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Hybrid products and goal oriented categories: the GPS camera case

Advisor: Prof. Tore **KRISTENSEN**

Master thesis of:

Marco Montanaro

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ABSTRACT

The last years have been characterized by a strong shift in the different creative processes adopted by firms to propose new products on the market. The latest technological convergence phenomenon, that has particularly characterized the electronics market, has brought incremental features and adds-on to be between the most utilized techniques; however, they not always have proved to be the most appropriate. The paper that follows, aims at investigating this trend through the study of the evolution of the GPS camera phone. An analysis of the firms' behaviors and strategic choices will be conducted according to cognitive psychology frameworks, and the results of the study will be presented. In addition, theoretical contributions and managerial implications that could serve as basis for offering firms useful insights will be proposed.

Research Questions: What has been the latest trend in the camera and in the cell phone market? What creative processes have characterized the firms' behaviors? What's the relation between the technological convergence phenomenon and firms' creative processes? What are the managerial implications for firms that are providers of content like programs, music or drama?

1. Introduction

The creative process has always been an important topic in the economic literature; however, it has often been surrounded by an air of mystery and mysticism. The incredible potential and, to talk in more concrete terms, revenues, that have been attached to the idea and necessity of being creative, has often collapsed with the idea of a quasi-supernatural ability belonging to few elected.

Indeed, over the years, innovation and creativity have grown in importance, becoming vital competences to business performance and firms' long-term prosperity. "*Macroscopically, they contribute to employment, productivity growth and economic development. Organizations and firms' have to deal with changeable environments and the need to respond to challenges from new competitors, new partners, new products and new technologies to remain competitive. An organizations' capacity to swiftly produce, assimilate and explore successfully*

innovations in the economic and social domains, can represent, indeed, an extremely important source of competitive advantage". *(J. Alves, M.J. Marques, M. Visser 2006)*

Firms seeking to undergo a creative process have tried to follow different paths that could, eventually, guide them through exploiting its potential. Many different approaches have been proposed ranging from complete boundary-free practices like workshop and brain storming, to more structured ones like focus group.

Too many companies, however, are stuck in a condition in which they seek for innovations looking closely to their core products and activity. While these companies can succeed in marginally improving what they are already good at, they miss out on the breakthroughs.

"Those ideas, differently from the common feeling, don't just come from nowhere. Instead, they are typically at the edge of a company's radar screen, and sometimes a bit beyond: trends in peripheral industries, unserved needs in foreign markets, activities that aren't part of the company's core business. To be truly innovative, companies sometimes have to change their frames of reference, extend their search space". (*J. Bessant, K. Moslein, B. Von Stamm 2009*)

New ways of thinking may require to break the conventional wisdoms and long lasting myths of the firm, and to start seeking for new possibilities. Indeed, none of this is easy to do; but companies that succeed may just recognize the next great opportunity before their competitors do. And that's important in tumultuous economic times with rapidly changing technologies. (*J. Bessant, K. Moslein, B. Von Stamm 2009*)

1.1 The Technological Convergence phenomenon

Innovations drive convergence. BlackBerry, camera phone, media centre, interactive TV and internet telephony all have one thing in common: they are the outcome of a budding convergence trend based on innovations in information and communication technologies and their products. This affects end-user devices, services and infrastructures.

New competitive relationships determine corporate strategies. Convergence often gives rise to new competitive relationships between hitherto unrelated industries.

This affects manufacturers of telecom terminal equipment, consumer electronics and PCs, for example.

Alliances and mergers across industries are becoming more valuable. This is due partly to higher technical demands that companies often cannot handle alone and partly to attempts to make their own range more attractive with complementary services or content.

Technical capabilities are no guarantee of market success. To win over consumers, convergent end-user devices and services must be clearly superior to existing offers. The limitations imposed on suppliers by what the consumer is prepared to pay are a challenge when competing for custom.

Standardisation is the major task moving forward. A balance has to be maintained between the openness and reliability of standards. On the one hand a standard must not be allowed to stand in the way of technological development; on the other it must guarantee the smooth exchange of data.

Examples of convergence

Example	Description	Convergence type
End devices		
- BlackBerry	End device integrating mobile phone and PDA; can send e-mails and receive them via push service	Subst. product convergence
- Camera phone	Integration of a digital camera into a mobile phone	Subst. product convergence
- Mobile phone with MP3 player	Integration of an MP3 player into a mobile phone	Subst. product convergence
- Personal video recorder	Video recorder with hard drive, often with time-shift feature	Subst. product convergence
- Mobile navigation systems	Navigation system via PDA or mobile phone	Compl. product convergence
- Media centre	Central storage and distribution unit for digital content in the home	Subst. product convergence
- Internet-enabled digital camera / printer	End devices can receive / send data wirelessly by e-mail	Compl. product convergence
Services		
- Voice over IP (VoIP)	Telephoning over a computer network on the basis of IP Protocol	Technological substitution
- Mobile TV	Broadcasting of TV content to mobile phones	Compl. product convergence
- IP TV	Broadcasting of TV content over the internet, expandable with interactive functions	Technological substitution
Infrastructure		
- Convergence of fixed and mobile network	Customers can telephone from a single device both in and out of the home	Technological substitution
- Triple play	Provision of telephony, television and internet across a common infrastructure on the basis of the IP Protocol	Technological substitution

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Source: Deutsche Bank Research, 2006

1.2 What is convergence?

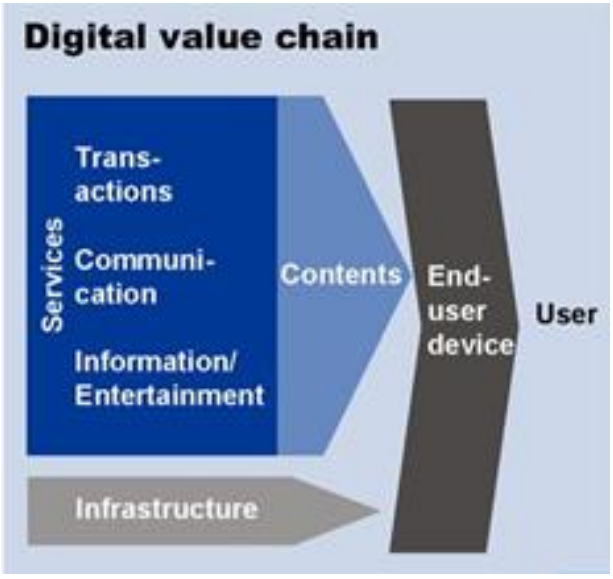
What seems to be the most quoted source for a definition of technological convergence comes from the Green Paper on Convergence issued by the European Commission in 1997.

The whole report is based on the fact that the sectors for telecommunications, media and information technology are increasingly using the same technologies. It is strongly pointed out that convergence is not just about technology, but also about services and new ways of doing business and interacting with society.

The Green Paper on Convergence defines convergence as “the ability of different network platforms to carry essentially similar kinds of services or the coming together of consumer devices such as the telephone, television and personal computer”.

Convergence, indeed, can be also defined in more generalized and simplified terms as a process by which telecommunications, information technology and the media, sectors that originally operated largely independently of one another, converge and star to grow together.

Convergence is a process of qualitative change that connects two or more existing, previously distinct markets. The driving force is usually the further development of one or the integration of various technologies enabling infrastructures, end-user devices or services to acquire new functionality.



Source: Deutsche Bank Research, 2006

Examples illustrate that these three levels of the digital value chain are already under the influence of convergence, albeit in varying degrees:

— With *IP convergence* voice and data communication is provided through an integrated network infrastructure on the basis of the Internet Protocol.

— *Smartphones* demonstrate convergence in end-user devices. They unite the functions of mobile telephone and personal digital assistant (PDA) and combine these with online services.

— *Interactive television* (iTV) is an example of convergence in services. With iTV consumers can use interactive services (e.g. teleshopping, video-on-demand) in the home on their TV sets.

1.3 What forms of convergence are there?

Convergence opens up new sales markets for companies. At the same time, however, new products featuring more sophisticated technologies can also represent a threat to established companies' traditional markets.

This happens when, as a result of technological progress, a new product potentially substitutes an existing one (e.g. smartphones supplanting conventional PDAs). Assessment of whether a technological innovation threatens a company's business model or enables it to develop new markets forms the basis of strategic corporate decisions. These will fundamentally depend on the pattern of convergence.

We distinguish between four generic types of convergence, depending on the convergence driver (technologies or products) and the relationship between the respective markets (substitutive or complementary):

— **Technological substitution**. In the 1990s, the underlying internet technology broadly penetrated various application markets, supplanting established technologies there. In the course of internet diffusion, further process and product innovations became possible in the relevant industries. These sectors are linked by the common basic technology.

— **Technological integration**: The example of the PDA shows how a new product can emerge from the combination of different technologies. In this case technologies from computer hardware and software, consumer electronics (LCD screen) and telecommunication were bundled together into a new product, the PDA .

To begin with, mostly suppliers of consumer and household electronics (particularly pocket calculators) entered the market for PDAs, later they were followed by suppliers from the computer industry.

— **Complementary product convergence**: With the increasing spread of internet technology and the related digital services users also wanted to be able to enjoy these capabilities “on the move”. But mobile data communication did not become user-friendly until introduction of the packet-based GPRS mobile radio standard featuring higher data transfer speeds than GSM.

In combination, the complementary “products” PDA and online services, which had previously been available only separately, added value for the user. This technological link is characteristic of complementary production convergence.

— **Substitutive product convergence**: The use of smartphones has been spreading steadily since the mid-1990s. They integrate conventional voice telephony, the exchange of data via e-mail and internet and the basic database functions of a PDA in one product.

Whereas there is no substitutive relationship between mobile phones and PDAs, the convergent smartphone can basically replace both the conventional mobile phone and the PDA. For the incumbent companies this substitution poses a considerable risk to their established business model.

Four types of convergence

Source of convergence	Relationship between markets: Substitutive	Relationship between markets: Complementary
Technologies	Technological substitution	Technological integration
Products	Substitutive product convergence	Complementary product convergence

Source: Deutsche Bank Research, 2006

1.4 How does the technological convergence affect the marketplace?

The technological convergence, indeed, deeply effects the marketplace; it lowers barriers of entry to the market for new operators and service providers. The emergence of new market players intensifies competition, giving consumers an extensive pool of providers and services to choose from and lower costs. Additionally in a technological convergent environment industry boundaries become blurred, allowing service providers to offer services in multiple markets.

Established companies will find in convergence an opportunity to operate more efficiently, increase returns on technology investments and realize other business benefits through development of new services and rapid market expansion.

Convergence opens up new sales markets for companies, a case observed, for example, in mobile operators. As the market saturates, they look to non-voice services, such as video streaming, portals, messaging, information services, and gaming, to drive future revenue growth.

At device level, consumers find in convergence an opportunity to enjoy the convenience of having many devices all in one, saving on both size and ownership costs. For example, a single mobile phone device can receive television programs

and play videos, thus enabling simplicity and convenience in device ownership as one device can be used to access multiple services.

As barriers to market access are significantly reduced, allowing an increased number of new players to enter the market and provide a wide variety of different service packages, established operators and services providers are required to reassess their business models and strategies not only to face these new providers, but also to upgrade their networks to integrate it into their own offering. Another challenge lies in convincing consumers of the value added by the new services offered.

Technology convergence offers massive opportunities for the development of new value-added services, convenience, efficiency and the expansion of markets and consumer choice. To properly take advantage of these opportunities, however, older routinized behaviors do not seem sufficient to deal with the technological convergence process pace.

The required technological competencies in adjacent technologies that is required, often is not present within the existing technology base residing within the single firm. For companies lacking such competencies, several options are open to acquire the essential technological knowledge. Technology can be developed in-house or it can be acquired on the market by arms'-length transactions (e.g. using R&D contracts) or through the acquisition of technologically sophisticated companies.

Between these two extremes, acquisition or internal development, several options are open to a company. Companies may perform R&D together with a partner, license-in technology or use other forms of cooperation. Internal development is costly but often necessary to achieve the required technological base. Cooperative strategies, on the other hand, involve less capital and are particularly suited to monitor new technological developments.

In the past decade the number of strategic alliances made by firms has increased substantially, in particular in high-tech industries (Hagedoorn, 1996). The use of alliances, however, often appears only effective in combination with internal development. Haklisch (1989) has argued convincingly that interdependence is often used as a viable strategy to strengthen independence.

Although acquisition of knowledgeable companies seems to be an attractive option for companies that have to deal with convergent technologies, acquisition strategies are hampered by at least three main problems (Aldrich and Auster, 1986).

The first problem is associated with information distortion and opportunism, which may mislead the acquiring company. A second problem is that creative and innovative companies which are incorporated in a large and bureaucratic structure often lose their flexibility and therefore lose much of their original creativity and innovativeness. The third problem is related to the externalities which are connected to the acquisition of a company. It is often difficult to divest those assets which were not sought for in the first place.

