2. MORPHOLOGICAL DEMARCATION

In this chapter the central concepts technology and licensing are defined; the licensing function and technology trading are positioned within management of technology within a company; the concept of techno-economic networks is introduced; and the concept of innovation is defined.

2.1 Technology defined

> A good starting point to understanding Technology Strategy is to affirm that the core of a company is what it knows and what it can do, rather than the products that it has or the markets it serves. Technology Strategy centres on this knowledge and these abilities. It consists of policies, plans and procedures for acquiring knowledge and ability, managing that knowledge and ability within the company and exploiting them for profit. (Ford, 1988: 85.)

Technology can be and has been defined in various ways, depending amongst other things on the reason a definition is required. Ford is implicitly proposing that a company's knowledge and abilities form its technology. This is acceptable as an approximation although it lacks the utility aspect as an integral characteristic. In his case utility or profit is an output of the technology *strategy*.

Van Wyk (1988: 342) in discussing new frameworks for the management of technology alludes to the existence of several different definitions of technology. For the admittedly specific purposes of his discussion he finds the following useful as a starting point:

> Technology is created capability: it is manifested in artefacts the purpose of which is to augment human skill. ……. Artefacts are the repositories of capability. They are to the study of technology what organisms are to the study of biology.

He confirms that technology, being created, does not come about by itself and that it is the utile product of deliberate action aimed at augmentation of human skill, or utility.

He also ties technology to an artefact. The New Oxford Illustrated Dictionary (1976) defines artefact as "Object, ….. made by human workmanship". Interpretation of this definition according to the ordinary meaning of the words would appear to limit Van Wyk's definition to the concrete or physical. It must be extended to include purely abstract "repositories" such as computer programmes, to retain the validity of the above definition of Van Wyk and to avoid returning to earlier views of technology:

> To a very large degree the early studies on technology and organization equated technology with equipment, and so excluded the disembodied knowledge, the spatial forms and materials. (Clark and Staunton, 1989: 213.)

Van Wyk's contention during discussion of his definition that technology does not come about by itself but is created should also be circumscribed. The discovered – not created - mathematical fact or algorithm, when applied to problem solving, becomes part of an artefact or repository. Its discovery will however have required human action – which added value.

Smith (1990: 156) states that technology can be formally viewed as the collection of knowledge underlying abstract or material tools with which natural capabilities are enhanced.

This description seems encompassing at first glance but it seems to imply that technology is abstract and it does not specifically include the technology that is part of, or is contained in, the material tools mentioned. An iterative process in the creation of the tools is not addressed.

Other views close to Smith's have been proposed:

> The word 'technology' is often used as a synonym for a 'technological artifact'. However, technology is the 'systematic application of knowledge to practical tasks' (as defined in the Oxford Advanced Learners Dictionary). As such it is a systems concept which covers the function, process and structure of human behaviour during actions of intent ..... Seen within the context of a *systems concept*, it is clear that there are close interrelations between the technological environment of an organisation and the other facets of

> the organisation's operating environment. (Institute for Futures Research, 1994: 3 – 4.)

There is confusion regarding the relationship between technology and arte(i)fact. Simplistically stated, one school of thought views artefacts as technology and *vice versa*, another views artefacts as repositories of technology, yet another defines technology without reference to artefacts as a carrier.

Metcalfe and Boden prefer to follow a dualistic approach, distinguishing technology as knowledge from technology as artefact. They do not focus on selection of artefacts but on selection of performance characteristics embodied in artefacts. Regarding the latter they say:

> The artefact dimensions of technology relate directly to the idea of technology as a transformation process in which energy and materials in one form are translated to energy and materials in different forms of a higher economic value. (1992: 56–58.)

In parallel, they see technology as knowledge which they describe as the concepts, theories and actions enabling a transformation process. "This knowledge is necessarily contained in the minds of individuals …..". They argue that it is here that the link between technology and the science knowledge data base is found, as well as distinctions between different kinds of technological knowledge.

It transpires that technology consists of both the concrete and the abstract which are used in combination in a useful systems context. Thus metallurgical knowledge turns into metallurgical technology which becomes part of a hardened screw driver which is used as artefact without conscious consideration of its hardened point by applying muscles via an algorithm.

