

Measure of Design M&As: Exploratory investigations of IP analysis in design

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ABSTRACT

Despite active participation of design firms in M&A markets, there has been little research measuring the value of design M&As. It is partially due that design has been seen to be an intangible asset. This paper seeks to the understanding of the value of design M&As and provides a possible metric for measuring the value using patent analysis. The value of design M&A was investigated at two levels: Design as differentiator (i.e., new product development) and Design as coordinator or integrator (i.e., organizational growth). The evolution of patenting quantity (e.g., the number of design patent applications, Locarno classes) and quality (e.g., forward citation, co-inventor networks) in pre- and post-acquisition deals was suggested. We conducted a case study using the design and utility patents of Adobe Systems Inc. The results show the dynamics of innovation area and the presence of the high values of inventors holding design-tech linkage, which could be a potential intangible source of company growth. This study further provides implications for companies which might consider design M&As as new ways of design investment.

Keywords: Design firms; M&As; Patent Analysis.

INTRODUCTION

“Businesses started by designers have created billions of dollars of value and are raising billions of dollars in capital, and VC firms increasingly see the importance of design” (Maeda, 2015, p, 10)

The value of design has been heralded in many tech businesses and the venture capital companies (Stamm, 2004; Maeda, 2016; Kim et al., 2017), and design is viewed widely as a key role to providing a strategic competitiveness in new product development (NPD) and organizational growth (Roy and Riedel, 1997; Borja de Mozota, 2002; Cañizares and Atondo, 2017). Design in Tech (Maeda, 2015) has reported that 36% of the top 25 funded start-ups since 2013 were co-founded by designers, such as Airbnb, Pinterest, Github and Slack. In a market of mergers and acquisitions (henceforth M&As), design has never been more valued as a financial force, nor has it been as competitive of an investment for tech businesses as it is now. Many tech companies recognize the ability to understand the human behavior and context, and they use that knowledge and their creativity to accelerate the innovation

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activities as a source of competitive advantage (Lengnick-Hall, 1992; Albrecht et al., 2015). From 2004 to 2017, 85 design firms or agencies were acquired by large companies, especially in the ICT industry (e.g., Google, Facebook, Adobe). More than half of them were acquired between 2016 and 2017 (Maeda, 2017). Figure 1 depicts the M&A activity of giant companies buying design firms since 2004.

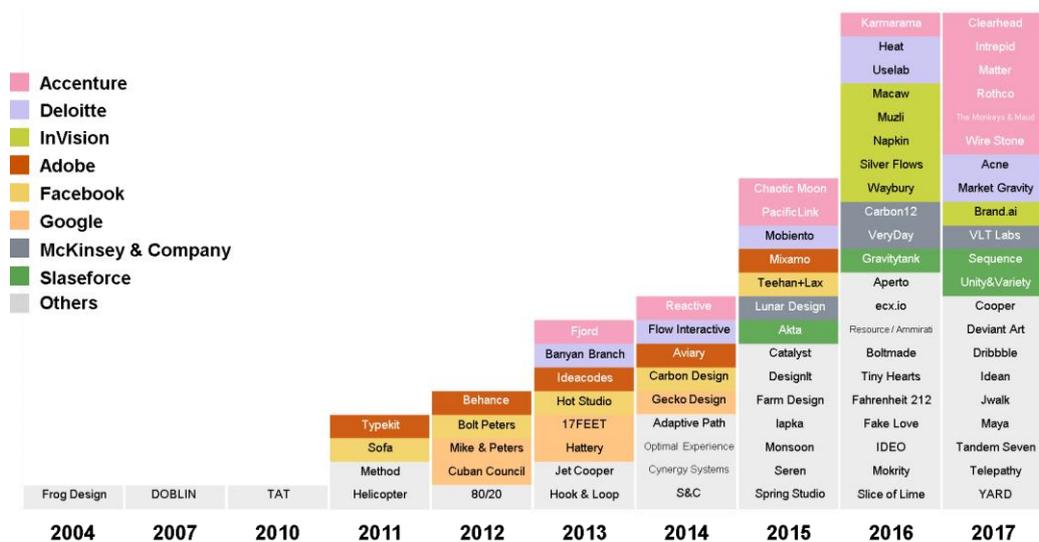


Figure 1. Acquisitions of design firms by tech businesses since 2004.

Google successfully acquired the design firm “Gecko Design” for its Google X labs in 2014, in an aim to investigate product design competitiveness and creativity as Google expanded beyond software (e.g., Google glass, project Loon). One of the oldest design firms in Silicon Valley, Lunar, was acquired by McKinsey & Company in the same year, with the hope to bring design forward in its corporate strategy and bring about a creative thinking culture. As more businesses understand the role that design can play in shaping their innovation activities and creative organizational culture, this type of move will likely increase in occurrence.

