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Theoretical background
Discussion and Conclusion

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FROM CONCEPTUALIZING TO READY-TO-SELL DESIGNING: CREATIVE NETWORKS AND DESIGN ENTREPRENEURSHIP IN A DIGITAL MANUFACTURING ERA.

Cabirio CAUTELA[a], Paola PISANO[*b], Marco PIRONTI[c], Alison RIEPLE[b]

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In this paper we argue that new 3-D printing technology is a form of disruptive innovation that is transforming the design and prototyping service sectors. Knowledge Intensive Business Services (KIBS) are growing in manufacturing industries, where they play the fundamental role of boosting and strengthening company innovation and competitiveness. Creativity based KIBS are especially flourishing as they support product innovation in design-driven industries. It is in these sectors that 3-D technology is fundamentally transforming the design and production processes, and thereby the industry's business model. The key feature of this technology is that it allows firms to produce small quantities of customized goods at relatively low costs. This is affecting incumbent companies by adding "Business to Consumer" (B2C) activities to their previous "Business to Business" (B2B) business models, and is accelerating the creation of new design ventures. B2C activities can be undertaken by new, small, firms with few technological capabilities, leveraging external creative sources and crowd-sourcing to create new products. In this paper we describe a number of business model "building-blocks" identified through qualitative inquiry of illuminatory cases. Finally, we develop a number of propositions to do with the business-models of prototyping companies and design new ventures.

Keywords: Creative and design services; 3-D printing; open business models

INTRODUCTION

Knowledge intensive business services are an expanding reality in modern manufacturing and industrial economies. In the form of "bridges of innovation" (Czarnitzki, and Spielkamp, 2000; Miles, 2005) these services connect companies that produce knowledge in the form of new products and processes with companies that apply and implement such knowledge to their own business models (Hargadon, 1998; Hargadon, and Sutton, 1997). Within KIBS, creative services are obtaining an important role, especially in association with design and development of new products (Abecassis-Moedas, Mahmoud-Jouini, Dell'Era, Manceau, and Verganti, 2012). These services - by transferring forms of knowledge from one sector (where it is known) to another (where it is unknown) – sustain companies' innovative processes by supporting the conceptualization and development phases of new artefact solutions. Specifically, prototyping services belong to that area where concept materialization in the form of mock-ups and prototypes supports the innovative process by providing input and feedback which are retroactive to the conceptualization phase for possible redesign operations of shape, product, interactive model, functional structure. (Droz, 1992; Schrage, 1993; Ulrich, and Eppinger, 2011).

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These prototyping services along with creativity – managed by manufacturing companies by using both internal asset and/or outsourced laboratories of physical and virtual prototyping – are going through a phase of fluidity and technological turmoil. Besides strengthening and boosting prototyping service performance, the achievement and spreading of 3-D printing technologies are having a great impact on organizational and business models that work in creativity sectors. By providing the opportunity to produce personalized finite and ready to sell products in smaller quantities, 3-D printing technology is creating new business opportunities for incumbent prototyping companies and increasing new-comers centered on exploiting 3-D printing technology by leveraging on external creative communities and crowdsourcing design Thus, the technological impact does not seem to affect only the reorganization of prototyping services, but especially the rearrangement of entire design-driven activity segments that involve scattered creative network and forces. Literature about KIBS and, in particular, about the services connected with design and creativity is scarce. (Abecassis-Moedas, et al., 2012).

This paper aims to partially cover this gap by examining how the achievement of 3-D printing technology is, on the one hand, rearranging organizational and business models of enterprises operating in creative prototyping and, at the same time, creating new enterprises that exploit the benefits and potentials of the new technology by leveraging on external creative communities and designers. Specifically we argue that established prototyping companies and new comers adopting 3-D technology are characterized by open business models, leveraging on external creativity sources. Qualitative in-depth analysis has been run on an empirical sample made up of three companies, of which new ventures and an established firm.

By the literature rooted frame of “business model” (Johnson, Christensen, and Kagermann, 2004) we have analyzed business models “building-blocks” of the selected companies figuring out their recurrences and divergences in the exploitation of 3-D printing business. With regards to speculative and explorative research, we don’t use the theoretical frame to test hypothesis but only to share a common language and a way to conceptualize the different business components and their relationships.

The article is made of five sections. The theoretical background pin points the features of open-business models. In this section the conceptual frame of business models is also presented as theoretical lens to analyze the empirical sampling.

