Academic Star Publishing Company
Http://www.academicstar.us

ISSN 2155-7950

Academic Star

Journal of Business and Economics

Volume 4, Number 7, July 2013

Journal of Business and Economics

Volume 4, Number 7, July 2013

Subscription Information:

Price: US$420/year (print)
Those who want to subscribe to our journal can contact: finance@academicstar.us.

Peer Review Policy:

Journal of Business and Economics (ISSN 2155-7950) is a refereed journal. All research articles in this journal undergo rigorous peer review, based on initial editor screening and anonymous refereeing by at least two anonymous referees. The review process usually takes 4-6 weeks. Papers are accepted for publication subject to no substantive, stylistic editing. The editor reserves the right to make any necessary changes in the papers, or request the author to do so, or reject the paper submitted.

Database Index:

Journal of Business and Economics (ISSN 2155-7950) is indexed by SSRN, EBSCO and Ulrich now.

Contact Information:

Manuscripts can be submitted to: economics@academicstar.us, jbe@academicstar.us or andy@academicstar.us. Constructions for Authors and Submission Online System are available at our website: http://www.academicstar.us.

Address: 228 East 45th Street, Ground Floor, #CN00000267, New York, NY 10024
Tel: 347-566-2153, 347-230-6798 Fax: 646-619-4168, 347-426-1986
E-mail: economics@academicstar.us, business_academicstar@yahoo.com

Journal of
Business and Economics

Volume 4, Number 7, July 2013

Contents

Articles

Case Study

Journal of Business and Economics, ISSN 2155-7950, USA
July 2013, Volume 4, No. 7, pp. 634-644

http://www.academicstar.us

The 3D-Technology: A New Competitive Arena

Paola Pisano[1], Marco Pironti[2], Alison Rieple[1]
(1. Westminster University; 2. Università di Torino, Italy)

Abstract: In this paper we argue that 3-D printing technology is a form of disruptive innovation that is transforming the design and prototyping service sectors where Knowledge Intensive Business Services (KIBS) are growing in importance. In manufacturing industries they play the role of boosting and strengthening innovation, an especially important role in design-driven sectors. It is in these sectors that 3-D technology is fundamentally transforming the design and production process, and thereby the industry's business models. The key feature of this technology is that it allows firms to produce small quantities of customized goods at relatively low costs. This is encouraging incumbent companies to add "Business to Consumer" (B2C) activities to their previous "Business to Business" (B2B) business models. It is also 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 the changes to business models identified through examination of the practices of a small sample of illustrative cases.

Key words: creative and design services; KIBS; 3-D printing; open business models
JEL code: O33

1. Introduction

Knowledge intensive business services (KIBS) are an increasing presence in modern manufacturing and industrial economies. As "bridges of innovation" (Czarnitzki and Spielkamp, 2000; Miles, 2005) KIBS fulfil an important role, especially in the design and development of new products (Abecassis-Moedas et al., 2012) by transferring knowledge from one sector (where it is known) to another (where it is unknown) (Hargadon, 1998; Hargadon and Sutton, 1997). They enhance innovation by improving the conceptualization and development phases of new products through providing input and feedback during the materialization of concepts in the form of mock-ups and prototypes. These are retroactive to the conceptualization phase, allowing for the redesign of shape, product, interactive model, or functional structure (Droz, 1992; Schrage, 1993; Ulrich, and Eppinger, 2011).

These prototyping services, along with manufacturing companies' own prototyping facilities, are going through a phase of technological turmoil. Besides strengthening and boosting prototyping service performance, the development and spread of new 3-D printing technologies are having an impact on organizational and business models in these sectors. By providing the opportunity to produce personalized finite and ready to sell products in

Paola Pisano, Assistant Professor, University of Torino; research areas: innovation, start up and new venture. E-mail:pisano@di.unito.it.
Marco Pironti, Associate Professor, Università di Torino; research areas: innovation, start up and new venture. E-mail: Pironti@di.unito.it.
Alison Rieple, Full Professor, Westminster Business School; research areas: strategic management. E-mail: A.rieple@westminster.ac.uk.

small quantities, 3-D printing technology is both creating new business opportunities for incumbent prototyping companies and increasing the potential for new entrants who can leverage external creative communities and crowdsourcing for design inputs. These technological changes not only seem to be affecting the reorganization of prototyping services but the rearrangement of entire design-driven activity segments that involve scattered creative networks.

