Strategically Developing Intellectual Capital Effectiveness: A Conceptual Model for Innovative Companies

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Abstract: Developing intellectual capital at companies often results in large numbers of patents filed with little results other than protection of firm historical patents against intellectual property intrusion by current competitors or future competitors. This paper presents exploratory research to classify into those patents filed in past years by several major technology companies as well as measuring the business results of the patents which shows the need for the new strategic conceptual model presented in this paper. A new approach to align corporate resources toward patent strategies, management capability and process with strategic intent is presented which enables firms to assure that all needed considerations are present in a comprehensive technology and patent strategy of intellectual capital development, especially at technology firms.

Keywords: technology development model strategy, intellectual capital strategies, innovation and patent myths

1. Introduction

This paper addresses the strategic gap between the stated objectives of many high technology companies to maintain a market leading position in the acquisition of intellectual capital and the outcomes that lead technology companies to explore a high number of intellectual property *dead ends* that result in no improved processes or new products to market or minimal protection of existing products' intellectual property at great expense. In addition, for some leading filers of patents, the financial results of their filings are hard to identify. This further leads this researcher to doubt the current strategic intellectual property development focus of many leading "technology" companies. The strategic implications of this gap are lowered earnings in the future coupled with faster firm decline to a follower or imitator position, often without the firm recognizing this fall.

The following Figure 1.0 summarizes the countries with the most international patent applications in years 2005 and 2009(Economist, 2012). The USA continues to lead by a wide margin with over 45,000 international patent applications in each year. Japan is second with over fifteen thousand each of these years in international patent applications. Both the USA and Japan are home to large numbers of electronics companies whose patent strategies I will discuss in this paper. It is important to note that the USA is filing fewer patent applications in 2009 than in 2005 and that countries such as Japan, Germany, South Korea, China and France are increasing their filings over their 2005 numbers. China has more than doubled filings over this same period.

Patents are the major intellectual property/capital of high technology companies (as well as trade secrets, copyrights and tacit knowledge). The question is what management strategic process or methods can be applied to allow companies to direct their resources toward the most productive of these major intellectual property categories. This question is answered by the intellectual property development strategy employed by the firm. Patents are the most visible major intellectual property of these companies and they serve as an example of what is happening at these firms. Only two US companies were in the top ten filers of USA patents in 2011. IBM was number 1 with 6180 filings followed by Microsoft at #6 with 2311. Trends indicate that Samsung Electronics is quickly gaining on #1 IBM and may gain the #1 spot as early as 2014. According to the

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United States Patent and Trademark Office the following *Table 1* presents the top 10 companies filing US patents in 2011:

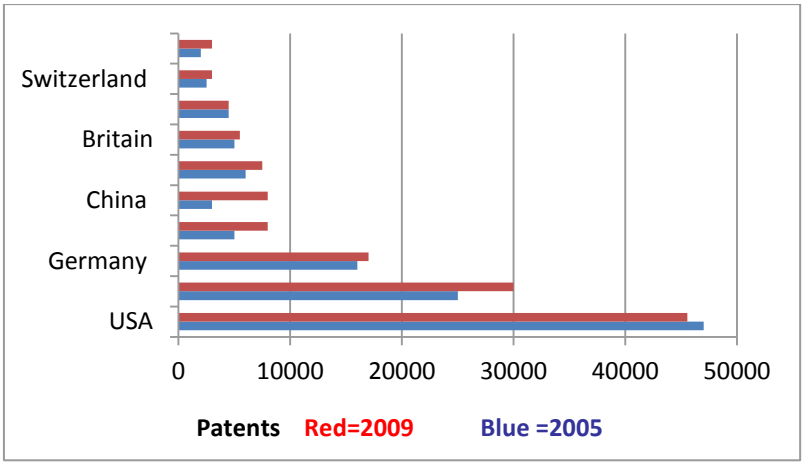

Figure 1.: Countries with the Most International Patent Applications (World Intellectual Property Organization, 2013)

Table 1: Patent filings 2011 by Company (USPTO, 2012)

Rank	Grants	Company Name	Country
1	6180	International Business Machines Corp	United States
2	4894	Samsung Electronics Co Ltd KR	Korea
3	2821	Canon K JP	Japan
4	2559	Panasonic Corp JP	Japan
5	2483	Toshiba Corp JP	Japan
6	2311	Microsoft Corp	United States
7	2286	Sony Corp JP	Japan
8	1533	Seiko Epson Corp JP	Japan
9	1514	Hon Hai Precision Industry Co Ltd TW	Taiwan
10	1465	Hitachi Ltd JP	Japan

The implication is that intellectual property is quickly moving from the developed to the newly developed world at an increasing rate and further that patent filings are increasingly seen as *defensive tactical moves* by many filers, not as part of an integrated strategy to develop strategic intellectual outputs. From *Table 1*, it is clear that this means that strategies employed by companies to protect intellectual capital using patents is increasingly a strategy employed by non-US technology companies as well as US companies and any US

leadership in this area is fading quickly. A new conceptual framework is needed for all technology companies to maintain their intellectual capital whilst meeting the competitive thrust of the other technology companies. It is clear that a trap is being sprung with the idea that patents equal intellectual capital protection and optimal resource usage in the pursuit of business applicable intellectual capital.