It would be completely unrealistic to expect all South African manufacturing companies to have considered technology as deeply as the learned scholars referred to above. It was however necessary to strive to establish a common understanding of the meaning of technology for purposes of the survey. The following practical definition of technology was therefore used to orientate respondents. Because it is inclusive rather than exclusive some specific exclusions were likewise shared with respondents:

Technology is regarded as the knowledge, concretely or abstractly embodied,

underlying machinery, equipment and processes severally and jointly and by means of which productive systems, products or services are constructed, operated, manufactured and supplied, as well as used, for economic benefit.

Excluded are

- **fruits of the mind or intellect such as works of fine art, music, poems and the like because of their aesthetic rather than industrial character,**
- **fine arts such as music, literature and paintwork except in so far as they may be employed for commercial purposes such as image building and the advertising of other goods or services and**
- **scientific knowledge whether known or still undiscovered if at least potential or dormant added value has not been added to it, through human intervention.**

2.2 Technology trading by an industrial company

2.2.1 Definition of licensing

To sell something usually means relinquishing and transferring ownership thereof in exchange for remuneration of some kind. It is obvious that the seller must have ownership before the sale while the buyer has ownership following the sale. Technology can be “sold” outright in this manner. It is even possible to sell technology many times over, as in the student-teacher relationship or the artisan selling his services. The latter two transaction types are excluded from further discussion.

To license means to grant leave or permission: "Licence *n*. 1. Leave, permission; …."(The New Oxford Illustrated Dictionary". 1976). To be able to grant permission means that the grantor must have some authoritative position from which the permission is being granted. In the case of technology the authority mostly subsists in ownership of some kind but can alternatively and perhaps as well, subsist in some derived authority such as a usufruct but mostly a licensed right. In the latter case the terms "sub-licence"(noun) and "sub-license" (verb) arise. The owner of technology becomes a licensor when permission to employ its technology in some way is granted to another who becomes the licensee: the licensor licenses the licensee. Similarly the licensee could grant a sub-licence: the licensee then sub-licenses a further licensee who becomes a sub-licensee.

A technology licence therefore is in the first place the grant of permission by an owner or proprietor of technology to another to use the owner's proprietary technology. Even more synoptic, a licence is a right-to-use granted by the proprietor of technology. Ownership is not transferred. Secondly it can be permission granted by a licensee to a further licensee – a sub-licensee. It is abstract and it and the other facts surrounding the licensing transaction form the licence agreement which is usually recorded in writing.

Numerous refinements elaborating on the above definition are possible. These are basically intended to define the scope, technically, commercially and in time and the cost of the right(s) granted.

In return for the right to use, remuneration of some kind is agreed upon, including lump sums upon conclusion or later during the validity of agreements, deferred payment or payment in instalments of lump sums and so-called royalties which usually become payable in proportion to the use taking place.

Remuneration could even partially or fully take the form of a licence regarding some other technology in return. In such cases, involving two or more parties, the concept of cross-licensing arises.

Technology licensing should not be confused with licensing by authorities such as national or local governments although common elements do exist.

Although reference is frequently made to the "selling" of licences such a concept is irreconcilable with the above framework and in fact is nonsensical because at least two parties - the licensor and the licensee - are involved in a resultant relationship over time in any one licence. Licences could be offered but not sold. Licences can of course be "sold" in the sense that an existing party to a licence transfers all the granted rights to a third party which takes the selling licensee’s or licensor’s place. Technically the conferred rights rather than the licence are sold.

Similarly, reference is made to the selling of technology when licensing is meant. This is also

technically incorrect but acceptable in the practical world where the technology or rights to parts thereof are being offered to other parties.

2.2.2 Positioning the technology trading function

A technology licensing practitioner in 1970 argued that licensing had traditionally been cast in a legalistic sense and that such a bias on its true function should be avoided. (King, 1970.) The business and technical functions of business also need representation. This contrasts with as well as complements the suggestion of Ford and Ryan in the quotation in Chapter 1, p1 that the *marketing* of technology should be seen and treated as special. King suggested that thinking about licensing in many cases focused on the patents, contracts and fees which are merely the end result of a long chain of events. He called upon practitioners to adopt the systems engineering approach which he defined for the purpose of his discussion as an examination of all the forces that influence a problem or goal. He mentioned as examples that these forces could be basic needs, economic, political, ethnic, business, technical and scientific, legal and ultimate usage. He made the point that annual license-out revenue of $3 million, taken as 5% profit after tax in an operating company could be seen as involving $60 million of sales, many employees and a capital investment of $20 million at 15% return – a sizable concern or substantial profit centre.