An additional problem that is associated with acquisitions occurs if a company does not have an already sufficiently developed level of technological knowledge in a specific field. Then it turns out to be extremely difficult to absorb the acquired knowledge into its own technological core. It is often noted that a firm's absorptive capability is to a large degree dependent on the degree of knowledge in a specific field (Dodgson, 1989; Cohen and Levinthal, 1990; Levinthal, 1994).

Therefore we might argue that if the core of a company’s technology base is not sufficiently adapted to the new technology, then the absorption of acquired technological knowledge within the technological core of a company is very difficult.

These factors may explain why most of the acquisitions were (until today) not very successful.

Cooperation, alternatively, is often considered as a viable means to monitor several technological developments at relatively low cost. Given the problems with acquisitions as noted above, it therefore appears as an interesting possibility.

1.5 Strategic alignment by convergence types

Different strategies are suited to different convergence types:

— **Technological substitution**. In the early stages of the launch and diffusion of a technology it is extremely uncertain whether the new arrival really will be able to oust

the incumbent. On the other hand, the value of the resources available to a company for the technical innovation is limited, since the new technology reduces the value of the existing one (as with VoIP) or heavy investment is necessary to upgrade existing infrastructures (e.g. triple play).

As the example of VoIP providers illustrates, newcomers are therefore often not at a systematic disadvantage. The greatest challenge is in building up new standards creating interfaces to existing products.

Extensive cooperation is inevitable to establish as broad a standard as possible. This is the only way to guarantee rapid diffusion of the technology. It explains why more than 300 companies from 40 countries are involved in designing the new standards for the delivery of digital television.

At the same time internal resources must be built up to bring products quickly to market after the early stage.

To minimize the technological risks, multi-technology strategies should be pursued at the transitional stage in which no dominant technology has yet emerged.

In principle, multi-technology strategies can also be pursued at the infrastructure level; however, the high capital intensity will presumably make this possible only for big companies, often indeed consortia. Only once a new technology standard has been successfully established must companies focus again more strongly. Then the industry is likely to consolidate rapidly as a result of mergers and market dropouts.

— **Technological integration**. Technological integration is the combination of several technologies into one new product, such as the PDA. Established companies have a systematic competitive edge because the value of their technological resources increases. Here, too, a multi-technology strategy makes sense in the transitional phase because integration can go wrong. The company must have a fall-back option on the existing standard.

Collective strategies are particularly important in marketing, for example between terminal equipment suppliers and a service provider to visualize the added value.

Whereas a timely commitment is important with technological substitution to achieve learning curve effects, an established company can enter technological integration processes later – its existing resources enable it to adopt a stand-by position.

— **Complementary product convergence**. When product markets meld (e.g. mobile TV, mobile navigation equipment, internet-enabled end devices) the existing corporate resources retain their value. But other sources of know-how must also be developed.

From the suppliers' point of view cooperative strategies are therefore important. At the early stage these will tend to be soft alliances, which can later turn into horizontal integration strategies. Pivotal to further market development is success with standardization.

In the initial phase it is a matter of winning the competition between standards – an extensive network with rapid penetration is vital. In the second phase rivals will compete within the new standard. At this stage horizontal alliances will presumably be dissolved again.

— **Substitutive product convergence**. Examples of this type of convergence are smart-phones, mobile phones with MP3 players or personal video recorders.

Established suppliers play a prominent part in substitutive product convergence because their existing resources give them a decisive competitive advantage and most of the competition is played out on an existing market.

Horizontal integration and/or cooperation could therefore make sense. But BlackBerry documents impressively that new companies can also enter the market with this type of convergence. Given a situation in which three similar products are vying for custom (two old products and one innovation) and it is not certain which will come out on top, suppliers will presumably operate on all three markets to reduce their risk. All four convergence types have three characteristics in common.

First, alliances are crucial. In some cases they encompass many market players and transcend traditional industry boundaries.

Partnerships between big and small companies are the norm. Second, some alliances will probably not be written in stone. Depending on what stage the market

has reached, regrouping will take place, because cooperation is driven chiefly by the extreme uncertainty of the early phase.

Once this is reduced by the formation of standards, the incentives to cooperate with potential rivals decrease. Third, traditional vertical value chains are transformed into value networks, whose organization and control becomes more complicated.

1.6 The problem of inertia

Both external and internal inertial forces significantly reduce the ability of firms to deal with changes in their technological cores. Firms are often simply not able to adapt swiftly to their changing technological environments.

It is extremely important to understand the broader implications of these patterns of convergence in IT markets. Inertial forces prevent organizations from quickly transforming their strategies and structures according to new demands of the environment; most of the firms' behaviors are relatively predictable and repetitive.

Such standard patterns of behavior are often labeled as routines (Nelson and Winter, 1982). These routines can be compared to biological genes because they govern a firm's behavior and are heritable in the sense that future behavior is largely based on today's characteristics (Nelson and Winter 1982, Shapiro and Varian 1999).

A firm's reliance on basic routines severely reduces its speed of adaptation. However, it would also be a caricature to perceive firms only as static organizations that are unable to change. Firms can be engaged in a search process in an attempt to increase their fit with the environment. However, firms with a relatively successful past are often more resistant to change than other firms.

This behavior of "success breeds failure syndrome", frequently observed with established industry leaders, is due to the fear of changing something that has performed well over the past years. However, firms miss the opportunity to better perform in the changing environment and, sometimes, lose the privileged position.

Firms which are engaged in a search process do not explore all possible directions but confine their search to the most promising directions.

Firms are often engaged in local search only, which means that search is limited to related areas. Local search and a continued reliance on their basic routines implies that firms are much better in doing more of the same than they are in adapting to change. We therefore expect that companies mainly stick to their core businesses and therefore patterns of convergence are not likely to be found as the most dominant features of changes within companies.

Because of surging R&D costs in combination with shrinking life cycles in all IT segments, firms are no longer able to monitor all the technological developments in the IT industry.

Therefore, access to knowledge from other players in adjacent markets is becoming increasingly important (Economic Commission for Europe, 1987; Korzeniowski, 1988). The convergence process causes the blurring of traditional technological and sectoral boundaries and therefore increases the need for companies to keep up with many different technologies (van Tulder and Junne, 1988). Broadening the existing technology base through internal development would call for a considerable increase of the already heavy R&D cost burden.

As one conclusion, one could argue that technological convergence in the end implies positive effects for challengers firms, whereas established incumbent firms are more likely to fail in converging environments. (Shapiro and Varian 1999)

Those incumbents, which manage to ‘face the brutal facts’, to critically assess their core competencies and related opportunities in the emerging environment, and finally to derive innovative solutions from the new technological paradigm, will succeed in leading the convergence process, instead of following it.

Technological convergence furthermore initiates other convergence processes, such as industry convergence. Industry convergence is one major reason behind the entrance of previously unknown players in the fields of smarphones.

As industry borders become blurred, actors seek business opportunities elsewhere than in their traditional markets. This is also the case for incumbent smartphones operators, who are obviously entering the market in order to establish a presence as well as reach some short-term revenues.

Whether operators are able to exploit and benefit from convergence processes is a fairly interesting question, as future competition clearly evolves around value creation – both for the company and for the end-customers.

Value can be created through focusing on core competencies and providing relational links between features rather than riding the hype of technology development and convergence. Developing the company's value network in order to find partners for maintaining customer satisfaction (e.g. develop converged products and services) might prove to be a better strategy than keeping one foot in all possible markets which in fact are outcomes of convergence processes.

Particularly in the IT, telecommunications and media sectors directly affected by convergence, companies are challenged to find strategic answers to this trend. They must engage with new competitors from other industries, because ultimately convergence means that many classical market access barriers will be lowered.

Even on convergent markets, barriers to market access such as research and development intensity or reliance on strategic resources will not become obsolete. But no dominant product design has yet emerged for many products, and sometimes not even a dominant standard. Consequently, companies are acting in a very uncertain environment. At the same time labor – and hence its specialized skills – have become more mobile.

A company's specific positioning also depends on its previous core competences. On the device market, for instance, Camera and PDA producers are entering into new competition with traditional consumer electronics manufacturers. Both carry different competences in their baggage. As a rule, PDA and Camera manufacturers produce technically sophisticated equipment, which is, however, comparatively failure-prone and calls for experienced users. Consumer goods producers, on the other hand, tend to make more basic products that seldom go wrong and require fewer user skills.

So while PDA manufacturers can be presumed more competent in the development of technical innovations, the strategic advantage of consumer goods producers arguably lies in the development of ready-for-market mass products. To prevent "first-to-market" pioneering profits being forfeited too quickly, a strategic alliance between Camera and consumer goods producers could then be advisable.

At issue here is not the transfer of know-how, but a tightening of the value chain when Camera and PDA products become important elements of consumer goods. Such an alliance could frequently also be appropriate inasmuch as some product developments are possible only through collaboration across industries.

1.7 Cooperation in technological convergence environment

Most companies, as said earlier, need to cooperate with others to acquire the necessary knowledge. However, once a new technological standard and a uprising single network of compatible users is established, these same companies shift gears and compete head to head for their share of that network.

The term "*coopetition"* captures the tension between cooperation and competition prevalent in network industries. When distinct components have to work together as a system, the paramount strategic questions involve cooperation and coordination; notwithstanding its difficulties, it can lead the way to extensive rewards.

To figure out which firms may represent the best ally, it is important to envision how the market is likely to evolve because of the technological convergence phenomenon. The disruptive changes that this phenomenon can deliver, need to be understood in order to properly take advantage of the potential benefits that it can deliver.

Standards enhance compatibility, or interoperability, generating greater value for users by making the network larger. They fuel beneficial networks externalities in two ways. First, and most directly, the standard makes it possible to share information with a larger network. Second, and indirectly, the enhanced ability to share data attracts still more consumers using this format, further expanding the available network externalities.

In addition, standards reduce the technology risk faced by consumers. This, too, accelerates acceptance of a new technology. A standard with many backers can go far to bolster the credibility of the technology, which then becomes self-fulfilling.

In contrast, with incompatible products, consumer confusion and fear of stranding may delay adoption. However, one of the risks in a standards war is that the battle to

win market share will undermine consumer confidence that either technology will prevail, resulting in a war with no victor. As each side strive to convince customers that it will be the winner, consumers may take the easy way out and sit on the sidelines, especially if a serviceable older technology is already available and standardized.

The same fate can easily befall a single new technology that lacks the support of a sufficient market participant to become a standard.

If the standard is truly open, consumers will be less concerned about lock in. Precisely because standards reduce lock-in, they shift the locus of competition from an early battle for dominance to a later battle for market share. Instead of competing for the market, companies compete within the market, using the common standards.

Aggressive penetration pricing is far less likely under a common standard, but so is lock-in. One of the worst outcomes for consumers is to buy into a standard that is widely accepted to be open, only to find it “hijacked” later, after they are collectively locked in.

Standards shift competition away from features and toward price, for the simple reason that many features are common across all brands; the more detailed the standard, the harder it is for each producer to differentiate its product and still comply with the standard.

So, while a more extensive standard leads to fewer compatibility problems, and stronger network externalities, it also can reduce the ability of each supplier to differentiate its products, thereby intensifying price competition. It follows that rival manufacturers may all be better off living with some incompatibilities and with a smaller total market in order to deemphasize price competition and focus competition more on product features.

Over time, however, there are strong incentives for suppliers to differentiate themselves by developing proprietary extensions, while still maintaining some degree of backward compatibility. Competition to extend a standard can certainly be a boon to customers, as new features are designed in a highly competitive race to offer improvements. But the resulting incompatibilities can be a major source of irritation.

Standards shift the locus of competitions from systems to components. The firm that can offer the superior total package of both hardware and software stands to win. It is for this reason that due to the technological convergence phenomenon that has particularly been affecting the electronic market, firms have decided to undertake different strategies.

Overloading products with features has proven not to be an appropriate approach as it has actually limited the customer experience with the product and, when successful, it was easily imitable. Firms need to seek for alternative solutions that can deliver a compatible advantage over competitors that, however, is difficult to imitate.

Consumers generally welcome standards: they are spared having to pick a winner and face the risk of being stranded. They can enjoy the greatest network externalities in a single network or in networks that seamlessly interconnect. They would enjoy mixing and matching components to suit their tastes. And they are far less likely to become locked into a single vendor, unless a strong leader retains control over the technology or wrests control in the future trough proprietary extensions or intellectual property rights.

Standardization does have some downsides for consumer, however. The main one is a loss of variety: the standard may be poorly suited to some customers' needs, or it may just turn out to be an inferior technology.

Like consumers, sellers of complements welcome standards, so long as their products comply with the standard. In fact, influential complementors can affect the choice of a standard, just as can influential consumers.

In addition, product standards for new technologies can pose a grave threat to established incumbents. After all, if standards fuel the positive feedback cycle and help launch a new technology, the can easily cannibalize sales from an older technology.

Incumbents have three choices. First, an incumbent can try to deny backward compatibility to would-be entrants with new technology in the hope of blockading entry altogether, thereby extending the life of its own technology. Second, an incumbent can rush to introduce its own new generation of equipment, perhaps with

the unique advantage of backward compatibility, to win a standard war. Finally, an incumbent can ally itself with the new technology, hoping to benefit from its established brand name, an expanded market, and perhaps from royalty and technology licensing income.