Despite such active participation of design firms in M&As, there has been little research measuring design M&A performance due to the nature of design as an intangible asset (Borja de Mozota and Kim, 2009). At best, a few studies have attempted to provide an empirical analysis to measure design activities and investment effectiveness to demonstrate the value of design (Gemser and Leenders, 2001; Chiva and Algere, 2009). Most of these studies have been limited to the NPD performance in design, not determining the value of design at the company level. Other essential intangible assets of design have been underrepresented (Borja de Mozota and Kim, 2009) such as human capital, referring to the talents of designers

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and innovators as individuals and on teams that will strengthen the next workforce, knowledge capital (e.g., intellectual property) and so forth..

In this context, this paper provides a much-needed exploration of a new and important topic of design M&As and possible metrics for measuring their performance. The measure of design M&As mainly investigates the evolution of patenting quantity and quality in pre- and post-acquisition deals. Patents provide very powerful data for firms' strategic changes and innovation performance, including the number of patents, inventor information, etc.; however, only very few pioneers (Filitz et al., 2015; Yoshioka-Kobayashi et al., 2018) have addressed it as a potential measure from a design management perspective.

The present study suggests possible patent metrics to measure the value of design M&A deals in view of innovation in new product development (NPD) and organizational growth. Adobe Systems Incorporation's M&A case was selected as a case study. Adobe stands out among the recent design M&As in large part thanks to the success of Adobe's cloud conversion. Beginning in 2011, a massive number of acquisitions were conducted, including mobile and web tech business and design startups and firms (e.g., Typekit and Behance) within a very short time period (see Figure 2)..

This paper is organized as follows. First, we introduce potential measures where patent metrics have been used to examine M&A activities and further attach them to a design management perspectives. Second, Adobe's patent data from 1988 to 2018 are analyzed to verify the suggested patent metrics, and its strategic changes pre- and post M&A deals are examined. Finally, the results and their implications for further research and practice are discussed.

1. PATENT ANALYSIS FOR MEASURING THE VALUE OF DESIGN M&AS

An M&A is defined as a consolidation of two companies and is used as a growth strategy (Faulkner *et al.*, 2012). Along with a sharp shift in technology – e.g., Digital, AI and IoT – and digital consumer behavior, many IT giants are using M&As as a strategic expedient to capture disruptive innovation growth opportunities (Deloitte, 2017). Indeed, powering design-led growth through acquiring design firms and start-ups might provide companies with the competitive advantages of boosting digital engagement with customers and increasing customer relationships, brand and loyalty, which can directly affect the intangible assets of a company. As intangible assets are usually much more costly to imitate than tangible assets, the competitive advantages of firms are usually based on the allocation of intangible assets such as patents (Barney and Hesterly, 2010). Although patents are intangible and their value

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cannot be accurately measured, companies must develop and increase their growth by proactively focusing on patents according to the resource-based view (RBV).

Borja de Mozota (2003) suggested that the competitive advantages of a firm through design can take two forms: *Design as differentiator* (e.g., new product development, brand image) and *Design as coordinator or integrator* (e.g., organizational growth, teams). The first concern is in line with the traditional measurement of M&A performance referring to innovation in NPD – e.g., the number of patents (Meglio and Risberg, 2011). Patent databases represent an appealing data source for tracking and assessing innovation. Patent data is publicly available, and patent systems have been instituted as a mean to protect valuable intellectual property (Mogee, 1991). As such, patents provide one measure of the flow of information associated with a firm's innovation and reflect the NPD status of a company, its activity in R&D, and its strategy concerning NPD (Grimpe and Hussinger, 2008). One of the objectives concerning M&As on intangible aspects is very often to protect intellectual property by adding people who will have more ideas in R&D or to "buy" intellectual property to obtain more protection in the field they work in. Examples of patent metrics include the number of patents granted each year, allocation of utility and design patents, and the number of utility patents by the International Patent Classification (IPC), which refers to technical fields and industrial sectors. The number of design patents are specially codified with Locarno classes and counted. The Locarno classification indicates the product categories in which the designs are intended to be applied (WIPO, 2018).

In addition to patenting quantity, patent citation analysis can measure the quality of patent based on an examination of the citation links among different patents. Citation analysis is essential in that many studies continually revealed a strong positive relationship between citations and technological impact (Albert *et al.*, 1991). The study of Breitzman and Thomas (2002) stressed out the importance of this citation measure to value the M&A candidates.

The second concerns *Design as coordinator or integrator*. This is a particularly novel approach compared to the conventional measures of M&A performance. Examining the dynamics of inventor movements in patents would be a means to clearly explore the people and skills organization at the company level. The inventors who have co-authorship data for a patent can construct an inventor network in the company. The underlying assumption is that tacit knowledge (e.g., design or technology) flows among individuals and organizations according to the contribution of an inventor's mobility (He and Fallah, 2009). Indeed, knowing the profile of the principal inventors who have produced the most patents in a specific technology or design section is crucial, in that M&A activities often lead to a

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redistribution of inventors and patents. Table 1 enlists a possible metric for measuring the value of design M&As on two levels of competitive advantages of a company using patent analysis.

