reference relevant roles and their degree of openness when characterizing a platform, instead of label it only as "open". Moreover they highlight the triangular structure that characterize exchanges in a platform mediated networks: demand side user - supply side user, demand side user - provider and provider - supply side user. The role of sponsor and provider of a platform can be covered by a company or a group of companies. Referring to the concept of *cybermediary*, or cybernetic broker, the authors identify three main functions that may be performed by a web platform: *matching*, namely encouraging connections between buyers and sellers, the *requisitioning* or apply for something, and the *problem solving*. In the first case the intent is to create a link between the buyer and seller by providing the same mutual information, on who is on products: the resulting role is an informative type. In the second case the goal is to provide products to consumers at the right time, in the right place and right amount allowing the occurrence of a transaction. This function has a dual role: the transactional, in facilitating the success of transactions through the exchange between buyers and sellers, and logistics, in which it is guaranteed that the product or service will be available to consumers in a predetermined physical or virtual environments. Finally, in problem solving, trying to ensure product quality and important assurances to sellers (security payment) and buyers (quality and safety in the receipt of goods). One method to achieve this role of insurance is obtained by creating a reputation system or using the certificate issued by a third party.
Within the latter category are the role of customization: customization is to realize more and more pressures to adhere better to the customers' needs and desires.

2.3 The emergent power of modularity

Modularity: basics and seminal background

Modularity is a systemic concept, describing how the components (modules) of a system can be uncoupled, separated and sometimes recombined. The abstract concept of modularity has been applied to different kinds of systems, including biological, technological and social systems, and to disciplines as different as mathematics, psychology, architecture, sociology, information science, biology, engineering. While we

will not be able to explore the extensive literature background on modularity here, just two seminal contribution are necessary to outline the reasons supporting the central role of modularity in collective innovation: Simon [20], Sanchez and Maloney [17].

The deep connections between modularity and complexity has been researched since the seminal paper in which Herbert A. Simon first introduced the concept of 'nearly decomposable system' [20]. 'Nearly decomposable systems' are hierarchic systems that consist of components (subsystems) that are interdependent in a peculiar way, summed up in two propositions:

- 'the short-run behavior of each of the components subsystems is approximately independent of the short-run behavior of the other components';
- in the long run, the behavior of any one of the components depends in only an aggregate way on the behavior of the other components';

These properties can be seen in different kinds of complex systems, including physical systems, biological systems and social systems. The reason why complex systems tend to evolve a modular hierarchy has been extensively debated, yet a comprehensive conclusion has not been reached. Indeed, Simon's conjecture positing that 'complex systems will evolve much more rapidly if there are stable intermediate forms than if there are not' still hold its ground. In simple words, modularity increases evolvability and promotes therefore evolutionary change. An important contribution for this paper purpose is the contribution of Sanchez and Maloney [17] who build on the concept of 'nearly decomposable systems' [20] to investigate the ability of a modular product architecture to coordinate an organization without the need of continually exercising authority. According to the authors technological knowledge about components interaction can be used to create a 'nearly decomposable system'. In essence the modular product architecture provides a form of 'embedded coordination' that reduces the need of external authority in coordinating the activities of an organization. The surprising yet sustainable claim is that 'although organizations ostensibly design products, it can be argued that *'product design organizations'*.

Indeed, while traditional product development is a form of 'programmed' innovation an alternative design methodology could be to create loosely coupled components design by specifying the components interfaces of an architectural product model. This could allow for effective coordination of the development of the product without the continuous need of central authority. The information structure of a modular product architecture is 'the glue' of embedded coordination of product development.

Knowledge management in new product development are strongly influenced by these concepts: in fact, while traditional development processes are sequential, modular product design can allow for a modular parallel product development process. This could also lead to different forms of organizational learning:

- at component level, improved by the fact that component-level learning processes can be carried out concurrently and autonomously by a distributed network of people;

- at architectural level, leveraging on the intentional decoupling of the architectural level.

Sanchez and Maloney forecast therefore '*new kinds of product development processes carried out by new forms of product development organizations*'. This 'new kind' of product development could be particularly significant and effective during the initial, uncertain and pioneering phases of the evolution of a new product and the creation of a new market. Indeed, uncertainty is associated with technological change, peaks before the emergence of a dominant design, and decreases soon after that convergence. The causes of this uncertainty are connected also with the complex link between invention and innovation (the commercial application and adoption of an invention, according to Schumpeter [18]). Fleming [10] focuses on invention, proposing that technological change derives from the inventor's process of search, involving the recombination of existing components through encapsulation and hierarchic modularization. Exploration-exploitation concepts are connected here, where exploitation has the form of 'local search' of (within the recombinant search space of the inventor) while the latter can be seen as 'distant' search. The usefulness and uncertainty of an invention are influenced by the recombination and refinement of familiar components, but when most of local recombination have been tried 'technological exhaustion' occurs, decreasing finally the invention's usefulness (opening the way towards distant recombination and possibly breakthrough).