Companies developing new technology collectively tend to welcome standards because standards typically expand the total size of the market and may even be vital for the emergence of the market in the first place. Whenever a group of innovators collectively benefit from a standard, there is always some way for them to structure an agreement in support for the standard. For precisely this reason, we sell literally hundreds of standards introduced each year.

When a group of innovators collectively benefit from setting a standard, but the standard impacts them in very different ways, a complex negotiation ensues.

Standards tend to have markedly different effects on different suppliers based on their underlying assets. Companies with a large installed base have the most to lose, while companies controlling far-superior technology have the most to gain. Size is important as well; as it was already highlighted, small players may especially welcome a standard, since standards tend to level the playing field between big and small suppliers.

In order to be able to deliver the right product to the customers and to maximize revenues, alternative possibilities need to be evaluated. Thinking in terms of goal oriented categories, delivering an ad hoc solution to a specific need, may represent the optimal answer.

2. Theoretical Background

Having understood what determines a technological convergence phenomenon and its possible implications in the marketplace, the following chapter will mainly focus on the creative path that allows firms to link idea belonging to apparently different markets.

The origin of the technological convergence phenomenon will be best understood, providing psychological insights on the mechanisms that allow firm to propose new

products on the market by combining different distinguish elements belonging to different technological categories.

The theoretical background proposed will represent an important component for the analysis of the following research.

2.0.1 Property Mapping and Relation Linking approach

In an increasingly globalized world in which brands have become powerful enough to break national borders and to gain worldwide visibility, stretching brands that already have strong equity has become an ever more important avenue for growth.

In the last decades, in fact, one of the common strategies to extend the brand and to propose innovative items, has been to load products with a large number of features, believing that each of them could be perceived as useful by customers and could represent a competitive advantage over the competitors. In addition, as the economic literature shows, it has always been preferable to remain "…*within the boundaries of the core product of the firm in order not to run the risk of over-extending the brand and to damage its image*". *(Griffin 1997; Urban and Hauser 1993)*

Furthermore, as technology has advanced overtime, enabling products to include more functions yet costing less and requiring less time to be manufactured, many firms have preferred to extend their products' feature instead of their product line. As a matter of fact, even if initially linked to a positive effect on the perceived capability, such strategy has proved itself to cause a negative effect on the customers' perceived usability of the new products. *(Thompson, Hamilton, Rust 2005)*

Notwithstanding this long lasting trend, however, in the last couple of years it has been possible to observe a sensitive shift in companies' strategies towards a mindset that would focus more on capabilities and synergies rather than on the exploitation of the core product and its possible variations.

As the previous strategy caused a sensitive loss in the products' usability, the attention has been inevitably focusing on the actual usefulness of the product rather than on its in-store appealing. Firms have started to link sensibly dissimilar ideas and

to propose new products deriving from this combination. *(M. Gibbert, D. Mazursky 2007)*

The ongoing trend, in fact, seems to be more oriented towards offering a solution to the customer, namely thinking in terms of goal-oriented products, even if it may mean to combine ideas that may seem far away between them. Their combination may result in a better solution rather than just exploiting the continuous technological progress linked to a single product enhanced with new features.

A persistent need for products not present on the market has started to grow, leading towards the research of a creative process that would allow to answer accordingly to the continuous customer demand. Not a product that could answer to every solution, but a specific product tailored for every need.

Marketing itself as a science, however, and more widely economics, can be considered as an extremely new subject that is mainly characterized by an ongoing process of theorizing the real world observations and that, so far, can count on a limited amount of literature at disposal. As a consequence, in order to better understand and analyze the ongoing changes, it is possible to use cognitive psychology literature as a back up to fill the gaps and acquire useful insights.

"Research in psychology suggests that creative thought is not a mysterious leap of faith but a result of underlying cognitive processes that are accessible to all". (Ward et al., 1997). "...The most widely studied among these processes are those of analogical thinking and conceptual combinations. Analogical thinking refers to our ability to understand new concepts by transferring knowledge from existing ones; conceptual combinations, on the other hand, refer to our ability to combine two or more existing concepts to create new ones". (T. Gill, L. Dubè 2007)

The article by Gill and Dubè *"What is a Leather Iron or a Bird Phone? Using Conceptual Combinations to Generate and Understand New Product Concepts",* introduces the framework of conceptual combinations, which underlies the creative ability to combine existing concepts, even if theoretically different between them, to create new ones.

A conceptual combination can be defined as the combination of two concepts known as the "modifier" and the "header". For instance, "digital" would be the modifier and

“camera” the header in the case of *digital camera.* According to the article, there exist two distinct processes to create and interpret novel conceptual combinations; namely, Property Mapping (PM) and Relation Linking (RL).

The former entails combining concepts by transferring a property from one concept to another. The latter, instead, entails linking the two combining concepts by a thematic relation. Thanks to the identified framework, the difference between a hybrid product and a differentiating feature will be also stressed.

Many conceptual combinations are created by mapping a property of the modifier concept onto the header. PM entails aligning the modifier and the header concepts, and comparing them to find similarities between them. These shared dimensions then form the basis for a property to be transferred from the modifier to the header concept.

Most combinations resulting from PM are represented as a header with one or more properties of the modifier. However, PM can sometimes result in hybridization; the formation of a hybrid concept that is a mixture of both the modifier and the header concepts. In such cases, the header concept loses its referential privilege, and the combination is represented as a mix of the two components.

In the case of artifact categories, such as new products, formation of hybrids entails mapping functional properties from the modifier to the header concept. In summary, in the case of product concepts, PM can result in the mapping of nonfunctional properties or functional properties from the modifier to the header concept.

When nonfunctional properties are mapped, PM results in a representation consisting of a header with one or more properties of the modifier; whereas, when functional properties are mapped, the result is a hybrid with dual functions, which is a mix of the modifier and the header.

When two concepts are combined, however, people do not always map a property from the modifier onto the header, but oftentimes create a novel combination by linking the two concepts by a thematic relation. The article proposes that when concepts are combined by Relation Linking, people search for plausible scenarios in which the modifier and header concepts can be linked.

Given that most products are used for a specific function, most RL representations of product concepts are formed around these functional scenarios. RL representations, in addition, can also be formed along scenarios signifying the interaction among the different features of a product.

From this first analysis it is possible to observe many similarities between the real world observations and the Relation Linking process. The shift towards a goal-oriented product is to be found in the need to create new products through a process that allows the combination of any type of products' features in order to obtain new functionalities. The process itself doesn't require the products, or indeed their functionalities, to be similar to each other, but poses as the only limit the usefulness of the combination's outcome in a particular context.

On the other side, however, Property Mapping entails aligning the two combining concepts, finding a structural commonality between them, and then transferring a property from the modifier concept to the header concept. The transferred property can be a nonfunctional or a functional one. The former is represented as the header with one property of the modifier, whereas the latter results in hybridization.

This last eventuality, represented as a hybrid concept with the functions of both the header and the modifier, differs, indeed, from the combination obtained through Relational Linking.

The process of RL, in fact, entails in constructing scenarios in which the modifier and the header can be linked by a thematic relation that results in a solution to a particular need.

The main difference is then represented by the ultimate aim. The Property Mapping process proposes a hybrid product that merges different functionalities, often of similar products, without tailoring the obtained combination to a specific application.

Products obtained through Relation Linking, instead, result from the combination of even different products with the scope of obtaining a specific functionality that represents the answer to a particular need aroused in a specific scenario.

The article than presents different studies aimed at testing the different effects that the combinations via the two different processes cause in the consumers' perception.

It is shown that New Product Combinations (NPCs) interpreted by RL take less time to be understood and, as a consequence, are easier to comprehend that those employing the process of PM. Furthermore, among NPCs using PM, those that combined functions of two categories, or hybrids, were more difficult to comprehend than those that mapped nonfunctional properties.

The reason behind these results is straightforward; while with the Property Mapping process features are linked because of their technological compatibility, in Relation Linking the combination of different characteristics is the result of a previous situation that lacked an ad hoc solution. It is so easier to appreciate a product when linked to its possible application rather than a product that may offer many features that, however, are difficult to link to a particular scenario.

Subsequently the article demonstrates that when two basic level product concepts are combined in a NPC, those combining concepts from the same super-ordinate category, thus being linked by some similarities, (e.g., phones and computers in phone computer) were most often interpreted using Property Mapping. On the other hand, those from different super-ordinates, being extremely different between them, (e.g., cars and computers in car computer) were mostly interpreted using Relation Linking.

The latter finding thus confirmed the different processing assumptions underlying PM and RL; specifically, PM requires the two combining concepts to share some structural commonalities, whereas RL does not.

Such results will be extremely important when applied to the following empirical study conducted, in order to understand the processes that guided the different players, namely cell-phone and camera manufacturers and, of course, customers, trough their actions.

Furthermore, for the purpose of this research, it is important to highlight the implications and insights that the article offers in relation to the context of the recent convergence in the electronics, computers, and telecommunications industries.

The aim of the paper, in fact, will be to understand the relation between the technological convergence and the creative process, identifying how each element affects the other.

Both Property Mapping and Relation Linking force the R&D department to work in tight collaboration with the marketing area, exploiting the technological knowledge not in the continuous evolution of a unique set of product features, but in its development trough the combination with products belonging to either similar or dissimilar categories.

The overlap in these industries has lead to a dramatic increase in the launch of new products that combine two existing basic level categories (e.g., PDA phones, TVs with Internet, camera phones etc.). The article findings indicate that such combinations from the same super-ordinate category lead to hybridization, which is difficult to interpret for consumers. Thus, although combining such products makes sense in the current environment of convergence, the cognitive demand on their comprehension may inhibit their adoption.

On the other side, however, the technological convergence itself is caused and affected by a Relation Linking and a Property Mapping kind of approach, where dissimilar technologies suddenly became compatible in order to offer a better solution to a specific need or to propose a variation of an already existing model.

The final objective of this reseach, indeed, will be that analyzing the evolution of the GPS camera phone and to understand the respective role played by both the technological convergence phenomenon and the creative processes engaged by the firms.

Summing up, the empirical study that follows will provide the necessary data to answer the following question:

What is the difference between a Relation Linking and a Property Mapping approach? How do they differently affect the firms' creative path?

What is the role of standardization in the technological convergence phenomenon? How can firm properly take advantage of a technological convergence phenomenon without running the risk of being locked with an "obsolete" standard?

What is the fundamental resource that allows firms to better leverage on the opportunities presented by this phenomenon?

3. Empirical Study: The GPS Camera Case

The aim of the empirical study that follows is to describe the process and the evolution of the convergence of the camera and GPS feature within the cell-phone category. In particular, the research aims at understanding the underlying reasons that made geo-tagging available within cell-phone only ten years later than for cameras.

The study serve the purpose of analyzing the different behaviors of both the camera and the cell-phone manufacturers and serve as a base for understanding, through the theoretical framework proposed, the mutual relation between the technological convergence that brought to the GPS camera phone and the creative processes mentioned before.

3.0.1 Methodology

Starting from the hybrid product that appeared back in 1997, a GPS camera, the research follows a chronological order that describes the main milestones of the process; from an external GPS device linked to a camera, to the appearance of Flickr and other online communities based on photo sharing and photo geo-tagging, until the integration of the GPS technology first within cameras and, in a later stage, within smart-phones.

Furthermore, the focus is put on the different behaviors that characterized the camera and the cell-phone producers with respect to the possibility of allowing geo-tagging. Particular emphasis is given to the appearance of the online communities based on photo-sharing that are considered as the key aspect in bringing important signals to the attention of the cell-phone manufacturers, representing the starting point of the hybridization process.

The research that follows relies mainly on secondary data; corporate releases, journalist reviews, research papers, official websites and statistics represent the majority of the sources for the data processed. In addition, a significant portion of the data analyzed comes from blogs and online communities' dissertations related to the analyzed topic.

While the use of secondary data represents an important starting point in any research, the added value is represented by the collection of primary data specifically tailored to the studied research question.

For the purpose of this analysis, the secondary data collected have been re-interpreted and used for a purpose different from the original. Furthermore, the primary data collected like blog entries and online communities' users conversations, even if not strictly complying with the business definition, have represented a fundamental source in analyzing and understanding the customers reactions and feelings to the continuous innovations proposed.

Notwithstanding the business definition, in fact, blog entries and communities conversations can be considered as primary data as they represent directly customers' opinions in relation to the topic analyzed. While not directly collected, this data have represented an incredible source of insights that have played a major role in the final analysis and evaluation of the results of this paper.

In addition, as to signify the importance of the data used, it is worth to stress that after their appearance on social networks' walls, every camera manufacturer decided not to rely on third party communities but to establish their own web space in order to take full advantage of the extremely precious information that were being exchanged.

Finally, it is important to stress that the approach followed by the research differs from the common marketing one. Not complying to the traditional protocol, in fact, the research aims at delivering value added insights to firms by highlighting the deep changes and, as a consequence, opportunities, that the technological convergence phenomenon is causing particularly in the electronics market.