Table 1. Possible patent metrics for measuring the value of design M&As

Metric	Possible unit	Description
Design as differentiator (NPD)	Number of Utility Patent applications	Innovation quantity in technology
	Number of Design Patent applications	Innovation quantity in design
	IPC/Locarno classification of Patent applications	Extensive Innovation scope in technology and design
	Forward citation of Main IPC and Locarno classes	Impact of innovation in technology and design Category
Design as coordinator or integrator (organization)	Density of network	Close (or broadness) of organization
	Modularity	Clusters of Innovation area
	Degree Centrality by Inventor groups	Influencer among inventor groups (Design, Technology, and Design-Tech groups)

2. METHOD A CASE STUDY: ADOBE ACQUISITION ACTIVITY AND DESIGN

Since Adobe first announced the Creative Cloud initiative in 2011, Adobe has completed 17 M&A deals and many analysts report that a key to Adobe's cloud conversion has been its acquisitive activities (Adam, 2017). Figure 2 shows Adobe's acquisition deals since Adobe's first acquisition deals with Emerald City Software and BluePoint Technologies in 1990. The Adobe case is particularly suited to examine how the design M&A affects innovation in NPD and organization. Between 2011 and 2013, Adobe set out to investigate the acquisition activities in design by targeting creative professionals and designers, which was a new approach. In 2011, Adobe first acquired Typekit Inc., which offers web-based typography and holds 250,000 web font subscribers, as a part of a larger creative cloud service offering (Dean, 2011). The next year, Adobe acquired Behance, an online community with a creative professional portfolio and relevant business. In 2013, a San Francisco-based design consultancy that specializes in "the design and user experience of smart applications, digital products and networked communities", called Ideacodes was acquired. These consecutive transactions have marked a crucial turning point in the company strategy, shifting to a software company as a service community.

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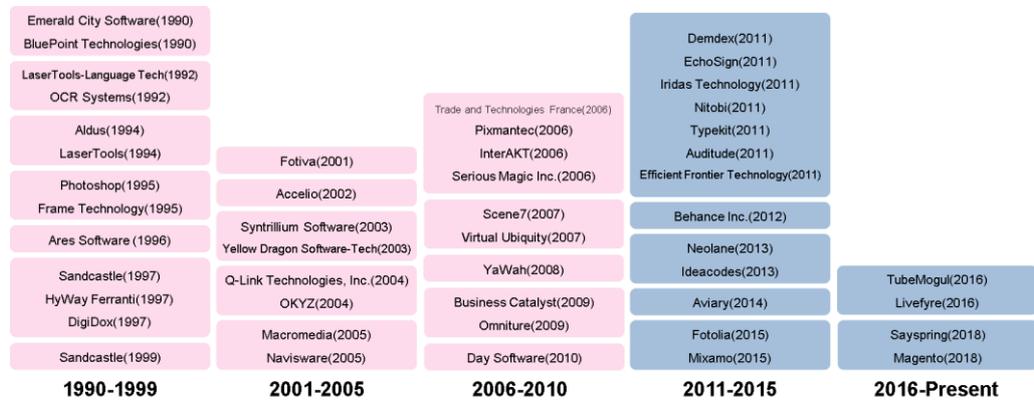


Figure 2. Adobe’s acquisitive activities.

2.1. Trends in annual applications

We have collected Adobe’s patent applications from the USPTO database. The first application of Adobe appeared in 1988 and was a type font in design patent (D317621 /11-05-1988). A total of 4,526 patents were identified between 1988 and 2018 (Data collected March 2nd, 2018). Figure 3 illustrates the trends of utility and design patents in annual applications. A first look at the figure showed a rise of utility patent production gradually starting before the massive acquisition and reaching its peak in 2008 with 407 utility patents. It fluctuated annually thereafter, and maintained a slight decrease after the transactions. The number of design patents between 2007 and 2014 was recorded in the two digits; however, the total number of design patent applications seems extraordinarily low given the number of utility patent applications. A deeper analysis using the classification of product types of design patents is needed here.

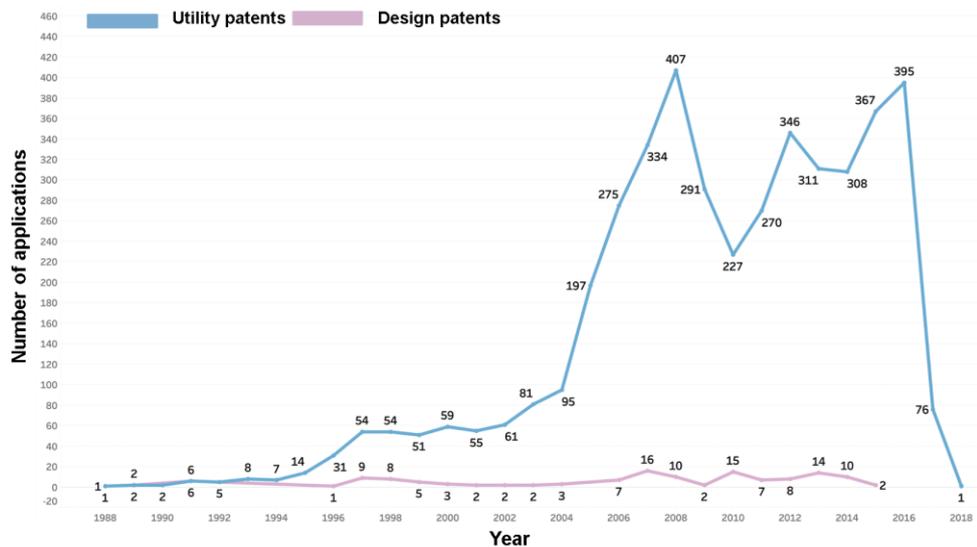


Figure 3: Trends in annual applications.