Modularity as a gateway for collective innovation

Actually, modularity emerges from the extensive literature background encompassing so many scientific and technological areas as a powerful enabler of evolutionary change. It is therefore amply justified to embrace modularization as a keystone of platform-based collective innovation. Actually, technological modularity is in itself a complicated concept, showing several facets and meanings. In particular, two aspects are relevant for our purposes:

- the engineering (manufacturer's) perspective of product: a modular artefact is seen as a complex assembly of interacting components);
- the user view, which sees modularity as 'a bundle of attributes'.

This is in particular significant in describing the product performance (and user expectation) at top level, reconciling the typically distributed modularized view with the holistic view usually propelling the emergence of a new market. Moreover, modularity is significant at several levels and in several phases of a product life (e.g. design vs. manufacturing). The relation form-function, central to the very concept of modularity, is also not as fixed in an innovation process as it is in engineering.

These observations suggest the possibility to describe four different scenarios of modularity-supported innovation along the two dimensions form-function stability (fixed vs. reconfigurable) , product-system production balance (design centric vs. manufacturing centric) (see Figure 3, Table 1).

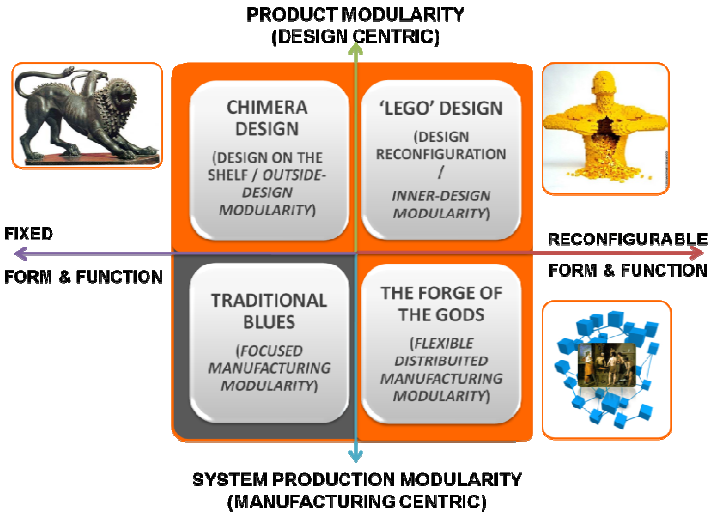

Figure 3. The results of a scenario thinking for innovation in the 2015.

3 Discussion and managerial implications

In the last years, a large number of web platforms based on the concepts of open innovation, collective intelligence and knowledge sharing are proliferating. In this context, it is established the pattern of the seeker-solver modality, in which a seeker is offering a reward (often monetary) to the solver to solve the problem or meet the needs expressed in the contest/challenge. Secondly there is the progressive rising of the open community and open source phenomenon as an attack emerging from below towards the dominant design of business models of pre-Linux economy. Between these two patterns a turbulent flow is due to processes of rapid and unpredictable change that shape the competitive landscape and continually force SMEs to divest marginal and passive role played so far. The structural and cultural limitations that SMEs are called to overcome, however, are deep-rooted.

The Collective project aims to develop an ICT-platform that enables the emergence of rich and healthy innovation ecosystems in which interacting agents, such as the SMEs, SMEAGs and other organizations and private individuals will collaborate and share knowledge, solutions, technologies, interests etc.

Table 1. The description of the four scenario for innovation in the 2015.

SCENARIO 1: TRADITIONAL BLUES (FOCUSED MANUFACTURING MODULARITY) The innovation of the product is driven by focused manufacturing modularity. The production technologies are strictly connected to the module which is needed to produce and are the differentiating value and competitive advantage. The production system is designed and implemented with settled form and locked functions, to make products for the same family. This scenario is the most conservative and more corresponding to the current innovation landscape, and for this reason it was called 'traditional blues'.
SCENARIO 2: THE FORGE OF THE GODS (FLEXIBLE DISTRIBUTED MANUFACTURING MODULARITY) The innovation of the product is driven by flexible distributed manufacturing modularity. The production technologies are spread and accessible within the network and could serve for many module when needed and for products belonging to different families. The production network is so flexible and reconfigurable for different needs and requirements. *Available example*: eMachine-Shop (An online platform where it possible to create custom metal parts and plastic parts a user need; www.emachineshop.com/)
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SCENARIO 4: 'LEGO' DESIGN ("DESIGN RECONFIGURATION"/INNER-DESIGN MODULARITY) The innovation of the product is driven by 'inner'-design modularity. The design modules can be "reconfigured" in order to obtain new products with variable form and variable functions. In this way, the purpose of the product may change over time, in a predictable way (purpose-built product) or non-predictable way (emergent purpose product). The metaphor of the bricks of Lego shows how these modules can be used from time to time to assemble objects with different shape and function. *Available example*: Bug system of the Bug Labs (it is a modular, open source system for building devices; www.buglabs.net/).

