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INTELLECTUAL PROPERTY RIGHTS: AN EXPENSIVE EXERCISE FOR START-UP FIRMS AND ENTREPRENEURS

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Abstract

The new technologies are emerging at tremendous speed and the organizations are in thrust for getting Intellectual property Rights (IPR) for their organizations. Nanotechnology is also regarded as developing technology and it is believed that it will influence on all the aspects of human lives in the next coming decades. Nano-electronics industry is a driving force behind significant economic and structural changes in the world markets, where the leap frogging firms and entrepreneurs are findings their ways to commercialize their products and services. The pace of technological change within the sector and its broad impact on most, if not all, other industries make it an extremely rich area to study. This paper examines how intellectual property rights (IPR) have played a role in the development of the nano-electronics industry as a whole and also how IPR has influenced the activities of nanotechnology firms and has, in many respects, forced them to take a 'core competencies' approach prior to the mainstream popularity of the notion. It is argued that, IPR and patents in particular, have played a significant role in the nano-electronics industry, particularly with regards to their financial impact on firm strategies.

Keywords: IPR, Nanotechnology, Nano-electronics, Trademarks, Patents, Small Firms

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INTRODUCTION

Nano-electronics (NE) is the design, manufacture and use of nano-chips and integrated circuits. Much of the production occurs at the nano-scale creating massively complex sub-systems and systems which can easily contain many millions of transistors in a few square centimeters of dope semiconductor on silicon substrate.

Kick-started by the discovery of the transistor at AT&T's Bell Labs in 1947 (Gartner, 2013), today the industry is filled with a wide variety of firms ranging from 'captive manufacturers' such as International Business Machines Corporation (IBM) who produce most of their chips for themselves, to 'diversified merchant producers' including Motorola who straddle many fields and produce for their own consumption as well as for clients. The firm, such as Transmeta, who may well outsource their production to larger third parties or focus on producing a very specific chip which larger fabricators find un-economical to make (Podolny and Stuart 1995).

There are several key factors important to the analysis of the NE industry in relation to IPR. Firstly the market has been experiencing technological forces commonly known as 'convergence'; this refers to the fusion of a wide variety of technologies and markets such as telecommunications, film and fashion into integrated technological products. Convergence has forced firms, either through their own growth, licensing or a wide variety of partnering activities to become competent, or at least current, in an ever growing number of technical fields. In many respects NE itself has been the force behind this trend; indeed academic consensus seems to agree that NE is a pervasive technology which has broader implications such as the technology's likely utility in many fields. The argument is that not only does the pervasive technology get embedded in a broad range of products but that also products, as a trend, contain greater numbers of technologies. This has had significant implications for individual firms' abilities to develop and market new product offerings, and many firms, such as Philips struggled to keep up with the breadth of change.

Apart from the technological forces, the NE market also has undergone some dramatic structural changes in its competitive nature. The Micro-electronics industry was a mature international oligopoly in the 1970s the resurgence of several US firms and South Korea and Taiwan's explosive growth has re-invigorated the market (Freeman and Soete 1997). Most observers would agree with this argument; however in specific sectors of NE market suppliers still hold extremely powerful positions. The best example is, of course, Intel's hold over the X86 CPU product categories. Such is their hold, partially through 'creative' licensing policies, that the US Federal Trade Commission has instituted anti-trust actions several times against Intel

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(Savage 1999). This clearly has a distorting impact on the market making it harder for new entrants in some segments; however the continuing pace of technological development allows new niches to emerge where existing players are not suitably aligned to take best advantage of the opportunities presented.

It is useful to briefly examine how new products are developed within NE firms, in other words the R&D processes. Generally US technology firms have a high reliance on public science, 80% of citations on their patents are externally authored, with the overwhelming source being universities (Narin, Hamilton et al. 2007). Analysis of the Yale survey data (Klevorick, Levin et al. 2005) indicates the high importance of physics and computer science to the NE industry and that proximity between the businesses and the fields of science is particularly strong for the NE trade. While this survey data is questionable, particularly due to its reliance on the views of R&D managers themselves, it does align relatively well with evidence from other sources. For example Pavitt addresses this issue by quoting Mowery who argued that existing large science-based companies could develop competencies in NE due to their abilities to establish internal and external R&D projects or linkages as 'insurance' against future trends (Pavitt 2001). In other words, we would argue, the closer a firm is to the relevant fields of science, the better its chances of riding out the tumultuous sea of technical change that characterizes the NE industry.