The methodology goes on to explain the different phases of qualitative and case-studies based research. Tools and protocol are presented.

Findings and data analysis results are expressed in forms of propositions as used in explorative and speculative research. These proposition are supposed to propose a first-sight picture of 3-D printing based businesses.

Based on findings and results, a discussion is presented linking proposition to emerging cultural and economic trends.

THEORETICAL BACKGROUND

Knowledge intensive business services are exploited by companies to booster and strengthen their competiveness and innovation potential.

KIBS cover a wide range of economic service activities including accounting, communication, advertising, engineering, design, strategic management and other more sector-specific knowledge based services. Literature about KIBS is scant and generally companies offering this service typologies have been investigated as “bridges of innovation” (Czarnitzki, et al., 2000; Muller, and Zenker, 2001) or “knowledge brokers” (Hargadon, 1998; Hargadon, et al., 1997). Moreover KIBS related to design and creativity is a quite completely unexplored field of research that only recently (Abecassis-Moedas, et al., 2012) is gaining interest by scholars.

The poor literature mainly pin points the operation logics of these companies in transferring knowledge from a sector – “where it is known” – to another sector – “where it is unknown” (Hargadon, et al., 1997) and some more recent studies try to identify internationalization strategies of design consulting firms (Abecassis-Moedas, et al., 2012)

In these studies design consulting firms are based on a “closed innovation” and “closed business models” leveraging on proprietary asset: their designers or the internationally recognized chief designer; their methodologies and creative process; their “proximity” to clients by the presence of world-wide distributed offices.

Besides these companies there are other entities centred on design activities and creativity assets that are covering a relevant segment of industrial manufacturing that are neglected by research of design and innovation management. These companies – mainly operating in the tail of the innovative process offering skills and capabilities to produce prototypes and mock-ups – are evolving as open design entities thanks to the adoption of the 3-D printing technology. On parallel this technology is becoming the triggering to the creation of new design ventures producing finite products with 3-D printing technologies and leveraging on external creative sources and design crowdsourcing.

Berman (2012) in a recent contribution examining the characteristics and applications of 3-D printing in comparison to mass customization and other manufacturing processes describes the technology as follows: “3-D printing employs an additive manufacturing process whereby products are built on a layer-by-layer basis, through a series of cross-sectional slices. While 3-D printers work in a manner similar to traditional laser or inkjet printers, rather than using multi-coloured inks, the 3-D printer uses powder that is slowly built into an image on a layer-by-layer basis”.

Some technical aspects of the technology are widely acknowledged (Berman, 2012):

- the full integration of printing with a CAD software in order to have a fully integrated design-product production activity along with the possibility of sharing the product technical codes via web reproducing it in different places and with different printers;
- the possibility to use different kinds of materials on the same printer (aluminium, stainless steel, titanium, polymers, ceramics);
- the opportunity fully personalize products on the basis of customers preferences and the possibility to handle some product evolution simply with some refinements managed by CAD;
- the reduction of the relevance of inventory risk and management connected to the opportunity to print on demand the desired artefacts;
- the reduction of materials and wastes to produce single product units.

3-D technology is spreading out, according to different popular economic and technical magazines (The Economist, Business Week, Wired, Make), changing the paradigm and logics of industrial manufacturing and the productive value chains.

A first emergent and acknowledged issue provides that established prototying companies adopting 3-D printing and new design ventures centered on 3-D printing technology cannot be investigated with the classical economic theory related to the management of proprietary asset and completely internalized innovation process. Last acquisitions of knowledge about open organizations (Chesbrough, 2006) seem better fit to analyze 3-D printing based companies, seeking for their business models and their asset management.

An open system model is a model in which the firm create and capture value take advantage of both internal and external resources. Chesbrough (2006) in his book “Open business model: how to thrive in the innovation landscape” analyzed the characteristics that a firm can have for creating an open organization.

In the old model of "closed organization”, companies must generate their own ideas that they would then develop, manufacture, market, distribute and service themselves. For years, this was

the "right way" to bring new ideas to market and successful companies are those who invested more heavily in internal R&D than their competitors and attracted the brightest and smartest employees . Thanks to such investments, they were able to discover the best and greatest number of ideas, which allowed them to get to the market first. This, in turn, enabled them to gather most of the profits, which they protected by aggressively controlling their intellectual property (IP) to prevent competitors from exploiting it. Closed organization then reinvested the profits in conducting more R&D, which then led to additional breakthrough discoveries, creating a virtuous inner cycle of innovation.