His approach together with that of Ford and Ryan is worthy of support and indeed both represent but a small step in the right direction. The in- and out-licensing and selling of technology by industrial companies, *i.e.* the trading of technology as defined in 2.1 above, deserves pertinent attention and it clearly has multiple management aspects involving extensive interconnections to the other functions and the various disciplines within the organisation and the world outside it. Although it can be viewed morphologically as an entity it cannot function independently of the company because its *raison d'etre* is the attainment of integrated goals set by the company as a whole, while it is dependent on the company in its many facets. Because its function has technology in its various forms as core it can readily be classified as an element of the management of technology (MOT). Further, because MOT in industrial companies ultimately serves, through a technology strategy, to define and attain the business goals of the companies MOT in turn is an element of the technology strategy; which is an element of business management which involves the business environment and the firm

as such.

MOT is an intricate and wide-ranging field of study and studies have resulted in taxonomies of characteristics of MOT from the topical, process and functional points of view. From the topical point of view aspects such as technology's dynamics, capability, technological innovation and learning and its environment are relevant. From the process and functional points of view aspects such as its identification, classification, manipulation, development, acquisition, exploitation, inbound or outbound transfer and influence between it and its environment are relevant. Figure 1 provides a simple elemental perspective of technology being managed and to some extent functioning within its environment and indicates therein the position of acquisition and disposition or exploitation of technology; and thus implicitly the sub-set technology trading or licensing and selling.

MOT is an element of an industrial company's technology strategy, influencing it and being influenced by it. No company can develop a technology strategy and thus plan the acquisition or the disposition of technology in isolation. All companies are part of the greater world and subject to influences from many directions and at many levels. Whether they are always aware of it or not, the macro environment with its diversity of structural and dynamic characteristics as well as the micro environment in which transactions are effected will

