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Conceptual combination: a semantic framework for innovation

Anna Comacchio and Massimo Warglien

Advanced School of Economics and Department of Business Economics and Management
Ca' Foscari University - Venice – Italy
comacchio@unive.it; warglien@unive.it

Abstract

An underestimated but pervasive aspect of innovation is its semantic creativity. Innovation is tangled with the generation of new meanings and new representations of familiar objects or processes. This paper explores semantic innovation arguing as a combination of pre-existing conceptual structures. First we shed light on the level at which innovative semantic combinations unfold, that is the conceptual level. Second the paper provides an in depth analysis of the dynamics of conceptual combinations, examining the processes underlying it: similarity detection, selective mapping and search for coherence. Our analysis of a rich set of cases opens up the complex architecture of conceptual combination and shows that, given its conceptual nature, semantic innovations shift among different level of abstraction (products, processes and business model)s and thus can be transferred to entirely different sets of activity. The paper provides a theoretical framework to understand the dynamics of semantic innovation and a contribution to the debate on innovation as knowledge combination in managerial and economic literature.

Keywords: conceptual blend, knowledge combination, semantics, innovation

1. Introduction

"Pocketable" is probably the first English word born in Japan. It was invented by Sony when it launched the TR-63, one of the first transistorised radios, in 1957 (Fig.1). The catch word was meant to establish a new product concept: the TR-63 wasn't just a smaller radio, it was a portable radio people could carry on themselves.

Thus consumers had to associate the radio to a familiar concept of portability: and what carries more the idea of portability than our pocket? Blending the small "unplugged" artifact with that fundamental extension of our body, which is our suit, was creating a conceptual discontinuity that was going beyond miniaturization to crystallize in a symbol of a wholly new functionality.

However Sony had to pay a price to establish a coherence between the new concept and the constraints of the real world. The TR-63 was a little bit larger than ordinary pockets and Sony had to endow its salesmen with shirts with oversized pockets.

Fig. 1 The TR-63 pocketable transistor radio

Source: Sony History-Sony website 2009

The above example suggests an often underestimated aspect of innovation: its semantic creativity. An innovation is often tangled with the generation of new meanings and new representations of familiar objects or processes. As it has been suggested, when new artifacts and processes are generated, "meaning matters more than function" (Krippendorff 2006) – innovations must be understood in terms of the new meanings that are created by those designing as well as by those adopting and using the new artifact or process.

This paper explores how pre-existing conceptual structures are recombined to generate new ones in innovation processes. Our theoretical framework will draw to a large extent on research looking at language innovation as a window on semantic creative processes. However our analysis will extend to examples that are not directly language related innovations to illustrate processes of conceptual recombination.

2. Innovation as conceptual combination

2.1 Innovation as a combination process

A common claim in the economic and managerial literature is that innovation is a combination process. Since Adam Smith, innovation has been conceived as a process of reconfiguring existing knowledge, the creative effort of integrating different and distant knowledge domains: "*A philosopher or "meer man of speculation" is one of these people whose trade it is, not to do any thing but to observe every thing, and who are upon that account capable of combining together the powers of the most opposite and distant objects ……the application of new powers, ..., belongs to those only who have a greater range of thought and more extensive views of things than naturally fall to the share of a meer artist. (Smith, 1976, 337-8).*

The recombinant nature of innovation is also central in Schumpeter and in contemporary evolutionary economics. In the words of Nelson and Winter "*Schumpeter identified innovation with the 'carrying out of new combination ' (Schumpeter, 1934, 65-66). This phrase gives useful emphasis to the fact that innovation in the economic system – and indeed the creation of any sort of novelty in art, science, or practical life – consists to a substantial extent of a recombination of conceptual and physical material that were previously in existence.*" (Nelson and Winter, 1982 pp.130) .

Nelson and Winter transfer this schumpeterian conception to organizational skills or routines suggesting a genetic metaphor for the process of routine innovation. In the same vein, Kogut and Zander (1992) maintain that innovation is the result of a combinative capability of a firm, which includes the exploration of new technological opportunities and the reconfiguration of a firm's knowledge base. According to this approach knowledge of the firm advances through local search and recombination.