The open organization model goes through some organizational characteristics. First of all Chesbrough (2006) underlined the importance of having a new management of innovation that included the process of acquiring and integrating such ideas into the organization and sales them. As “valuable ideas can come from inside or outside the company and can go to market from inside or outside the company as well” (Chesbrough, 2006a), in the open organization model, firms commercialize external (as well as internal) ideas by deploying outside (as well as in-house) pathways to the market. Specifically, companies can commercialize internal ideas through channels outside their current businesses in order to generate value for the organization, and external ideas through channels inside their current business.

Some vehicles for accomplishing this include start-up companies (which might be financed and staffed with some of the company's own personnel) and licensing agreements.

Second, in this mechanism the number of ideas that can be potentially produced increases massively. So the companies need to screen their ideas and separate the bad proposals from the good ones: while both the closed and open models are adept at weeding out "false positives" (that is, bad ideas that initially look promising), open innovation also incorporates the ability to rescue "false negatives" (projects that initially seem to lack promise but turn out to be surprisingly valuable). From this point of view the profit of a company is not only gained by using the patents developed, but also by misusing the unused patents and selling them to other companies

Third, the firm’s value is contingent upon its ability to create and lay claim to knowledge derived from participation in various kinds of collaborations with other actors.

It has been shown that connectivity with external actors is important in order for firms to remain innovative (Freeman, 1991), and in the network literature it is commonly argued that firms benefit from the social landscapes in which they are embedded. Scholars writing along these lines have developed important findings in terms of how certain network structures influence firm behaviour and performance (Ahuja, 2000; Baum, Calabrese, and Silverman, 2000; Gulati, Nohria, and Zaheer, 2000). Relationships with other actors help firms to absorb different knowledge (Ahuja, 2000), improve survival rates (Baum, and Oliver, 1991), increase innovativeness (Baum, et al., 2000; Stuart, 2000), improve performance (Hagedoorn, and Schakenraad, 1994; Shan, Walker, and Kogut , 1994) and in general grow faster (Powell, Koput, and Smith-Doerr, 1996; Stuart, 2000).

Some of the literature underlines the firms’ need to increase processes that ensure assimilation of developments in the external environment through progress of absorptive capacity (Cohen, and Levinthal, 1990; Lane, and Lubatkin, 1998; Zahra, and George, 2002). Research has shown that firms need to have competences in areas related to their partners’ in order to assimilate external sources (Brusoni, Prencipe, and Pavitt, 2001; Granstrand, Patel, and Pavitt, 1997; Mowery, Oxley, and Silverman, 1996). Internal capabilities and external relations must therefore be seen not as substitutes but as complements. The ability to absorb external inputs depends on what the firm knows. Another important point is related to the similarity of knowledge bases and how they facilitate the integration of ideas from distant realms (Kogut, and Zander, 1992), because shared languages, common norms and cognitive configurations enable communication (Cohen, et al., 1990). In absorbing new knowledge, the firm also increases its possibilities of making novel re-combinations. Incorporating knowledge bases too close to what the firm already knows will hamper the positive effect of assimilating external inputs. For instance, Ahuja and Katila (2001) suggested

that knowledge relatedness between the acquiring and acquired firms is curvilinear related to innovative performance. Too distant inputs are harder to align with existing practices, and if knowledge bases are too similar it is difficult to come up with novel combinations (Sapienza, Parhankangas, and Autio, 2004). In other words, the effectiveness of openness is also contingent upon the resource endowments of the partnering organization*.

Open business models of the centred on 3-D printing companies have been assessed according to the following (Johnson, et al., 2004):

- Customer value proposition, that explain the specific "job-done" for the customer that alternative offerings don't address;
- key resource: key element (people, technology, product, facilities, equipment, channel, brand) that create value for the customer and company and the way those element interact;
- key processes: the key-activities (training, development, manufacturing, planning, sales but also norms, rule and metric) required to build and deliver the value proposition to targeted customers.

METHODOLOGY

The existing scarse literature abou KIBS based on creativity and design (Abecassis- Moedas, et al., 2012) lays the basis for an exploratory research using proposition that form an initial structure to be used to start future specific research strands.

