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A PROPOSAL OF METRICS TO ASSESS THE CREATIVITY OF DESIGNED SERVICES

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Abstract: An emerging thread of research is represented by the attempt of quantitatively assessing creativity, its dimensions and how it influences the design process. The endeavour of previous works has consisted in the assessment of creativity concerning designers, methodologies, concepts and products. As the scope of engineering design is expanding so to include not traditional aspects of the product development process, the paper proposes metrics tailored to evaluate the creativity of services. Such metrics are built as a result of the extension and adaptation of previously formulated criteria, including the evaluation of novelty and usefulness. An exemplary sample of successful innovative services is considered, giving rise to a considerable variability of creativity scores. The outcomes may represent a starting point for a wider discussion about which dimensions of creativity majorly impact the success of products and services in the marketplace.

Keywords: *creativity assessment, design of services, degree of novelty*

1. Introduction

The measurement of creativity can support the selection of innovative products and solutions, thus it concerns one of the most relevant topics in the research agenda of the design community (Gero, 2010).

The interest of the engineering design community is going beyond the development of methods and tools to support traditional design activities and several scholars are focusing their research efforts towards the identification of customers' needs (e.g. Weber, 2008), with a value-centred approach (e.g. Cascini et al, 2011; Zhang et al., 2011). In this sense a considerable attention has to be attributed to the design of original services. As well, in the last decades, the literature has observed a large number of contributions aimed at establishing more robust links between products and related services. Several methodologies and tools have been introduced and further developed to fit the exigencies of the so called "servitization" trend, e.g. Product-Service Systems (Tukker & Tischner, 2006), total-care products (Alonso-Rasgado et al., 2004), Service-Product Engineering (Sakao et al., 2009).

The relevance of creativity within service design has been plainly recognized in literature, e.g. Kaner & Karni (2007) have proposed specific approaches dedicated to stimulate idea generation in this field. The same authors, following an established school of thought, include service planning within the whole set of engineering disciplines, thus assessing that creativity in service innovation takes into account the same factors considered in other design contexts. Hence, in this paper the authors assume that investigating service creativity requires no speficic determinants to be mapped.

Besides, the application of methodologies traditionally devoted to foster creativity within product development, for instance TRIZ (Chai et al., 2005), have been experienced to produce innovative services. Given these premises, the assessment of service creativity results a subject requiring investigation, since no previous research has been performed according to authors' survey in the literature and personal knowledge.

The manuscript is organized as follows. Section 2 briefly reviews the main approaches and aims within the research devoted to assess design creativity. Section 3 illustrates the schema advanced by the authors to measure the creativity of services by extending some metrics, recently defined to assess the creativity of products. Section 4 describes the application of the upgraded method for a sample of successful innovative services. Section 5 concludes the paper with a discussion about the achieved outcomes and the future work to be carried out.

2. Overview of the approaches to assess design creativity

Creativity is acknowledged as a fundamental ingredient for the completion of engineering design tasks, but its assessment results a quite recent, besides much debated, subject. The studies aimed at assessing the creative level of designers belong to a more developed branch of research, by benefitting of decades of experiences and models pertaining to other research domains. An interesting survey by Thompson & Lordan (1999) discusses the useful outcomes of the knowledge about creativity accumulated within psychology and management in the perspective of building models for engineering design.

However, a full understanding of the influence of natural talent and dedicated training is still missing, as witnessed by the open issues reported in a recent work performed by Charyton et al. (2011), who focus on engineers and designers with the aim of improving educational programs. With reference to engineering design, the initial efforts have been dedicated to evaluate the contribution provided by design methodologies and tools, claiming to foster creativity and innovativeness. Verhaegen et al. (2011) argue that no standard technique has been yet defined and acknowledged to conduct tests for evaluating the effectiveness and the creativity stimulation of design methodologies. Besides, the research efforts are progressing towards the refinement of the employed metrics. Still according to Verhaegen et al. (2011), the pioneering work of Shah et al. (2000) has opened up a thread of research aimed at assessing the creativity of the ideas generated during a design task. For instance, a subset of their metrics has been recently revised by Oman & Tumer (2011) in order to rank the novelty and the quality of solution concepts. Chiu & Salustri (2010) review previous experiences in academics addressed at measuring the creativity of design projects and carry out further tests. They extrapolate that novelty and usefulness are the most agreed assets of creativity; they consequently evaluate the projects made by their students on the basis of judgements on those assets provided by peers and experts. Still focusing on novelty and usefulness, Sarkar & Chakrabarti (2011) put forward a proposal to quantitatively assess creativity of products. Its main strength stands in the employment of objective metrics, which do not require evaluations of individuals. The suggested model exploits a previously developed functional model to characterize the degree of novelty, i.e. SAPPhIRE (Srinivasan & Chakrabarti, 2009) and multiple criteria to estimate usefulness including the urgency of the need to be