This paper examines how 3-D printing technology is not only causing the rearrangement of firms' organizational and business models, but also the industry's structure itself. We have analysed a sample of three companies, two new ventures and one established firm. Using Johnson, Christensen, and Kagermann's (2004) conceptualization of business models we have examined the business model "building-blocks" of the selected companies in their exploitation of 3-D printing technologies. As this is an exploratory study, we don't use this theoretical framework to test hypotheses but only as a way of examining the different business model components in our sample companies.

The article is in five sections. After the introduction, the second section outlines the theoretical background to our study, and pinpoints the elements of business models that we examine. The elements of open business models are also discussed. The next section presents our methodology. Then, in the fourth section, we present our data analysis and findings. Based on our findings, the final section discusses the implications of changes in 3-D printing technologies for KIBS, design and prototyping firms.

2. Literature Review

Berman (2012), in a recent contribution comparing the characteristics and applications of 3-D printing to mass customization and other manufacturing processes, describes the technology as employing an "additive manufacturing process" in which products are built on a layer-by-layer basis. 3-D printers work in a manner similar to traditional laser or inkjet printers, but rather than using ink the 3-D printer uses powder that is slowly built into a physical artefact, layer-by-layer. There are some additional technological aspects to the process:

- the integration of the printer with CAD software to achieve a complete design-production function;
- the sharing of the product's technical codes via the web, allowing the design to be reproduced in different places and with different printers;
- the ability to use different kinds of materials on the same printer (e.g., aluminium, stainless steel, titanium, polymers, ceramics);
- the ability to personalize products on the basis of customers' preferences and make amendments to the product simply with some adjustments to the CAD program.

Although there is debate over some of the economic claims made for 3-D printing (2012 personal interviews with 3-D researchers), because the process is an additive one, there tends to be less waste, leading to a reduction in inventory and lower manufacturing costs. It also reduces risk, as artefacts can be printed on demand, as well as minimizing set-up redundancies when producing small batches or single units.

Some recent studies have examined the internationalization strategies of "traditional" design consulting firms (Abecassis-Moedas et al., 2012). These firms were typically found to be based on "closed innovation" and "closed business model" structures, leveraging a number of proprietary assets: their designers or the internationally recognized chief designer; their methodologies and creative process; and their "proximity" to clients through the presence of world-wide offices. In contrast, some newer firms that supply design and creativity inputs to industrial

manufacturing—mainly capabilities in the production of prototypes and mock-ups—are evolving into more open structures thanks to their adoption of 3-D printing technology. In parallel this technology appears to be stimulating the founding of new businesses designing finished products that use 3-D printing and which leverage external creative sources and crowdsourcing (Chesbrough, 2006). This applies to established prototyping companies that adopt 3-D printing, as well as new design ventures centred on 3-D printing technology. Recent conceptualisations of knowledge creation by combining, applying and accumulating knowledge from several sources, typical of the KIBS seem a better fit for 3-D printing based companies, their business models and the management of their assets.

3-D printing use is spreading, according to a number of both economic and technical sources (e.g., The Economist, Business Week, Wired, Make). Nowadays, in order to bring new products, processes and services to the market, firms have to mobilize a broad set of skills, which are often beyond their internal capabilities, that not only include technical skills, but also market analysis, logistics and behavioural sciences (OECD, 2007). Cooperation with other firms and outsourcing enables 3-D focused KIBS to use their own internal knowledge resources optimally, to combine them with specific competencies of their partners, to further specialise and enhance their competitive advantage (Coffey and Bailly, 1991; Porter, 1990; Abramovsky et al., 2004).

Under this framework, a product emerges from the bringing together of various constituent services and technical characteristics both material and immaterial (Gallouj and Weinstein, 1997). It can be considered the output of an integrated knowledge-based value chain (Gallouj and Savona, 2009) that cuts across industries (Schettkat and Yocarini, 2006). Not surprisingly, along with this process of knowledge diffusion, the boundaries between manufacturing and services are becoming blurred. This process of convergence between manufacturing and services may be interpreted as a sign of the transition of advanced countries from service economies to economies based on service relationships (De Bandt and Gadrey, 1994).

KIBS are increasingly recognised as important carriers of new knowledge developed in upstream sectors and then diffused into manufacturing industries, which increasingly rely on them as inputs to their production process (European Commission, 2011). 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. As such, their significance goes beyond their large and growing share of GDP, and is deeply rooted in their solid forward linkages with the rest of the economy. Nevertheless, the extent to which KIBS contribute to the economy is generally underestimated as it is usually measured adopting a sectoral approach which cannot account for the shifting boundaries between market and in-house firms' activities.