The search process that drives to new combinations has been studied by the literature on innovation and absorptive capacity. In Cohen and Levinthal's model (1990) the capacity of recognition, assimilation and exploitation of external valuable knowledge, named absorptive capacity, is a *"critical component of innovative capability"* (Cohen and Levinthal 1990: 128). This literature suggests an asymmetry in the process of combination, in which the existing knowledge of the firm filters and selects potential external sources of new ideas for recombination. Cohen and Levinthal emphasize the role of pre-existing broad and rich knowledge structure arguing that *"the ability to evaluate and utilize outside knowledge is largely a function of the level of prior related knowledge"* (Cohen and Levinthal 1990, 128). In other words, past in-house experience is indeed one of the entities to be retrieved and combined, but a certain degree of overlap with external knowledge also helps to recognise distant solutions that can be effectively assimilated and blended in novel associations. Other contributions have analysed the complementary role of combination capability and absorptive capacity (Zahra and George 2002; Todorova and Dursin 2007; Love and Rope 2008), and the central role of brokering different knowledge domains (Hagardon and Sutton 1997).

While there is a broad convergence on portraying the innovation as a combination process, the choice of the level of analysis and the definition of the entities which are candidates to recombination are still, to a large extent, an open issue.

2.2. The conceptual level of analysis

Coherently with the goal of exploring innovation as a semantic creative process, we focus here on the conceptual level i.e. on structured representations of artifacts or processes (Norman 1988; Fauconnier 1997; Gärdenfors 2000). Concepts are units of meaning – they can be loosely defined as basic mental representations that organize relations among our experiences, and embed their properties and mappings (Gardenfors 2000). For example, the concept of "apple" will carry associations to its color, shape, texture, taste, dimensions, as well as to its nutritional properties or its "type of fruit" properties, so that we can distinguish it from other fruits, relate it to them by similarity judgments, and make inferences about it. Concepts are fundamental in the way we understand (and use) a daily object like a spoon or a coffee machine, but also more complex, structured and immaterial entities such as a business model (actually Peter Drucker originally defined a business model as "nothing else than a *representation* of how an organization makes (or intends to make) money").

Without entering in the controversial debate over the nature of concepts, we simply want to direct attention to the fact that an innovation has to be conceived and understood, and that this implies that it has to be somehow related to changes at the level of our conceptual representations. In particular, innovation implies a restructuring of such representations – defining new relationships among more elementary conceptual components, associating concepts previously separated, putting old components in new contexts. This process is often defined as conceptual combination (Thagard and Verbeurgt, 1998; Gardenfors, 2000; Fauconnier, 1997), and it is the core of new meaning creation. It is at this level that we will carry our analysis of the recombinant nature of innovation.

A historical example of innovation may help to clarify what we mean by the conceptual level of analysis better than a long definition. The first digital computing machine, a fundamental innovation indeed, was probably designed by Leibniz in 1671 (Fig.2). No new single component, physical law or production advancement is implied in this design. Leibniz exploited pre-existing knowledge about mechanical synchronization in clocks via gear ratio (Penzias 1989). In fact by combining gears with different numbers of teeth one can multiply or divide the number of turns accomplished by each single gear (one turn of an thirty teeth gear will produce three turns of a ten teeth gear; thus turning two times the larger gear will produce two times x three the smaller one, the gear ratio is a multiplier) (Fig. 3). All this was well known by clock makers and use to synchronise different time scales in clocks.

Fig. 2 The Leibniz computing machine

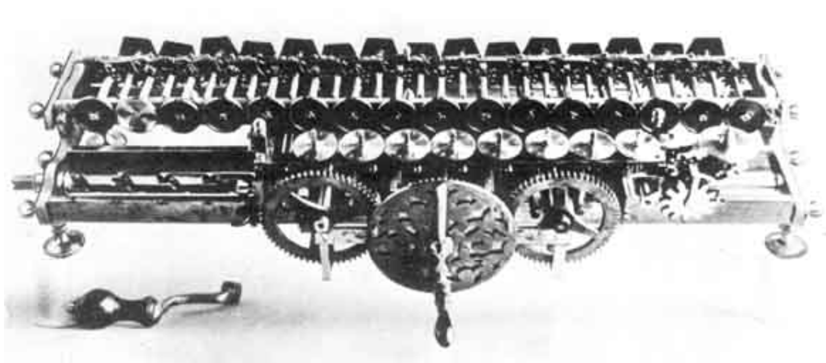
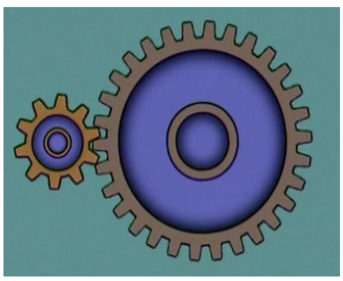