satisfied, the potential quantity of people interested in the product, the duration of the employment of the system or of the provided benefits. The final assessment of creativity results by multiplying the degree of novelty and the three levels of usefulness according to the cited dimensions.

Given the advantages consisting in a major repeatability of the outcomes in light of substantially objective metrics, the authors decided to adopt the model advanced by Sarkar & Chakrabarti (2011) as a starting point in the perspective of measuring the creativity of new service definition.

3. Extension of the reference metrics to assess the creativity of services

The extension of the creativity metrics by Sarkar & Chakrabarti (2011) to the assessment of innovative services requires to modify and adapt the criteria related to novelty and usefulness evaluation. The following paragraphs describe an original proposal that preserves intent and structure of the selected reference model, but is tailored to be applied to any kind of immaterial innovation, with a specific focus on services.

3.1. Modified criteria to assess novelty

The first step of this research consisted in evaluating whether the chosen reference model could be employed for design outcomes not represented by physical artefacts. The major hurdle resulting by the experiment was the difficulty in referring elements and procedures pertaining services to the constructs which constitute SAPPhIRE model (Table 1) and whose transformation along generations of systems determine the degree of novelty. According to a first test conducted by the authors, categories might be easily used to describe the mechanisms involved in the delivery of services treating the negotiation and the maintenance of tangible products (e.g. shops specialized for the selling of certain goods, car rental, boiler cleaning). In these cases, the benefit provided by the service approximately corresponds to the need satisfied by the functions of the treated artefact, as well as several elementary constructs can be likewise identified. On the other hand, the definition of the functional components required by the schema can be hardly accomplished if pure services (e.g. healthcare, education) are involved, with a particular reference to SAPPhIRE terms regarding physical structures. In order to overcome such limitations, a redefinition of the elements constituting SAPPhIRE model has been carried out by means of an abstraction process. Whereas a tangible product is composed by elementary objects and more sophisticated parts, a service is structured in various procedures and operations that allow the final fruition of the expected benefit. The physical system, as a whole, can be associated to the service itself, activated by the foreseen preliminary phases and according to the designed interface between the provider, the beneficiary and any other stakeholder (intermediary, adviser, buyer). Similarly, the outcomes of the interaction resulting by the working of a technical system can be related to the perturbations observed as a consequence of the service delivery. On the basis of the above considerations, the redefinition of the SAPPhIRE elements to fit the modelling of services is reported in Table 1, which compares the original formulation and the tailored new description.

Table 1. Elementary constructs for the working of products and services according to the SAPPhIRE model

SAPPhIRE item	Original definition for products and technical systems	Redefinition for services
Parts	Physical elements and interfaces that constitute system and environment.	Phases constituting the service negotiation and delivery. Items involved in the negotiation.
Organs	Properties and conditions of system and environment required for interaction.	Properties and conditions of phases and environment required for the delivery of the

		service.
Effect	Principle that governs interaction.	Principle that governs the delivery of the service.
Phenomenon	Interaction between system and its environment.	Interaction between the service provider and the customer
State change	Change in property of the system (and environment) that is involved in interaction.	Modification of the state of the stakeholder (beneficiary, provider, intermediary, etc.) and of the environment as result of the service delivery.
Input	Physical quantity (material, energy or information) that comes from outside the system boundary, and is essential for interaction.	Amount of tangible objects and intangible resources not given by the provider that is essential for interaction.
Action	Abstract description or high-level interpretation of interaction.	Abstract description of the benefit provided by the service delivery.

