1. INTRODUCTION

Précis

> All too frequently technology sales are the part-time responsibility of top management. The marketing of a technology during all the stages of its [technology life cycle] requires specialized decisions usually beyond the expertise of top corporate managers as well as conventional product marketers. Our research suggests that this marketing function be separated both from a company's overall strategic planners and from its regular marketing staff. Only after the specialists have carried out detailed analyses of a technology and its potential markets should their work be integrated with that of general strategic planners. (Ford and Ryan, 1996 : 117.)

The volume, sophistication and complexity of technology are ever-increasing while it is already omnipresent, influencing the lives of everybody. It can metaphorically be regarded as the key that will unlock the door to a prosperous future for those who employ it correctly. But it threatens disaster to those who ignore it or try to ignore it. It is a key strategic resource and should be properly strategically managed and the management should include its innovative creation and appropriation; and acquisition and disposition, also on the technology market.

The acquisition and disposition of technology, whether by outright sale or purchase or by licensing its application, are indeed special, the results of a complicated underlying process; and of strategic import. Aspects of this multi-functional, multi-disciplinary field have received the attention of several scholars. Surveys have been conducted to establish its morphology in national and international contexts, mostly in developed countries. Its function within strategic technology management has been studied. Proposals have been put forward regarding improved organisational forms and staffing.

However no comprehensive and systematic information about its morphology and function in South African context was available. Neither, in general, had deserved attention been given to its dynamics. This research set out to redress the deficiency regarding South Africa and to explore the notion that manufacturing companies can deliberately organise some organisational characteristics to optimise, reduce or increase licensing activity.

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Background and overview of licensing environment

The already vast and varied body of technology in the world is being expanded at an ever increasing rate under ever more competitive conditions. A regular quantitative pattern resulted in 1964 in "Moore's Law" concerning the annual doubling of the number of components on microchips. In three decades the doubling time of computer power per US dollar has fallen from two years to one year. (Pretoria News, 1 September 1998: Itechnology supplement: p5.) In semiconductor engineering it is estimated that the half-life of a newly minted Ph.D. is about seven years. (Maidique and Hayes, 1996 : 24.)

The cost of generating technology is escalating, placing various development and exploitation pressures on organisations. It took Motorola 15 years and $150m to bring cellular telephones to market. (Lynn, Morone, Paulson, 1996: 371.) At the same time however, product prices can drop significantly. The price of a 4-function calculator was $250 in 1972 and $10 a few years later. (Roger, 1983: 214.) Recoupment of the development cost of an electro-mechanical Siemens telephone switch required capture of about half the German market in the 1960s. By the 1980s recoupment of the cost of newer generation digital switches needed the whole German market plus a good portion of the broader European market. The next generation of switches may require capture of a 20% share of the global market to break even. (Prahalad and Hamel, 1994: 272.)

Increasing complexity, lengthening development times, shortening product lines, and the need to contain cost characterise industry and the markets. These are forcing specialisation in development, in industrialisation, in production and also rapid expansion of flexible domestic and international logistic supply arrangements. Specialisation can lead to increasing isolation, or a debilitating formation of islands of expertise. Cross-fertilisation among companies, industries and functions should be managed properly and stimulated to maximise returns. In the extreme a company can find itself with no technology, as three writers warned:

> The trend in international business towards what Miles and Snow call dynamic networks - characterized by vertical disintegration and contracting - ought thus to be viewed with concern. (*Business Week*, March

> 3, 1986 has referred to the same phenomenon as the Hollow Corporation.) Dynamic networks may not so much reflect innovative organizational forms, but the dissembly of the modern corporation because of deterioration in national capacities, manufacturing in particular, which are complementary to technological innovation. Dynamic networks may therefore signal not so much the rejuvenation of American enterprise, but its piecemeal demise. (Teece, 1996: 249.)

Technology impacts everybody, be they generators or users thereof, including the young and old, the small and large, natural and legal persons, governments, universities and technicons.

In industry, every company creates and applies technology, whether manufacturer or service provider, large or small. The technology can originate from various sources and be applied in many places and ways. Although not all companies will have a formal approach or view their technology origination activities as research and development, perhaps preferring a more modest description, most of them are indulging in renewal activities resulting in new methods and products. Likewise, whether or not they prefer to be, they are exposed to and dependent on the application of technology from elsewhere. The literature abounds with chronicles concerning the rise and fall of major and minor companies and in most cases the root causes include the correct or lackadaisical management of technology, new or old. Companies are immersed in technology and it is incumbent upon them to structure themselves organisationally and operationally to manage any technology, defensively or aggressively as the case may be, to optimum effect to attain their broader goal of creating wealth.

An industrial company functions within an environment and is surrounded by and interacts with many, ever-changing, structures, forces and influences including a technology market. Technology is simultaneously a result and a determinant of these and of a company's own actions. A company therefore has to understand its encompassing as well as its technology environment to plan its competitive strategy including its own technology strategy which can be visualised as interposed between the company and its technology sources and market. Overall alignment of the company's goals and actions with its macro or external and micro or transactional environments is a prerequisite.