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2.2. Evolution of innovation fields using IPC and Locarno international classes

Adobe patents in different technical fields and industrial categories were identified using the International Patent Classification (IPC) and Locarno classes were identified. Note that the IPC classes were only designed for utility patents; we mapped the Locarno classes to design patents instead.

Among a total of 4,526 patents, Adobe innovation displays 72 different IPC classes and 6 Locarno classes. Table 2 shows the distribution of IPC and Locarno classes for Adobe's patent portfolio. The two main IPCs (Class G and Class H) and the design patents of Class 18-03 and 14-04 were identified. Class G and its subclasses (G06F, G06K, G06T, G06Q, G06G and G06N) covered more than 80% of the entire classes, and Class H at 10.54% and Design (18-03 and 14-04) at 2.46% followed. Referring to the top ten IPC classes predominantly describing cloud computing technology (Icady, 2012; Huang, 2016), for example, 'G06F: Electric digital data processing' and 'H04L: Transmission of digital information,' Adobe's eight largest shares of main IPCs (G06F, G06K, G06T, G06Q, H04L, H04N and G09G) were dominated this landscape, covering 89.83% of the patent portfolio. The results indicated that Adobe concentrated more on the business area of Adobe's cloud platform and more patents were allocated to developing creative cloud and image/video computing.

Table 2. Proposition and Description of the IPC and Locarno classes of Adobe

		Class	(%)		
G06F		G06F	2,019 (44.61%)	Electric digital data processing	Cloud Computing relevant main IPCS (89.83%)
		G06K	625 (13.81%)	Recognition of data, presentation of data; record carriers	
		G06T	449 (9.92%)	Image data processing or generation, in general	
		G06Q	274 (6.05%)	Data processing systems or methods	
		H04L	270 (5.57%)	Transmission of digital information	
		H04N	225 (4.97%)	Pictorial communication	
		G09G	204 (4.51%)	Arrangements or circuits for control of indicating devices	
		18-03	65 (1.44%)	Type and type faces	
G06K		H04N	225 (4.97%)	Pictorial communication	
G06T		G09G	204 (4.51%)	Arrangements or circuits for control of indicating devices	
G06Q		18-03	65 (1.44%)	Type and type faces	
H04L		G06N	57 (1.26%)	Computer system based on specific computational models	
H04N		14-04	46 (1.02%)	Screen display and icons	
G08G	18-03				
G06N		etc.	292 (6.45%)	-	
ETC	14-04				

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In design, the Locarno class 18-03 (Type and typeface) and 14-04 (Screen display and icons) had the largest share of design patents (48.15% and 34.07% respectively). The design patents in Locarno class 14-04 (e.g., D698362, D691157, D691158, D691169) played a large role in introducing Adobe's look and feel in Creative Adobe Software. Adobe is the largest producer of fonts in the world, and the major share of the class 18-03 (Type and typeface) confirmed that Adobe has continued to invest in the design of new fonts. Typekit's patent (8683006: Method and systems for serving fonts during web browsing sessions) was added after the Adobe's acquisition deals in 2011.

A further analysis of patent citation was conducted on forward citations. First, forward citations are used as a measure of the impact of innovations. The more forward citations, a patent has, the more impact it has on other patents. Note that the number of citations for a patent is strongly dependent on its age. A fresh patent does not have enough time to influence other patents and hold a forward citation to others. To counter this concern, the number of forward citations was compared to those of patents granted over time. Table 3 shows the evolution of forward citations according to the main IPC and Locarno classes: G06F, G06K, G06T, H04N, G09G, H04L, 14-04 (Design), G03B, B41J, G06Q, and 32-00 (Design) accounted for 94% of the total forward citations.

Table 3. The cumulated number of forward citation by Adobe's IPC and Locarno classes (2000-2018)

	IPC	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Utility	G06F	511	1,107	2,372	3,224	3,980	5,595	7,577	9,527	11,243	12,794	13,931	14,582	15,291	15,548	15,721	15,757	15,769	15,770	15,770
-	G06K	181	436	557	833	1,134	1,472	1,916	2,172	2,916	3,203	3,636	3,831	4,391	4,564	4,673	4,709	4,721	4,723	4,723
-	H04N	23	101	101	154	189	205	267	617	788	1,084	1,981	2,094	2,261	2,329	2,334	2,338	2,338	2,338	2,338
-	G06T	370	606	682	747	817	902	1,034	1,213	1,638	1,752	1,911	1,974	2,055	2,125	2,152	2,168	2,178	2,178	2,178
-	G09G	296	326	431	613	689	873	1,191	1,351	1,402	1,460	1,557	1,607	1,616	1,639	1,646	1,646	1,646	1,646	1,646
-	H04L	10	63	66	387	420	498	657	776	1,041	1,137	1,206	1,397	1,483	1,533	1,553	1,573	1,575	1,576	1,576
Design	14-04							268	787	787	787	1,113	1,269	1,375	1,378	1,402	1,402	1,402	1,402	1,402
Utility	G03B							136	136	501	691	691	855	878	878	879	879	879	879	879
-	G06Q		68	349	349	358	360	458	485	554	573	602	636	667	711	744	757	762	762	762
Design	32-00								32	548	609	618	625	625	625	625	625	625	625	625