The literature on KIBS is scant, and generally companies offering this type of service have been investigated as "bridges of innovation" (Czarnitzki et al., 2000; Muller and Zenker, 2001) or "knowledge brokers" (Hargadon, 1998; Hargadon et al., 1997). Those KIBS that provide design and creativity services are an almost completely unexplored field of research that only recently (Abecassis-Moedas et al., 2012) is gaining interest by scholars. What literature there is mainly pinpoints the operational 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). KIBS must adopt a new method of managing innovation that includes the process of acquiring and integrating ideas into a new form. 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), the KIBS commercializes external (as well as internal) ideas by deploying outside (as well as in-house) pathways to the market. Open innovation starts with the disaggregation of conception-conceptualization-engineering-production-sales activities. The "pulverization" of integrated value chains (Porter, 1980) gives rise to companies specialized in micro-activities and, above all, to a number of

"knowledge brokers" and "bridging ties" that link actors who develop new knowledge in the form of new ideas and products with actors who are able to accomplish, implement and sell them .

The most important aspect of the KIBS business model is the ability to generate value from participation in various kinds of collaborations with other actors. Networked structures influence innovativeness (Ahuja, 2000; Baum, Calabrese, and Silverman, 2000; Gulati, Nohria, and Zaheer, 2000). Relationships with other actors help firms to absorb different knowledge (Ahuja, 2000; Baum, and Oliver, 1991; 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).

Bearing these in mind, we focused our analysis on three aspects of 3-D printing KIBS (Johnson et al., 2004): the open innovation model typical of KIBS; product development processes, and distribution networks.

3. Methodology

The limited literature on the role of KIBS in product design (Abecassis- Moedas et al., 2012) suggested that exploratory research was warranted. The methodology adopted in our study uses multiple sources and an iterative process where the authors compared theory and data (Eisenhardt, 1989). The first task was to understand the scope and type of the uses of 3-D printing technology world-wide, in order to understand its functionality and applications, along with associated production technologies. Thus we carried out:

- An analysis of 45 articles from the international, technical and economics literatures (see Table 1), that covered 3-D printing; this reading enabled us, firstly, to identify the terms used to describe the technology, the main applications, and the most important companies in the industry;
- An analysis of 3 blogs on the topic of 3-D printing (see Table 2); comprising 405 posts, this enabled us to identify emerging views on the potentials offered by this technology, on bloggers' own experience of using and interacting with the technology, and on the main companies reported as being users of 3-D printing technology.

Table 1 Examples of Articles and Journals 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 3D 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 3D printing use -Manufacturers and companies users of technology
Make	February 2010 Vol. 21	Your Desktop Factory–3D Manufacturing at home	-Technology working logics -Producers of 3D 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

In addition we interviewed a small number of academics working in the area of 3-D printing helped to clear up the limitations of 3-D printing technology, the main application contexts that this technology is being used in, for example automotive, fashion, health and care, interior design, and to identify potential case study companies.

Our sample, in line with the theoretical sampling criteria for case studies (Eisenhardt, 1989; Pettigrew, 1998), comprises three cases which have distinctively different approaches to their use of 3-D printing technology:

- 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 work with small businesses, users and craftsmen in the production and sales of their products.

The sample includes companies that have traditionally worked in the world of prototyping services, characterized by “B2B” business logics which, with the development of 3-D printing, have moved towards “B2C” logics; and companies that have been set up exclusively around this new technology using only “B2C” business logics. Data on these companies came from their websites as well as analysis of the articles (24 out of 45) that reported on their business models and competitive behavior.

Table 3 Content Analysis Dictionary

Business model building block	Reference dictionary	Context qualification dictionary
Customer value proposition	Customer	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*

Computer-assisted content analysis (CATA) was used to analyze the qualitative data from the companies’ websites. Similar to human coding schemes, CATA analyzes content through word usage (Morris, 2004) and assumes that insights about the business model can be detected through the occurrence of and frequency with which certain concepts are used in texts (Carley, 1997; Short, Broberg, Cogliser, and Brigham, 2010). CATA is advantageous in that multiple texts can be analyzed without suffering from errors and from bias associated to human coders (Stevenson, 2001). Our dictionary (see Table 3) of business model constructs was based on our

prior review of the literature. We chose the representative words for each element of the business model and selected a set of words (see column “Reference” in Table 3) that described each element. Then we contextualized each word (see Table 3) .To assess the relevance of different words and their usefulness in measuring the business model we then undertook a key word in context analysis (Krippendorff, 2004). The content analysis provided the authors with a set of sentences that were helpful in identifying and assessing the elements of the companies’ business models .The texts were analyzed manually by at least two of the authors (Table 4 provides some examples of sentences included in the analysis).