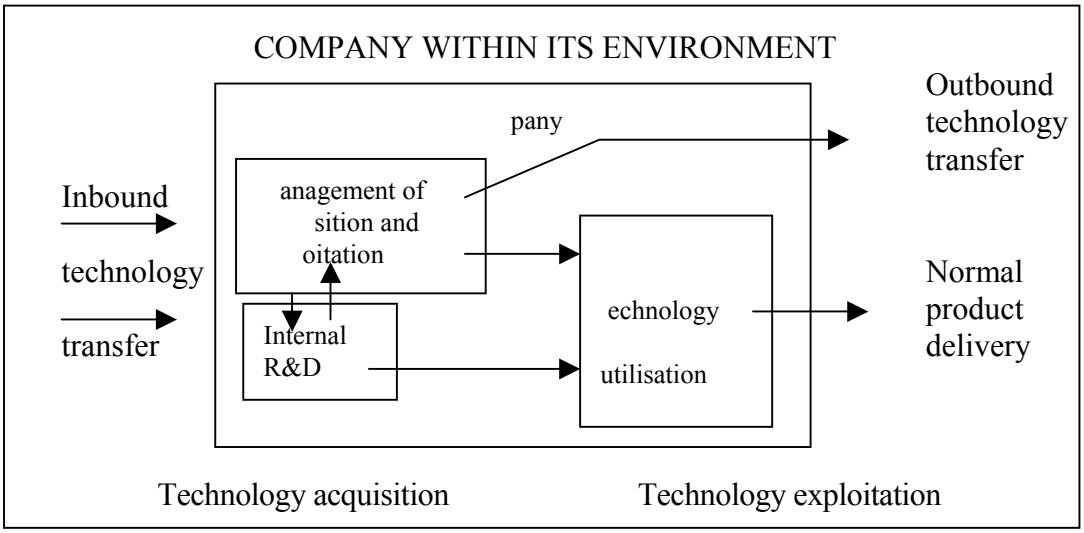


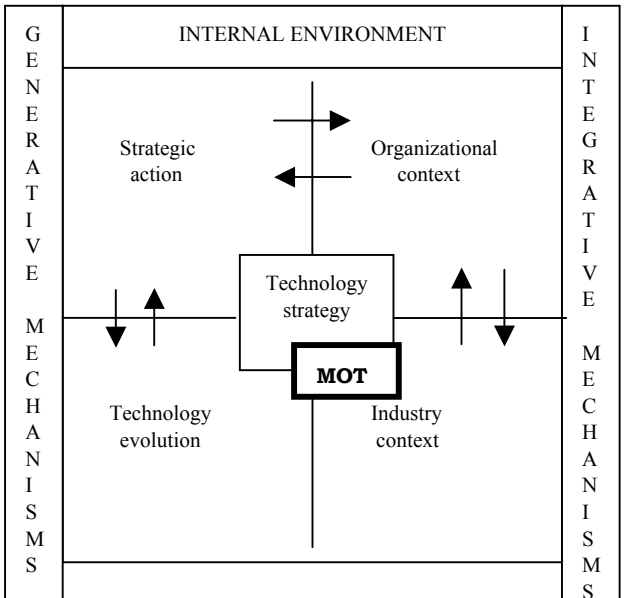
Figure 1. The elements of management of technology.
(Adapted from class notes: TLB882. University of Pretoria. 1998)

impinge directly or peripherally upon all of the company's structures, resources and plans including the seemingly simple sub-processes of structuring and organising for licensing and selling technology. Companies should be pro-active and ideally strive to be aware of these characteristics, allow for them and factor them into their overall competitive and technology strategies and licensing planning.

……

A convenient framework is available to conceptualise the internal and external evolutionary factors shaping technology strategy alone. This is presented in Figure 2. The MOT sketched in Figure 1 can be visualised as a resultant sub-set of the centrally positioned Technology strategy and has been added to the original framework.

The evolutionary factors include accounting, market and marketing, financial, legal, social, ethical, technological, emotional, hierarchical, ethnic and political factors and the organisation itself as well as various people. Not only the present is involved. The future is particularly involved and this will require forecasting which is itself problematic. Local and global views have to be taken. Some of the challenges facing companies can perhaps be appreciated better if some of the questions raised during the developmental phase of technology are considered. For example: What should its characteristics be? For whom is it? What skills do the users have? Maintenance requirements? Market characteristics? What should it do? Cost? How long should it last? Manual production or automation? Time frames? Totally self-made or partially bought out? Environmentally friendly? Packaging attractive? Disposability? Requirements imposed by statutes, government regulations, treaties and international standards organisations? Patents? Return on investment? Money back period? What will the trade union(s) say? What is the competition doing and planning?



EXTERNAL ENVIRONMENT

Figure 2. Determinants of technology strategy.
(Burgelman, Maidique, Wheelright, 1996: 39)

South Africa is arguably in a special situation requiring even more attention to the evolutionary factors which may be new to it in some respects. It has resumed its position as a fully-fledged member of the world as a result of the political changes since 1994 and has made great progress towards a true open economy in an era of ever greater globalisation in general. This means that new markets are potentially available but it means equally well that South Africa as a market, at various systems levels, has opened up to foreign companies including some fierce competitors. Conditions within South Africa have certainly changed and new playing fields and contestants have been added while others have changed.

Moving from a company's technology strategy to its complete competitive strategy the intricacies surrounding a technology strategy are compounded. A company's competitive strategy can then be visualised as subsuming the complete Figure 2, bringing technology licensing into overall company perspective. Tidd, Bessant and Pavitt (1997: 64-69), while discussing the development of a framework for innovation strategy, list Porter's "five forces" driving industry competition, and quote Porter (p64): "[T]he goal of competitive strategy …. is to find a position in an industry where a company can best defend itself against these competitive forces or can influence them in its favor". They then proceed to demonstrate how technology from potential entrants and substitute products, suppliers and rivals can influence all of the five forces. It becomes clear that the company cannot be isolated from technology of various types from various sources.