I have researched both financial results for the past five years and patent filings for the past five years of IBM, Microsoft, GE and QUALCOMM. A summary of key financial results is presented in this paper as well as relationships of patent filings to financials results and an outcome analysis of patent filings. This analysis has led to the new model that I am proposing for a strategic focus on offensive patents for managers.

A closer examination at selected financial results of IBM and their public annual report (IBM, 2012) reveals that total expenditures for R&D are declining as an internal activity and being maintained only by the acquisition of other firms. From 2011 to 2012, investment in R&D at IBM actually declined from 6% of revenues to 5.9 %v of revenues as a total number even when including these acquisitions. When acquisitions of new technology are excluded the percentage investment the actual percentage of revenues invested in R&D at IBM for 2012 was approximately 4%. This is not the investment that might be expected when a company is a high technology company working on leading edge technology. IBMs movement from 2001 to 2012 toward more and more services and software products while keeping hardware revenues almost constant reveals a strategy that has been reported in the press and is explained and charted in their 2012 Annual Report (page 11). The chart shows the percentages of earnings per share from software increasing to over 50% by 2015.

Microsoft is known as a worldwide provider of software products based in its Windows operating system. Based on financial results for the past five years, it is not known now as a stellar investment. For the past five years financial results at Microsoft have been disappointing to investors. The nominal return reported in their annual report for 2012 (page 32) reveals that their return on investment was only 15% above the S&P and approximately 20% less than the almost 60% return by the NASDAQ computer index for this same period (6/2007-6/12). The following Table 3 below summarizes those results.

Table-2: Comparison with the S&P and NASDAQ computer index of Microsoft Returns on $100 invested over a five year period(Microsoft Annual Statement, 2012)

Invested In	6/2007	6/2008	6/2009	6/2010	6/2011	6/2012
Microsoft	100	94.69	83.82	82.69	95.69	115.66
S&P	100	86.88	64.10	73.35	95.87	101.09
NASDAQ	100	96.38	93.36	102.86	139.68	162.75

* $100 invested on 6/30/07 in stock or index, including reinvestment of dividends

QUALCOMM is a technology provider of integrated circuits, software and designed integrated circuit components to the mostly wireless industry. They also have positioned themselves as owners of CDMA technology and patents to sell licenses to their patents to wireless infrastructure and handset providers worldwide. Their results have been uneven over the past five years and they have a current Beta value of 1.16. This is lower than values for 2009 and 2008. For the past four quarters they have spent approximately 24% of total revenues on research devilment according to their financials 10k (QUALCOMM, 2013) reports for this period. In addition they hold patents on the majority of what is termed 4G technology for mobile phones and

their new products such as the Snapdragon processor for mobile devices combines their advantage in 4G patents with their capability in fabless semiconductor manufacture.

General Electric (USA) is a conglomerate business which participates in diverse product markets globally. They are leaders in several industrial product categories including aerospace propulsion, industrial power generation, financial services, medical devices and locomotives. Founded by Thomas Edison, GE has a long history of innovation and continuity under superior managers. Their business follows general business trends and their last year's revenues and earning s have rebounded back to financial results seen before the current financial crisis in 2008. They hold an impressive portfolio of patents in medical, aerospace propulsion and other consumer (lighting) and technical industries.

Table 2 below presents this researcher's analysis of the four targeted USA companies and their patent usage developed from United States Patent and Trademark Office (USPTO) that was researched and categorized into the various patents awarded (name withheld 2012) over the previous year. The research shows that only about a third of the patent filings were directed toward new products or processes and that the vast majority were either basic research or product extensions or incremental improvements. While patents in these non-new product areas are necessary at times, the over reliance on numbers of patents filed seems striking. *Table 2* shows that for these four companies usually perceived as high technology innovation companies the overwhelming numbers and percentages of new patent filings are in ***process or*** *product improvements* (35-59% of the patent filings of the companies researched) indicating an incremental approach to innovation, not disruptive new processes or products. In addition, a large number are classified by the researcher as of *"dubious"* quality (10-23% of the patents filed by the four companies) and most likely will never see usage in a customer product or company process. This analysis is only a preliminary start toward the research needed to change the intellectual property development direction of technology companies away from their dubious non-new product focus innovations and protective patents toward a strategic focus on truly new market driven inventions.

Table 2: Analysis of patent outcomes /usage by company by total numbers and percentages (USPTO, 2012; name withheld, 2012)

Type of Patent/#	**All**	***Dubious Value***	**% D**	**Basic Research**	***% BR***	***Product /Process Extension***	**% PP Ext**	**New Product**	**% New**
IBM	6180	*632*	10	1278	21	*2992*	48	1278	21
Microsoft	2311	*451*	20	164	7	*1367*	59	329	14
GE	1448	*212*	15	345	24	*649*	45	235	16
QCOM	928	*211*	23	161	17	*321*	35	235	25

The following analysis presented in Table 3 shows the four firms' revenue and net income results for the past five years and the numbers of patents granted from 2008 to 2012. The effects of the recession in the United States and global markets is clear in that several companies experienced declines in either revenues, net income or both. The data shows very little relationship between patents and net income and revenues, respectively. The data indicates that my analysis of patent value has a degree of validity when measured over this period.