More specifically the ICT-platform aims to let SMEs and SME Associations to:

- identify future emergent technological and economic trends/discontinuities by developing network-based approaches to early detect 'weak signals';
- manage creativity and collective and distributed intelligence in the process of new product development in order to carry out new product ideas and business models;
- design modular products in a collaborative way reducing the market risk since relevant inputs and feedback from customers and end users will be constantly 'embedded' in the design process.

We identified some dimensions for the analysis of the open innovation approach (subjects/actors, platform, value sharing, horizon of sustainability). In the figure 4, we propose a match between these dimensions and the strategies that can be pursued in a business ecosystem [12]. We suggest embracing an ecosystemic vision in order to nurture and feed innovation idea-spaces, providing to the European SMEs an ICT-platform designed accordingly to the principles and considerations described so far. In this perspective, the digital world could acts as an extended mind, rich of self-organizing network of communities and idea-spaces of embedded collective intelligence [16].

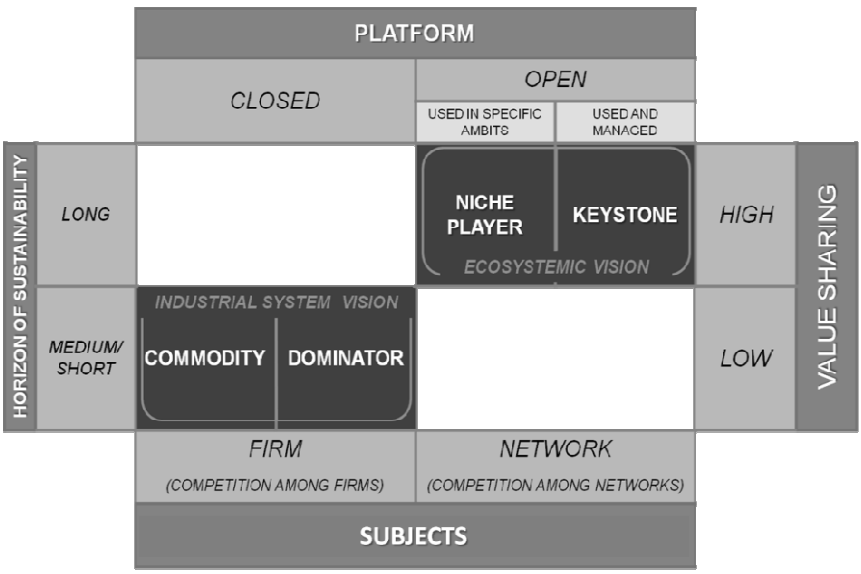

Figure 4. Strategies and roles inside a business and innovation ecosystem accordingly to the dimension of analysis.

The ambitious goal that raises the Collective Project is precisely to be able to give a strong support to SMEs also in the first phase of the innovation process, creating a fertile environment for ideas and opportunities, a new digital agora for ecosystemic innovation (see Figure 5) that foster collective intelligence, collaboration, and the power of web tool

applications. In this perspective, the Project aims to develop an ICT platform, not only for the connection between companies, but also for their co-evolution focused on developing innovative product, services and business models.

				INNOVATION APPROACHES			
				AS IS			*TO BE*
				Closed Innovation	Open Innovation		Ecosystemic Innovation
					Large enterprises	Small Medium Enterprises	
DIMENSIONS OF ANALYSIS	1) Subjects			Firms as 'castles'	Firms with porous boundaries	Innovative High-Tech Firms and Start-ups	Niche Players in the innovation ecosystems
	2) Platform	Organizational		Internal R&D	R&Connect&D	R&D&Connect	R&Coevolve&D
		ICT	Intra-firm	For internal co laboration	For internal collaboration	(rare)	For interna collaboration
			Inter-firm	/	For external connection	For external connection	For external collaboration
	3) Value sharing			Internal flows	Mostly incoming flows	Mostly outcoming flows	Mostly synchronous flows with value creation
	4) Sustainability			Ability to maintain the virtuous cycle described by Chesbrough	Avoiding the risk of assuming unbalanced power relationships	Sustaining technological and financial growth	Sharing fate for technological and financial growth

Figure 5. Ecosystemic innovation (to be) in large and small-medium enterprise.