Innovation by companies, *i.e.* renewal of themselves, is essential for their prosperity and indeed, their survival in the modern world. Their innovation must certainly include but must not be limited to innovative technology in the perhaps general sense that new products,

service and production technology should be found and applied. Their renewal must also encompass the innovative application in and acquisition from the technology market of such technology - innovative technology should be traded with innovative managerial technology for many reasons which can be conveniently grouped as strategic, operational and financial.

The acquisition and disposition of technology and its intentional or unintentional diffusion from and to several diverse sources and applications form an important subset of technology management. It involves many methods, traditional or innovative, that are available to companies to acquire, use and divest technology, including employment and separation of people, developing it and selling or buying or licensing it in an organised manner. Several industry leaders have realised this and are actively involved in amongst others systematic processes of identification and transfer of technology between the various sources and markets and themselves. Unfortunately, many have failed or are failing to do this, to their detriment and even at their peril.

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Licensing inwards as well as outwards assumes an important role in the management of technology acquisition and disposition. The President of the Engineering Association of South Africa has described as a great tragedy the foreign payments South Africa makes for royalties and licence agreements. He stated that it was high time that South African firms realised that they should be owning their own intellectual property. (Financial Mail, March 8 2002, p29.) The South African Reserve Bank does not publish details but annual royalty payments of all kinds have been estimated at up to R $2{,}5 \times 10^9$ per year. This is implicit support for Ford and Ryan's call to put management mechanisms in place and into operation deliberately to achieve success through selling and buying technology and licensing-in and licensing-out technology. (Précis, p1.)

Not only are excessive outflows of funds undesirable. Of even greater and strategic import is that national economies of "technology colonies" (De Wet, 2001) such as South Africa are at risk to reductions and other changes in their markets in the developed world. Consequently there is a compelling need for "technology colonies" to diminish their "colonial" status which is characterised by predominant industrial activity at the manufacturing and trading end of the business cycle, limited research, large flow of technology from the developed world to them,

and severely limited flow of technology from the local research and development community. Proposed strategies include backward integration, beneficiation, solving local problems, clustering and establishment of businesses altogether novel to the colony. De Wet suggests that awareness and development of these will be advanced by reorienting engineering education, adapting the functions of scientific institutions and focussing the National Systems of Innovation.

A national system of innovation for South Africa was first proposed in 1996 in the Government's Department of Arts, Culture, Science and Technology's White Paper on Science and Technology, subtitled *Preparing for the 21st Century*. In this policy instrument, which followed on widespread consultations and intensive discussions of the prior green paper, reference was made to plans to improve South Africa's intellectual property protection system and to bring it more in line with those of other countries, while it clearly recognised other shortcomings regarding the use and acquisition of technology. (1996: 24 and 36, 37, underscore added.)

> The capacity of firms to innovate is to some extent determined by both horizontal and vertical linkages between firms. For instance, the differentiation of a product line is often informed and driven by customer feedback, whereas close co-operation with suppliers may well result in economies of production…….
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> The DTI [Department of Trade and Industry] is currently involved in several studies which are designed to result in concrete and sector-specific measures to enhance inter-firm linkages.
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> Efforts to support SMMEs [Small, Medium and Micro enterprises] around the world have led to programmes responding to five generic needs of those enterprises. These are:
> access to finance;
> access to markets and market information;
> improved management;
> skills upgrading for members of the work-force;
> best-practice technology.
>
> … to date, most of the attention has been focused on the first four needs listed above. The time has now arrived to put significantly increased emphasis on addressing the technological needs of SMMEs.

The Director of The Institute for Technological Innovation of the University of Pretoria commented that the proposed National System of Innovation was a step in the right direction

on the national level, but pointed out that the time had come to implement the management of technology at company level in a formal way. (Pistorius, 1996: 1.) Both the need for information on innovation practices and government's serious intent with the System were illustrated when, also in 1996, the first national Survey of Innovation in South Africa was carried out to gather insights into South African practices. This proved both worthwhile and lacking in some respects and was followed by a second national survey covering the period 1998 – 2000.

While innovation in its widest sense is generally recognised as an important generator of new technology, licensing can be viewed as one of its important concomitant or inherent instruments, generally operating at company level. This and the general importance of licensing are evident from various studies and surveys in and regarding various parts of the world. Several authors have paid attention to the role of licensing. Ford (1988) clearly identifies its position and role in technology acquisition and exploitation. Kim (1997) proposes strategic management perspectives to suppliers and recipients of technology further to his contention that transfer cannot be stopped. Roberts and Berry (1985) position it regarding the selection of strategies to enter new business. Tidd, Bessant and Pavitt (1997) discuss collaboration in the development of new technologies, products and processes including technology transfer and the role of licensing is clearly discernible. Likewise types of licenses such as horizontal and vertical (Barton, Dellenbach and Kuruk, 1988) and exclusivity and the content of licenses (Ishii and Fujino, 1994; Degnan and Horton, 1997; Contractor 1981) have been examined and discussed.