The research doesn't hold the point of view of one single player but, by embracing a wider and objective point of reference, aims at presenting a deep analysis of the important changes that are taking place. Contrary to the traditional approach, the study describes all the elements that come into play because of the technological convergence phenomenon and particularly stress their inter-relation and reciprocal influence.

The purpose of this approach is straightforward; the aim of this study is not to limit the understanding of the technological convergence phenomenon to a particular field

of interest but to try to make a more general, but at the same time accurate, analysis that can serve as an important basis for firms belonging to different markets, being them from the cell phone industry, the camera industry or even the Television industry.

The “Managerial Implication” section, however, will hold the point of view of single firm and will propose possible strategies to properly take advantage of the opportunities described in the research.

3.1 From 1997 to 2005: first GPS enabled camera models

3.1.1 The first attempts and the first difficulties: Nikon D1H and Kodak Pro DCS 760

The first GPS camera ever produced dates back to 1997, when the Federal System Division (FSD) created custom cameras to meet the special needs of government and military customers by modifying the available commercial products.

Among the different combinations made to satisfy the different requests, there were Global Position System (GPS) compatible models and color infrared (CIR) models. These made-on-demand cameras, provided a unique capability that was ideal for environmental and law enforcement that required forestry and vegetation analysis. In addition, GPS and CIR enabled cameras were used in combination with small aircrafts for topographic purposes.

The first model provided with these features was a Kodak Digital Camera System (DCS) 420, based on the body of a Nikon N90s, enabled with an external GPS device. For all DCS images provided with a Global Positioning System (GPS) data added at capture, in fact, the Kodak DCS Acquire Module was able to annotate acquired images with the GPS data, namely latitude, longitude and altitude, in textual form rendered into the first 16 lines of the image. *(Nikon Website, Paper 1)*

The result of the new combination between a camera and a GPS device was kept secret, and it was only few years later that both Nikon and Kodak decide to commercialized their first GPS camera; the Nikon D1H was brought to the market in

February 2001while the Kodak DCS 760 made its debut one month later of the same year.

The D1h was the first Nikon on the market to have an input for GPS signals. It presented a dedicated serial port so that an external GPS device could be connected. The GPS data were transferred from the device to the camera and embedded in the images as they were taken, so that the photographer could easily locate where the pictures were taken at a later time. This data were embedded in the EXIF headers (or metadata) of the image files, which is the standard holding for information. At a second stage, it was also possible to retrieve the photos together with the GPS data through a computer and a number of different software packages.

The port presented itself in the form of a stereo mini-jack and needed a specific cable, neither included nor sold by Nikon, to make the connection between the camera and the GPS device available. It was so up to the clients to make their own cable to fully explore the functionality of the camera. *(Nikon 1, Nikon 2)*

Similarly to Nikon, Kodak did not facilitate its customers to exploit the Kodak Pro DCS 760 GPS feature either. Notwithstanding the possibility of linking an external GPS device to the camera, the serial port was physically marked with the symbol “Test” and the official manual itself, didn’t explain how to take advantage of the potentiality of the camera.

In trying to evaluate the first attempts to propose a GPS camera to the market, it appears clear that the first moves were reluctant and timid, mainly tailored to a narrow market segment that had to have both a specific need to be answered to and a deep understanding of the technology of reference.

As a consequence, the first reactions to this new combination where mainly negative and it seemed like only professionals and governmental agencies with particular needs could benefit from what appeared to be, at first glance, an awkward intuition.

The great majority of the market was not even aware of the possibility proposed by the two big multinational enterprises and, among those that were aware of the possibility, people either miss to see the benefits of the combination or discarded it as technologically demanding.

This first model, however, was the result of a Relation Linking process where two extremely distant technologies, like a camera and a GPS, were linked in order to offer a solution to a specific need. This attempt represented the first step towards a later technological convergence that would have set the basis for the birth of a platform like the smart-phone.

Because of the lack of response from the market, due among other things to the at least opinable strategic choices, other camera models that followed kept on proposing the geo-coding feature available only through an external device, stressing its relevance only for a dedicated and quite small segment.

The main reason behind this choice, however, can be understood from a marketing perspective. The segment that seemed interested in the possibility of geo-coding pictures seemed still not big enough to make a dedicated model economically feasible. In addition, the strategic choice of promoting just one model that could eventually serve both purposes, had the aim of testing and acquiring more reliable information on the geo-coding trend and to establish its potentiality.

Furthermore, there were still many technological problems related to GPS devices that, apart from a non optimal reliability, still proposed big challenges in receiving and keeping the satellite signal, in the lasting of the battery life and in the dimensions of the device itself. To make things even more difficult, installing the systems required some technical savvy, and using them required two or three hands to hold all the pieces.

Last but not least, the products that offered such possibilities represented the best that the camera market could offer at that time and, consequentially, the high price kept people away from the exploration of the new combination proposed.

3.1.2 Moving forward: Ricoh Caplio Pro G3

Because of the perplexities outlined before, the incredible potentiality represented by the link between a camera and a GPS device, remained undervalued; the market didn’t respond as the firms would have like to, and the combination appeared to be valuable only for few professionals. It took four years for the camera producers to

believe more in the potentiality of the new product and to come out with an easy-to-use GPS-enabled camera dedicated to the mass market.

Ricoh Corporation, a Japanese based firm leader in specialized digital imaging devices, introduced in January 2005, after having tested the product in its home market for two years, its GPS camera model: the Caplio Pro G3.

The camera had a compact flash card slot that accepted a GPS card. After having plugged in a compatible card, the camera could record, along with the date, the GPS coordinates on the image or, eventually, in the image EXIF header area. The operation was fast and easy, finally allowing any person without a specific knowledge to start taking location-stamped pictures. In addition, the camera's LCD screen displayed the satellite status, showing how many were being used and whether there was a solid signal for location purposes, simplifying even more the process.

The Ricoh camera was a 3.24 megapixel camera with a 3x optical zoom lens, clearly intended to be a consumer digital camera and not to compete, at least on a quality level, with other GPS enabled camera like Nikons' and Kodaks'.

The main objective was to spread the use of a GPS camera, allowing every person to geo-code his pictures and to easily share them; for this purpose the camera was featured with Bluetooth, Wi Fi and Ethernet adapters for communication and file transfers.

Furthermore, the package comprehended software, called GPS-Photo Link, which provided several useful ways to take advantage of the GPS data in the photo EXIF header. After connecting the camera to a PC or, eventually, plugging the camera memory card in a reader, the GPS-Photo Link software could read the embedded GPS data and create HTML pages with the image and location maps automatically showed.

The Ricoh Caplio Pro G3 was designed to provide Geographic Information Systems (GIS) users with a simple and seamless method to integrate images into mapping applications. Notwithstanding its willingness to address the camera to the consumer market, however, the price for having the complete bundle of camera, GPS card and

PC software, was still pretty high ($ 1.149) and it turned out to be more appealing to business customers rather than consumers looking to explore new possibilities.

"The camera had a great success and it was soon adopted by different governmental organizations and business professionals. The Federal Emergency Management Agency (FEMA), for example, adopted it to photograph storm damage in the southeast United States, while many archeologists used it to scout out dig sites. Furthermore the camera was used by universities, advertising agencies, insurance agents, realtors, government agencies, engineers, National Park personnel, farmers, and even museums that found that their GIS workflows could have been optimized thank to the Ricoh Caplio Pro G3 digital camera". *(Ricoh Caplio Pro G3)*

Notwithstanding the good success of the Caplio Pro G3, Ricoh failed to meet its initial objective of delivering an easy-to-use GPS camera to the mass market. The price represented a big barrier for many photo-enthusiasts that had been asking for a similar product since years, forcing them to continue to relay on more economic alternatives. (*GPS Camera*)

In addition, the software bundled with the camera only allowed to place pictures on a map that could be downloaded from the web, undervaluing the potentiality of creating a geo-tagging community. Through the software, in fact, the customized maps were downloaded on the PC and could not be shared with other people. Geo-coding was still intended to represent an answer to the needs of different business professional and any other possible application was undervalued.

Notwithstanding the initial difficulties, however, steps towards a different kind of software that would allow to manage pictures, to locate them on virtual map and to share them with friends through the internet was close. The combination between GPS and camera had received, differently than few years ago, an incredible response. People where once again driving the market and demanding for an accessible product.

Soon geo-coding pictures would have moved from an almost exclusive business professional practice, to an outstanding phenomenon that was going to definitely hit

the market and to force camera producers to meet the always growing demand for pertinent solutions.

3.2 28th August 2006: The Turning Point

3.2.1 Flickr: "almost certainly the best online photo management and sharing application in the world"

Created by Ludicorp, an online research and development company based in Vancouver, British Columbia, Flickr claims to be, "almost certainly", the best online photo sharing and organization application in the world. Its first beta version was released in February 2004 and, from that moment on, Flickr has been on a steep curve rising towards incredible popularity.

When Flickr entered the photo-sharing market, it was already an overcrowded category that started two years back, in 2002. By the date that its entrance was decided, Microsoft was offering a service via MSN, Google was about to offer Picasa, its own for free photo organizer, and Kodak had its Ofoto site. All these free sites allowed photographers to upload digital photos to websites to which friends, family and any other user could be directed to view their latest pictures. Indeed, it appeared fundamental for Flickr to propose some new features that would have turned out to represent a competitive advantage over its rivals.

The years prior to Flickr, had been characterized by sites creating online walled gardens: they allowed to store users' photos, and to direct people to where they were stored. Despite having terabytes of image data on their sites, however, none of the before mentioned applications invested over their size and popularity. Whether there were millions of subscribers to the service or not, it was impossible to communicate and share personal opinions with the rest of the community; no network effect was provided.

Flickr spotted the opportunity and took advantage of it. While not obligatory, *"…every user had the possibility to be connected to every other subscriber through tags, groups and feeds. It allowed to search and to track the feed for any keyword, showing all the photos uploaded to the site that people had tagged with that*

particular keyword. In addition, both communication and sense of membership to a community were stressed through giving the possibility of joining a group and to share and comment photos, or any other kind of image". *(Flickr 3, Flickr 4)*

As of June 2009, five years after its entrance on the market, Flickr claimed to host more than 3.6 billion images, having definitely passed its competitors.

Nowadays, after having gone through many adjustments, Flickr is, without any doubt, one of the most popular free service that allows to easily store, organize, share photos online and, most interesting, to add metadata tags to them.

Its system for building a shared database of pictures, developing a metadata vocabulary about the images, performing metadata-driven queries, and monitoring change in areas of interest has been revolutionary. Adding tag content to photos opens new dimensions of navigation and search. As soon as a tag is assigned to a picture, cluster of items carrying the same tag are shown. If that's not what expected, it is possible to change the tag or add another to refine the search.

This system offer lots of ways to visualize and refine the tag space. It's easy to know whether a tag used is unique or, opposite, popular. It's easy to rename a tag across a set of items. It's easy to perform queries that combine tags. Armed with such powerful tools, people can collectively enrich shared data.

Flickr can, indeed, host photo albums. it is possible to allow anybody to instantly see your own recent photos, as well as any albums created or, eventually, it is possible to restrict certain photos' visibility to just the users that have been identified as Friends or Family.

"…The result is a dynamic environment, created by members inspiring each other to go in new directions with their cameras. It makes digital photography not only instantly shareable, but immediately participatory, creating collaborative communities around everything from the secret life of toys to what grocery day looks like. The result is an only-on-the-Web conversation where text and image are intermingled in a polyglot that has all the makings of a new kind of conversation". (*Flickr 2)*

Since all it takes is snapping a photo and e-mailing it to the site from a camera phone, or uploading it from a digital camera, it's become easier to take and share a photo than to write an e-mail or a blog entry. *(Flickr 2, Flickr 5)*

The outstanding growth of Flickr brought the company to the attention of big internet-related companies and, in March 2005, it was acquired by the second biggest web search engine Yahoo!.

3.2.2 26th August 2006: geographical coordinates added as tag

In its first two years of existence, Flickr allowed to mark and explore photos by photographer, tag, time, text and group. In August 2006, however, leveraging on the acquisition with Yahoo!, a geo tagging functionality was enabled.

Users could start geo-tagging by an incredibly intuitive procedure; after having accessed their account and the map tab, pictures could be linked to either a city or a specific address by simply dragging it from its source and dropping it on the place of reference. In addition, location information were featured with their own privacy setting so to permit to keep the location of where the photo was taken private, while keeping the picture available for the public.

Searching photos by location was an immediate consequence. Users could explore the map to a location, from world down to street level, and type in a search query. Markers would appear on the map with photos that contain that query in the tags or description of the photo.

Geo-tagging was an immediate hit. Within 24 hours, according to Flickr's statistics, 1.6 million photos had been geo-tagged and the number was inexorably condemned to grow way further. A year later, 29 million public photos had been geo-tagged, at an increasing rate of 150,000 new ones per day. *(Flickr 6, Flickr 7)*

As the popularity of the website continued to growth, in February 2009 the hundred million geo-tagged photo goal was broken, at an incredible rate of growth of one geo-tagged photo per thirty pictures uploaded. Of those, around two thirds had public geo-tags and could be searched for on the map, and about 33 million had some level of private restriction. *(Flickr 8, Flickr 9)*

3.2.3 The Geo-tagging phenomenon

Even if the possibility to add geographical coordinates to the photos metadata had been possible since almost a decade, it had always represented an answer to particular professionals' needs and, in only few cases, a hobby for extremely photo-passionate. Notwithstanding its limitations, however, geo tagging had always sound interesting and fascinating to an incredible growing online community that kept on asking for an accessible solution.