4 Conclusions

In this paper we want to suggest how the basic concepts of complexity theory and business and innovation ecosystem can inspire and guide the design of a web platform to support innovative and collaborative process of European SMEs. More specifically, we have highlighted the power of modularity [2] towards the design of new products, services and business models, which potential has been already only partially exploited. The innovation led by an eco-systemic vision and the systemic assumption of the modularity principle are therefore proposed as the self-organization and self-poiesis enablers of collaborative network.

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Appendix

Table 2. Nine laws governing the idea spaces [16].

1) The law of tipping points[3]
In an open, dynamic network, under certain critical conditions, more becomes different. More change in lower-level elements prompts a self-organizing process that gives rise to a new, quantitatively different pattern. In an open, dynamic, scale-free[4] network, at some critical point *more is different*.
Key concepts: Self-organization, Emergence, Edge of chaos.
2) The law of the fit get rich
In an open, dynamic, scale-free network, the fit[5] get rich.
Key concepts: fitness, tipping point.
3) The law of the fit get fitter
In an open, dynamic, scale-free network, with positive feedback loops between hubs, the fit get fitter.
Key concepts: emergent systems, adaptive intelligence, emergence, feedback-loops.
4) The law of spontaneous generation
In an open, dynamic network, the creation of potentially meaningful relationships or patterns is spontaneous, emergent, and self-transforming.
Key concepts: Cantor's principle[6] for network (in any network there are always more links, including potential links, than nodes); meaningful relationships.
5) The law of navigation
In an open, dynamic network, identifying a potentially useful pattern (form of intelligence embedded in an idea-space) increases in difficulty as a function of the size of the search space of possibilities. Finding a path to a successful creative breakthrough increases in difficulty as a function of the size of the search space, as measured by the power set (i.e., set of all possible subsets) of its component nodes.
Corollary: In a search space dominated by sets of reciprocally interacting (i.e. context-determining) hubs, the size of the search space diminishes as a function of the delimiting conditions each hub places on the others via feedback loops.
Key concepts: navigation problem, accident, analogy, tinkering.

[3] Gladwell (2000:12) defines a tipping point as a sociological term: "the moment of critical mass, the threshold, the boiling point." Malcom Gladwell, *The Tipping Point: How little things can make a big difference* (Little Brown, New York, 2000).

[4] A scale-free network is a network whose degree distribution follows a power law, at least asymptotically.

[5] According to Barabási (2002:95), fitness "is a quantitative measure of a node's ability to stay in front of the competition" (A.L. Barabási, *Linked: The New science of networks*, Perseus, Cambridge, MA, 2002).

[6] "In elementary set theory, Cantor's theorem states that, for any set A, the set of all subsets of A (the power set of A) has a strictly greater cardinality than A itself". (source: Wikipedia)

6) The law of hotspots
In term of the extended mind, hotspot are highly energized, densely interconnected hubs (idea-spaces). They represent the natural outcome of the extended operation of the laws of fitness, which jointly produce two core characteristics of hotspot: rapid growth through attracting links, combined with a high level of integration. Fitness trigger preferential attachment – the fit grow rich. As new nodes link up to a hotspot, possibilities for a meaningful relationships and feedback loop increase. The law of the fit get fitter progressively gives rise to a central set of nodes that are well integrated with one another, thereby creating a stable core of embedded intelligence. This core fitness triggers still further growth, and so on (Ogle, 2007:166).
The potential transformative power of a hotspot relative to another idea-space is a function of fitness combined with distance.
Key concepts: hotspot, meaningful connectivity, weak ties, fitness.
7) The law of small-world networks
In a large scale-free (hub-dominated) network, the distance between any two nodes is small, typically less than six. While each additional hub potentially increases the total size of the network exponentially, increasing fitness (in the form of reciprocal relationships) will lead to the emergence of narrow, even uniquely defined worlds, thereby concretely specifying navigation pathways. Conversely, such worlds, once configured, expand rapidly as the law of the fit get rich is accelerated by closely linked hubs.
Key concepts: small world networks, hubs, navigation problem.
8) The law of integration
The integration of intelligence embedded in major idea-spaces is an essential component of creative breakthroughs. This integration, driven by the law of the fit get fitter, leads to a tipping point whose magnitude is a function of the laws of hotspots.
Key concepts: integration, fitness, hotspot.
9) The law of minimal effort
Creative leaps come from imaginatively harnessing the generative powers of the networked intelligence embedded in the extended mind.
Key concepts: extended mind, network effect.

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