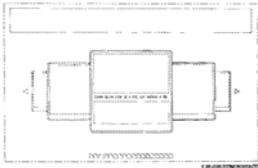
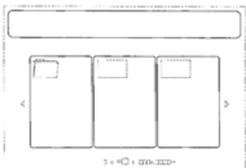
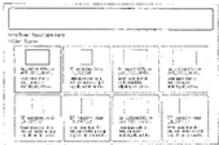
Again, the main IPC classes of G06F, G06K, H04N, G06T, and H04L showed a good record of patenting quality and quantity. Very interestingly, the Locarno class 32-00 (User interface for a device) had newly risen to the top 10 forward citations. This class involves only 11 design patents (D664153, D664154, D659705, D633917, D608364, D608365, D607889, D603415, D603416, D593117, and D591764); however, the yearly cumulated number of forward citations had massive increasing trends from 2007-2011, peaking at 625 counts. Of the

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design patents that were cited, the class 32-00 received an average of 625 forward citations while the class 14-04 received 1,402. The average design patent quality of the 32-00 can be thus interpreted to be better than the class 14-04, which shares the most number of design patents.

Table 4 tabulates the top three design patents in the class 32-00, referring to over 100 forward citations: US D603415, US D603416, and US D608364. Interestingly, more than 89.06% of the forward citations of these top three design patents were cited by utility patents. The main applicants were T mobile USA Inc., Samsung Electronics Co. Ltd., PepsiCo Inc., Outbrain Inc., and Microsoft Corp. They attached to their main business area like mobile based cloud services, except for those of PepsiCo Inc.

Table 4. Examples of design patents classed in Locarno 32-00

Patent	Drawing	A total number of forward citation (Utility / Design patents)	The top three applicants (% of forward citations)
US D603415 (User interface of a display screen)		160 (23 / 137)	T mobile USA Inc. (45, 28.1%) Samsung Electronics Co. Ltd. (23, 14.4%) PepsiCo Inc. (15, 9.4%)
US D603416 (User interface of a display screen)		129 (24 / 105)	T mobile USA Inc. (44, 34.1%) Outbrain Inc. (22, 17.1%) Microsoft Corp. (8, 6.2%)
US D608364 (User interface of a display screen)		108 (17 / 91)	T mobile USA Inc. (34, 31.5%) Outbrain Inc. (22, 20.4%) Microsoft Corp. (15, 13.9%)

One of the interesting issues in this context is whose design patents are cited, and to what extent they cite design patents to utility patents. This has important implications for the study of design-led innovation (as a differentiator): presumably, when a design patent includes novelty in shape, its aesthetics might be an important moderator and thus have a greater impact on new functions and technology that are mostly innovative, compared to citations within the same category, i.e., Design to Design or Utility to Utility.

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2.3. The dynamics of Adobe organization: an inventor network

The inventor network analysis was employed to measure the value of design M&As, in the view of design as coordinator or integrator. In a patent inventor network, degree centrality and modularity can analyze an inventor's innovation activeness and close or broadness of organization in time changes, which are key factors for identifying the dynamics of a company's organization. A network analysis, Gephi™ v.0.9.2 and Circle pack layout (Hierarchy 1: Modularity class, Hierarchy 2: Degree centrality) for visualization were used (Bastian et al., 2009). The summary of the results of the inventor network analysis is, as shown in Table 5. Figures 4 and 5 compared the inventor networks by clusters using a modularity measure.

Table 5. Summary of the results of the inventor network analysis of patent applications

Period	Number of Inventors (node)	Number of co-inventions (link)	Avg. Degree centrality (<i>sd</i>)	Density	Modularity
1988-2010	1,780	2,730	3.07(3.05)	0.002	0.898
1988-2018	3,175	6,621	4.17(4.97)	0.001	0.787

First, the metric of degree centrality was employed for understanding the level of connections to other inventors (Newman, 2004). Here, each node represented patent inventor. Whenever there were multiple common inventors involved with a single patent, we added them up and assigned the number of inventors with the link. In the period from 1988-2010, Adobe produced 2,411 patents with a team of 1,780 inventors with 2,730 links. Drawing the results to the present (1988-2018), the total number of patents was 4,526 with a team of 3,175 inventors with 6,621 links. Thus, the results of degree centrality confirmed that the average degree of inventors before and after 2011 were 3.07 and 4.17 respectively. This means that three inventors co-worked on one patent on average in the period of 1988-2010; however, a slightly larger group of four co-worked during the period up to the present. The difference is statistically different ($t = -9.665; p < .001$).