They agree that Porter's four generic market strategies influence and are influenced by innovation strategy which can be one of innovation leadership (requiring strong corporate commitment to creativity and risk-taking and close linkages to major sources of new knowledge as well as the needs and responses of customers) or innovation followership (requiring competitor analysis, reverse engineering, cost cutting and learning in

manufacturing). Their discussion is graphically summarised in the column on the left in Figure 3.

All the elements mentioned as well as more such as financial resources, will result in a competitive strategy for the company. Adding a technology strategy which explicitly embraces elements such as an intellectual property portfolio and licensing brings greater clarity and brings licensing into proper perspective within the company as a whole. Then it can be seen that interaction among the listed six strategies and the five forces will result in a competitive strategy; and this strategy will govern and often be governed by the company's technology strategy, leading to a second, refined, competitive strategy.

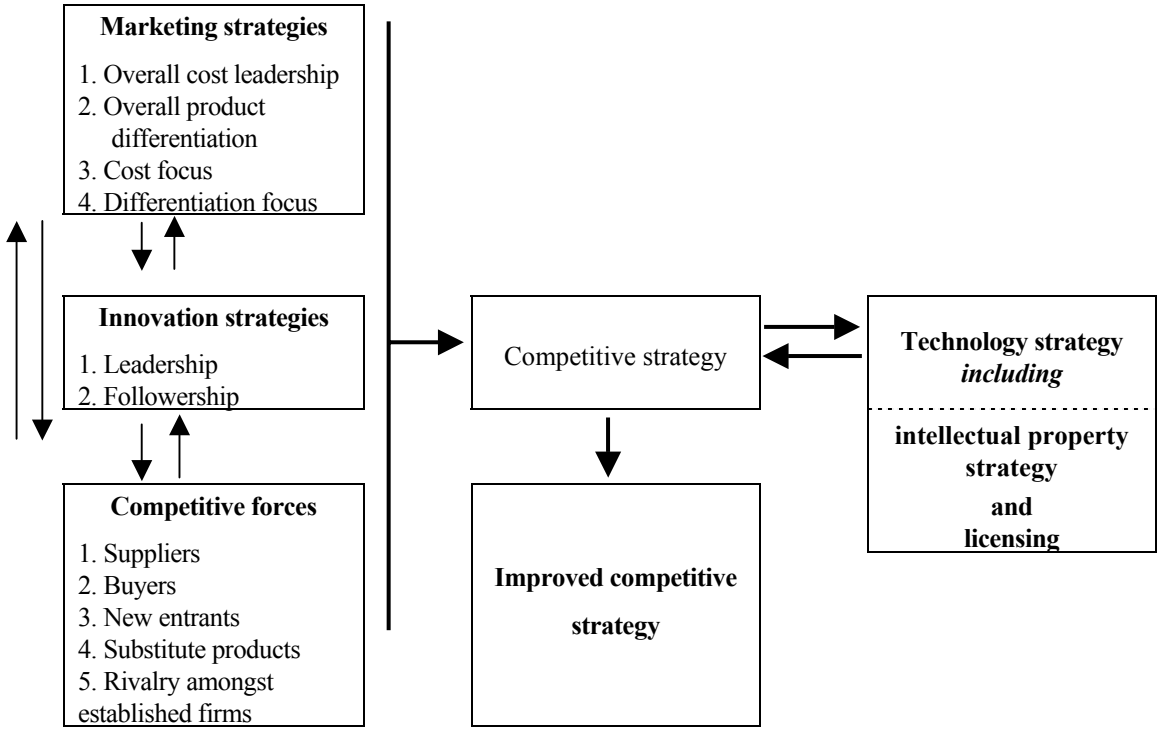


Figure 3. The shaping of technology portfolio strategy.

Whereas the first strategy will revolve around a product including services portfolio, the second will involve a technology portfolio as well - which can and should be treated like a product portfolio albeit of different "products".

The strategies have to account for many factors. A heuristic presentation identifying and grouping some of the factors to be accounted for morphologically and functionally by a

technology strategy appears in Figure 4. MOT including licensing is grouped with techno-economic networks (2.3 below) at the centre of the influences and thus not as a factor or influence to be managed but as a tool.