Fig. 3 The gear ratio



The basic idea of Leibniz was to reorganize the pre-existing concept by inverting the process. Instead of coordinating time scales one could make an arbitrary number of turns to generate multiplications and divisions. It is a little like turning *n* times the hour needle and record the number of turns of the minute needle to compute 60 x *n*. Thus the innovation was generated by decoupling the concept of gear ratio from the clock conceptual frame and by reversing the cause-effect relation.

3. Conceptual combination: a framework of analysis

3.1. Definition of conceptual combination

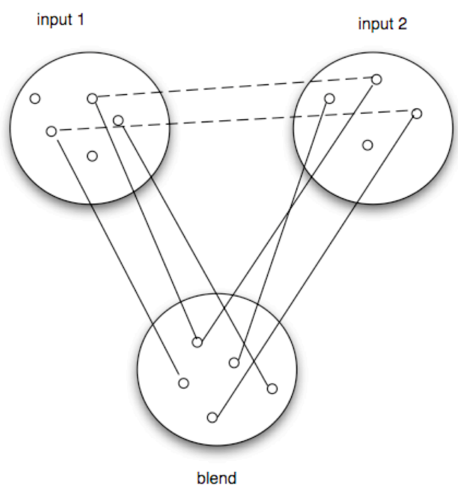
We focus here on a particular type of conceptual innovation: conceptual combination– a.k.a. "blending" (Fauconnier 1997; Fauconnier and Turner 1998).

Blending is a basic mental operation to produce new conceptual integration (Turner 2007). It is a process of mapping between different mental spaces, which are "small conceptual packets" (Fauconnier and Turner 1998) and are "structured by information from discrete cognitive domains" (Coulson and Oakley 2000: 178).

The creative construction of meaning realised by blending is based on an array of mental spaces each containing a mental coherent representation of entities. They are interconnected, they can be modified and provide inputs to a new conceptual blended space. Input spaces from which blending unfold have an underlying composition of elements and structural relationships (e.g. causal relations). Blending implies a process of similarity detection based on the recognition of partial connections between components of counterparts spaces and their selective projection to a blended one (Fig.4). The blend is a new concept that selectively inherits elements and relations of the inputs but it also has its own emergent structure: elements from the input spaces are composed and new relations among them are discovered (Fauconnier and Turner 1998: 144). The emergent structure has to reconstruct the internal fit of elements and relations, which in turn may imply processes of further selective deletion or addition of new elements and structural relations. During the on-line elaboration of a blended space, the structural coherence of the "prototype" concept is simulated and tested by an iterative process, "running the blend" (Fauconnier and Turner 1998).

Indeed the recombination process is not a simple assembly of the input sources but the integration of components of extant concepts and implies a more complex structure of similarity detection, selective mapping and coherence finding.

Fig. 4 Conceptual blend



Source: Fauconnier and Turner 1998

An example of creative blending in innovative industrial design is represented by two masterpieces exposed at Museum of Modern Art in New York City (Tab.1): the Radio TS 502 designed by Marco Zanuso and Richard Sapper in 1962 and commercialised by Brionvega (Italy) in 1964, and the Grillo folding telephone, designed by the two architects and manufactured by the italian subsidiary of Siemens in 1965.

In the case of Radio TS 502, the conceptual creative process of Zanuso and Sapper was driven by mapping two main input spaces: one is the domain of radio's technology and design (which in turn had undergone many innovations till the 60s), the other one seems to be a sub-space of *biological models*, that have been a prolific source of inspiration of man-made innovations in the nineteenth century (Rinaldi 2007; Ball 2001). Specifically in the case of Radio TS502 it seems that the designers mapped the "natural" design of seashell bivalves and the radio functions into a new blend space. The radio was realised in two "cubic valves", in which were separately located the audio section with the speaker (left box) and the receiver (right box), thus exploiting the decoupling of radio architecture in input and output modules. The seashell source also exported the functionality of protecting by closing the valves, which allowed to conceive a more robust and portable object.