Second, Adobe's network density was 0.002 and 0.001 in 1988-2010 and 1988-2018, respectively, which was very low. The value of 0.002 in the period of 1988-2010 is similar to Samsung's network density examined in 2016 (Choi and Park, 2016), and this value is a very common phenomenon in a large organization. Adobe has worked on diverse business units (e.g., Beyond mobility, cloud native, Intelligence everywhere, Open ecosystem) with many inventors, and these different business units are not tightly connected. Indeed, after the massive M&As since 2011, 445 inventors (16.3%) were newly introduced and produced the

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patents. Most patents were recently acquired rather than developed in house. We can notably see the presence of the organization broadened a lot compared to the inventor networks in the pre-acquisition period.

Third, we identified the modularity value to determine the closeness of the nodes (here, inventors) within similar patent fields. A modularity value implies a strong structure of a team and helps to find the active inventors in the group. In both periods, the values were more than 0.70, which pointed to a very strong group structure in the network (Q value 0.30~0.50: a reasonably strong group; above 0.50: a very strong group; Valente et al., 2015).

The inventor network identified four clusters in the period from 1988-2010 (Clusters 1-4) and six clusters in 1988-2018 (Clusters A-H), as illustrated in Figures 4 and 5. Colored clusters are those with more than 100 nodes in their cluster.

In the period from 1988-2010 (refer to Figure 4), Cluster 1 (209 inventors; 11.74%) centered on the document generation, security, and encryption technologies of PDF readers, mainly empowering a well-known Acrobat product line. The principle inventors include Sunil C. Agrawal (Degree =18), John P. Brinkman (Degree=17) and Roberto Perelman (Degree=15). Cluster 2 (202 inventors; 11.35 %) had a similar sized of team structure, covering computer vision and image synthesis techniques. The inventors in this cluster mainly attached to Adobe's Photoshop and other products in digital media (e.g., illustrator, InDesign). Inventors in cluster 3 (137 inventors; 7.7%) investigated mobile applications and interactions across various platforms. Cluster 4 (108 inventors; 6.7%) consists of inventors from the field of human computer interaction and display interaction.

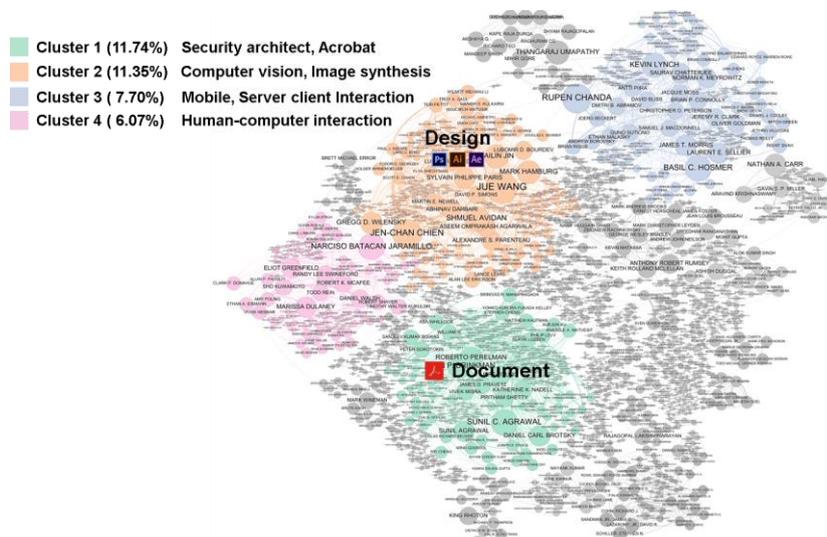


Figure 4. Adobe's inventor network (1988-2010)

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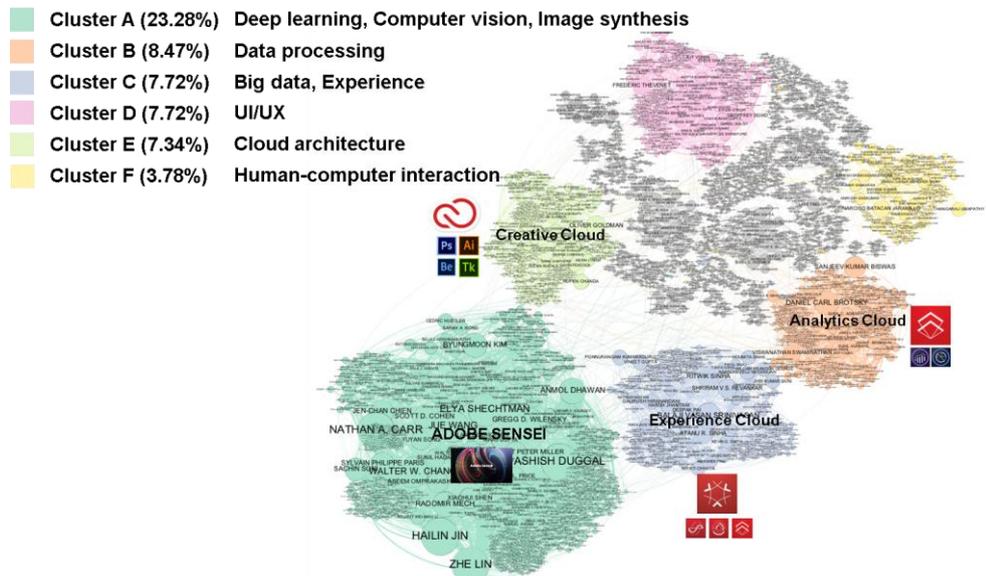