Table 3: Revenue, Net Income and US Patents Granted Years 2008-2012(Annual Reports, 2008-2012; USPTO, 2012)

Company	Parameter	2008	2009	2010	2011	2012
IBM	Revenue(B$)	101.3	95.76	99.87	106.92	104.51
	Net Income(B$)	**12.33**	**13.43**	**14.83**	**15.86**	**16.6**
	Patents	4169	**4887**	**5866**	**6198**	**6457**
QUALCOMM	Revenue(B$)	11.13	10.42	10.99	14.957	19.12
	Net(B$) Income(B$)	**3.16**	**1.59**	**3.25**	**4.57**	**5.33**
	Patents	**286**	**356**	**657**	**923**	**1292**
General Electric	Revenue(B$)	183	155.8	149.1	142.2	144.8
	Net(B$) Income(B$)	18.1	11.03	11.64	14.15	13.64
	Patents	991	976	1222	1041	1650
Microsoft	Revenue(B$)	60.42	57.55	62.48	69.94	73.7
	Net(B$) Income(B$)	**17.68**	**14.57**	**18.76**	**23.15**	**16.98**
	Patents	2026	**2901**	**3086**	**2311**	**2610**

A *new conceptual framework is* needed to strategically drive the creation of usable intellectual capital along with the coupling of strategic intent to create new and novel products rather than expend resources and talent on broadly defined protection patents, patents of dubious quality and product/process extension patents. Further, a new model of intellectual capital development and strategic choice is needed for top managers that matches strategy with intellectual capital management capability and that model is presented in this paper.

2. Literature review

Intellectual capital *has been used as a proxy for knowledge and as a proxy for tacit knowledge as well.* All of the definitions of intellectual capital imply that knowledge is both known to management and can be converted into value (Edvinsson and Sullivan, 1996) and is about knowledge and knowing capability of a social collectivity (Nahapiet and Ghoshal 1998), packaged useful knowledge (Stewart 1997), " and Intellectual capital= competence × commitment" (Ulrich 1998). From this notion that management knowledge can be converted into value the idea of an intellectual property strategy can be developed. From a definition standpoint, intellectual capital refers to the difference in value between tangible assets (physical and financial)

and market value and is sometimes referred to in financial terms are goodwill or human knowledge or capital. From a standpoint of research, the relationship of human knowledge's output is innovation. Amiri (2011) has developed a relationship between human capital, structural capital and relational capital on incremental innovation and radical innovation

While most researchers have looked at intellectual capital as a positive force, the ability of intellectual capital "in action" to develop as a destructive force is less recognized by researchers and managers. "This destructive intellectual property can often destroy income producing current products and leave companies scrambling to replace revenue and income" (Guiliani, 2013). It is not sufficient to have *knowledge assets, patents, or other marketable intellectual property.* In a knowledge creating company, managers have the responsibility to unleash that knowledge into value-creating actions aimed at customers and to generate and exploit that knowledge-either public or proprietary-more effectively than their competitors. Some managers have been known to short circuit the innovation process in the quest for immediate profits and from a lack of understanding of new technology and "big ideas" (Martin, 2010). Often ideas are killed at the incubation stage as simply a "lurking danger" (Martin, 2010). In addition, managers are also responsible to generate and exploit current firm knowledge better than their competitors and to use public knowledge better than their rivals (Von Grogh 2000). Von Krogh, Roos and Slocum (1994) suggest that there are essentially only two strategies used and that those two are 1) advancement and 2) survival.

The late Peter Drucker (1999) said that "knowledge has become the key economic resource and the dominant-and perhaps even the only-source of competitive advantage." The firm specific concept of intellectual capital was introduced in the early 1990s which connected the idea of a firm's knowledge to the concept of firm intellectual capital to address valuation of intangibles and to further explain the idea of value creation and its relationship to firm performance (Roos and Roos 1997) Since this time, researchers have attempted to understand how intellectual capital is generated at firms and what effect this intellectual capital has on firm performance. Understanding how intellectual capital can be converted into metrics/methodology and which methods produce the most valuable tacit knowledge has been presented in prior work (Harlow 2008). The key question is what are the "origins and nature of the firm's IC"? 'An Intellectual Capital-Based View of the Firm Competition' highlights the strategic role of different intangible assets such as tacit knowledge, relationships, customer relationships, internal working relationships with its stakeholders-both internal and external (Martín-de-Castro, et al, 2011).

A stated intellectual capital strategy for technology firms becomes more important as firms participate in more "turbulent" (Ansoff 1990) environments. Turbulent environments that are those where lack of visibility to the future and increasing complexity dictate a managerial climate of strong competence, high rewards and flexible risk taking. Incremental innovation uses the tried and true method of following the trend line for the product innovation and developing an improvement, not a breakthrough or new product or process. While this type of innovation is needed to increase product performance and efficiency of production, novel new products (as well as business areas) are left unfunded while the corporation slowly matures out of its industry. This is the strategy that appears from the research presented in this paper to have developed in patenting intellectual property of dubious value and without strong customer centric focus.