We may also recognise the emergence of new structural relations. The combination composed elements of the inputs in a new compact and "artificial" form of rounded parallelepiped: inside were embodied the speaker, the receiver, the screen and the handles for tuning dial, while the smooth plastic exterior easy to be manufactured in brilliant colours fitted the emerging demand of colourful objects of the 60s, and gave the radio a new aesthetic meaning.

Three years later, working with a different company, the designers studied a new telephone[1], combining by analogy the folding radio input space with telephones input space (both objects have in common a modular architecture that can be decoupled in two parts). In the new conceptual space (folding telephone) emerged the Grillo, a radically new product with a revolutionary flip-design (automatic opening as the phone is picked up) in a compact, pocketable, form that made it an hand-held phone. Indeed Grillo clam-shell design inspired the future cell phone industry and it is legitimately considered the precursor of an entire generation of mobile phones.

Tab.1 Two revolutionary conceptual combinations: Radio TS 502 and Grillo Folding Telephone

Radio TS 502 - 1964 produced by Brionvega (Italy) Moma - The Museum of Modern Art – New York	**Grillo Folding Telephone – 1965** produced by Siemens (Italy-Germany) Moma - The Museum of Modern Art – New York
	
Designers Marco Zanuso (Italy, 1916-2001) Richard Sapper (Germany, born 1932)	**Designers** Marco Zanuso (Italy 1916-2001) Richard Sapper (Germany, born 1932)

Source: our elaboration on Moma collection 2010

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[1] the sequential order of the production of the two products suggest that the concept of unfolding radio came first and then it was blended with the concept of the telephone

To shortly illustrate an example of conceptual combination at a different level of abstraction (processes instead of products), a remarkable example is the Toyota kanban system combining the classical fordist assembly process with the "pull" feature of a supermarket system (the anecdotal legend is that a visit to the Piggly Wiggly chain store triggered the reorganization of the Toyota production system by Ohno). An other complex example, implying the reconfiguration of a whole business model, is the multiplex cinema, which is the conceptual combination of two inputs: the theatre and the mall. These examples suggest that a same process may underlie different kinds of innovation from product design to the redesign of a business model.

3.2. The structure of conceptual combination

3.2.1 Process asymmetry

In general the recombination process is not a simple assembly of the input sources as the luggage-trolley might misleading suggest, but, as illustrated by the other cases, the integration of pre-existing concepts implies a more complex structure of similarity detection, selective mapping and coherence finding. Furthermore, in general inputs are not symmetric. In most cases one of the concepts works as an anchor to which the other inputs acts as carriers of novelty. Following a common linguistic distinction, an input can be defined as the *head* and the others as *modifiers*.

In language, the head-modifier distinction is a fundamental principle of composition in phrases or clauses; the modifier qualifies or transforms the head, which is the main carrier of meaning. For example, an adjective "modifies" a noun by selecting a property of it (e.g. "a *tall* woman") or a preposition phrase transforms it metaphorically ("a woman *like a lioness*"). We submit that such an asymmetry is an important architectural feature of innovation, that is anchored in one of the conceptual inputs acting as the main carrier of meaning. An example which is transparent at the language level is *portable radio*. At a more complex level, in the Toyota case, the assembly line clearly acts as the *head*, while the Piggly Wiggly "pull" concept is the *modifier*. We shall see below that this same asymmetry is fundamentally at the basis of the notion of absorptive capacity.

Three more cases of combination, one of a very familiar object (the fork), a second of a revolutionary fabric (Velcro), and the third of a fundamental process innovation (the Ford moving assembly line 1913), may help to illustrate the architectural dynamics of conceptual combination.

The three examples are blends of two main inputs. The contemporary four-tined fork combines the original fork with two long, straight and pointed tines and the spoon. The Velcro combines the traditional hook-and-eye fastener with the biological model of tiny hooks on Burdock. The Ford moving assembly line combines the original Ford T linear production lay-out with the moving “disassembly line” of slaughtered animals observed by a Ford’s engineer, William "Pa" Klann, visiting a Chicago slaughterhouse in 1908.

Neither objects are simply the additive composition of inputs. Input concepts are modified through a process which is not a straightforward sequence of phases but rather an iterative search cycle.