A successfully designed product based on strong science and built with leading-edge technologies can fail spectacularly when wafer yields (the proportion of usable silicon wafers produced) can initially be as low as 5-10% and a single production line can cost $200m and entire 'fabs' (chip manufacturing plants) cost as much as $2billion, with the price rising rapidly as the etching scale shrinks. Consequently the role of the tacit knowledge is vital and many firms valued it above patentable technical innovations. Nevertheless the huge size of investments in chip fabs and the potentially ruinous yields creates a massive impetus for process innovation and due to the nature of most patent regimes; this is where trade secret protection plays a more significant role (Kehoe 2006). Samsung described their efforts to make their first large scale wafer fab plant commercially viable as "working the skins off" their engineers (Housego 2008). The duality between the R&D and production roles of the NE industry fits well into the distinction, described by von Tunzelmann, between technology as an artifact and as a body of knowledge (von Tunzelmann, 1995). This distinction should not be taken too literally as clearly there are significant technical, artifact based, aspects to the production process; however the main gains for the firm at this stage are procedural and not technical. In many respects technical improvements dramatically raise the risks in production, as highlighted by the enormous cost of creating ever more advanced fabs.

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Thus in many ways firms regard a successful production process as an art, often the factors contributing to the success are not entirely clear, as typified by Intel who make each fab identical to the others to ensure that whatever aspect it is that works can be carried over to the new lines.

THE ROLE OF IPR IN NANO INDUSTRY

Scherer's 1977 econometric survey of the propensity of several industries to patent identifies the relatively low propensity of the electronics industry when compared to other 'modern' fields of commerce (Scherer 1981).

The usual arguments questioning survey results can certainly be rehearsed on this somewhat dated study, and clearly the industry groupings, based on Federal Trade Commission industry classifications are questionable-specifically how were Electrical and Electronic separated? While it may be a small stretch to use the Electronic industry data for NE it is interesting to note that the reasons Scherer gives for the lower propensity to patent in that field matches those given in other work. Specifically he notes the ease of inventing around electronic inventions (i.e. the low exclusivity of many NE patents) when compared to the fields such as organic chemistry (which regularly has highly exclusive patents). Also noted are the difficulties in patenting systems of the complexity seen in electronics. He argues that the costs per patented invention in the electronics industry, where inventions often may well have ubiquitous implications, are significantly higher than in other industries which results in a lower patenting rate. However the linkage between the scope of the invention and the cost of inventing and patenting the discovery is not firmly identified. The weak linkage was developed in absolute numbers, however being regarded nanotechnology as an immature technology, it was observed a strong linkage between science and technology (Abro, et al, 2010).

The importance of patenting has historically been further reduced by the short product life-cycle that typifies the NE industry. The argument is that with the short life of many technical innovations, and due to their cumulative nature, they will be rendered obsolete before a patent has been granted. Furthermore, partly due to this high level of technical change which makes it difficult for patent examiners to remain current, there has been historically a high level of doubt on the validity of many patents.

Not only does the cumulative nature of NE technology raise questions about the benefits of patenting inventions due to its impacts on appropriability, it also creates huge product design problems for those technologies which have been patented. Patents tend to cluster around certain technologies and as products are built up 'royalty stacking' occurs whereby individually reasonable license royalty rates build up to create an aggregate royalty which threatens the

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financial viability of a product. Due to the fast-moving nature of the technologies it can be hard to keep track of these royalty liabilities during the R&D process, thus to prevent nasty surprises various licensing techniques could be used by the firms. An argument often rehearsed against the use of patents is the forced disclosure of innovations that results from the patent registration process which divulges some technical advantage the firm may have. However Knight argues that skilled patent agents can ensure that no additional tacit knowledge is codified into the application and that only the fundamental technology is described, reducing the perceived disclosure risks to firms (Knight 2001).