Flickr, together with the other online services, represented an important turning point that changed the perception of geo-tagging from an extremely complicated and technological related feature to an immediate easy-to-access way of communicating.

"*The objective was to empower every single internet users armed with a camera to participate in a community where pictures could be shared, commented or simply kept private. Flickr leveraged on the relationships between users, pictures, tags and groups to establish a community that would go behind just photo sharing*". *(Flickr 10)*

However, the reasons behind Flickr success and, as a consequence, of the spreading of the geo-tagging phenomenon, are to be found not only in community considerations but in technological ones as well.

From a technological point of view, in fact, all the online photo-sharing services had the incredible merit of moving the problem from the source of the picture to its later utilization. If, indeed, the possibility of adding geographical information had been already possible through different technological solutions, it is important to highlight that these methods were cumbersome other than dedicated only to technological experts.

Among others, these technological barriers represented one of the reasons behind the scarce utilization of this feature and, requiring only the internet as a discriminatory variable to participate in the process, brought the phenomenon up to the mainstream market.

Thanks to the online photo sharing services, and in particular to Flickr, in fact, people were granted the possibility of adding geographical information when uploading the picture, so overcoming the known technical problems. Following this different path

opened the door of geo-tagging to every person that had not only a professional need but even an interest or a passion in the photography world.

Second, and probably even most important, Flickr was able to able to capture the best aspect of every social network and to propose them in a unique service. The creating of an incredible popular community played a fundamental role in bringing to the attention of the camera producers and upcoming not unanswered need.

"*Flickr is not only about uploading photos but, as a matter of fact, about the community. Flickr is playful, open, powerful and participatory. From the beginning it had a very enthusiastic community and great press. Its directors did take advantage of new technologies to make people more productive, powerful and happy. In addition, they allowed them to maintain and strengthen their relationships with their friends, family and communities. Flickr spotted the opportunity to create new efficiencies in what people already did or asked to do, empowering them with different forms of interaction*". *(Flickr 9)*

In contrast to other social platforms, Flickr provides a simple way users can express appreciation for the work of other users. Flickr's members take advantage of the social network functions and form a densely connected network in respect to contact relations and group memberships.

All these factors provided Flickr with the necessary tools to strongly propose its attention and its results on the market. Different groups were autonomously formed around different camera brands, where members shared not only to passion for the photos but for the firm itself.

Their comments, advices and complaints did represent an incredible valuable resource that firms had been missing for a long time and that now represented a warning for an immediate call of action. Not only people could suggest and provide useful upgrades for the existing products but, even if indirectly, by discussing and dreaming about unmet problems, they were offering important insights on future trends.

Among others, it appeared commonly accepted the need for a product that could represent a bundle between automatically writing geographical information in the

pictures' metadata and simplicity of use. Many complaints, indeed, were about the boring and long procedure required by the internet service to geo-tag pictures.

A demand for a product that could represent a valid answer to this need was arising and now it was up to the market and to its players to take advantage of a new incredible opportunity.

3.3 From 2006 till nowadays: The GPS reality

3.3.1 16th January 2007: Ricoh Caplio 500SE, the first GPS integrated camera

One year later, in the beginning of the 2007, the incredible hype around the geo-tagging phenomenon forced the market to answer to the always increasing demand for a new camera solution.

Ricoh Corporation, again, solidified and confirmed its leadership position in providing cameras, by releasing the 500SE GPS-ready digital camera. The camera, enabled with integrated GPS technology, was developed for outdoor location-based photography. The 500SE, completely dedicated to the mobile GPS photographer, was based on an extreme durability and high resolution to meet the image quality and all-weather usability demanded.
The camera's integrated precision GPS module provided for an all-in-one, easy- to-use device for geo-coding images and video at the time of capture. For applications that require even greater precision, the camera was capable of receiving NMEA data streams from external GPS devices via its on-board Bluetooth(R) radio. Furthermore, the camera was empowered with a GPS lock function in order to record the position of an object as opposed to the position of the photographer. *(Ricoh Caplio 500 SE 1)*

Ricoh's design philosophy was to produce a camera that could meet the unique needs arising from a new market segment, and the 500SE was specifically designed to optimize map-based workflows. It aimed at providing the definitive process to easily integrate location-based multimedia files into mapping software and overcame

all of the detriments found in other methods of associating pictures or videos with a point on a map. *(Ricoh Caplio 500 SE 2)*

In addition, the captured geo-images and geo-video files could be easily transferred to a PC or to handheld devices wirelessly via its Bluetooth or WiFi. Once transferred, the pictures were automatically merged into geo-databases for instant integration into Geographic Information Systems (GIS). Points representing each file's position could be hovered over to display a thumbnail of the file, or clicked on to access the original image or video.

The Ricoh Caplio 500SE GPS-Camera was available, also, with an integrated digital compass. Besides the coordinates, now the camera was capable of capturing the direction from which the photo was taken. In combination with the several software solutions the photos could then be placed on digital maps or used in Geo Information Systems. The Ricoh 500SE was priced £549.99 in the UK, while in the US it was priced around $1.000. *(Ricoh Caplio 500 SE 1, Ricoh Caplio 500 SE 2)*

Once entered the market, the Ricoh Caplio 500SE GPS-ready caught the attention of all the professional and amateurs photographers. While it was reviewed and considered not on the same quality level as other cameras in the same price range, its one-of-a-kind features evened out any differences. The camera was extremely appreciated not only by professionals but from the growing geo-tagging communities as well. The former could finally have just one product substituting the two to three external devices, like a camera, a GPS device and a compass, that they had to continuously carry with them. *(Ricoh Caplio 500 SE 3)*

Geo-tagging lovers and communities, instead, spotted in the camera the opportunity to simplify their on-line geo referencing process and to discover new possibilities. As a matter of fact, notwithstanding the success that the camera had even among non professional users, the high price still continued to represent a high barrier for many potential customers waiting for their possibility to access a similar product. *(Ricoh Caplio 500 SE 3)*

3.3.2 Rolling down the hill: Nikon Coolpix P6000

In August 2008, Nikon Corporation announced the introduction of the new flagship model in the Nikon COOLPIX lineup. Practical new features were proposed in order to place shooting control and optimized performance in the hands of photographers. The Nikon Coolpix P6000 was officially tailored to enable photo and camera enthusiasts of all levels of experience *"to enjoy real photography".*
As to continue the Nikon quality tradition, the Coolpix P6000 was featured with a 13.5 megapixel image sensor that could capture the finest details with sharp resolution. In addition the zoom and the lens used were aimed at delivering clarity and precision throughout its range. Additional shooting options engineered to maximize image quality and offer greater control over the final results included Nikon's original COOLPIX Picture Control System and NRW* (RAW) support. The COOLPIX Picture Control System featured intuitive operation that enable in-camera finishing and conversion to JPEG format, allowing photographers to adjust images to their liking. *(Nikon Coolpix 1)*

As the flagship model of the Nikon COOLPIX lineup, "*the COOLPIX P6000 was designed to deliver innovative functions in addition to optimum image quality*". It was, indeed, empowered with wired LAN support to offer easy access to the Internet for automatic and secure online image storage. In addition, a new built-in GPS (Global Positioning System) unit could record the location of shots when taken and attach geo-tags with information about latitude and longitude to each image file. This added the possibility of being easily able to view the location on maps or to edit or add geo-tag information, finally meeting the need aroused in the last years. *(Nikon Coolpix 1, Nikon Coolpix 2)*

"We are eager to see the response to the integration of the new capabilities for COOLPIX cameras, as the demands of our consumers are always a priority in product design," said Bill Giordano, general manager marketing, COOLPIX for Nikon Inc. "The P6000 is an exciting product offering for Nikon's COOLPIX line, as it not only provides expanded creative control for photo enthusiasts, but also empowers them with GPS functionality and *My Picturetown* connectivity."

One of the biggest news was, indeed, the possibility of downloading the geo-tagged pictures taken directly to “My Picturetown”, Nikon’s new photo organizer wed service born in 2008.

The “My Picturetown” connectivity, following the wave of its famous predecessors, was established in order to aim to deliver powerful photography experience. Uploading images to Nikon’s “My Picturetown”, via connecting the camera by LAN cable to a PC, directly allowed sharing them with others over the internet. In addition, the Picture Bank feature provided the possibility to store them or to send images directly to a blog or other websites. *(Nikon Coolpix 3, Nikon Coolpix 4)*
With “My Picturetown”, Nikon tried to emulate what Flickr had already been doing for the last four years, trying to leverage on its incredible large consumer base. If, in fact, the possibility of posting and sharing pictures didn’t represent a particular innovation, the new website represented the second camera company owned web service aimed at acquiring knowledge and spotting opportunities time ahead.

The Flickr example had showed a great consumer interest around the brand, since it represented the reason for the creation of one of the largest members group. In addition, enriching the service with the possibility of interaction and comments, had given great insights around the ability of customers of facing products related problems and in expressing their needs. It was time to finally take advantage of these extremely important resources.
In an overall evaluation, it can be stated that the COOLPIX P6000 was the first consumer camera with an integrated GPS device and with a built-in Ethernet connector, allowing users to geo-tag and share images effortlessly. Even if its quality level was in line with the Nikon’s standards, the Coolpix P6000 was designed and marketed for the consumer market, being price, in fact, at $500 American dollars.

3.3.3 Later comers and hybrid products

The incredible success of the Nikon Coolpix P6000, a product that could finally meet all customers’ expectations, forced other players on the market to enter the category.

While some cameras producers kept on introducing the GPS feature through an external device, like Canon and Kodak, the market was characterized by a category blurriness that saw GPS producers arising as new protagonists. The year 2008, in fact, represented the starting point for many Portable Navigation Device (PND) manufacturers, to enter the market.

The first was Altek, a Taiwan based company founded in 1996 which is deemed to be the earliest domestic corporation to have headed into the R&D of mega pixels digital still camera (DSC) technology, in addition to its manufacturing role.

On 15th August, Altek claimed to introduce "*the world's first integrated GPS satellite navigation camera*". This multipurpose camera not only could be used as a fully functional digital camera for image capturing purposes but, it also offered useful features such as electronic map browsing, search functions for points of interest and satellite navigation.

When capturing images using the camera, the built-in GPS would automatically record the coordinate data on to the image files. By using toll-free websites such as Google Earth, Google Map and Flickr, in addition, it was possible to integrate the images captured into the world map for a brand new user experience. Also, users could upload images containing coordinate information to their blogs, online photo albums or share them with their friends via E-mail.

"*The new feature allowed users, by using Google Earth or Flickr, to be able to obtain the travel route they have taken based on the time stamps and coordinates recorded on every image*". The firm claimed that this new concept, denominated "navigation through photographs", was bound to change consumers' user habits in the future. It was studied, indeed, to allow friends and online contacts wishing to travel to a place that had been visited before to obtain immediate directions to arrive at their destinations by downloading photographs taken at that location to their navigation camera. *(Altek 1)*

Mio, another Taiwan based firm, in June of the same year followed a similar path, offering GPS devices enabled with camera functions. The "Mio PND Camera", as the

manufacturers have dubbed it, combined the advantages of a consumer-grade digital camera with those provided by a portable navigation unit, thus creating a device with a very high level of versatility.

In addition, the PND with built-in camera module featured a 3.5-inch touch screen display which was designed for viewing either the navigation maps or the photos taken with the help of the optical zoom lenses. By using the PND camera, users could take geo-tagged photos and use them either to get back to that specific location or to share them with other people by uploading them to the Internet. *(Mio 1, Mio 2)*

Garmin, instead, announced in April 2009 its Oregon 550. "*The GPS device, has a 3.2 megapixel integrated digital camera, which creates geo-tagged images. Moreover, it features a 3-axis compass into the popular series of intuitive touch screen handhelds. The global leader in satellite navigation offered Oregon 550's easy-to-use interface and versatile features making it the ideal solution for customers looking for a multipurpose GPS device*". *(Garmin 1)*

"As everyone looks for ways to do more with less, Oregon 550 and Oregon 550t can be the one GPS device you turn to for all of your activities, in any climate, on any terrain, at any time of year," said Dan Bartel, Garmin's vice president of worldwide sales. "Easy enough for beginners to master, Oregon will guide you in your adventures, capture the highlights and bring them back home."
"*Oregon 550's 3.2 megapixel autofocus digital camera with 4x digital zoom automatically geo-tags each photo with the location of where it was taken, allowing to mark, remember and navigate back to that exact spot in the future. These pictures can then be printed or stored and shared online. Once connected via USB, it is possible to access my.Garmin.com to detect Oregon's photos, simplify the selection and uploading processes and then store those photos on an online photo sharing community for friends and families around the world*". *(Garmin 1, Garmin 2)*

Notwithstanding the possibilities described so far, the most interesting option that could offer the best possibility for GPS and camera combination was represented by the cell phone. In the last years, because of the increasing number of features

availability, the term cell phone has been substituted by the term smart phones indicating, indeed, the incredible potential that resides with one of the most spread piece of technology worldwide.