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-Materialize on one hand gives the designers the chance to show off their talent and sell their products thanks to a worldwide 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* Technology	I-Materialize is an online 3D printing service, based in Belgium (I-Materialize) 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-Materialize is an online 3D printing service, based in Belgium (I-Materialize)

The features of the business model were discussed with three academics working in the field of business strategy and 3d design to clarify any questions, and informally test the validity of our theorizing. .

4. Data Analysis

Our data demonstrated that 3-D technology is spreading in two different ways: (1) the first as an “additional” service from organizations specialized in prototyping services to businesses; (2) secondly, through the creation of new companies.

The first companies originally offered knowledge intensive business services (KIBS) mainly in the final phases of the innovation development process where, with prototyping and materializing facilities, they provided input and feedback on the quality and characteristics of products. Such KIBS provided designers and R&D departments 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 has been 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. In this latter model consumers and/or designers can conceive and make their concepts with the chance to then use and/or sell them.

The second category, new ventures founded exclusively on providing 3-D services—like Quirky—are marketplaces for gathering, collecting and selling ideas and concepts that are “posted” by both external designers

and consumers. For these enterprises there are three main types of users: designers who self-produce their own ideas and creations to sell them through their personal channels (customization-driven designers); designers who propose their own products to be marketed by firms such as Quirky (market-oriented designers); and users looking to make products that are not standardized or sold in great volumes (customization-driven users). In both cases the use of 3-D printing technology is associated with an open creativity model in which companies obtain, bring into production and sell ideas and concepts produced by external designers and clients.

Each of our sample organizations had:

- A proportionately large number of designers both internally and outside to the firm. For example Quirky has 8 designers on staff out of a total of 40 people in the firm, plus a larger, but indeterminate, number of external designers bought in as necessary;
- A basis of knowledge resources necessary to select ideas and manage the many products that come from external sources: for example in Quirky, the ideas submitted received a double evaluation from the community and from a member of Quirky's staff;
- The opening of 3-D printing facilities to external users, firstly as a means of compensating for the limitations of their own resources but with an important second motive, to promote the benefits of 3-D printing. For example Fab-lab lends 3-D printers and linked technological devices to those inventors and/or designers who can prove their ability, or who have been educated by the Fab Lab Academy to use these technologies properly.

Each of our sample companies conform to the KIBS' open innovation model. The open model adopted may be attributed to the following motivations: the desire to meet the needs of consumers who themselves want to have a different business model; inventors who do not have the means to produce their own ideas; the inherent desire to develop new product categories as a result of 3-D printers' capabilities, such as "ready-to-sell" products; and limited entry barriers for creative communities and crowdsourcing to design in a digital network. All of these affect the dynamics of manufacturing competition.

Skills in managing mainly external creative resources connected with crowdsourcing or externally sourcing design know-how, combined with expertise in the use of 3-D printers, form the two main types of capabilities in both conception-conceptualization and production. This is true for both established prototyping companies and new ventures. Quirky and I-Materialize, for example, who have both been excited about the idea of a creative marketplace community, have developed on-line shops that give users the chance to buy products generated by independent users/designers. Alongside this, Quirky, in line with the logic of pushing a distribution strategy, partners with a network of retailers that sell products produced on their own platform. Firms specializing in organized distribution, such as Safeway, Target, Barnes & Noble, Amazon, and Toys "R" Us, are a few of the companies where you can buy products made by Quirky.

A third model adopted by our three sample companies is the open shop. Enterprises like Fab-lab have a world-wide distribution network with over 50 laboratories open to designers, production self learners, and consumers driven by the desire to personalize small products such as accessories, musical instruments or toys. Fab-lab's model introduces a further innovative element, their territorial presence, which, being often highly integrated with the local social milieu, encourages the direct involvement of the final client, bypassing normal distribution channels. As a result the client becomes not only the buyer but also an important tester of product effectiveness or of the idea conceived in the labs.