The used methodology has counted for a case study qualitative analysis using multiple resources and an iterative process where researchers constantly compare theory and data- iterating towards a theory which closely fits the data (Eisenhardt, 1989).

The first activity of data gathering was carried out in order to bound world wide uses of 3-D printing technology, understand their functioning logics and interactive models with the productive technologies and opportunities provided.

In order to obtain this picture of pre-understanding, the following activities were carried out:

- An analysis of 45 articles taken from main international, technical and economics magazines (see table 1), dealing with 3-D printing topic in several articles and special issues; this reading enabled us, at first, to write down the terms and verbs mostly used to describe the technological potentials, the main productive applications, and the most recurrent cases;
- An analysis of 3 blogs on specific arguments dealing with the topic of 3-D printing (see table 2); this analysis – developed on 405 posts/comments made by different blog participants – enabled us to extract users' emerging views on the potentials offered by this technology, on their own experience using and interacting with the technology, on the main cases of companies reported as being users of 3-D printing technology

* We have not included in the analysis of the business model the "profit formula" due to a lack of comparable and consistent data among the selected cases.

Table 1: A selected collection of articles and special issues published by main magazines dealing with 3-D printing technology

Magazine	Date	Article Title	Emergent Issues
Business Week	26 April 2012	3D Printers: Make Whatever you want	- Manufacturers and companies users of technology - Technology working logics - Sectors mainly involved in the 3D printing use
Business Week	09 May 2012	Bre Pettis: 3D Printing's First Celebrity	- Producers of 3-D printing technology - Contexts of application
Business Week	03 May 2012	How About Them Gams: 3D Printing Custom Legs	- Integration between design and prototyping - Customization potentialities
The Economist	10 February 2011	The printed world	- Manufacturers and companies users of the technology - Technology working logics - Prototyping companies using the 3D technology
The Economist	21 April 2012	A third Industrial Revolution/Solid Print	- Manufacturing scenarios - Facts and figures about 3-D printing technology - Technology working logics - Manufacturers and companies users of technology
Wired	05 September 2011	An industrial revolution in Digital Age	- Technology working logics - Sectors mainly involved in 3 D printing use - Manufacturers and companies users of technology
Make	February 2010 Vol. 21	Your Desktop Factory – 3 D Manufacturing at home	- Technology working logics - Producers of 3-D printing technology

Table 2: Selected blogs dealing with 3-D technology

Blog	Topic/Title	Posts/Comments
The Economist	The Third Industrial Revolution	364
Business Week	3D Printers: Make Whatever You Want	8
Wired	Cube indoors and outdoors	33

After these two introductive analysis we conducted 3 semi-structured surveys at Full Professor of Technology Management at Stanford University, at the Westminster University of London and at the University of Turin. These surveys helped to clear up the limitations of 3-D printing technology, the main application contexts that this technology has gained access to (i.e. automotive, fashion, health and care, interior design), some international reference cases about the use of 3-D printing.

The reduced spreading of this technology and the repetition in articles, blogs and case study surveys enabled to find an empirical sampling. This sampling – in coherence with the theoretical sampling criteria in the case study qualitative analysis (Eisenhardt, 1989; Pettigrew, 1998) – is made of cases which have distinctively different characteristics in the use of 3-D printing technology.

In particular, our analysis was founded on three types of companies:

- Materialize, a company specialized in prototyping services which created, with 3-D printing, I-Materialize, a digital connection platform between creative communities and users;
- Quirky, a new venture created around the potentials of 3-D printing, based on the development of ideas and concepts suggested by users/designers which are then promoted by means of e-commerce or more traditional distribution networks;

- Fab-Lab, a global network of design shops that have 3-D technology printers, which works with small businesses, users and craftsmen in the production and sales of their products .

The sample presents companies that work in the world of prototyping services, typically characterised by “B2B” business logics which, with 3-D printing, have grown towards “B2C” logics; and companies that are set up exclusively around this technology using only “B2C” business logics.

The business model analysis of these companies was conducted with two different activities:

- The analysis of companies’ websites;
- The analysis of a subset of articles (24 out of a total of 45) reporting data and information on the selected companies’ business models and competitive behaviour.