2.3 Techno-economic networks

An agent is necessary to evolve the various strategies and to conduct investigations and connect the various continually varying and adapting factors presented in Figure 4. The concept of techno-economic networks and in particular the dynamics of these networks provide a useful overall paradigm to understand this agent. Callon describes a techno-

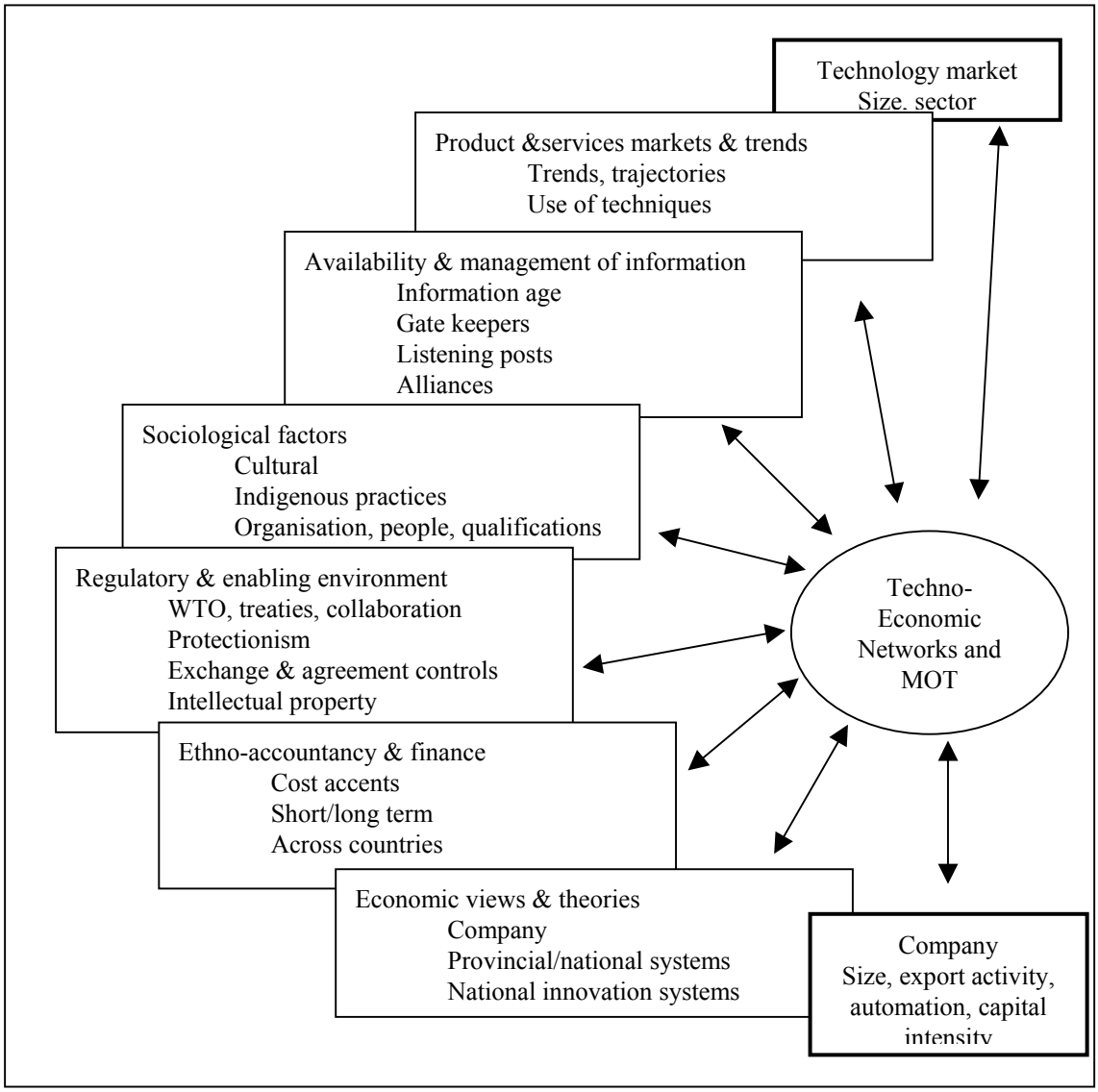


Figure 4. Heuristic presentation of factors a technology licensing company has to consider.

economic network (TEN) as a set of diverse actors such as laboratories, companies, banks, users and the government who participate collectively in the conception, development, production and distribution of products and services. He suggests that TENs are organised around three poles, *viz*. the scientific pole producing empirical knowledge, the technical pole which produces artefacts to fulfill specific purposes and the market pole which produces needs and tries to satisfy them. (Callon, 1992: 72–102.)