In "open innovation" and "open business" models, creating new solutions and products requires more than sharing technological, aesthetical, or product category links (Sanderson, and Uzumeri, 1995; Chesbrough, 2003).

Breaking these links reduces the power of branding. Some types of products, such as accessories, interior design products, jewellery, are typically linked to brand driven purchasing processes. In the case of 3-D printed products these lose the signaling value of the brand and acquire instead the signaling power of customization. You buy from Quirky or I-Materialize because you share a conceptual and productive idea which is embedded in 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 organizational critical success factors shaped by values centered on customization, anti-standardization, creative sharing, and open source creativity.

The intrinsic characteristics of 3-D printing technology also enable the production of different categories of products, in limited quantities and without any technological complementarities between them. In all of our sample organizations, a heterogeneous range of goods is produced, including fashion accessories, jewels, toys, shoes, musical instruments, lamps, and interior design products In fact, the major problems connected with this technology concern the ability to use different raw materials and the ability therefore to source and sell products with diverse components to diverse customers. The normal manufacturing logic founded on profitability coming from small numbers of product lines made in large batches and benefitting from economies of scale is turned on its head to profits coming from numerous product lines made in small volumes (Kekre and Srinivasan, 1990; Osterwalder and Pigneur, 2010; Amit and Zott, 2001). This also reduces the need for branding, and the identification of design coherence between products.

Apart from the operating of 3-D printing machines themselves, the main activities which are central to the success of 3-D printing organizations are: (1) the management of creative networks and crowdsourcing; (2) the management and selection of projects, ensuring their visibility and promotion; (3) the management of the marketplace and/or distribution channels (if 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. Technology does not have intrinsic value (Teece, 2010). In other words, obtaining a dynamic competitive advantage and transforming it into a profitable position goes through competence (Hamel and Prahalad, 1990) and dynamic capabilities (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 (Chesborough, 2006). From this viewpoint, the development of Arduino's adopters' open-source communities enabled an interchange that helps to use the technology, and also creates new knowledge and new ideas: technology becomes an accelerator of the spread of creativity.

5. Conclusion

The development of KIBS 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. Instead of the current competitive arena, which features stable and consolidated relationships between large scale producers, incumbent designers and design

consulting firms (Capaldo, 2007; Dell'Era, and Verganti, 2010), there is a new scenario which features new players who base their competitive advantage on external networks and the leveraging of wide-net creativity. The spreading of design education, the accomplishment of designers—not typically seen as an elite profession, but as "mass employment" (Branzi, 2010)—the proliferation of instruments and software enabling open design, the spreading of cultures linked to the "making" and to advanced self-production (Senneth, 2009; Micelli, 2011) together with the potentials of 2.0 web and social networks are the background factors for the development of new forms of design and industrial production.

This scenario does not seem, at least for the moment, to be competing directly with the current one, which is founded on a trading relationship between manufacturers and designers. In this scenario, new technologies (e.g., 3-D printing) do not have a central or leading role, but they are trend accelerators of new business models. The distributive models which are found in these contexts differ from the traditional vertical relationships between producers and distributors. The basic concept is having access (Rifkin, 2000) to an organized and open system of productive resources. Inside this expanding context, products do not need to have 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 category ties induces the redrawing of boundaries and actors' relationships within the value chain.

Our study, based on an analysis of three cases, does not identify a new industrial paradigm, but outlines some trends in industrial design and production that are becoming complementary and, in some cases, "competitors" of the existing models of production. The findings reported in this paper are aimed at helping to identify future research paths that can discover new business models and forms of creative business along with their associated implications and patterns of consumer behavior.

Acknowledgments

We would like to thank colleagues from Stanford University, Westminster University and the University of Torino and in particular Martin Steinert, Donald Nordberg and Luca Console for their thoughtful advice. We are also grateful to Rebecca Pera for facilitating the development of the business case, and Mauro Giraudo for assisting us in the content analysis.

References:

Abecassis-Moedas C., Mahmoud-Jouini S. B., Dell'Era C., Manceau D. and Verganti R. (2012). "Key resources and internationalization modes of creative knowledge-intensive business services: The case of design consultancies, creativity and innovation management", Online Version of Record published before inclusion in an issue.

Ahuja G. and Katila R. (2001). "Technological acquisitions and the innovation performance of acquiring firms: A longitudinal study", *Strategic Management Journal*, No. 22, pp. 197-220.