We used computer-assisted content analysis (CATA) on the web site analysis. Similar to human coding schemes, CATA generally analyzes content via word usage (Morris, 2004). Relying on text assumes that insights about the business model can be detected through the occurrence of and frequency with which certain concepts are used in text (Carley, 1997; Short, Broberg, Cogliser, and Brigham, 2010). It goes without saying that CATA is advantageous in that multiple texts can be analyzed without suffering from errors and from bias associated to human coders (Stevenson, 2001). We build our dictionary (see table 3) on the “business model block” according with the literature frame on the business model. We choose the representative words for each block selected a set of words (see column “Reference” in table 3) used by Christensen to describe each block. Then we contextualized each word from the reference in accordance with our specific context (see the table 3) .To assess the relevance of different words and their usefulness in measuring the business model in texts under study we then perform a key word in contest analysis (Krippendorff, 2004). For all occurrences of the words included in the dictionary, all the sentences were analyzed manually by at least two authors (table 4: provides some examples of sentences included in the analysis). The results of the analysis was discussed during 12 meeting and 8 conference call. In the Table we provide some examples of sentences that included words of our dictionary.

Table 3: Content analysis dictionary

Business model building block	**Reference dictionary**	**Contest qualification dictionary**
Customer value proposition	Custom*	User* designer*
	Relation*	Collaborat* Participat*
Key resource	People	Crowd* User*
	Technolog*	3D printing
	Product*	Finite* Customize*
	Channel*	E-commerce Shop*
Key process	Manufact*	Digital*
	Interact	Network* Select*

Table 4: Examples of keyword occurrences in content analysis

Dictionary	Sentences
Collaborative	Quirky is one of the biggest reality in the collaborative design field: it creates links and conversations between a global influencer community (people able to advice and feedback to help the design process), the experts of the design team pool and the inventor (Quirky)
Design	Designers will be on-site to accept original product ideas from the public (Quirky) I.materialise on one hand gives the designers the chance to show off their talent and sell their products thanks to a worlwide distribution network, on the other hand the potential buyer can access to a unique products collection realized on demand (I-materialize)
People	For this process to work, you need to find the right people, ask the right questions and appeal to the right market," says Jeremy Brown, CEO of Sense Worldwide, a consultancy that has helped Nike and Procter & Gamble set up co-creation initiatives (Quirky) People made the staff, by the end of this year it's planned they are going to be 80(Quirky)
Develop*	R&D (research and development) canter for big companies which can prototype products (Fab-lab) Fab Lab San Diego program has developed in response to the need to inspire students while engaging them in learning next generation technology (Fab-lab)
Service*	I-materialise is an online 3D printing service, based in Belgium (I-materialize)
Technology	The flexibility given by the type of technology overcomes the 'minimum quantity' so even one single piece can be produced (I-materialize)
3D printing	I.materialise is an online 3D printing service, based in Belgium (I-Materialise)

The content analysis provided the authors the set of sentence useful to identify and assess the business model building blocks to meaningful business elements.

The features of the detected business model were given to three professors of Technology Management to validate. These professors were interviewed during the first phase after they had looked at the websites of the tested companies and at the subset of articles reporting elements and information on the selected case-studies. A methodology process articulation is presented (Figure 1).

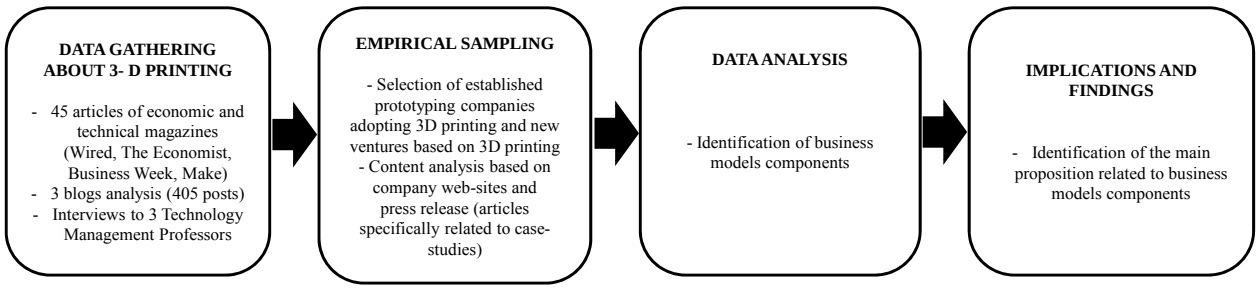

Figure 1: Methodology process

DATA ANALYSIS AND PROPOSITIONS

The data analyzed show that the achievement of 3-D technology is spreading in two different ways: (i) the first as an "additional" service from organizations specialized in prototyping services to companies; (ii) second with the creation of new companies.