Being already featured with camera and integrated GPS devices, smart phones represented the product whit the easier and immediate link to offer a geo-tagging service. The technology already allowed great compatibility within the features and, in addition, most smart phone are empowered with WiFi connection in order to enrich the geo-tagging experience directly uploading the picture on one of the many online communities.

This first part of the empirical research has served the purpose of presenting the history of the GPS camera. In addition, the different manufacturers' behavior has been stressed, focusing on its effect on the market. Following a Relation Linking approach, in fact, the camera manufacturers have adopted a creative process aimed at spotting and serving what had been, till that moment, an unmet need. However, the causes that contributed to the reaching of the actual technological convergence, and at the birth of the GPS camera phone, are to be found, also, in the evolution of the cell phone category.

3.4. Form the first camera phone to nowadays GPS camera phone

3.4.1The first camera phone

A camera phone is a mobile phone that incorporates a small digital camera, and is able to store these pictures in the internal memory of the phone and share them with other devices using cables or wireless networks. More than half of all the mobile phones in the world today are camera phones.

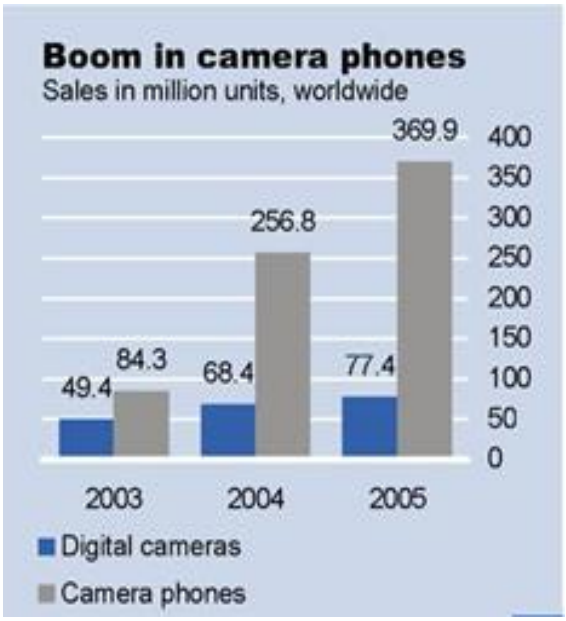
"*Although there have been landline based video phones for a number of decades, the first cell phone to be able to transmit, receive, and display digital images was a prototype device called the Intellect, which was designed in 1993 by the American inventor Daniel A. Henderson. The Intellect was, in essence, a hand held mobile*

phone with a large, high resolution monochrome screen, that was able to display images and video files that had been transmitted by a computer connected to a wireless transmitter. Many of the technologies and data transfer protocols that were pioneered by Henderson are still in use today, in our modern camera phones." *(Camera Phone 1)*

Other early experiments with wireless image sharing in conjunction with mobile telephony included Apple's Videophone/PDA in 1995, and several prototype digital camera/mobile phone combinations demonstrated by Kodak and Olympus in the mid 90s. However, none of these devices were capable of connecting to the internet wirelessly, which was to prove a crucial development as it allowed instant media sharing with anyone regardless of their location. *(Camera Phone 2)*

However, it was not long before some bright scientist, namely Philippe Kahn of Lightsurf enterprises in the US, invented a mobile picture sharing structure. As a consequence, the first camera phone to make use of this was the Sharp J-SH04, which was developed in the late nineties and received a commercial release in 2001 in Japan.

The camera feature proved popular right from the beginning, as J-Phone in Japan had more than half of its subscribers using camera phones in two years. The world soon followed. By 2003 more camera phones were sold worldwide than stand-alone digital cameras. In 2004 Nokia became the world most sold digital camera brand. In 2006 half of the world's mobile phones had a built-in camera.



Source: Deutsche Bank Research, 2006

As a direct result of the rapid popularity of camera phones, two of the traditional four giant camera makers, Minolta and Konica, had to quit the camera business altogether. By the beginning of 2009, there were over two billion camera phones in circulation worldwide. *(Camera Phone 1, Camera Phone 2, Camera Phone 3)*

3.4.2 The year 2008: The first GPS camera phones hit the market

The year 2008 was crucial to the cell phone market as it represented the beginning of an incredible technological progress that brought up to the consumers' attention what has been later dubbed with the label "smart phone".

In February 2008, Sony Ericsson strengthened its phone range with two models that were aimed at "taking photos further". The two phones, namely C702 and C902, packed with the latest camera technology, make it effortless to take pictures at any moment and to instantly share them with friends and family. Both the C702 and the C902 introduced for the first time in a cell phone an integrated GPS device and a range of location-based imaging services that had the scope to add a new dimension to taking and managing photos with a mobile device.

When taking a picture, information about where the picture was taken could be automatically added to the image. It became reality to always share pictures with

friends and family according to where the shots were taken. In addition, thanks to the Internet connectivity, pictures could be sorted through a photo gallery on the web. In order to fully take advantage of the integrated GPS, both phones allowed using Google™ Maps for Mobile in order to be located and guided to any destination. The GPS could pinpoint the exact location and provide a turn-by-turn voice guidance to the destination required. In addition, the maps were enriched with more than 20 million points of interest.

Furthermore, both phones also allowed transferring the images to a computer by using the phone's memory card USB adapter. Once the photos had been saved to the phone's memory card, it could be removed and pop into the USB adapter. Once connected to a PC, photos could be dragged across, managed and organized. *(Sony Ericsson 1)*

In close proximity to the Sony Ericsson announcement, Nokia as well proposed to the market its first GPS camera phone, the Nokia N78.

The Nokia N78 was expressly designed to take advantage of the new suite of Nokia services, including the "Nokia Music Store", "Nokia Maps", and "Share on Ovi", a new online service that enables consumers to share their personal media.

The Nokia N78 was packed with a powerful range of technologies, including integrated A-GPS, with free Nokia Maps, WLAN and high-speed HSPDA 3G connectivity, a 3.2 megapixel camera, and support for microSD memory card, to store favorite music and photos. *(Nokia 1)*

The novelties of the N78 were the possibility of geo-tagging photos and an integrated FM transmitter that allowed music to be played on any FM radio, in a car or at home.

Taking advantage of its integrated A-GPS functionality and 3.2 megapixel camera, the Nokia N78 introduced the increasingly popular online practice of geo-tagging to a Nokia device. The Nokia N78 could automatically tag images with capture location metadata, making it possible to view the capture location on a map either on the device itself, or online. With its high-speed internet connectivity, over WLAN or

HSDPA, uploading photos and videos to online communities like Share on Ovi, Flickr or YouTube was designed to be easy and immediate. *(Nokia 1)*
At a few months distance, precisely in June 2008, the third GPS camera phone entered the market to directly compete with its two predecessors and to leverage on the GPS feature success.

On June 9th 2008, Samsung Electronics announced the launch of Samsung OMNIA. The new Samsung smart phone allowed users to switch seamlessly between Microsoft Outlook email and productivity applications that replicate the look and feel of a PC, with a stroke of their finger. Indeed, it was also the first Samsung touch phone. *(Samsung 1)*

Based on the most up to date Windows Mobile 6.1 Professional operating system, Samsung OMNIA could provide users with a mobile extension to their PC experience, with access to MS Office documents such as PowerPoint, Excel and Word. In addition, users could also send and receive email and manage their appointments in Outlook while on the go. The Windows Mobile 6.1 Professional operating system allowed users to download additional programs as to customize it for their individual needs.

Samsung OMNIA was empowered with a wide 3.2-inch WQVGA LCD screen for viewing videos and slide shows in high-resolution and advanced audio capabilities. Furthermore, the phone was enriched with a five-megapixel camera with the latest value-added features, which include auto-focus (AF), face and smile detection and auto-panorama shot.

Rounding out the fully comprehensive feature set, Samsung OMNIA also offered an integrated GPS device, including navigation and geo-tagging capabilities, so to allow users to take advantage of the navigation software and of the photo sharing online communities.

Geesung Choi, President of Samsung Telecommunication Business, said: “I am very excited to introduce Samsung OMNIA, a mobile device that truly delivers the best possible features for today’s busy, connected consumer. Samsung OMNIA

demonstrates our vision for the Samsung mobile business, which is to provide premium phones for users who desire functionality, style, usability and entertainment in one innovative device. The OMNIA mobile range will help users to be at the forefront of work and play and at the same time, to stay connected anytime, anywhere." *(Samsung 1)*

The year 2008 represented a new opportunity for phone manufacturer that had finally leveraged on the consumer hype about geo-tagging that had been spreading in the last years. GPS camera smart phones represented the last technological achievement that could provide, within a single device, the coordination and interaction of different features, posing the basis for an ever growing potentiality.

3.4.3 Apple's iPhone: missing something?

On 9th January 2007, Apple introduced the iPhone. The new born in Apple combined three products; a mobile phone, a widescreen with touch controls, and a Internet communications device with email, web browsing, searching and maps.

The iPhone was the first smart phone to introduce an entirely new user interface based on a large multi-touch display and pioneering new software, letting users control iPhone with just their fingers.

"iPhone is a revolutionary and magical product that is literally five years ahead of any other mobile phone," said Steve Jobs, Apple's CEO. "We are all born with the ultimate pointing device—our fingers—and iPhone uses them to create the most revolutionary user interface since the mouse."

The first iPhone featured a 2 megapixel camera and a photo management application that allowed users to browse their photo library, with just a flick of a finger and choose a photo for their wallpaper or to include in an email. In addition, in its preliminary version, the iPhone was a quad-band GSM phone which also featured EDGE and Wi-Fi wireless technologies for data networking.

Furthermore, the iPhone provided a 3.5-inch widescreen display that offered the possibility to watch TV shows and movies on a pocketable device, with touch controls for play-pause, chapter forward-backward and volume. iPhone also played videos purchased from the online iTunes Store. The iTunes Store offered over 350 television shows, over 250 feature films and over 5,000 music videos. *(Apple 1)*

In addition, the iPhone also included Google Maps, featuring Google's maps service and iPhone's maps application. Users could view maps, satellite images, traffic information and get directions, all from iPhone's touch interface. All those services, however, where provided through internet connection as the iPhone wasn't featured with an integrated GPS device.

The iPhone was first available in the US in June 2007, in Europe in late 2007, and in Asia in 2008, in a 4GB model for $499 (US) and an 8GB model for $599 (US), and was meant to work with either a PC or Mac. *(Apple 2)*

It's hard to think of any other device that's enjoyed the level of exposure and hype that Apple found in the launch of the first iPhone. Steve Jobs expressed high hope for the iPhone and planned to capture 1 % of the mobile phone market, meaning ten million iPhones. However, notwithstanding its reviews proclaiming that all the attention towards it where well-deserved, the first iPhone was still far from being perfect.

One of the major complaints regarding the iPhone had to do with the life of its battery. It is said that because of the complicated technical features of this gadget, the battery was easily drained, actually lasting no more than one day. Another major complaint was on the camera feature. Apple did provide all the latest gadgets from accelerometers to light sensors but offered a dated 2 Megapixel camera sensor when its main rivals offered up to a 5 Megapixel camera. Furthermore, the camera wouldn't allow to record video. (Apple 5)

More criticisms pile up as the iPhone's absent features started to be scrutinized. With the increasing appreciation for 3G technology, it truly surprised people that the iPhone didn't support it. MMS functions, even, were not provided.

In addition, when it came to messaging, users would have to stick with traditional emails and SMS because it still didn't have an instant messaging function. Copy and paste functions were also absent. Going even further, its Bluetooth capabilities were limited as it could not support regular file transfers.

Most important, however, it seemed odd that a smart phone claiming to be a revolutionary model being "*5 years ahead of competition*," was not provided with an integrated GPS device and didn't allow using the smart phone to actively participate in the online communities' phenomenon.

Although the iPhone represented for sure a revolution in the handheld mobiles, it still had a lot of space for improvement. *(Apple 5, Apple 6)*
As to take advantage of its enormous potentiality, In June 9, 2008 Apple introduced the new iPhone 3G. It combined all the revolutionary features of the iPhone with 3G networking that was supposed to be twice as fast as the first generation iPhone. In addition, it provided a built-in GPS for expanded location based mobile services and iPhone 2.0 software.

The new operating system included support for Microsoft Exchange ActiveSync and it could run hundreds of third party applications, partially answering to the critics that the first model received.

iPhone 3G focus was mainly stressed on its connectivity capabilities. It provided users with faster access to the Internet and email over their cellular network with quad-band GSM and tri-band HSDPA for voice and data connectivity around the world. iPhone 3G supported Wi-Fi, 3G and EDGE networks and could automatically switch between them to ensure the fastest possible download speeds.

iPhone 3G included the new App Store, providing iPhone users with native applications in a variety of categories including games, business, news, sports, health, travel and, finally, it did allow third parties software. *(Apple 1, Apple 3, Apple 4)*

Another important additional feature available with the iPhone 2.0 software included the ability to do real-time mapping with GPS technology. However, notwithstanding the presence of both a GPS device and a camera, Apple didn't take advantage of the growing geo-tagging phenomenon, not allowing any such feature on its device.