3.1.1. Explanatory application of the proposed categories within the video rental industry

The following example, which involves different kinds of services developed in the home video industry, aims at illustrating how to individuate the novelty degree concerning different components of the service-oriented SAPPhIRE model. The video rental outlets have introduced the possibility to watch new movies at home at the chosen timing, supplying therefore unprecedented benefits (innovation about Action) for film enthusiasts.

Since then, alternative business models satisfying the same customer need have offered novel features or radically redefined the ways through which the service is provided. For the purpose, three options are compared, namely traditional Blockbuster video stores, the DVD-by-mail service offered by Netflix and more recent web-based movie providers, such as Movielink and Cinemanow (Dick, 2006).

Blockbuster rental stores were requiring the customer to visit its outlets, choosing the favourite available film and returning the video support (at the beginning videocassettes, then DVDs) when the movie had been watched. The disc rental proposed by Netflix consists in a flat-fee service activated by subscribers, who have to order a list of movies (to be periodically updated) sent via mail with a maximum amount of DVDs available at the customer's home. The remaining films of the rental queue are posted by Netflix upon the receipt of the previous ones, since the customer has to post them back. Eventually, web-based providers allow to download movies that can be viewed on computers or on connected TV sets for a certain amount of time, after which the file containing the video elapses.

The distinction between the services delivered by Netflix DVD-by-mail and Blockbuster stores can be interpreted through modifications of the following categories:

- Parts (in terms of the sequence of activities): planning a series of movies to be watched vs. choosing films one by one; paying monthly fees vs. paying at each rent;
- Organs (in terms of conditions of the phases that enable the delivery of the service): return of the DVDs that allows subsequent deliveries vs. possibility to rent a plurality of discs at once;
- Phenomenon: active and lasting relationship between the customer and the provider vs. interruption of the negotiation when the movie has been returned;
- State change (in terms of the state of the provider): enabling the posting of new movies when the previous ones are sent back vs. passive state of the service provider;
- Input (in terms of the information provided by the customer): continuous update of the list of the desired movies vs. periodical rental of movies chosen at each negotiation.

On the other hand, the Effect that governs the supply of the service results unchanged, since both the rental options require the delivery of a physical object, i.e. the disc.

With respect to the introduction of the Internet-based delivery of movies, the Effect is conversely modified, since digital copies of the videos have replaced physical supports and the user does not need to return any item.

3.1.2. Matching the modifications of the elementary constructs and the degree of novelty

The criteria to distinguish among systems with very high, high, medium and low degree of novelty can remain unchanged with respect to Sarkar & Chakrabarti (2011). Therefore, very-high originality is supposed to be brought by services with innovations at the Action level, for which the residual elementary constructs do not play any role in the determination of the novelty. Low novelty is deemed for new services, for which modifications occur just at the Parts or Organs level. Whereas transformations take place also at the Effect or Phenomenon level, the degree of novelty becomes medium. Further changes concerning State Change or Input give rise to high novelty.

In the followings, when assessing creativity through quantitative metrics, the score assigned to very high, high, medium and low degree of novelty, will be equal to 4, 3, 2 and 1 respectively.

3.1. Metrics to assess usefulness

The criteria introduced by Sarkar & Chakrabarti (2011) to measure the usefulness of systems can be considered as general purpose metrics. The importance of the fulfilled benefits is evaluated according to the suitable level of needs in terms of the hierarchical scale developed by Maslow. In order to categorize services through the proposed criterion, a slightly modified version is proposed with respect to the reference model to assess creativity, thus encompassing a wider range of benefits than those currently satisfied by products and material artefacts. It is also possible to replicate the metrics concerning the usefulness in terms of the arena of potential recipients of the service and the duration of the expected benefits. Such criteria give rise to coefficients expressed in terms of continuous variables ranging from 0 to 1. However, the determination of such issues is often affected by the impossibility to establish such values with exactness, due to a lack of information whereas demographic, statistical or census data are not available. With regards to such limitation, a ranking is hereby introduced to classify, through discrete variables, the amount of service recipients and the rate of use or of the duration of the benefit.

Table 2 summarizes the proposal of the present paper to cluster the three dimensions of usefulness for services and provides suitable examples for each category. Together with each reported category, the quantitative scores to be employed for the final determination of creativity are reported in brackets.