Although the poles may have seemingly mutually exclusive objectives their activities are nevertheless brought into relation by so-called intermediaries who both describe and compose or give form to the TEN. They include texts of various kinds on various media, technical artefacts or hardware, human beings and their skills and money in all its forms.
A TEN for an industrial company can be visualised and begins to form when three actors are aligned by interposed intermediaries. Its ultimate effect could be constructive or destructive following the synthesis of some common view. A TEN could expand or shrink and various TENs could link in various ways to form new ones. TENs can form and exist within individual companies and between separate companies, even internationally.

Survey objectives. (Results are presented in 8.3.)

The concept of a TEN was proposed as a valid construct. It is clear that a TEN will manifest through activities and results and not as a permanent person or persons or a body. Its existence therefore has to be established through indirect measurement. It was posited that the existence of a licensing TEN or TENs will manifest through the indicants awareness of competitors' successes, competitors' failures and competitors' licensing activities and the aggregate of these; top management's liking of licensing; international experience and travel abroad and the aggregate of these; and the maximisation of technology capabilities amongst disciplines, amongst functions and business units and the aggregate of these. It was further notionally proposed that there will be positive correlation between these indicants and licensing activity. The indicants represented aspects that offered acceptable content validity because they could reasonably be expected to be understood by a diversity of respondents as well as reliability because the questionnaire response menu was to be limited.

2.4 Innovation

What are innovative activities within industrial companies?

> Innovation, *n*. The action of innovating; the introduction of novelties; the alteration of what is established by the introduction of new elements or forms. (The Oxford English Dictionary. Second edition 1989.)

> Rapid and turbulent technological change gives considerable advantages to those firms most capable of dealing with novelty. (Dodgson, 1992: 136.)

It is clear that Dodgson is referring to dealing with the effects of innovation. Dodgson may imply but does not say expressly that firms should deal with the effects of innovation in an innovative manner. In a way this is so obvious and so hidden in definitions of innovation, including that of the Oxford English Dictionary, that it rarely receives proper attention. Consequently, it is neglected. But it is equally a purpose to explore innovative management of, including trading with, such technology.

The term innovation stems from the Latin "novus" which means "new". Hence the inclusion of the term "novelties" which includes the term "novel" in the above. Newness is non-negotiable in any definition of innovation. The structure of a definition should therefore rather be of the form: "Innovation is the making new of <something>." The term technological innovation is analogously perhaps placed in better perspective when it is amended to technology innovation thus clearly referring to the making new of technology.

> We consider innovation to be the rearrangement in novel ways of technical, scientific and organizational elements. The degree to which each of these elements plays a role depends on three variables: the type of technology, the type and size of the organization, and the firm's place in its own industry and the characteristics of the market. (Vergragt, 1992: 231.)

This provides a practical basis for a definition. Two aspects need accentuation. First, it must be clearly read that “organizational elements” are also subject to rearrangement in novel ways; and continuously so. A reader may easily and erroneously focus on the terms "technical" and "scientific" and see the organisational elements as merely or mundanely serving the "technical" and "scientific". The fact is that, analogous to the case with technology which is both an object and can be applied to itself, innovation should be managed

innovatively. Vergragt confirms this when he includes the type and size of the organisation, its place in its own industry and the characteristics of the market, thus placing the organisation firmly back in and exposing it to the influences of the complete world. Clark and Staunton (1989) add a cautionary and confirmatory note when they say that many studies have imposed an objectification on innovations so that innovation is treated as a "thing" which is detached from its context and its pathways. They say that the plurality of players such as suppliers and users also tend to be ignored. Objectification leads to a limited and flawed understanding. There is a strong tendency to equate innovations with equipment and to neglect the knowledge which is embodied in other dimensions such as raw materials, layouts and standard operating procedures. They contend that too little attention has been given to the role of unembodied knowledges and to the application of the knowledge technology perspective (Ibid: 8). They contend that a strong bias towards innovation has resulted in almost total neglect of the problems of the removal of existing practices so that they can be replaced, or as they say, exnovation. Exnovation may require the closure of plants and production lines, staff reduction, take-overs and outplacement of certain functions (Ibid: 12). Yet another insight comes from their caution that the occurrence of innovation should not be seen as a detour which will be followed by a return to normalcy. It is not a leap ahead of rivals which is followed by stability (Ibid: 10).