3.2.2 Similarity detection

The inputs of the blend are not arbitrarily chosen. Usually they are the result of a search process driven by similarities among their components, elements, and/or structural features. It is often observed that similarity detection can act at two levels. A domain (or a situation) can be viewed as a system of objects, attributes of the objects, and relations between objects (Gentner 1983). Similarity detection requires to establish a mapping between two (or more) domains. Such mapping can capture “surface” similarities (i.e. common attributes, like same color of objects) or “relational” or “structural” similarity, such as “the electron revolves around the nucleus like the earth around the sun”. In the latter case, similarity is in the correspondence between relations: the electron is in the same relation to the nucleus as the earth to the sun. We submit that while surface similarities may be instrumental in triggering the recognition of a potential conceptual input, the detection of structural similarities is fundamental to innovative blends.

In the case of the four-tined fork, a mixture of surface and structural similarities makes it easy to map two-tined forks and spoons. The two-tined fork and the spoon have a common component – a handle supporting the tool - both are made with similar materials, and they are used in a same context (eating) with similar function (picking food).

In the case of Velcro, historians (Weber 1992) tell that a Swiss engineer, George de Mestral, back from a walk in the Alps, noticed the burrs (seeds) of burdock stuck to his clothes and his dog's fur. A closer examination under a microscope revealed hundreds of "hooks" (tab.2). The detection of a surface similarity between the shape of biological hooks and the existing hook-and-eye closure triggered the invention process of one of the most diffused and admired fabric. Indeed “Velcro” is itself a conceptual combination at the word level. De Mestral named its revolutionary idea blending the French words for velvet (*velours*) and hook (*crochet*).

In the case of the Ford moving assembly the original similarity is more subtle. In 1908 Ford had already introduced a linear lay-out for the production of its T-model. But cars were pushed from station to station by workers, and their progress along the line was just determined by the workers‘ pace. When "Pa" Klann visited a Chicago slaughterhouse he observed a very different “production process” (the disassembly of an organic entity rather than the assembly of a mechanical one); but he could recognise the efficiency induced in a linear process by coordinating the pace of workers with an automated conveyor device. The common element here is only structural: the motion of an object through a linear lay-out in a sequential task.

3.2.3. Selective mapping

In conceptual combination, elements and relations from input concepts are selectively projected to a separate blend. Only subsets of the input elements and structures are preserved while other subsets are deleted or modified (Fauconnier 1997; Fauconnier and Turner 1998). The selection is driven by the recognition of similarities among elements of the input spaces. Then the selective mapping process “composes elements from the input spaces, providing relations that do not exist in the new inputs” (Fauconnier and Turner 1998: 144). The creation of new relations helps to understand which components are most salient for the new combination. Thus through an iterative process of recruitment and composition, some irrelevant or redundant elements and relations are discarded and more coherent components are again grafted from the input spaces and added to the blend, as a one fused element or as separate elements.

In the case of the fork, the four-tined type inherits from the spoon the concave shape that facilitate collecting food (fig.5) but loses the spoon integrity (actually the four-tined fork was also known as “split spoon”) (Petroski 1994). On the other side, the original two-tined type modifies the number of tines, their shape and smoothes their points to capture some of the spoon functionalities.

Fig. 5 The four-tined fork as conceptual blend: selective mapping of the concave shape

In the invention process of Velcro, De Mistral selectively mapped the shape of biological hooks from the “burdok” conceptual space (the modifier) into the blend space in which it recruited the similar concept of hook from the traditional garment closure input space (the head). But the selective mapping went far beyond the first recognition of a surface correspondence (hook shape) between the two conceptual spaces. De Mistral also mapped the structural similarity between the stickiness of numerous natural hooks on a “velvet” surface like a jumper or a dog’s fur and the function of fastening of a strong steel hook slotted into its twin loop. Moreover he also creatively retained separated subsets of the two conceptual spaces: the small size and flexibility of biological hooks and the man-made hooks and eyes sewn to their respective pieces of cloth.

Components of the two input spaces were also discarded: for instance the concave disposition of biological hooks on the round seed on one hand, the smooth point of the man-made hook and the material with which is made (steel) on the other (tab.2).

In the Ford assembly case no elements of the slaughterhouse production process remain: nor the worked objects, nor the device, nor the task. The only but fundamental preserved elements are two structural features: i. the specialized labour division by which each single worker repeats the same task along the line, ii. coordination along a linear sequential task is ensured by the automated progress of object worked upon. Of the original 1908 T-model assembly process the basic layout, the division of labour and the assembled model are preserved. Yet the backbone of the production process is transferred to the conveyor belt assuring, together with the progress of the car through the line, also the whole coordination of the work process.