The first companies originally offer Knowledge intensive business services(KIBS) which mainly work in the terminal phases of the innovative process where – with prototyping and materializing concepts – they provide input and feedback on the quality and characteristics of products. Such organizations, by materializing objects, provide companies' designers and R&D offices with the input for the revision of engineering and conceptualization phases, paying off the relationship between "thought" and "practice" typical of creative processes. (Shon, 1984).

3-D printing technology, as it results from the analysis, is adopted by these companies both as an advanced technological instrument to keep offering prototyping services to manufacturing companies, and as the creation of new business services for digital platform consumers, where the final consumers and/or designers can conceive their creations and concepts with the chance of use and/or selling them.

With regards to the new ventures founded exclusively on 3-D – like Quirky – these are platforms gathering, collecting and selling ideas and concepts "posted" by external designers and consumers.

These platforms are mainly supported by three types of users: designers who self-produce their own ideas and creations to sell them in their personal channels (*customization driven designers*); designers who propose their own products to market them on the platform (*oriented to market designers*); users looking for products that are not standardized or sold in great volumes on industrial scale (*customization driven users*).

In both cases – whether in the case of additional service development on behalf of established prototyping companies, or in the case of new ventures – 3-D printing technology is associated with an open creativity handling model distributed in those places where companies obtain, bring into production and sell ideas and concepts produced by external designers and clients. In fact, these organizations have:

- A few designers and creative figures: for example Quirky has 8 designers on staff for a total of 40 people in the team) in line with the dimension of Cherbrough's knowledge worker underlined in our literature review;
- A basis of knowledge resources needed when dealing with idea selection and management of products coming from external sources: for example in Quirky, the Ideas submitted received a double evaluation from the community and from the member of Quirky staff;
- The ability to promote the potentials of 3-D printing technology using their own limited creations: for example Fab-lab lend 3-D printing (and other technological devices) to those inventors who can prove their ability –or who have been educated by the Fab Lab Academy to use these technologies properly.

The characteristics of these models can be fully attributed to the models of "open innovation" (Chesbrough, 2003). Open innovation starts with the disintegration of conception-conceptualization-engineering-production-sales activities. The pulverization of integrated value chains (Porter, 1980) gave rise to companies specialized in micro-activities and, above all, to a number of "knowledge brokers" and "bridging ties" that link actors who propose a new knowledge in the nature of new ideas and products with actors who are able to accomplish, implement and sell them .

The "open innovation" model – adopted expressly by companies who use the new 3-D printing technology – may be attributed to the following motivations: the impossibility of meeting the need of market/consumers to have a different business model (the need is that of inventors who don't have the means to produce their own ideas); new market opportunities such as 3-D Printing which enable the production of "ready-to-sell" finite products and change the dynamics of competition; limited barriers for creative communities and crowdsourcing design on a digital network which also affect the dynamics of competition.

With these considerations we suggest the following first proposition.

Proposition 1: *the 3-D printing technology induces established companies and new design ventures to develop open business models as marketplaces or open design shops centred on community and design crowdsourcing*

The management of mainly external creative resources connected with crowdsourcing design together with 3-D printers and machines form the two main assets for both activities of conception-conceptualization and production. The market of the different products generated from 3-D printing is entrusted to the management of distinct distributive channels and strategies. This is valid for both established prototyping companies and new ventures.

Quirky and I-Materialize, for example, extremely excited about the idea of a creative marketplace community, have developed on-line shops giving users the chance to buy products generated by various users-designers. With this, Quirky, – mostly in line with the logic of pushing a distributive strategy – combines a retailing network of products conceived with their own platform. Actors specialized in organized distribution, such as Safeway, Target, Barnes&Noble, Amazon, Toys "R" Us, are only a few examples of partners where you can buy products powered by Quirky. These new relationships bring important innovative elements to the classic models of relationships between manufacturing organizations and distributive channels.