Ahuja G. (2000). "Collaboration networks, structural holes and innovation: A longitudinal study", *Administrative Science Quarterly*, No. 45, pp. 425-455.

Amit R. and Zott C. (2001). "Value creation in E-business", *Strategic Management Journal*, Vol. 22, No. 6-7, pp. 493-520.

Barney J. (1991). "Firm resources and sustained competitive advantage", *Journal of Management*, Vol. 17, No. 1, pp. 99-120.

Baum J. A. C. and Oliver C. (1991). "Institutional linkages and organizational mortality", *Administrative Science Quarterly*, No. 31, pp. 187-218.

Baum J. A. C., Calabrese T. and Silverman B. S. (2000). "Don't go it alone: Alliance network composition and startups' performance in Canadian biotechnology", *Strategic Management Journal*, No. 21, pp. 267-294.

Berman B. (2012). "3-D printing: the third industrial revolution", *Business Horizons*, Vol. 55, No. 2, pp. 155–162.

Branzi A. (2010). *Ritratti e autoritratti di design*, Marsilio Editori, Venezia.

Brusoni S., Prencipe A. and Pavitt K. (2001). "Knowledge specialization, organizational coupling, and the boundaries of the firm: Why do firms know more than they make?", *Administrative Science Quarterly*, Vol. 46, No. 4, pp. 597-621.

Capaldo A. (2007). "Network structure and innovation: The leveraging of a dual network as a distinctive relational capability", *Strategic Management Journal*, Vol. 28, No. 5, pp. 585–608.

Carley K. M. (1997). "Extracting team mental models through textual analysis", *Journal of Organizational Behavior*, No. 18, pp. 533-558.

Chesbrough H. (2003). "The era of open innovation", *Mit Sloan Manageme Review*, Vol. 44, No. 3.

Chesbrough H. (2006). *Open Business Models: How to Thrive in the New Innovation Landscape*, Harvard Business School Press.

Chesbrough H. (2006a). "New puzzles and new findings", in: Chesbrough H., Vanhaverbeke W. & West J. (Eds), *Open Innovation: Researching a New Paradigm*, Oxford University Press, Oxford.

Cohen W. M. and Levinthal D. A. (1990). "Absorptive capacity: A new perspective on learning and innovation", *Administrative Science Quarterly*, No. 35, pp. 128-152.

Czarnitzki D. and Spielkamp A. (2000). "Business services in Germany: Bridges for innovation", *ZEW Discussion Paper*, 00–52, Mannheim.

Dell'Era C. and Verganti R. (2010). "Collaborative strategies in design-intensive industries: Knowledge diversity and innovation", *Long Range Planning*, Vol. 43, No. 1, pp. 123-141.

Droz D. (1992). "Prototyping: A key to managing product development", *Journal of Business Strategy*, Vol. 13, No. 3, pp. 34-38.

Eisenhardt K. M. (1989). "Building theories from case study research", *The Academy of Management Review*, Vol. 14, No. 4.

Eisenhardt K. M. and Martin J. A. (2000). "Dynamic capabilities: what are they?", *Strategic Management Journal*, Vol. 21, No. 10-11, pp. 1105-1121.

Freeman C. (1991). "Networks of innovators: A synthesis of research issues", *Research Policy*, No. 20, pp. 499-514.

Granstrand O., Patel P. and Pavitt K. (1997). "Multi-technology corporations: why they have 'distributed' rather than 'distinctive core' competences", *California Management Review*, Vol. 39, No. 4, pp. 8-27.

Gulati R., Nohria N. and Zaheer A. (2000). "Strategic networks", *Strategic Management Journal*, No. 21, pp. 203-215.

Hagedoorn J. and Schakenraad J. (1994). "The effect of strategic technology alliances on company performance", *Strategic Management Journal*, Vol. 15, No. 4, pp. 291-309.

Hamel G. and Prahalad C. K. (1990). "The core competence of the corporation", *Harvard Business Review*, Vol. 68, No. 3, pp. 79-87.

Hargadon A. B. (1998). "Firms as knowledge brokers: Lessons in pursuing continuous innovation", *California Management Review*, No. 40, pp. 209-227.

Hargadon A. B. and Sutton R. I. (1997). "Technology brokering and innovation in a product development firm", *Administrative Science Quarterly*, No. 42, pp. 716-749.

Johnson M. W., Christensen C. M. and Kagermann H. (2004). "Reinventing your business model", *Harvard Business Review*.