Various useful initiatives concerning licensing have over the years been launched in South Africa to meet expressed and sensed needs. These include lectures by the South African chapter of the Licensing Executives Society, those of universities, the Intellectual Property Institute, *ad hoc* published articles and various initiatives by the Council for Scientific and Industrial Research which also included the founding of the South African Inventions Development Corporation as far back as 1962. The seeming continuing need for information and education was again demonstrated by a recent action to improve the situation through the formation of the Southern African Research and Innovation Management Association (SARIMA) whose expressed main aim would be to move knowledge and inventions from the laboratories which absorb about $R1x10^9$ in government research funding per year into the

market, by educating and training researchers in all aspects of research and intellectual property management. (Financial Mail, ibid.)

Lack of information and directed study

Licensing is an important element of the management of acquisition and disposition of technology, also during the process of innovation. It should itself be managed properly to avoid harmful consequences and to maximise advantages, at company as well as national level. To be able to do so requires insight which in turn requires facts and an understanding gained from the study of these and their import.

- It has become apparent, through personal experience and the seeming scarcity of learned and comprehensive writing on the subject, that the morphology and function of the multi-functional, multi-disciplinary field of licensing has in respect of South Africa not been given the formal attention necessary to understand its operation as is evidenced by unanswerable questions. Examples are: Why do South African companies license? Why not? To what extent? What encourages them or bothers them? How do they compare to companies in other countries? The lack of basic information renders comparisons and understanding and study of licensing practices and views impossible while possible formulation of policy to enhance conditions and practices at company and national level may be seriously impaired.

- As part of the study of licensing in general, proposals towards improving organisation and management of licensing have been made (Contractor, 1981, Goldscheider, 1990; Teece, 1996; Ford and Ryan, 1996). These proposals imply that companies can deliberately organise to optimise, reduce or increase licensing, which is multi-disciplinary and multi-functional and if executed properly, the end result of complex interactions. However the dynamics of licensing have been neglected and questions arise: Which inherent or acquired company characteristics will promote or hinder licensing? Which are most influential?

Research framework

Objectives

Three objectives were pursued to redress the deficiencies defined above:
1. Empirically obtain a profile of technology licensing practices and views of South African manufacturing companies; and contrast them where possible and useful with international practice. Summaries of profiled aspects appear in Chapter 7: Methodology at 7.1.1, p110.
2. Explore the notion that manufacturing companies can deliberately use some organisational characteristics to act as drivers to influence licensing activity. A summary of characteristics appears in Chapter 7: Methodology 7.1.2, p111.
3. Identify and present aspects of both to stimulate further research and discussion.

The term "manufacturing companies" refers to companies in industry known to have or to have had at least one licence agreement or patent or trade mark and specifically excludes statutory bodies, science councils, universities, merchants, the retail trade and technology brokers. A company-level as opposed to a national-level approach is followed. Licences involving only trademarks, trade names, copyright, franchising and distribution rights are excluded.

Research logic

Meeting the objectives required descriptive and exploratory research. It was decided that empirical data would be gathered through a cross section survey by written questionnaire. For purposes of the survey, characteristics profiling licensing practice had to be identified and a selection from these pragmatically made with the objective of limiting the questionnaire to what was considered a manageable scope while including the most important characteristics. From these in turn a selection had to be made and some aggregates synthesised to be tested as notional determinants of licensing. A guiding consideration was to strive for a quantitative/positivistic rather than a qualitative/ethnographic approach. The technology

licensing and technology management literature was examined to evolve the set of characteristics used, which appears in most easily understood form in the questionnaire which is attached as Annexure A.

The research logic is further described in detail in Chapter 7.

Structure of thesis

The thesis is structured to accommodate as far as possible the multi-dimensional discussion required because of the interaction between a company's characteristics, its operating and regulatory environment, its management and its technology licensing practices. Its Chapter sequence, shown below with summarised content, further reflects and explains the research logic.

Chapter 1	Outline of information available and needed; why needed; delineation of research problems and objectives; research framework.
Chapter 2	Basic morphology of the licensing field through definitions of technology, licensing, techno-economic networks and innovation; licensing positioned as business function.
Chapters 3 - 6	Evolvement of the theoretical framework for the research through theory and literature investigation and development aimed at the identification of attributes that were important and thus were to be surveyed relevant to licensing; and synthesis of drivers. The evolvement follows a topical order allowing the prior clarification of terminology and concepts, and introduction of basic definitions required to facilitate subsequent discussion: building on chapter 2, technology migration, intellectual property strategy, the licensing market and overall company attributes relating to licensing activities are discussed.
Chapter 7	Methodology.
Chapter 8	Results accompanied by brief comments where deemed necessary.
Chapter 9	Conclusion: Salient findings with comments; recommendations.