Figure 5: Adobe’s inventor network (1988-2018)

Figure 5 shows Adobe’s inventor network in the period from 1988-2018. The most notable difference we see is the presence of a group of highly connected core inventors in Cluster A in 1988-2018, compared to a more evenly dispersed innovation structure in 1988-2010. Refer to Figure 5, the network is characterized by one giant cluster (Cluster A) and many small, tied clusters (Clusters B-E).

Cluster A (739 inventors; 23.28%) is on the bottom left of the network (refer to Figure 5), and represents the inventors that contributed technology in image recognition, editing, video recognition, and image classification using deep learning, computer vision, and image synthesis (e.g., Adobe Sensei; Adobe, 2017). Adobe Sensei is the artificial intelligence- and machine learning-driven framework that is being deployed across all Adobe’s solutions (Adobe, 2017). Inventors in Cluster A were mostly coming from the Clusters 1 (Document generation, Security) and 2(Computer vision, Image synthesis) in the inventor networks in the period from 1988-2010 and new inventors after massive M&A deals (e.g., Aviairy and Mixamo).

The inventors having the highest degree centrality in the patent applications were Hailin Jin (Degree=58) and Zhe Lin (Degree=57). Both inventors belong to Cluster A and co-work (25 co-inventions) within the Adobe's Creative Intelligence Lab. The inventors having the highest degree centrality in the patent applications were Hailin Jin (Degree=58) and Zhe Lin (Degree=57). Both inventors belong to Cluster A and co-work (25 co-inventions) within the Adobe's Creative Intelligence Lab.

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Hailin Jin, a senior principal scientist, who has been at Adobe for 14 years. Before 2011, he mainly worked on Adobe's flagship products, including Photoshop and After Effect, which attached to Cluster 2 in Figure 4. After the release of Adobe Creative Cloud initiatives, his works focus on computer vision, deep learning, alignment, 3D reconstruction, and motion estimation and he is continuously playing a key role in Adobe Sensei Platform (refer to Cluster A in Figure 5). Zhen Lin worked for only 6 years at Adobe since 2012. Surprisingly, he filed the largest number of patents (113 utility patents). His area of interest includes techniques for recognizing images using machine learning and deep learning.

Cluster B includes 269 inventors (8.47%) specialized in data processing technologies linked to Adobe's Analytic Cloud. Cluster C (245 inventors, 7.72%) consists of the inventors who bridged the ties between big data technology and user experience. This cluster is very in line with Adobe's Experience Cloud business, which seeks for the analytics and data driven marketing for cultivating customers with personalized offers. Cluster D (245 inventors, 7.72%) contains display screen with UI elements (i.e., graphical user interface and icons) for Adobe's product lines. Cluster E includes 233 inventors (7.34%) concerning cloud architecture technologies (e.g., Creative Cloud). In the early years, only 137 inventors in Cluster 3 (mobile and server client interaction) were visible. Over time, however, a larger Cluster E emerged as shown in Figure 5. There is a drastic increase in the number of new inventors by 70% (96 inventors) since 2011.

There is a big shift in the responsibilities taken to focus more on the new direction – notably Adobe Sensei. Indeed, the triangulated connection with small clusters among Cluster B (Data processing), Cluster C (Big data, Experience) and Cluster E (Cloud Architecture) is also noticeable. The evolution of inventors revealed a real move of the company between the former top inventors of Adobe, the historic inventors of Adobe, and the new inventors.

Further, it would be interesting to look at a value of degree centrality of the inventors and inventors' groups. The degree centrality of an inventor is the count of the direct connections between the focal inventor and other co-inventors in the network. An inventor or inventor's group with a high degree centrality can secure considerable reliability of information and is a highly influential actor in a network (Choi and Park, 2016). Based on this concept, Adobe's inventors were divided into three groups: Design group, Technology group and Design-Tech group, according to the counts of design and utility patents in their patent portfolio. For instance, an inventor having both design and utility patents was grouped in Design-Tech group. Table 6 presents the average degree centrality of the three inventor groups. The result shows that the inventors in design group, who are producing design patents only, have

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a small degree centrality 1.02, compared to Technology Group 4.18. What is remarkable is that the inventors who have both design and utility patent are connected to 6.42 inventors on average. Thus, inventors involving in both design and technology area have, as a matter of course, more possibility of becoming influential actors in the center of organization, than those producing design or utility patent solely.