The first step is to understand the concepts of knowledge and intellectual capital and how these relate to how we see knowledge generation and more specifically tacit knowledge creation. Somech (1999) details how tacit knowledge is quantified in college freshmen and can be measured as the students gain more tacit knowledge as they progress to seniors. The term *practical intelligence* has been used as a proxy for tacit knowledge (Sternberg, 1997). Others have developed tools for measuring tacit knowledge as part of their work on quantifying managerial intelligence (Wagner and Sternberg 1992). Measuring tacit knowledge is also seen as "risky business" (Nonaka and Takeuchi 1995). O'Dell and Grayson (1998) detail ways that internal knowledge can be transferred using "best practices" that supports this paper's development of a theory. The Intellectual

Capital Services (IC Index), originally developed in Scandinavia and Australia by Johan and Göran Roos (1998), identifies four categories of intellectual capital: relationship, human, infrastructure and innovation; it then looks at the relative importance of each, and also at the impact of changes in intellectual capital. This is an important input to the conceptual model presented in this paper.

The development of organizational knowledge is crucial in developing the products and processes of the firm (Kogut and Zander, 1996; Teece, 1998). A Spanish study of professional firms' organizational knowledge systems explored the influence of the different forms of organizational knowledge (Intellectual Capital) on the innovation capability of these firms and indicated that intellectual capital factors to be considered are "Human Capital, Structural Capital, and Relational Capital". The role of customer relationships, as well as IT-based competences, alliances, and corporate reputation were also identified in this empirical research (de Castro et al, 2009). While overlapping constructs (reputation and goodwill for example) exist for many of these variables, the use of measurement and empirical research shows the importance of tacit knowledge to both operational efficiency and effectiveness. Other studies have identified Intellectual Capital (IC) as "a key strategic asset for organizational performance, and innovative solutions and its management is critical for the competitiveness of organizations" (Yitmen, 2011). Yitman's (2011) research analyzed the "relationships among intellectual capital, competitiveness, and innovation drivers in engineering design firms of the Turkish construction industry". The research details how "how firms can leverage their intellectual capital as the main competitive asset for innovative solutions to offer their clients".

Another aspect of innovation is that of the human capital talents and skills. Human capital has been defined by Adam Smith as "…of the acquired and useful abilities of all the inhabitants or members of the society. The acquisition of such talents, by the maintenance of the acquirer during his education, study, or apprenticeship, always costs a real expense, which is a capital fixed and realized, as it were, in his person. Those talents, as they make a part of his fortune, so do they likewise that of the society to which he belongs. The improved dexterity of a workman may be considered in the same light as a machine or instrument of trade which facilitates and abridges labor, and which, though it costs a certain expense, repays that expense with a profit." Human capital is essential in the development of innovative products and ideas.

A longitudinal study on biotechnology firms globally researched the effect of three kinds of human capital, 1) pure scientists, 2) bridging scientists, and 3) pure inventors on the two innovation variables of recombinatory innovation and pioneering innovation. The applied measure used to develop the study included patents, publication and financial data. Relationships were found significant to both types of intellectual capital development and innovation. (Subramanian, 2012)

Sofian (2011) reviews the effect of intellectual capital on the relationship between earnings and cost of equity in a literature review that demonstrates that "enhancement and improvement in quality of information pertained to relevance of earnings through recognition of intellectual capital lead to the reduction of information asymmetry (information risk), and concurrently increases the investor's willingness to invest by eventually leading to reduction in cost of equity". The conclusions indicate a possible relationship could be established between revenues and net income and the cost of equity to intellectual capital since it seems to offer a moderating influence on risk assessment by investors. While this study needs further empirical study (such as this paper), the relationship and direction seems clearer from the Sofian et al (2011) literature review. Intellectual Capital Management (ICM) and Knowledge Management (KM), two highly popular topics in current management discussions, are often bracketed together. The common understanding of ICM is that concepts of measurement, reporting and valuation most distinctively define this perspective, whereas KM connects debates about organizational knowledge with possibilities and limitations of management. That raises the question of how the management focus on knowledge in KM discussions is connected to the valuation and measurement approaches of ICM. An extensive review of the literature shows that knowledge plays a background role in Intellectual Capital (IC) measurement discussions. Referral to knowledge as an intangible

asset appears more rhetorical than based on in-depth understanding of what knowledge as an organizational resource or capability is or is not. More particularly, the predominant view of knowledge in IC measurement discussions is a neo-functionalist, possession approach, even if flow elements of knowledge are used to supplement stock elements. Critical understanding of knowledge, for instance, as practice-based dispute, are virtually absent from the ICM discussions. What the blind spots identified in the review highlight is that ICM and KM discussions, which are presently mostly developed in isolation, should set up more meaningful and elaborated liaisons than are currently established. Two important areas for building such liaisons include (1) the perusal of the contextual, possibly disputed and power-related nature of knowledge in relation to measurement and (2) developing a systematic approach to understanding what measuring or not measuring does to organizational knowledge (Hendriks & Sousa 2013).[