Second, the term innovation should be and is usually used to include various activities such as invention, research, development, production engineering and design. It is understood for the purposes of this research that these activities should have something new, capable of commercial application, as end result. This approach would eliminate the results of what is sometimes referred to as exploratory research or research which has as its sole aim the expansion of human knowledge.

Innovation has many aspects which appear in various taxonomies. For example, although Vergragt's definition does not specifically mention it, it must be understood that the newness can be of varying degree. Clark and Staunton (1989: 10, 11) mention five levels of innovation: generic, resulting in new techno-economic paradigms (steam engine); epochal, resulting in sectoral change (automatic gear-change, Plexiglass); altering at firm level (EFTPOS); entrenching which modifies existing methods but proceeds in the same direction; and incremental in which existing inputs are reconfigured to increase output. The newness as

such needs for this research not to be novel in the absolute sense but must at least be novel to some industrial company or even a part of such a company.

Various other taxonomies of innovation exist, *e.g.* Abernathy and Clark (1985) classify innovations in terms of their reinforcing or destroying effect - their transience - in one dimension on production systems and their operation and in another dimension on a firm's consumers and its markets. Yet another taxonomy describes innovation on a scale from informal to very formal.

Apart from its being innovative, innovative technology will show one or more of several other characteristics, including existing overtly or covertly, being regarded as or in fact being important or incidental, being clearly defined or not, being confidential or not and being statutorily protectable or in fact protected or not. It will be transferable, to a greater or lesser degree, which may mean easier or with difficulty.

Innovation is pervasive and can occur in the most unexpected places. Industry at large should always be alert. One metaphor visualises technology as having boundaries but a moving front edge. Likewise any particular part or sector of industry or company has its own body of perceived technology. In each case the front edge is of particular importance while the front edges of "other" bodies of technology should also be scrutinised in the quest for opportunity and to avert threats. It is at the front edge and at the nexus of different front edges - indeed often from different industrial sectors - that technological innovation exists and comes about. Thus, *e.g.*, the transistor has largely displaced the electronic valve, the personal computer has largely displaced mainframes, long range passenger aircraft largely replaced other modes of long distance transport, voice recognition technology may render the computer keyboard redundant, cell phone technology seems to offer lucrative opportunities, the video telephone may make inroads into long distance transport.

Innovative technology will be created and will exist inside as well as outside a particular company. Because of its intrinsic and perceived characteristics, it will be valuable to its current owner and practitioner and may be marketable to others, that is, be a candidate for selling or licensing.

The following practical definition was used to orientate respondents:

Innovation is the ongoing as well as recently completed rearrangement in novel ways of technical and scientific as well as organisational elements for economic benefit.

Survey objectives. (Results are presented in 8.8.)

The concept of innovation is widely acknowledged as a valid construct. Because multiple factors contribute to innovative activities it would be futile simply to ask directly how innovative a company is. Innovation levels cannot be measured by a one-dimensional parameter such as number of patent applications filed in a given period. Multiple aspects contribute to innovative activities and thus innovation levels. For example, number of patent applications filed could be viewed as one result of innovation levels.

It was posited that the existence and strength of innovation will manifest through the indicants use of various governmental funds for technology development; international co-development and countertrade or offset activities; aspiration to become an own brand manufacturer; and encouragement of innovative activities in products and processes, production, logistics and management. It was further notionally proposed that there will be positive correlation between these indicants and licensing activity. The indicants probe activities which go beyond routine production while offering acceptable content validity because they could reasonably be expected to be understood by a diversity of respondents as well as reliability because the questionnaire response menu was to be limited.