Table 6. Comparison of degree centrality between cross patent applications and others (1988-2018)

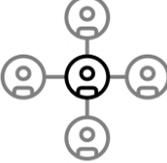
	Design group	Technology group	Design-Tech Group
	Design patent only (n=41)	Utility patent only (n=3098)	Both design and utility patent (n=36)
Average degree centrality			
	1.02	4.18	6.42

Table 7 enlists the top 10 designers in order of number of patent at Adobe, with the hope that we might discover designers with active and core roles in the organization. It is interesting to see that some inventors have higher degree centrality regardless of their number of patent applications. Eight designers of Design-Tech Group (refer to Table 6) showed a higher degree centrality compared to those of Design group. The inventors in design group (Robert J. Slimbach and Ryoko Nishizuka) mainly work on Adobe's typeface. A principal type designer, Robert J. Slimbach has filled 23 design patents, which are the second largest share of design patent since 1989. He has rather organized a very closed design team with around three people for one design patent, meaning a relatively weak influence to other inventors.

Table 7. Top ten Adobe inventors in design patents

Inventor name	A total number of patents (Utility / Design patents)	Inventor group (refer to Table 6)	Degree centrality	The first patent application	Business area/ Current position
Daniel Walsh	31 (7/24)	Design-Tech	16	9946692 (2008)	UX Design / UX Design Manager (Google)
Robert J. Slimbach	23 (0/23)	Design	3	D318290 (1989)	Font Type Design / Principal Type Designer (Adobe)
Liang-Cheng Lin	13 (1/12)	Design-Tech	7	D682853 (2010)	UX Design / Senior Experience Design Manager (Adobe)
Amy Poling	10 (4/6)	Design-Tech	9	9946692 (2008)	Document Cloud / (Adobe)
Andrew Borovsky	12 (6/6)	Design-Tech	10	8726168 (2005)	Experience Design / Head of Product (CADRE)
Geoffrey Dowd	19 (14/5)	Design-Tech	21	9619108 (2011)	Experience Design / Vice President of Design (Tuneln Radio)
Jacob Surber	8 (3/5)	Design-Tech	16	D678321 (2010)	Creative Cloud Ecosystem / Senior Product Manager (Samsung Electronics)
Ryoko Nishizuka	5 (0/5)	Design	0	D578565 (2006)	Type Design / Chief Type Designer (Adobe)
Tyler Lettau	6 (1/5)	Design-Tech	2	D565060 (2006)	Sound Design / N/A (Adobe)
Ethan Eismann	5 (1/4)	Design-Tech	4	D565060 (2006)	Experience Design / Senior Experience Designer (Adobe)

In comparison, the most influential designers with a high degree centrality, have produced both design and utility patents (i.e., Design-Tech Group) and they are currently allocated to empowering experience design area. Daniel Walsh would be a good example here. He filed twenty-four design patents and seven utility patents and showed the highest degree centrality (degree=16). Since he joined Adobe in 2007, his expertise in experience design has been evolved and contributed to the company along with Adobe's digital transformation initiatives. He delivered a new breed of digital experience from Adobe document product (e.g., Adobe Acrobat Reader) to the Adobe Marketing Cloud.

3. CONCLUSIONS AND FUTURE WORK

The aim of this paper was to explore a possible metric for measuring the value of design M&A activities in two forms: *Design as differentiator* (e.g., new product development) and *Design as coordinator or integrator* (e.g., organization). This study focuses on quantitative measures of intangible assets, in particular, patent quantity and quality. Patents provide very

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powerful data for analysis of M&A performance; however, they also have some deficits in measuring design M&A value. For instance, design patents are to protect novel product shapes, but do not include special consideration of intangible features such as the semantics or meanings of products (Yoshioka-Kobayashi et al., 2018). The principal experience design manager at Adobe, Liang-Cheng Lin, interviewed that “*design patents issued might not represent the fanciest or most creative ideas we explored*” (Adobe blog, 2015). This quote means that adding the value of design as differentiator cannot fully result in a design patent, so other metrics are needed here. Galindo-Rueda and Millot (2015) and Bruce and Bessant (2002) have addressed the concern that good product design is sometimes protected by utility patents and other kinds of intellectual property rights.

Interestingly, our metric of forward citation provides some rather rich information. A crucial benefit of citation analysis is that it uniquely displays the relations of design and utility patents. For example, using citation data, we can identify how knowledge spillovers originating from design affect the technological innovation that results in a utility patent (Design 32-00 case in Table 3).

As for *design as coordinator or integrator*, we can draw several interpretations attached to organizational reshape. One of the biggest challenge is how to embrace the culture of organization during the acquisition. The evidence of Adobe proves that the activities of designers were not isolated from the technology development team after the massive acquisition deals in 2011. The team was well connected (team network degree = 3.07 and 4.17, before and after 2011, respectively) and pursued the core business area of “Adobe Sensei Platform”.

Of course, many large companies also tend to keep the creative team in separated to empower their culture of coming up with new ideas. This is a rather different decision in an organization, and it holds the potential for success or failure in the long-term view, which is presently still under debate. Considering the noticeable value of an inventor network as a new metric to understand organizational directions, this would further address the value of designers in business development and growth.

Beyond these limitations, this paper contributes to future metrics measuring design-relevant activities at the company level, by confirming the quantitative approach with a patent data source. Attempting several patent analyses, a new breed of design M&A activities in the area of organizational dynamics and new product development processes for design innovations can be studied.

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