The integrated GPS device served the purpose of satellite navigation but, once again, it seems awkward that, even if provided with all the relevant technology, the iPhone wouldn't allow a communication between the GPS and camera. *(Apple 7, Apple 8, Apple 9)*

In order to finally solve all these problems, Apple followed a double path. It released its third version of the operating system fixing most of the know problems and, in addition, it also release in June 2009, its new iPhone version called 3G S.

"*The OS 3.0 software update, makes many features available to all iPhone users, like: a landscape keyboard for all core applications; an innovative and useful implementation of cut, copy, and paste, the long-elusive iPhone feature; A2DP stereo Bluetooth; push notifications, an improved call log that shows details like the time and length of a call; shake to shuffle; voice memos; and support for MMS*". *(Apple 11)*

Because of the available software update, it would be easy to dismiss the Apple iPhone 3GS as an inconsequential hardware upgrade. However, doing so would underestimate how much, collectively, the phone's new features augment the iPhone experience. With the iPhone 3GS, in fact, Apple aims at solidifying its leadership position in a crowded smart-phone landscape.

On the outside, the iPhone 3GS looks and feels virtually identical to the existing iPhone 3G but, inside, the iPhone 3GS has been fully redesigned, with new core components like CPU, memory, an integrated compass, and video recorder capability.

The new iPhone allows surfing the internet twice as faster as its predecessor thanks to its new components updates. Beyond the performance boost, the iPhone 3GS

features a notably improved imaging experience that ranks high among the hardware upgrades built into the iPhone 3GS handset.

"*The camera jumps from 2 to 3 megapixels, and it now includes a video mode. The iPhone 3GS camera application has a slider switch to activate the video camera, which records 30 frames per second video at 640-by-480 resolution. In video mode, the camera shutter turns into a red record button to press once to start recording, and again to end recording. In addition, thanks to the integrated hook into YouTube, video can be easily shared with the most famous video online community*". *(Apple 12)*

The Picture Camera Roll application, however, still lacks the same integration with b services; when taking pictures, and eventually having geo-tagged them thanks to new feature available, it is not possible to directly post and share them leveraging on one of the many of photo-sharing online communities.
In addition, as long as the GPS capabilities are concerned, the phone comes with a version of Google Maps equipped with Google Street View. In addition, the new iPhone 3GS, finally allowed the possibility of geo-tagging pictures.

Also, the new iPhone 3GS is enriched with a digital compass and Google Maps can use this to tell the user which direction he is before he starts his trip. The newly integrated compass is also handy for location-based and mapping applications. It has a distinctive, easy-to-read graphics, and it allows applications to orient to your current position. For example, the Maps app will reorient based on your directional heading. *(Apple 11, Apple 12, Apple 13)*

The new iPhone, after having gone through continuous improvements for the last two years, finally appears to be offering all the solutions that the market has been requiring in the last years.

4. General discussion

The data collected and presented in the empirical research, offer the possibility to analyze the evolution of the technological convergence that has brought to the GPS camera phone. Furthermore the geo-tagging phenomenon can be best understood.

In addition, thanks to the cognitive psychology theoretical framework presented before, it will be possible to better understand how the technological convergence can affect firms' behaviors, and what important marketing implications can derive from this deep change that is mostly affecting the electronics market.

4.1 Results

In order to gain any insights about the mutual relation between the technological convergence and the creative processes, it is important to analyze the empirical research data from a different angle.
In the first place, cameras and cell-phones belonged to two different and distant categories, not sharing any commonalities between them. However, the creative processes engaged by the firms in order to propose new products to the market led, at a later stage, to a technological convergence that has deeply affected the market structure, posing important questions about any future firms' decision.

In the beginning, the hybrid products that both categories proposed were the result of two extremely different path; namely Relation Linking and Property Mapping. One of the first important examples of a hybridization process in the camera category was, in fact, the first commercialized GPS camera that dates back to the year 2001.

Notwithstanding its scarce appeal, it technological difficulties and its significantly high price, the Nikon D1H is invested with great importance as it was one of the first attempt of employing what has been later defined as Relation Linking.

The new product was the result of a creative process where two extremely distant technological concepts belonging to different super-ordinate categories, were linked

together with the purpose of solving a specific problem. However, due to the difficulties linked to its niche segment of interest, the product didn't expand into the mass market but remained specific for governmental agencies and institutions serving detailed requests.

In the meanwhile, the cell-phone category, definitely more distant and separated from the camera one as it is nowadays, was hit by the introduction of the camera phone. In this case, however, the product was the result of a different innovation process; namely Property Mapping.

The new product, in fact, proposed the combination of the functions of two products belonging to the same super-ordinate category, leading to a hybrid that offered both functionalities. Notwithstanding the lack of the problem-solution syllogism, the camera phone had an incredible success and from 2001 to 2004 it spread all over the world conquering the title of revolutionary product.

In the years that followed the two categories continued to develop following different paths, without showing any sign of an unexpected but extremely significant convergence that was about to come. In the two year period from 2004 to 2006, in fact, the advent of the photo sharing online communities deeply affected the market, posing the basis for a trend that would have brought to the blurriness of the respective categories boundaries.

The technological convergence had an incredible effect on the market structure, completely overcoming any barrier. What till that moment had been considered as extremely distant products with different functionalities and purposes, where now consider to be almost substitutes. The cell-phone category in particular significantly widened its orison, becoming a product-platform that could serve as a basis for any future innovation.

The GPS functionality had been till the moment a prerogative of the camera category that started to propose better technological solutions, leveraging on an increasing customer base that was, however, still strongly linked to business customers. Flickr, one of the most popular photo-sharing online communities, however, revolutionized

the way photography and geo-tagging had been intended so far, opening the GPS-camera relation to the mass market.

The data collected, show that non-business customers were pushing for a solution that could fit their needs. Many different blogs and forums were indirectly stressing the appreciation for the geo-tagging feature, even suggesting new way of utilization; however, because of the fragmentation of the information, firms had missed the opportunity.

Flickr, indeed, had the fundamental merit of allowing users interaction and, thanks to its outstanding success, highlighted and stressed what had been previously ignored. Allowing to add geo-tagging references to the pictures uploaded on the community, represented the answer to the desires that were continuously flowing from the web. The intuition marked the beginning of the geo-tagging era and has the merit of having once again stressed the importance of both listening to customers to acquire direct insights but, even more important, to observe and to interpret their behavior for capturing gestures and other indirect signs that may result to be even more valuable.

Customers had always commented on blogs and forums any new technological upgrade related to the GPS camera, highlighting pro and cons and indirectly stating wishes. At a later stage, when Flickr brought it to the firms' attention, a four year period was already passed and customers where still demanding for a product that could fit their needs.

Because of the Flickr effect, indeed, firms were more prepared to seek and to leverage on any possible insight and they didn't miss the opportunity. Online users were showing a growing sentiment of boringness towards the online procedure of geo-tagging pictures; while easy and immediate, it was time consuming especially because it was strictly dependent on the number of pictures to geo tag.

The situation provided room for an ad hoc solution that could solve the problem by automatically adding geographical references to picture at the moment of capture. Even if the product already existed, camera manufacturers provided a modified solution tailored to the new needs; in 2007 cameras with an integrated GPS

functionality were introduced to the market and they were priced at a more accessible level.

Notwithstanding the striking signals, cell-phone manufacturers didn't behave accordingly. Apple's iPhone, for example, was first marketed in 2007 but it didn't provide a GPS receiver. Indeed, it did allow to take pictures and to directly upload them on the web thanks to its internet connectivity, but it didn't take advantage of the geo-tagging possibility.

When in 2008 a new version of the smart phone was released, few changes were made. In fact, the new iPhone was equipped with an integrated GPS receiver but, however, it still didn't allow to automatically geo-tag pictures. It was only in the current year, after a 3 year period, that Apple finally provided its revolutionary smart phone with the geo-coding functionality.

As for the purpose of this paper, it is extremely important to stress the different behaviors that have characterized the evolution of the camera and of the cell-phone category. While in the first case the need for new products was met trough a Relation Linking innovation process, a completely different approach was adopted by the smart phone manufacturer.

The GPS camera phone has been the result of a Property Mapping process where, after the introduction of the camera within the cell-phone category, the GPS technology was introduced to form a new hybrid.

While it is possible to contest the previous affirmation because of the membership of the GPS and the cell phone to different super-ordinate categories, it is striking the lack of connection between the two functionalities. Even if the process provided a new hybrid that combined the functions of diverse concepts, in fact, what lacked was the specific problem to which the product needed to be addressed as it is showed by the missing link between the two technologies.

As it emerges from the empirical data, the cell-phone manufacturers acted in terms of Property Mapping, considering the GPS functionality as a "modifier" to add the

“header” (smart-phone) and didn’t consider its potentiality in answering the arising needs.

This perspective explains why Apple and the other firms in the cell phone market didn’t allow in their first models with GPS functionality to geo tag photo but considered the camera and the GPS as two separated entities.
It appears clear that the technological convergence phenomenon played a major role in this situation. Having significantly widened their orison thanks to the latest technological development, cell-phone manufacturers were more interested in exploiting the new product rather than consciously proposing innovative solutions.

As it often happens with new product-platform that have the potentially to represent truly innovative solutions, the creative process that firms most often engage into is Property Mapping.

As the research conducted shows, in fact, the commercialization of the first camera phone was followed by an incredible number of different product features aimed at differentiating the camera phone. Once again, the new product-platform became the “header” and many “modifiers” deriving from the same super-ordinate categories were applied in order to form new products. Among the different features there were radio, touch and voice control, video and music player and, of course, also a GPS.

This kind of approach, however, resulted to damage the cell phone manufactures that didn’t take advantage of the customers’ desires. Even if the product had a great number of capabilities that was inexorably condemned to grow, the actual product usability didn’t correspond to the market expectations.

4.2 Theoretical contributions and Managerial Implications

The empirical study has highlighted two different behavioral paths that have characterized the evolution of the GPS camera phone.

Thanks to the psychological theoretical framework proposed, it has been possible to clearly distinguish between two different approaches undertaken by the camera and

the cell-phone manufacturer that have led to the technological convergence; while the first have followed a Relational Linking kind of creative process, the latter have adopted a Property Mapping one.

As for the purpose of this paper, it would be valuable to try to understand the different choices within a marketing perspective, evaluating pro and cons and trying to set the basis for a more general approach. In addition, it will be important to analyze the effects of the technological convergence and to try to state which approach could better fit different situations. If, in fact, it would be superficial to state that one approach is definitely better than the other, it may result interesting to understand the different circumstances that may render either approach more valuable.

The first GPS camera commercialized was the result of a Relation Linking process while the first camera phone was the result of a Property Mapping one. The evaluation of the success of the two different products is straightforward; the camera phone was an incredible hit while the GPS camera remained an unknown product for many years.

The opposite, however, happened at a later stage; right after the Flickr success, camera manufacturers, thanks to a Relation Linking approach, were able to surf the wave and conquer the market while, for cell phone manufacturers using a Property Mapping approach, it took longer to take advantage of the new possibility.

Useless to say, there is no absolute best choice but understanding the different behaviors from a marketing perspective may serve as a thumb rule for firms.

It appears as in the short run a Property Mapping approach would offer better solutions while a Relation Linking one may serve better in the long run. When the first camera phone was introduced, in fact, the cell phone manufacturers didn’t have a customer base to serve, but obtained the product as the result of a technological convergence. It was so up to the firm to actually create the need for its new product and to market it properly.

The downturns of such strategy are, however, important; as the product is the result of a technological convergence not guided by an expressed need, it is characterized by a strong uncertainty component. It, in fact, may require extensive marketing tests in its trial version to acquire customers' responses that may, or may not, be positive about the product.

In addition, even if successful at a first stage, a Property Mapping approach doesn't offer any insights about future trends. The cell phone manufacturers, in fact, notwithstanding the incredible success obtained with the camera phone, didn't have enough knowledge of the market and of the growing customer demand to offer a solution to a specific, but related, need.

It took both the Flickr effect and the camera new products, to offer a camera phone with an integrated GPS receiver that, however, couldn't be used together. The strategy of just delivering products as the result of a technological convergence didn't offer the possibility to exploit on any customers insights and, in the long run, it proved to represent more an obstacle than an advantage.

The Relation Linking approach, instead, proved to be more valuable in the long run. If, in fact, in the beginning the GPS camera appealed only to a niche segment, it posed the basis for a growing demand that would have eventually led to an even greater revolutionary product.

The camera manufactures themselves, however, didn't fully understand the incredible potential of the product and had to rely on third party information. Notwithstanding this, when it finally appeared clear that the GPS camera had the possibility to move from a niche product to a mass market one, the Relation Linking approach served them with the necessary tools to exploit the new possibility.