Table 2. A proposal to assess the urgency of fulfilled needs, the relevance within the population and the duration of the benefits with regards to services

Degree of importance	*Example*	**Expected beneficiaries**	*Example*	**Rate of use or rate of duration of the benefit**	*Example*
Life saving and support, wellness (5)	Healthcare	The whole community or a large majority (4)	Muslims in Arabic countries	The whole time (5)	Benefits by nutrition
Compulsory activities (food, rest, hygiene) (4)	Contract cleaners	About half of the population (3)	Women or men	Daily or several days in a week, for a considerable amount of time (4)	Sport training for athletes
Shelter, safety, transportation and	Press	Consistent groups of the population	Pensioners	Daily or several days in a week, once or more	Public toilet

social interaction (3)		(2)		times, commonly for brief periods (3)	
Fulfillment of personal needs and services required for job-related issues (2)	Intranet	Restricted groups of the population (1)	Billionaires	Periodically or seasonally (2)	Vacations
Entertainment and recreation (1)	Cinema			Once or few times in a lifetime (1)	Mountain rescuing

4. Measurement of the creativity of successful services

A sample constituted by seven services, attaining success as witnessed by a plurality of literature sources, is hereby reported to show the applicability of the proposed metrics for assessing creativity. Such sample is a subset of a larger group of twenty success stories, which has been examined by the authors in details. The residuals are not reported for the sake of brevity; the selection has been performed with the aim of presenting at least one example for each score of novelty and usefulness. The cases are described in the following Subsection, which provides useful hints for the subsequent evaluation of creativity.

4.1. Set of employed successful services

The Body Shop (Hartman & Beck-Dudley 1999; Kaplan 1995, Kim & Mauborgne, 2005; Livesey & Kearins 2002, Martin 1998) is a large franchise in the cosmetics industry, which has transformed the sector by offering natural-scented items characterized by their practical way of use. The Body Shop has banned the hiring of top models and "eternal beauty" promises from its advertising campaigns, resulting in a textbook story to show the potential success of ethical business models. From a functional viewpoint, the innovation of the service has resulted in the large diffusion of different kind of cosmetics, beyond structuring a tailored selling environment for the franchised outlets.

Cirque du Soleil (Bennet 2005; Harvie & Hurley 1999, Higgins & McAllaster 2002, Kim & Mauborgne, 2005; Peterson 2007) is a Canadian company initially raised by artists involved in street entertainment, which has proposed sophisticated circus performances, avoiding shows with animals and international stars. Their entertainment proposal can be considered as a mix between circus and theatre, since the presented shows are enriched by sorts of plots. In this way, Cirque du Soleil has revolutionized the circus environment and the way the spectator is involved in the show.

Curves® Fitness Company (Goodman & Focault 2006; Kim & Mauborgne, 2005; O'Toole 2009) is a franchise of gymnasia, attended by women requiring sport activity for wellness purposes and scared by the competitive environment of traditional outlets. The gymnasia are simply equipped with few basic and practical training tools. Curves® has resulted in an alternative to videocassettes purchased for home training, deemed too challenging for carrying out a constant and careful sport activity. In this sense, Curves® has resulted in a considerable innovation, not just from the viewpoint of the environment and the use of gym tools, but also by modifying the interaction between the trainee and the trainer (from virtual recorded videos to direct interaction).

Direct Line (Channon 1998; Kim & Mauborgne, 2005; Oakley 1997; Willcocks & Plant 2001) is a British insurance company specialized in selling policies and other financial services by phone or web. The elimination of brokers has resulted in a different sequence of tasks in charge of the insured parties, a different kind of interaction between the policy holders and the company, a different way for the organization to manage the customer portfolios. Benefits have resulted in not negligible reductions of the policies price, which have determined the success of Direct Line.

Facebook is a well-known social network, giving the opportunity to a multitude of users to share information and feelings. Given its enormous success, witnessed by the greatest number of subscribers among all the social networks, Facebook can be considered a milestone in the history of communication with a vast range of potential developments and employments, as reported, e.g., by Bozkir et al. (2010).