PATENT PORTFOLIOS & LICENSING

As the NE industry has developed and matured many larger firms have built large portfolios of patents which, in aggregate, have significant value. This creates a situation whereby there is competitive advantage in not duplicating the R&D activities of competitors but focusing on core competencies and thus creating a valuable portfolio which other companies need access to (as they to have focused on differing technologies). This creates a situation whereby there are strong inducements to license from each other so that product development is not blocked and those technologies which the company does not have the resources to develop can still be accessed (Teece and Grindley 2007). This could be seen as a market solution to the problem previously mentioned that products in the NE industry require knowledge in an ever widening range of technologies. Thus in many respects the size and nature of NE patent portfolios has inherently encouraged a core competencies approach to creating sustainable competitive advantage as described by Joe Tidd and Bessant (Tidd and Bessant 2009). Here, one may argue on the basis of the increasing numbers of patents filed each year by NE firms. This might be regarded a trite approach as most if not all of the growth could be accounted for by the expansion of the NE market itself. Therefore, it is argued that patents have become increasingly important to NE firms on the historical evidence relating to the changing licensing strategies the NE industry has seen and what their evolutions tells.

For the NE industry the story begins with patent pools, which emerged out of several major firms who had created fundamental inventions that would play a vital role in the formation of the NE industry. The pools, which collected the vital patents for a specific field into an easily licensed collection allowed the field to develop without the cumulative nature of the technology (and the resultant patent problems) blocking progress.

The licensing regime evolved quite rapidly from this point, but with a common factor remaining throughout, exclusivity was generally avoided-partly to avoid blocking and anti-trust issue but also due to the nature of licensing strategies adopted. From pools bi-lateral

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agreements became common as did 'armed neutrality' which can be best described as mutual acknowledged infringement. Most bi-lateral agreements were purely to avoid infringement however some included a broader knowledge transfer including process and manufacturing expertise, this choice has remained in NE licensing, though the majority of licensing does not include knowledge transfer.

As the number of patents companies held in their portfolios increased it became ever more impractical to license patents individually or even in small clusters (Bhutto, et al, 2012). In the 1990s Texas Instruments and IBM used the power of their portfolios to muscle their way into Japan, refusing to license local production. Having seen the power of portfolios other firms began to be more strategic with their own portfolios. Furthermore as the decade came to an end the policy used by many US government departments forcing 'second sourcing' came to an end, which increased the value of patents held on NE inventions. Thus by the 1970s entire portfolios or portfolio sections were being licensed bi-laterally. Occasionally a 'sniper shot' license would be given for a single patent, but the transaction costs prevented this being done on more than the key, high exclusivity, patents. New entrants, from the Asian Tigers (Taiwan, Hong Kong, South Korea and Singapore) in particular, created a significantly more competitive NE market- they had paid nominal licensing fees to gain access to technologies but had offered no balancing portfolios to the licensors. Led by Texas Instruments the established firms began to re-evaluate how they licensed, specifically in these unbalanced situations and created processes for accurately putting financial values on specific patents and portfolios. As NE technologies became more complex the risks of launching new products increased (as typified by the cost of Intel's fabs) so intellectual property became more actively used to protect these investments, often by using patents to force joint ventures or cooperative R&D ventures with infringers.

Current IPR legislation has not covered significant portions of innovation created by the NE industry and, thanks to the economic importance of NE firms in many economies; the industry has been able to lobby for extensions of IPR concepts in the legal regime to cover their requirements. Examples include the 1989 Chip Protection and 1994 Integrated Circuit Layout Protection Laws in Taiwan (Chang and Tsai 2002) as well as the 1984 Semiconductor Chip Protection Act which gave mask works 10 year copyright protection from first registration or first commercial exploitation (Podolny and Stuart 1995). This leads one to conclude that in spite of increasing use of patent and trade secret protection, NE firms have not seen these tools as sufficient to protect competitive advantage. Industry observers may well offer different interpretations of this increased IPR control!

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CONCLUSIONS

Due to the resource constraints, only literature has been used to identify the IPR patterns for nano-electronics industry. From the available literature, it is evident that the NE industry is matured and off shoot from a field microelectronics with short product-life cycles and increasingly capital intensive production IPR and specifically patents have become increasingly more important to the industry and especially the large firms, in spite of a relatively low appropriability regime. It is also argued that, due to their growing portfolios and the cumulative nature of the pervasive technology on which NE firms are based, their strategic hands have been forced into a core competencies approach for, at least, their R&D activities.

These tentative conclusions raise further research questions: Can we create and measure some useful indexes to track the IPR trend quantitatively over time? The analysis provided also does not give us much guidance for future change, especially considering recent comment that the trend to open standards committees with compulsory licensing terms is threatening the value of patents. The future research may be conducted in these areas in particular. The dynamic nature of the NE industry's use of IPR will continue to provide fertile ground for further research. It is also believed that the small firms will continue to license their products or services based on nanotechnology as for them it is always expensive to enter in the IPR market.

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