In trying to offer a more generalized view, it appears from the empirical study conducted that the Property Mapping approach offers a shorter creative process linked to a greater uncertainty component while the Relation Linking one, despite its longer duration, offers more valuable insights.

Property Mapping may deliver in the short term the “next market hit” as it was, indeed, with the camera phone. Its limitations, however, are to be considered as well. Notwithstanding the success that a Property Mapping creative process can deliver trough its new product, it doesn’t offer any information or insights that may serve as a basis to fully exploit the potential of the new product. It definitely leaves the creative process up to the R&D department, without considering the market signs at all.
In addition, it is important to remember that a Property Mapping approach cannot be the ultimate answer to the creation of new products. As it has been proved, there is a limit to the number of features that can actually add value to a product; the risk of just exploiting technological convergence and to make the product lose its perceived usability needs to be considered as well.

The Relation Linking approach, instead, may easily link dissimilar ideas that may belong to super ordinate categories not served by the same firm. Its potential, however, resides in the ability to offer a goal-oriented product that would answer to a specific need. Applying this approach can turn into a competitive advantage towards other market players as it offers the possibility to properly answer to the continuous market changes.

Indeed, a Relation Linking approach can require a greater investment of resources from the firm. As the process is customers-guided, once the relation with the lead users is established, extensive time and resources will be needed in order to finalize the product to the mass market expectations. Notwithstanding this, the rewards may definitely be worth the costs.

The managerial implications deriving from this study, however, may not be so straightforward. From the results obtained, in fact, it could be stated that a Relation Linking approach would represent a better solution, offering to the firm the possibility to be ahead of the competition and to have a better knowledge of the market of reference.

In my academic career, in fact, all the economic theories studied have always stressed the importance of the long run mindset compared to the short run one. The long run kind of mindset has always being proved as to represent the best choice for

the firm, which needs to be a long lasting entity providing, hopefully, continuous cash flow.

Even if perfectly correct from a theoretical point of view, however, the long run may not always represent the choice that firms make. As some economists have stated, the long run mindset can be easily discarded; even highly-located managers stress the importance of obtaining immediate results, citing probably one of John Maynard Keynes most famous statement: "*in the long run we are all dead*".

Indeed, it is extremely important to state that the two approaches are not mutually exclusive; according to the circumstances, in fact, a firm may decide to follow either process. A Relation Linking approach could, for example, serve to create a new product which marketing potentialities could be exploited thanks to a Property Mapping approach that could add on the header non-functional properties.

In my opinion, basing my perceptions on the study conducted, a good fit between the two approaches would be to use a Relation Linking approach to seek radical innovations, while using a Property Mapping one for delivering incremental adds-on.

As the case has demonstrated, using a Property Mapping approach to create a hybrid may result in a double edged sword. While offering the possibility to create a breakthrough product with relative low costs, it fails in highlighting its potentialities. Creating a revolutionary product without being able to envision its role in the market, hinders the firm capabilities to understand its limits and advantages, failing to take advantage of any possibilities. On the other side, a Relation Linking approach may result in an extensive effort from the firm that may not be able to properly sustain it in every moment of its economic life.

As it often happens, the best solution may reside in a compromise. Property Mapping may result extremely useful in allowing quick adjustments and incremental adds-on on a core product, thus taking advantage of the continuous technological convergence that is particularly taking places in these turbulent years. The long run plan of the firm, however, needs to be following a path and direction that can be only assured trough a continuous observation and exploitation of customers' insights.

Having discussed the different implications of the two creative processes proposed, it is now worth analyzing with particular attention the role of the technological convergence. It is important to understand how different markets that seem far away can converge within a single product offer and how this process can deeply affect the firms' strategic choices.

In the tumultuous economic environment in which we live nowadays, the continuous technological development poses the basis for an always increasing convergence. This phenomenon can, indeed, deeply affect those beliefs that represent the solid foundations for many firms.

The different creative processes proposed offer the double possibility of following both a structured and an unstructured path. While Property Mapping can be consider as representing the irrationality and may better resemble the creative process as it has always been considered, Relation Linking offers a structured approach in the sense that it inevitably ask the solution to be pertinent to a specific situation. Linking products that belong to different super ordinate categories, however, can without any doubt offer important insights but, at the same time, may limit their potential.

Differently from the Property Mapping approach, in fact, Relation Linking evolves with a pre-definite aim, limiting the possibilities for other solutions.

It is from the combination of the two approaches that the technological convergence between the camera and cell-phone categories was possible; while the Relation Linking approach was offering important insights to firms on how to properly answer to the customers' desires, the Property Mapping approach offered the "creativity" that was hindering the camera manufacturers. The result was unexpected and led to an important revolution in both categories.

If, in fact, the creative processes affected the evolution of two different markets leading towards a convergence, the technological convergence itself deeply affected the following creative solutions.

Once a product-platform is brought to the market, firms are invested with the incredible desire of loading it with any possible feature that can be considered economically viable. However, as the case study demonstrates, this approach may limit the product perceived usability and may hide to firms some important breakthroughs.

A Relation Linking approach, in fact, could best serve the purpose of actually addressing the new creative solution towards an offer that can be tailored to the customers need and that can overcome the pure technological boost.
Once a technological convergence is reached, however, it is important not to run the risk of overextending the new product features because of it economical viability. Too often a product-platform, intended as a product that has the potentiality for representing the solution to different needs, is loaded with features that do not represent an answer to specific needs, and that can limit the product perceived usability.

As the research shows, a Property Mapping approach may not represent the best solution when having to deal with similar situation. While, as said, it can represent a good choice in the short run and it can play an important role in the determination of a technological convergence, it may not be the appropriate tool for properly exploiting a product platform. Using a Relation Linking approach offers the possibility to tailor the product to the specific needs of the customers and to differentiate the offer according to the different situations in which it may be used.

However, the combination between the two may actually represent the best available choice and can provide the firms with the necessary tools to properly take advantage of the technological convergence.

While, in fact, the Relation Linking approach offers the goal orientation and the necessary knowledge about the market and its needs, the Property Mapping approach, thanks to the possibility of leveraging on the technological convergence phenomenon, can offer the possibility to consider combinations different from the original that can result in the optimal choice for responding to the customers' needs.

5. Challenges for the future

5.1 Standardization: A must with risks

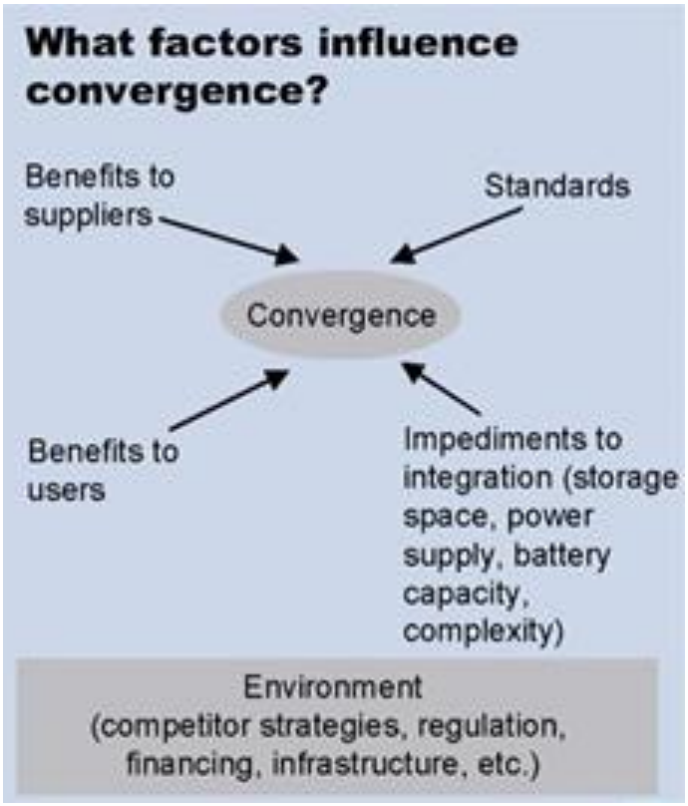
Convergence is driven by a complex bunch of factors. Interoperability and standardization are particularly important to progress on all four types of convergence. Yet developing an optimum standardization path is still by no means inconsequential, given that blueprints are hardly possible when technical progress is uncertain.

Typically there is a choice between proprietary and open standards. With proprietary solutions licenses can later be sold. However, they entail the risk of losing the race to become the standard because a company's own standard is too slow to spread. This is why preference is often given to open standards in the contest to set the benchmark. They increase the possibility of a company's asserting its own standard. In this case, though, potential license fees are forfeit, and there is a risk of infringing latent rights.

Proprietary standards consequently make strategic sense for a company if it has a strong enough market position and sufficient liquidity, if its own products lend it substantial marketing power, and if a technical product is already established in the marketplace. These points tend to apply more with convergence on product markets.

Open standards, on the other hand, are a particularly good fit for young companies developing new processes and technologies, which do not possess large corporate networks or marketable products. This is often the case with technological substitution, i.e. with technologies directly rivaling dominant market incumbents, where the value of existing resources is comparatively slight.

However, organization is indispensable for an open standard. There must be a coordinating body, be it an industry association, say, or a dedicated institution. The challenge is that the standard has to be open to further technical development yet at the same time stable enough to acquire general validity.



Source: Deutsche Bank Research, 2006

5.2 Knowledge is the decisive resource

The four convergence types also have in common that knowledge is a critical choke-point. It is not always necessary or possible to build up this resource in-house. Indeed, in a technologically very uncertain environment tying up too much specialised knowledge can sometimes be a risk, because the convergence of infrastructure, services or equipment does not develop along a deterministic path at all.

Instead, the dynamics of innovation will mean that the losers in the innovation race have to chalk up their extensive technical know-how as a “sunk cost”. This is precisely why knowledge networks will become more valuable: they limit the level of sunk costs. This strategy is more safety-focused, aiming not so much for maximum (monopolistic) profit – the glittering prize of a successful go-it-alone approach – but rather for the lesser cooperative gain on the lower risk taken. Given heightened uncertainty, this is often the predominant strategy in the long run.

5.3 Technically possible – but always necessary?

In a converging world the plethora of service, device and infrastructure offers is growing rapidly, spoiling the consumer for choice.

Often, this implies considering whether new products and services really do add sufficient value to justify the costs of their acquisition (e.g. set-top box for interactive television). Most importantly, providers must not be rash in succumbing to the temptation to confuse the attractiveness of new products or product features as perceived by their engineers with the user perspective.

Companies must pay particular attention to the following aspects when launching new products:

— *Is there a basic need for new services, end devices or infrastructure?*

This is the question that poses the Relation Linking approach as a fundamental part of a firm strategy. It is fundamental to think of the technological convergence phenomenon in terms of possible relation links that need to deliver an answer to a specific customer need.

— *Are convergent solutions superior to existing offers?*

To win the marketplace, the solution provided needs to be superior to the existing one. Customers will have to move from an older technology to a new one, having to undergo trough a new learning curve. They will support this cost only if the outcome will result in making them better off when compared to the previous position.

— *Are consumers prepared to pay for new features or services?*

The best technological solution for a specific need, may not be adopted by customers. It is extremely important to understand the willing of the customers to pay for a better solution that needs to deliver an important benefit. Customers will pay in proportion to the benefit received, and different customers may be willing to pay different prices.

6. Limitations and further research

The main limitation of this research is that it was performed using mainly secondary data. Notwithstanding the possibility to consider blog and communities entries as a sort of primary data due to the direct opinion that customers and professionals expressed, further research could study the topic in question acquiring more direct information. Moreover, primary data related not only to customers but to managers and professional that actually played an important role in the convergence process described, can without any doubt offer other important insights.

A second limitation is related to the single case used. In order to establish if the conclusions drawn can be generalized and actually serve as a rule of thumb for firms facing similar conditions, further research should focus on the analysis of other cases in order to verify the validity of the perspectives proposed.

Finally, an important limitation is due to time and resource constraints. Further research should have the possibility to invest more time and resources for the elaboration of the data and for the evaluation of the results.

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Appendix

Camera market:

1997: first GPS enabled product created for governmental needs. Early example of Relation Linking process in the category.

2001: Nikon commercializes the first camera with an external GPS device: Nikon D1H

2005: Ricoh commercializes Caplio Pro G3, its first camera with an external GPS device

Phone Market:

2001: Sharp J-SH04, first commercialized camera phone obtained through a Property Mapping creative approach

2003: more camera phones were sold worldwide than stand-alone digital cameras

2006: half of the world's mobile phones had a built-in camera

Technological Convergence

2007: Ricoh introduces Caplio 500SE, the first camera with an integrated GPS device
2007: Apple launches the iPhone, its Camera Phone without a GPS device
2008: Nikon introduces its first camera with an integrated GPS device, Coolpix P6000
2008: Apple launches iPhone 3G, its first GPS Camera phone; however geo tagging is not allowed as it is intnded to be just one of the "modifier" of the Camera Phone
2009: Apple launches iPhone 3GS, it GPS Camera Phone that allows to directly add geographical coordinates to the picture taken.

Nikon D1H with external GPS device

Caplio Pro G3

Sharp J-SH04

Ricoh Caplio 500SE with integrated GPS

Apple iPhone