Formule 1 (Fiorentino 1995; Kim & Mauborgne, 2005; Verweire et al. 2007) is a low-cost hotel chain, founded by the French company Accor. The hotels offer small-sized, but comfortable and clean rooms and minimize extra services, such the availability of common accessories and the opening time of the reception. Self-organized travellers and business voyagers have become the core clientele of this sort of hotels, who require just a bed in a quiet environment. The main changes with respect to traditional hotels concern the kind of environment and the decreased interaction between the staff and the visitors.

Eventually, Netjets (Budd & Graham 2009; Kim & Mauborgne, 2005) has introduced the fractioned property of private airplanes. Rich people or big companies can buy flight time rather than private jets. This results in a dramatically simpler administrative management of the travel. Times required for urgent transportation are not significantly higher than those carried out through private jets. The modifications with respect to previous business models include the sequence of activities in charge of the customer, the interaction between the client and the company (picking up the passengers instead of providing the jet), the resources required for the travel organization, the way the company changes its state after it has been contacted by the service user.

4.2 Creativity assessment

With the aim of assessing the creativity of the above-mentioned exemplary services, the provided description allows to individuate the SAPPhIRE categories subjected to change. Table 3 summarizes whether, for each illustrated service, modifications have been observed; the analysis is limited to those issues resulting relevant for the determination of the degree of novelty. Table 4 shows the final assessment of creativity, multiplying the scores assigned with reference to the level of novelty (resulting by the examination reported in Table 3) and the three components dedicated to estimate usefulness.

Table 3. Redefined SAPPhIRE categories undergoing changes in exemplary service innovations: the label "Yes" stands for observed modification, "No" if no transformation is revealed, "N.R." whereas any variation would not impact the assessed degree of novelty

Case study	Action	Parts	Organs	Effect	Phenomenon	State change	Input
Body Shop cosmetics	No	Yes	Yes	No	No	N.R.	N.R.
Cirque du Soleil	No	No	Yes	No	Yes	No	No
Curves fitness company	No	Yes	Yes	Yes	Yes	No	Yes
Direct Line	No	Yes	Yes	Yes	Yes	Yes	No
Facebook	Yes	N.R.	N.R.	N.R.	N.R.	N.R.	N.R.
Formule 1 hotels	No	No	Yes	No	Yes	No	No
NetJets	No	Yes	No	No	Yes	Yes	Yes

Table 4. Final assessment of creativity for the sample of surveyed services with reference to previously established scores: the case studies are ordered according to decreasing creativity

Case study	Novelty	Degree of importance	Expected beneficiaries	Rate of use or rate of duration of the benefit	CREATIVITY
Curves fitness company	3	5	2	5	150
Direct Line	3	3	2	5	90
Body Shop cosmetics	1	4	3	3	36
Facebook	4	1	2	4	32
Cirque du Soleil	2	1	4	2	16
Formule 1	2	4	2	1	16
NetJets	3	2	1	1	6

5. Conclusions

The paper proposes a metric to evaluate the creativity of innovative services, which has been developed by extending the model proposed by Sarkar and Chakrabarti (2011) to assess products in terms of novelty and usefulness, i.e. the most acknowledged determinants of creativity within engineering design. The possibility to measure the creativity of both physical artefacts and intangible goods allows to estimate the originality of a large series of design activities. In a broader sense, such kind of metrics could allow the characterization of innovations impacting the user's value and experience according to their creative content.

The presented preliminary experiment is intrinsically affected by two kinds of limitations. Firstly, a greater quantity of case studies should be analyzed to prove the usability of the proposed metrics. Additionally, the outcomes of the described creativity assessment should be compared against results obtained with other, albeit more subjective, criteria. Nevertheless, the small subset of data presented in Table 4 is sufficient to show that very different creativity scores can be associated to successful services from disparate industrial fields. It is well known that the diffusion of innovation depends on many factors and not just on the usefulness and the originality of an invention. The outcomes of the present study confirm once again this phenomenon, whereas the creativity ranking reported in Table 4 does not clearly match the commercial success and the social impact of the investigated services.

According to these considerations, the future research will be aimed at comparing the presented results of service creativity with different metrics and establishing the most influential dimensions of originality and usefulness in light of designing projects supposed to thrive in the marketplace.

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