Kekre S. and Srinivasan K. (1990). "Broader product line: A necessity to achieve success?", *Management Science*, Vol. 36, No. 10, pp. 1216-1231.

Kogut B. and Zander U. (1992). "Knowledge of the firm, combinative capabilities, and the replication of technology", *Organization Science*, No. 3, pp. 383-397.

Krippendorff K. (2004). *Content Analysis: An Introduction to Its Methodology* (2nd ed.), Thousand Oaks, CA: Sage.

Lane P. J. and Lubatkin M. (1998). "Relative absorptive capacity and interorganizational learning", *Strategic Management Journal*, No. 19, pp. 461-477.

Micelli S. (2011). *Futuro Artigiano, L'innovazione nelle mani degli Italiani*, Marsilio I Grilli, Venezia.

Miles I. (2005). "Knowledge intensive business services: Prospects and policies", *Foresight*, No. 7, pp. 39-63.

Morris R. (1994). "Computerized content analysis in management research: A demonstration of advantages & limitations", *Journal of Management*, No. 20, pp. 903-931.

Mowery D. C., Oxley J. E. and Silverman B. S. (1996). "Strategic alliances and interfirm knowledge transfer", *Strategic Management Journal*, No. 17, pp. 77-91.

Muller E. and Zenker A. (2001). "Business services as actors of knowledge transformation: The role of KIBS in regional and national innovation system", *Research Policy*, No. 30, pp. 1501-1516.

Osterwalder A. and Pigneur Y. (2010). *Business Model Generation*, Wiley.

Pettigrew A. (1988). "Longitudinal field research on change: Theory and practice", in: *The National Science Foundation Conference on Longitudinal Research Methods in Organizations*, Austin.

Porter M. E. (1980). *Competitive Strategy*, New York: The Free Press.

Powell W. W., Koput K. W. and Smith-Doerr L. (1996). "Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology", *Administrative Science Quarterly*, No. 41, pp. 116-145.

Rifkin J. (2000). *The Age of Access*, Penguin, New York.

Sanderson S. and Uzumeri M. (1995). "Managing product families: The case of the Sony Walkman", *Research Policy*, Vol. 24, No. 5, pp. 761-782.

Sapienza H. J., Parhankangas A. and Autio E. (2004). "Knowledge relatedness and post-spinoff growth", *Journal of Business Venturing*.

Schrage M. (1993). "The culture(s) of PROTOTYPING", *Design Management Journal* (Former Series), Vol. 4, No. 1, pp. 55-65.

Senneth, R. (2009). *The Cfraftsman* (1 ed.), Yale University Press.

Shan W., Walker G. and Kogut B. (1994). "Interfirm cooperation and startup innovation in the biotechnology industry", *Strategic Management Journal*, Vol. 15, No. 5, pp. 387-394.

Shon D. A. (1984). *The Reflective Practitioner: How Professionals Think in Action* (1st ed.), Basic Books.

Short J. C., Broberg J. C., Cogliser C. C. and Brigham K. (2010). "Construct validation using computer-aided text analysis (CATA): An illustration using entrepreneurial orientation", *Organizational Research Methods*, No. 13, pp. 320-347.

Stevenson R. L. (2001). "In praise of dumb clerks: Computer-assisted content analysis", in: M. D. West (Ed.), T*heory, Method and Practice in Computer Content Analysis*, Portsmouth, NH: Greenwood, pp. 3-12.

Stuart T. E. (2000). "Interorganizational alliances and the performance of firms: A study of growth and innovation rates in high-technology industry", *Strategic Management Journal*, Vol. 21, No. 8, pp. 791-811.

Teece D. J. (2010). "Business models, business strategy and innovation", *Long Range Planning*, No. 43, pp. 172-194.

Teece D. J., Pisano G. and Shuen A. (1997). "Dynamic capabilities and strategic management", *Strategic Management Journal*, Vol. 18, No. 7, pp. 509-533.

The Economist (2012).The Third Industrial Revolution, Special Issue, 21 April.

Ulrich K. T. and Eppinger S. D. (2011). *Product Design and Development*, McGraw Hill, Maidenhead.

Vance A. (2012). "3-D printers: Make whatever you want", *Business Week*, 26 April.

Zahra S. A. and George G. (2002). "Absorptive capacity: A review, reconcepualization, and extension", *Academy of Management Review*, Vol. 27, No. 2, pp. 185-203.