Knowledge Management Systems have been employed at many companies in an attempt to capture the tacit and explicit knowledge of the firm. A lack of empirical information on the effect of Knowledge Management Systems (KMS) that includes both tacit and explicit methods has meant that firms often choose technology solutions that are designed to capture and disseminate mostly explicit knowledge (Almeida and Kogut 1999). While these mostly explicit knowledge capturing systems offer the advantage of ready *usage* metrics, their actual contribution to effective knowledge management (KM)within the firm is less clear (Berman et al 2002). The degree of explicit codification- more manuals, patents or product plans *do not presage success at firms* and *does not indicate that the knowledge encoded is valuable or unique*. Firms may have extensive libraries of codified knowledge (patents) that is rarely accessed or is bypassed by unmapped tacit processes. This is another prior research that indicates a strong need for a new conceptualization of firm intellectual property development driven by people and processes.

Gaps in the current research reveal that there is only one study (Harlow 2008) that addresses the validation of which KM methods (either explicit or tacit or a combination of both) are more or less effective, and there has been little research that looks at the relationship of KMS to the firm's outcomes (Grant 1996). The Harlow (2008) study proposes an innovation strategy based on the use of knowledge management learning systems to promote measureable outcomes in innovation. Firms are able to develop a sustainable competitive advantage in KM by developing a mix of KM methods that complement and enable their core strategies (Hansen 2002). However, despite large investments in KM technology, many of the performance outcomes are not clear and the causal relationship between what works and what does not work has not been established empirically (Liebeskind 1996). This gap in the causality is another rationale for this research.

A firm's overall economic, strategic, and innovation performance is dependent on the degree to which the firm can use all of the knowledge created by the firm and turn this knowledge into value-creating activities (Krogh 1998). Tacit knowledge extraction, dissemination, and collaboration are difficult to effect (Markus 2001). Tacit knowledge may be best understood by the assertion that 'we know more than we can tell' (Polanyi 1966). This observation is quickly supported if people are asked to write out a certain process or workflow. Persons asked to explain how to drive a car cannot fully describe how to accomplish this common task of everyday life. Much of the process and workflow is contained in a mutual understanding of the work or process and it is not easily documented nor can it be easily communicated.

While tacit knowledge and explicit knowledge coexist in a continuum (or as a knowledge spiral) complementing each other, the explicit knowledge forms are more easily extracted and measured (Nonaka 1998). The measurement of tacit knowledge is less clear. Tacit knowledge can be part of the group collective knowledge (Spender 1996). This socio-cultural knowledge (Castillo 2002) drives the organization, but it is difficult to measure.

Insch, McIntyre and Dawley (2008) have developed a model for the measurement of *tacit knowledge*. **"**They present six (6) hypotheses that support their proposed academic outcomes tacit knowledge model regarding

the role of cognitive (self-motivation, self-organization); technical (individual task, institutional task); and social (task-related, general) skills" (Insch et al, 2008) All six of their hypotheses are supported in their research.

Value-creating capability resides in *the know-how or tacit knowledge* of the engineers, managers and marketing staff and this dynamic tacit knowledge capability creates sustainable competitive advantage (Teece 1998). These subject matter experts must be able to fit into an automated system that allows tacit knowledge dispersal and tacit knowledge use by both the experts and the rest of the firm's staff and depends to a large degree on the KM systems that are employed (Maybury et al, 2000). This is needed for both the firm's survival and advancement strategy (Von Krogh and Ichijo 2000).

Stehle et al (2011) analyzed the validity of the "value added intellectual coefficient (VAIC) method" as an indicator of intellectual capital. "The paper describes VAIC through its calculation formula and aims to establish what exactly it is that the method measures. It also looks in detail at how intellectual capital is understood in the method, and discusses its conceptual confusions. Furthermore, the paper tests the hypothesis according to which VAIC correlates with a company's stock market value, and reflects the contradictory results of earlier studies". The analyses show, first, that VAIC indicates the efficiency of the company's labor and capital investments, and has nothing to do with intellectual capital. Furthermore, the calculation method uses overlapping variables and has other serious validity problems. Second, the results do not lend support to the hypothesis that VAIC correlates with a company's stock market value. "The main reasons behind the lack of consistency in earlier VAIC results lie in the confusion of capitalized and cash flow entities in the calculation of structural capital and in the misuse of intellectual capital concepts. The analyses show that VAIC is an invalid measure of intellectual capital. The result is important since the method has been widely used in micro and macro level analyses, but this is the first time it has been put to rigorous scientific analysis".

It is apparent to anyone researching in this area that the idea of what tacit knowledge is a confusing and often divergent set of ideas. Many studies -Hennert (1992) Kim and Hwang (1992), Hansen(1992), Sveiby (1987), Sternberg (1993), Ruggles (1998) and Harlow (2008)-have demonstrated empirical approaches to quantify tacit knowledge and in the case of the Harlow study link empirically innovation to the tacit knowledge found in firms. This research forms a solid foundation to imply that measurement of tacit knowledge can be successful and also give the researcher a way to measure its effect on innovation.