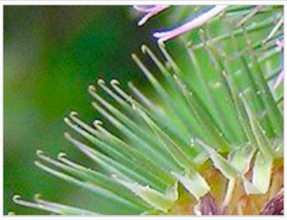
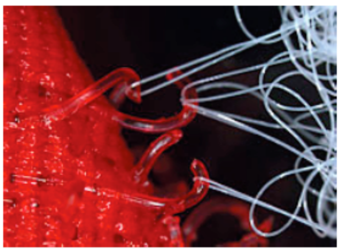
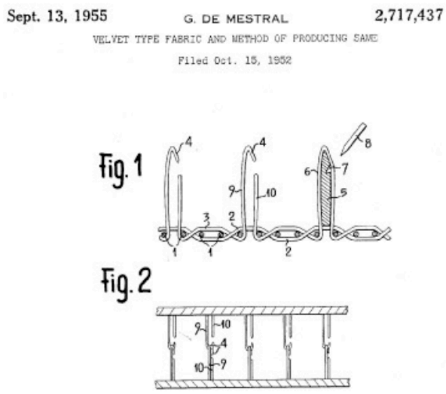
3.2.4. In search of coherence

Selective mapping from inputs is not enough to ensure a working new concept. Elements mapped into the blend can cohere (fit together) or incohere (resist fitting together). Furthermore the blend needs to be integrated through the introduction of new elements, the modification of others, the establishment of new structural relations. The blend must evolve into a stable concept that maximises its internal coherence (the overall satisfaction of the constraints determined by the positive and negative associations between elements) Furthermore the new concepts has to satisfy the constraints determined by the interaction with the usage environment. Thagard and Verbeurgt (1998) provide a basic framework for analyzing coherence in a conceptual system. They suggest that a conceptual system can be described as a (potentially heterogeneous) set of elementary concepts, propositions, goals, parts of images and so on. Such elements can mutually cohere (fit together) or incohere. For example, elements can be related by facilitation relationships rather than conflict. Whenever they fit, there is a "positive constraint" associating them. Symmetrically, if they incohere, a negative constraint associates them. A positive constraint is satisfied when the elements it associates are kept together, and it is violated otherwise. The reverse holds for a negative constraint. The search for coherence implies deciding which elements have to be accepted or rejected from a conceptual system; the coherence criterion is that the emerging concept should "accept" elements which minimize the violation of constraints – the process can be imagined as "descending" a surface whose height represents the amount of constraint violation. Of course, a concept cannot always satisfy all constraints – but it can at least provide locally stable solutions (bottoms of the "surface") that cannot be improved by incremental changes. This also implies that there may be more than one solution which is locally coherent (to stay on the same metaphor: the surface may have more valleys to descend).

The four-tined fork is the result of a long experimentation that has modified the number of tines (three, six..), its curvature, its complementarity with the shape of the knife (Petroski 1994) to maximise fit. To better fit the usage environment the fork has differentiated in several types (fish fork, salad fork, etc.), providing a clear example of multiple, locally coherent solutions.

The Velcro conceptual innovation is a creative and long search of coherence. First the reduced scale of flexible biological hooks did not cohere with the concept of a linear tape of eyes of the man-made closure (impossible to match side-by-side a pair of miniaturised hook and eyes) and they did not cohere even with a strong closure previously guarantied by parts made in steel. Thus the concept of hook and eye was modified in two ways (Weber 1992): i) from a linear array of hooks and loops to an surface of them, ii) from a determinate matching between an individual hook and an individual eye, to an indeterminate match-up. Furthermore the two-dimensional surfaces were also coherent with the requirement of a powerful fastener. The strength of the steel was replaced by the strength of the higher number of hooks and loops in the two surfaces (De Mistral's aim was 300 hooks and loops per square inch) (Thomas 2007). The choice of using a fiber like cotton seemed to be coherent with the subset of elements and relations of the new concept. But cotton wore out quickly, thus de Mistral choose a synthetic new fiber, the nylon. This set of new relations at least provided a locally stable solution, indeed by a simulation process, de Mestral "discovered that nylon, when sewn under infrared light, formed tough hooks for the burr side of the fastener" (Thomas 2007: 1). But it took several years and simulations of prototypes and production processes to eventually submit the idea for patent in 1951 (granted in 1955).