A third distributive model adopted is the open shop design. Cases like Fab-lab have a distributive network in the world with over 50 laboratories open to welcoming designers, production self learners, users driven by the desire of personalizing small products such as accessories, musical instruments, toys. Fab-lab's experience introduces a further innovative element: their territorial presence, which, being often highly integrated with the local social-productive material, determines the direct involvement of the final client, bypassing even the entire distributive channel. The client becomes the buyer but also an important tester of product effectiveness or simply of the idea conceived in the labs. In other words, 3-D printing technology – already in this first exploratory research – does not seem particularly associated with specific distributive models. In other words, there is no structural combination between "technology" and strategies and distributive policies. Given these considerations it is possible to draw the second proposition:

Proposition 2 **:** *3-D printing technology allows new design ventures and established prototyping companies to develop different distributive strategies: direct e-commerce, alliances with distributive and retailing specialized channels, design open shops*

The intrinsic characteristics of 3-D printing technology enable to produce different categories of products, in limited quantities and, above all, without a technological complementary relationship among them. In all of the cases studied, there is an extremely high heterogeneousity of produced and sold categories of goods. Fashion accessories, jewels, toys, shoes, musical instruments, lamps, interior design products are indistinctively found in all product portfolios managed by 3-D printing companies. In fact, the major problems connected with this technology concern the different exploitable materials. The absence of links and technological complementarity among potentially creatable products together with the absence of production scale and volume economies – as found in several cases – lead to a wide and heterogeneous management of product portfolio. The profitability logic is founded on generating profits as well as on a number of product lines with low product volumes(Kekre, and Srinivasan, 1990; Osterwalder, and Pigneur, 2010; Amit, and Zott 2001). This characteristic is found in "open innovation" and "open business" models, where creating new solutions and products is more than just sharing technological, esthetical, or category links of products (Sanderson, and Uzumeri, 1995), they share a fixed knowledge and common processes and dynamic capabilities which they come from. (Chesbrough, 2003). Breaking the technological, esthetical and category links can also reduce the brand power on these productions.. Some categories of the products dealt with – such as accessories, interior design products, jewels – typically linked to brand driven purchasing processes, in 3-D printing cases they lose the signaling value of the brand and acquire the signaling power of customization, which is in turn linked to creative processes and communities. You can buy it on Quirky or I-Materialize because you can share a conceptual and productive idea which is linked to the world of "Making", self-production and distributed design.

> *…I usually buy new products that look interesting to me from a conceptual and productive point of view. I make my personal considerations and criticism about the projects and concepts shown on-line and, if they take the creative direction that I am looking for, I'll buy the derived products. I feel as if I am contributing to the extended*

creative process and, above all, to a new way of perceiving the making and marketing of a product (Blogger, 20/07/2011)

In this case, processes and communities are the new brand drive , shaped by values centered on customization, anti-standardization, creative sharing, and open source creativity. Given these considerations we can obtain the following proposition:

Proposition 3: *The open business model induce design ventures to define a profitability product-portfolio made of a great heterogeneous variety of customized and low volume products with no technological complementarities whereas the processes and community management prevail on the brand management.*

Technology has not an intrinsic value (Teece, 2010). In other words, obtaining a dynamic competitive advantage and transforming it into a profitability position goes through competence (Hamel, and Prahalad, 1990) and dynamic capabilities mastering (Teece, Pisano, and Shuen 1997; Eisenhardt, and Martin, 2000), moving resources and transforming them in values for the client. In "open innovation" models, with greater dynamism, capabilities are limited to physical capitals and mainly come from the management of relational ties and knowledge. (Chersborough, 2006).

Apart from the management of 3-D printing machines, the main activities which are central to the management of 3-D printing organizations are: (i) the management of creative networks and crowdsourcing; (ii) the management and selection of projects, taking care of their visibility and sales promotion; (iii) the management of their marketplace and/or distributive channels (if there are any). These activities can easily be attributed to the "double-sided" business models (Osterwalder, et al., 2010), that is, platforms that connect content providers – in the case of new product conceptions – with their users. This mainly happens in cases where the designer posts new concepts and products to be placed on the creative community market. From this viewpoint, the development of Arduino's adopters' open-source communities enable an interchange that helps to use the technology, and also creates a new knowledge and new ideas: technology becomes an accelerator of spread creativity. Alternatively, like in the case of FabLab, companies are physical platforms – design-open-shops – open to users for the self production and prototyping services of their own artifacts. For what concerns the key capabilities that outline our analysis, we can obtain the following pro position:

Proposition 4: *3-D printing new design ventures are based on dynamic capabilities related to network management, project selection and customer relationship.*

The following table links the value proposition to the practice case analysis.