Generic strategies of firms include several types. S*trategy types* have been proposed (Miles & Snow 1978) and empirically tested (Dess and Davis 1984). Key components of strategy types include scope of the business or domain, resource deployment in marketing or R&D, asset management or parsimony, degree of vertical integration, and so forth (Miles and Snow 1978). All of these strategies are driven by the use of firm-specific competencies gained through effective use of knowledge. Within these strategy types, goals such as new product and financial results are intertwined with the choice of innovation sub-strategies (i.e., first to market or follower).

Generic strategies are closely related to the Prahalad and Hamel core competence models because they target developing core competencies for cost leadership, differentiation, and market and product focus. Porter's (1998) discussion of sustainable competitive advantage relates sustainable competitive advantage as the ability to "outcompete" other businesses in the chosen industry. Empirical studies (Dess and Davis 1984) of these strategies have been made to determine the validity of these strategies. The results are that high profitability contains information on investment strategy, relative cost position*, technology leadership*, timing of market entry, *new product introduction*, product quality, marketing expenditures relative to competitors, characteristics of the market served and market environments, the nature of competition, barriers to market entry, and operating results and financial performance of each business. Each of these measures can be used as a proxy for effective use of Knowledge Management Systems (KMS).

3. The model

While Polyani (1965) is correct that we "know more than we can tell", his work reflects a time of early and first thoughts concerning tacit knowledge and intellectual capital. It is time to bring this concept up to present day standards and proceed to apply this concept more thoughtfully to business success by adding both qualitative and quantitative measures driven by a conscious company strategy of intellectual capital generation and intellectual property management capability.

A conceptual model is presented in this paper which guides top management at innovative technology companies in the development of intellectual capital which is not necessarily a derivative of past patent or product successes but which focuses corporate resources on the strategic direction and processes needed to increase the *intellectual capital* of the firm and the delivery of new products to customers. This new intellectual capital would be either patents or trade secrets and would represent a conscious strategy of offensive intellectual capital creation rather than the defensive strategies apparent by the company patent usage research presented earlier in this paper.

The model is straightforward and uses the idea that intellectual capital strategy drives firm processes which are dependent on management capability. This ultimately drives firm objectives (Ansoff 1990). Those end point objectives are measureable and include measures such as patents or copyrights as well as other market performance measurements. The following model (Ansoff, 1990) starts with an identification of which strategy to pursue and uses the following scaled input factors. Intellectual capital aggressiveness indicates a firm that uses all of the following *strategic parameters* to create a cohesive intellectual capital strategy illustrated in the first element of the model:

- Future Competitive Positioning(FCP)
- Product Dynamics
- Positioning Dynamics
- R&D Investment
- Technology Dynamics
- Competitive Dynamics
- Environmental Turbulence
- Aggressiveness of firm's strategy

Future Competitive Positioning refers to the future predicted leadership/follower position relative to the research product and process that the firms employ. FCP is a market assessment parameter that can be determined based on the (1) level of strategic investment planned, (2) the assessment of competitors' future competitive position and (3) a prediction of future competitive capability needed by the firm. This is an essential element of the model since it contains strategic objectives and goals. Ansoff (1990) refers to this assessment as intensity of the factor and focuses the intellectual property importance of each project, any strategic gaps and priorities for product and process development.

Product Dynamics refer to the frequency of new products, length of product life cycle and successive technology product advancements. Markets whose products exhibit a steep S curve would necessitate faster and higher frequency of new products as well as exhibit more frequent product obsolescence from disruptive new products. Again, a measure of the intensity of this assessment's importance to future success, strategic gaps and priorities for product and process development is applied.

R&D investment is measured as a percentage of the firm's sales invested in R&D, with a breakdown by R as a percentage of profits and D as a percentage of profits. This allows for strategic assessment of whether or not products are coming out of both R&D functions at a competitive rate. This strategic factor can be measured against industry R&D spending patterns as well as against key competitors R&D spending. A measure of the intensity of this assessment's is important to predict future success, assess strategic gaps and set priorities for product and process development.

Technology Dynamics is defined as the length of the product life cycle, frequency of new technologies and the number of competing technologies. This factor is closely coupled with product dynamics and the product life cycle is a product of the technological turbulence (as measured by frequency and disruptiveness of successive technology stages) and the capability of the organization to strategically manage each new technology effectively. Some markets and technologies exhibit very different modes with each successive iteration of technology. An example of competing technologies would be computer data storage as its technology moved from large tape systems through portable disc drives and now to a RAM memory model for many applications. At each stage competing technologies were forwarded but dominant technologies won out.

Competitive Dynamics is a market parameter that includes technological product differentiation, technology as a competitive tool, competitive intensity and rivalry between firms, forced product obsolescence, technological response to government regulations and technological response to consumer pressures. Technological product differentiation occurs when products are compared by ultimate users and can be assessed as to better performing and perhaps less expensive and easier to use. Technology as a competitive tool can occur at both product and process level and results in both acknowledged and hidden technology that confers a completive advantage to the firm. Forced product obsolescence occurs when manufacturers either force new purchases by end users by limiting the product life or by introducing new incompatible technology to the market. Both strategies result in higher sales due to conversion to the new product. Competitive intensity and rivalry occurs when each competitor in a highly competitive market copies each competitive move of their most important competitor. Markets with limited growth and declining markets exhibit high competitive rivalry. Technological response to government standards involves each competitor attempting to exact excess rents by having their product chosen as the one technology solution or as the recommended solution to a government initiative. Sometimes customers exert pressure to gain the advantage of new technology by requiring "green" initiatives such as mileage regulations or GPS availability.