Tab.2 The Velcro process of conceptual combination

Similarity detenction (1941)	Selective mapping and search for coherence	The conceptual innovation Velcro Patent (1955)
 Tiny hooks on a Burdock (Arctium lappa) (detail)  Hook and eye clasp	 The hooks on a piece of Velcro 	

Source : our elaboration on Wikipedia 2010 and Thomas 2007

The search of a coherent solution of the Ford assembly line has implied a long process of seven years in which a prototype assembly line has been tested. As described by Sorensen (1956) , it has been a gradual process of "moving the work from one worker to another until it became a complete unit" that made it possible to coordinate assembly in a moving line. The same famous choice of producing the Ford T with only one colour (eliminating other colours previously available) was dictated by the need to suppress an incoherence in the process, a bottleneck in drying times – only japan black dried fast enough. Search for coherence implied extensive use of "pilot" simulated experiences to check the internal fit of the system. For example in a first run the conveyor belt was simulated by continuous human traction of the car to experiment the optimal motion speed. When the cost of incoherence is high the tuning of the blend may imply a large amount of "off-line" experimentation and artificial modelling.

4. Conclusion

In this paper we analyse the innovation through a semantic lens. We see semantic novelty as a pervasive aspect of any kind of innovation rather than a specific type of innovation (Krippendorff 2006) . To some extent any innovation implies a generation of new meaning both from who is designing it and who is using it (Norman 1988).

In particular our level of analysis is the conceptual one , i.e. the level of structural representations of artifacts or processes. In this paper we focus on the emergence of new meanings from the combination of pre-existing concepts, also known as conceptual blending.

We described the main building blocks of conceptual blending, analysing some examples of different kind of innovation. By drawing on the cognitive science and linguistics literature, we suggest that a new conceptual blend is not simply the additive composition of at least two inputs but it derives from a complex and iterative process based on three central sub-processes: similarity detection (Gentner 1983), selective mapping of elements (Fauconnier 1997; Fauconnier and Turner 1998) and the search for coherence (Thagard and Verbeurgt 1998). We show that a common architecture can be found in cases as diverse as the incremental, diffuse evolution of an implement of daily usage (the fork), the design of a technological product (the clam-shell phone), the invention of a new type of fabric (Velcro), the structuring of a new manufacturing process (the assembly line, the Toyota system) and the generation of a new business model (the multiplex cinema).

Given its conceptual nature this architecture allows innovation to shift among different level of abstraction and thus be transferred to entirely different sets of activity. So Gillette "razor and blade" model combining the traditional structure of durable good such as a razor with notion of the disposable parts, can be easily generalised and than applied to a different industry such as the computer printers one.

The analysis of the cases helps to illustrate the architectural dynamics of conceptual combination, which may shed more light on how meaning creation process is organized and managed.

Some implications are worth considering. First, similarity detection can only work on a large repertoire of available sources and on the capability to recognise non superficial similarities among superficially distant domains. We have already stressed the asymmetric nature of this process of recognition which is grounded in what we have called the “head” input space. This bridges our analysis with the literature on absorptive capacity. Investments in prior knowledge are clearly correlated to a productive similarity detection process which is at the heart of absorptive capacity (Cohen and Levinthal 1990; Zahra and George 2002). Our work can contribute to a more detailed understanding of some key conceptual processes related to knowledge absorption.

Second, our framework helps to analyse a powerful process generating complementarities rather trade-offs between the depth and breadth of knowledge implied by innovation process. Finding the right balance between investments in the depth and the breadth of knowledge (Wang and Von Tunzelmann 2000; Prencipe 2000) is a fundamental architectural problem of innovation process. However conceptual combination moves ahead the line along which such balance should be found. In particular in-depth knowledge of the head input space allows to detect structural similarities in superficially distant modifier input spaces. Often a structural proximity is hidden by superficial, feature-based distance: deep competence in the head domain is often a prerequisite for making knowledge breadth usable.

Finally the notion of running the blend as simulation and test of dynamic coherence may help to better understanding of the role of prototyping and other pilot activities in the innovation process. In the light of our reconstruction prototyping can not be considered as mere test of the new concept, but is a potential important moment of the further elaboration of the original blend and can be in itself carrier of novelty. In particular by generating a material implementation of the concept, prototyping provides material anchors that help to stabilise the blend and carry new projections and integrations (Hutchins 2005). Moreover prototyping may help to highlight the temporal dimension of the concept by running it in real time as in the ford assembly line prototyping example.

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