Table 5: the value proposition linked to the practice case analysis

MAIN PROPOSITIONS	DETAILS	QUIRKY	FAB-LAB	I-MATERIALIZE
The 3-D printing technology induce established companies and new design ventures to develop open business models as marketplaces or open design shop centred on community and design crowdsourcing	Open system model	Marketplace based on online community (65,000 member) and staff member (40 employees of which 8 designers) that through crowdsourcing turn invention/idea in product.	Open design shop based on global network of national and regional labs. The R&D centre linked to big companies to prototype activities.	Marketplace based on the connection among inventors and the technology
3-D printing technology allows the new design ventures and established prototyping companies to develop different distributive strategies: direct e-commerce, alliances with distributive and retailing specialized channels, design open shops	Distributive channel and partnership	-12 retailers -E-commerce direct selling	- Design shop	E-commerce direct selling
The open business model induces design ventures to define a profitability product-portfolio composed by a great heterogeneous variety of customized and low volume products with no technological complementarities whereas the processes and community management prevail on the brand management	Product category /product portfolio	Kitchen; Toy; Home Decor; Lawn & Garden; Electronics; Organization; Fitness; Accessories; Pets; Other	Healthcare; agriculture; housing; communications	Lamps; furniture, fashion accessories, jewelleries and toys
3-D printing based new design ventures are based on dynamic capabilities related to network management, project selection and customer relationship	Dynamic capability	Design team; inventors; and distributive channels management Project selection Costumer relationship	Fab-Foundation; Entrepreneurship centre; Fab Academy management Informal player Project selection capability Costumer relationship	Inventor community management and design team management Project selection capability Customer relationship

DISCUSSION AND CONCLUSION

The development of Knowledge intensive business services in modern industrial and manufacturing economies is speeding up new competitive mechanisms based on different business models. In particular, it seems that a new competitive arena is emerging in services connected with design and creativity, rather than having a pre-existent radical change in the design and creativity professional services. Like the current competitive arena, which features stable and consolidated relationships between large scale production players, incumbent designers and design consulting firms (Capaldo, 2007; Dell'Era, and Verganti, 2010), there is now a new scenario

which features new players (including new comer designers) who base their competitive advantages on external networks that leverage on spreading creativity models. The spreading of design education, the accomplishment of designers – not seen as an elite profession, but as "mass employment" (Branzi, 2010) – the proliferation of instruments and software open to design, the spreading of cultures linked to the "making" and to advanced self-production (Senneth, 2009; Micelli, 2011) together with the potentials of the 2.0 web and social networks make qualified factors and are "the background" for the development of these new forms of design and industrial production.

This latter scenario does not seem, at least for the moment, to be competing with the current one, which is founded on a trading relationship between manufacturers and designers. The reason for this is that the current scenario does not focus on providing design services to companies, but on providing B2C or C2C offer systems to markets where content sharing and the manufacture of products developed in a "shared" way acquire their own value, overcoming the classical logics of fordism trading. In this scenario, new technologies (e.g. 3-D printing) do not have a central or leading role, but they are trend accelerators of a new business model building. The 3-D printing technology induces players, incumbent and new comers to develop an open business models as marketplaces or open design shops centered on community and design crowdsourcing. These distributive models which are found in these contexts often exceed the traditional vertical relationships between producers and distributors. The basic concept is having access (Rifkin, 2001) to an organized and open system of productive resources. Inside this expanding context, products do not have a technological complementarities or branding relationships. With 3-D printers –given material limitations - companies produce, lamps, shoes, accessories, toys, without any kind of category ties and complementarities. The absence of merchandise categories ties induces to reconsider, although still partially, about companies boundaries and the actors relationships within the value chain.

As outlined in the data analysis and empirical evidence of selected cases, in fact, the open business model induces design ventures and prototyping established companies to define a profitability product-portfolio made of a great heterogeneous variety of customized and low volume products with no technological complementarities, whereas the processes and community management prevail on the brand management.

Our analysis, based on 3 empirical pieces of evidence, does not intend to indentify the characteristics of a new emerging industry, but wants to outline some trends in industrial design and production that are becoming complementary and, in some cases, "competitors" of the consolidated models of production and consumer goods. The propositions reported in this paper would like to propose tips for future research paths aimed at finding new business models and new forms of creative business associated with emerging implications and consumer patterns.

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