An overall measure of the firm's strategic aggressiveness coupled with an assessment of the environmental turbulence of the market completes the technological strategic factor analysis (Ansoff, 1990). Strategic aggressiveness is the degree of discontinuity between successive strategy implementations such as from a follower to an innovator to a disruptor strategy. Environmental turbulence is defined by Ansoff (1990) as a continuum of levels from 1 to 5 with increasing turbulence as you proceed from repetitive (scaled as a 1) business environments to discontinuous (4) or surprising environments and most turbulent non-linear environments(5). Turbulence is also determined and measured as to your firm's ability to predict and assess the future coupled with the future complexity of the environment. An assessment of these factors leads to a clearer understanding of the current strategy as well as any *"chasms'* that exist that must be addressed by your strategic plans. While an overall picture of the technological strategic factors can be used to measure the intensity of the five factors presented the forward looking strategy is a combination of assessment of these factors and the strategic chasms.

Strategic chasm assessment is crucial in the model as this assessment determines what is missing from your technology strategic posture. The "chasm "may be technology capability, management capability or a lack of strategic marketing aggressiveness but of these the most important to intellectual property is management technological capability chasms arising from 1) Lack of Information, 2) Semantic and 3) objectives/ values (Ansoff, 1992). Managers often are "out of the loop" when it comes to technology. They often do not get the

vital, vague and crucial information needed to understand and make good R&D decisions. Their focus may be on production, not R&D, and they also may be technophobic when it comes to new technology. Engineers and managers speak a different language when it comes to technology. While R&D managers are discussing with great excitement the new breakthrough in basic science from the laboratory, managers are more often thinking about returns and products. This language chasm often may make it difficult for business managers to understand what this new breakthrough solves for a customer. This leads to the third chasm in perception about basic values. A manager is concerned with profitability and the uniqueness or technological advance of the breakthrough is reason enough for the technologist to bring the new breakthrough to market.

An assessment of the five technological strategic factors combined with the chasm analysis leads through the first element of my model.

The second major element of my model is the *Intellectual Knowledge and Management Capability* (Harlow, 2008). This part of the model is based on the work of Harlow (2008) and others indicating that tacit knowledge (knowhow) can be developed and a measure applied to that parameter and let managers know how capable (tacit knowledge management capability) their firms are toward the meeting the strategic objectives of the firm. Managers who exhibit this tacit knowledge management capability are skilled and highly rated on the tacit knowledge management scale by both degree of methods usage and span of methods. They are uniquely qualified in using methods to extract, retain and develop tacit knowledge using knowledge management techniques such as experting, collaboration and working on teams.

People and processes support this layer of the model and enhance the intellectual capital and management capability enhancing parts of the model. The organizational processes include the culture of the firms and enhancement of a knowledge creating environment with proper rewards for managers (climate), capacity and managerial slack to apply to new ideas and technologies and a tilt toward highly competent managerial measures such as tacit knowledge and new products launched rather than only a focus on the technology aspects of new products. Technical competence is essential in bringing new technology products to market. While managers may have been able to manage in the production-oriented and marketing-oriented business environments of the past, the new frontier of successful products requires more technical knowledge and often an ability to speak the lingua franca of the R&D function as well as the business knowledge. These new breed managers constantly work effectively between both the technical world of wonderment and the hard decision world of product launches. Knowledge management and sharing knowledge and creating social capital within the organization are crucial to development of this Intellectual Capability (IC). Also essential to development of this intellectual capital capability are the human capital and the social capital generated by organizational processes and support functions such as human resources.

The human capital may be the most important element in generating intellectual capital at high technology companies. While large centralized R&D functions are being replaced by smaller R&D facilities with R&D working closely with product managers, the essential ingredient are the chosen few with the technical brilliance, serendipity enhancing communication skills and persistence to develop breakthroughs that result in large scale customer adoption of these new products/ideas.

Firms that enhance the climate of the workplace by allowing R&D engineers to work on their own projects while rewarding those who succeed at a level that indicates their value to the company have an inside track on developing the outputs of this model. Social capital in this paper is the collaborative efforts that skilled technologists and managers will expend in developing new ideas for the firm. At its basic it is a form of consensus whereby all of the firm's actors have a stake and interest in an outcome and are willing to expend organizational relationship resources and effort toward common goals. The social capital enhancement can take many forms from recognition by the company to access to funds to keep credentials and training current. Human capital is the skills and capabilities of the organization to do the actions required to meet a goal or create a product or idea.

The Outputs from the IC development model include new products, patents, trademarks, copyrights, trade secrets, as well as more effective marketing due to market knowledge from customers and meeting new customer needs. These outputs represent the final part of this model and are depicted in **Figure 1** below:

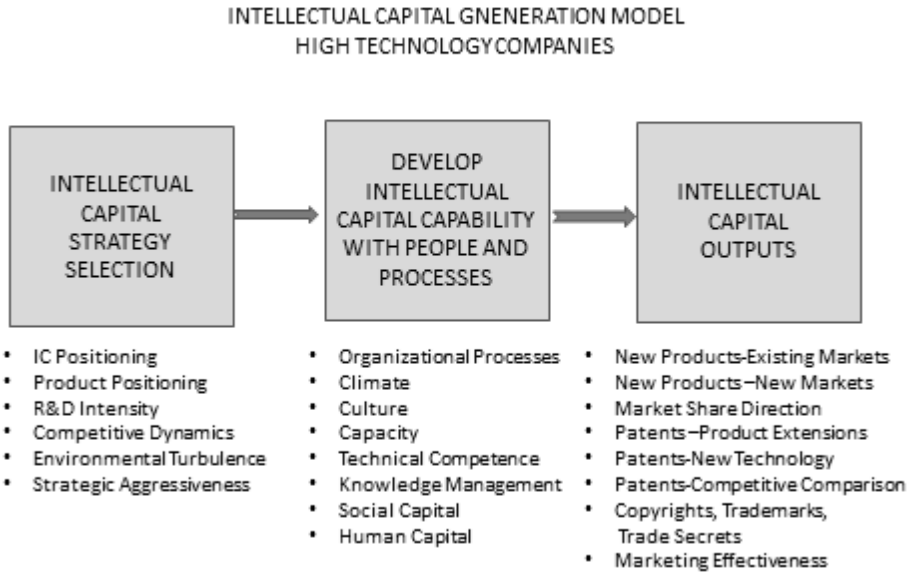

Figure 1: The model of intellectual capital development

The identification of what is intellectual capital coupled with applicable metrics and the model developed enables firms to create a platform for intellectual capital generation that starts with the strategy, is enabled by knowledge creating and capability enhancing processes and ends with measureable outputs. The model takes intellectual capital out of the realm of unknown phenomena into that of scientific inquiry. My model has immediate use for practicing managers to integrate their technology strategy, knowledge management methods and performance outputs in a logical and both qualitative and quantitative way.

4. Conclusion

While the aforementioned "questions" are open to discussion in the realm of "knowledge" research, there can be little doubt that some method of identifying tacit ways of knowing is necessary. In addition, the combination of both ways of identifying tacit knowledge with a methodology to measure through manager's ratings is a giant step forward in the intellectual capital generation of tacit knowledge toward a more scientific approach to measuring firm intellectual capital and tacit knowledge.

The prior research in the intellectual capital and knowledge management field of study can be summed up as concentrating on the processes that produce outputs such as patents and new products and processes. While this is descriptive for understanding the concept's impact on business it is not sufficient to understand what intellectual capital and knowledge *creation* is and what it is not.

What is intellectual capital? According to Roos (2006) intellectual capital is "an extension of strategic innovation, an integrated part of any business model thinking and an extension of the resource and competence based views of the firm". Roos (2006) also describes intellectual capital as a process of transforming assets of the firm using financial, competence, physical, organizational and relational assets into

intellectual capital. These assets are a matrix which enables the firm to alter the intellectual property creating paths to create a different business model or intellectual capital output.

My conceptual model builds on Roos (2006) and his idea that paths can be created for intellectual capital output (IC) and can be measured and intellectual capital increased by managers stating their innovation and intellectual capital strategy as part of their firm's innovation strategy (prospector /innovator, analyzer/follower, defender/ imitator). Employing knowledge management capability methods that identify the novel and new for the company while measuring their effect on the firm's innovation metrics results in a more complete understanding of why R&D is focusing on particular research agendas. Firms may find that increasing their knowledge management capability leads to more trade secrets and process improvements and less need for expensive and unproductive R&D where the chance of success in the marketplace is often 10% or less.

The research implications for this model are that changes in IC inputs and IC capabilities can be measured and specific methods related to the most gain for the investment made. A new strategy for knowledge creation would be accompanied by a change in intervening processes using the tacit knowledge measured changes as a proxy for the intellectual capital generated as well as a new set of outputs. The research using this model could be targeted toward technology companies to identify whether or not the chosen knowledge generation strategy is having the intended effect and what changes need to be made to processes and people that would yield the desired outputs. Preliminary results from this research show poor relationships between several major firms' patent filings and performance. Further research is planned to expand the sample of firms and develop an analysis of the performance of these firms using the topology presented in this article's introduction. New product and disruptive technology patents are a low percentage of all patents filed by the four companies studied. The relationship of patent filings to firm performance is mixed and needs more study.

Further research to advance this preliminary research that uses this model to explore the model's *prevalence* in technology companies is planned using a four-step process of 1) determining which patents are less or more useful toward the development of new products to see which firms are creating *useable* intellectual property and 2) assessing the strategic intent of the firm and 3) determining the strategic management capability of the firm and 4) assessing the use of people and processes that drive the creation of those strategic intellectual outputs.

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