INNOVATION RESEARCH CENTRE

CHALLENGES IN COLLABORATION MANAGEMENT IN OVERSEAS TECHNOLOGY UNITS

by

John W. Medcof

Innovation Research Working Group
WORKING PAPER NO. 50

April, 1996

McMASTER
UNIVERSITY
MICHAEL G. DeGROOTE
SCHOOL OF BUSINESS

CHALLENGES IN COLLABORATION MANAGEMENT IN OVERSEAS TECHNOLOGY UNITS

by

John W. Medcof

Innovation Research Working Group
WORKING PAPER NO. 50

April, 1996

CHALLENGES IN COLLABORATION MANAGEMENT IN OVERSEAS TECHNOLOGY UNITS

John W. Medcof

The Michael G. DeGroote School of Business

McMaster University

Hamilton, Ont. Canada

L8S 4M4

Phone: (905) 525-9140 X27434

Fax: (905) 521-8995

E-mail: medcof@mcmaster.ca

CHALLENGES IN COLLABORATION MANAGEMENT IN OVERSEAS TECHNOLOGY UNITS

Abstract

Overseas technology units are classified according to the collaboration challenges they present and the type of technology work they do. This system of classification provides an improved platform for understanding overseas technology units and their management.

CHALLENGES IN COLLABORATION MANAGEMENT IN OVERSEAS TECHNOLOGY UNITS

Since 1990 the Japanese have established over 75 technical units in the US (Serapio, 1993). Between 1986 and 1991 the US increased its overseas technology work by 88% (Gates, 1995). In the 1980's the Swedes increased their overseas technology work by over 250% (Hakanson & Nobel, 1993a). Clearly, there is a trend among transnationals to perform increasing amounts of technical work outside their home countries (Gates, 1995; Granstrand, Hakanson & Sjolander, 1992; Howells, 1990; Pearce & Singh, 1992 a, b; Pearson, Brockhoff & von Boehmer, 1993). Technical work is drawn off-shore by many forces including the need to access high quality science located there, the need to support overseas marketing and manufacturing, and foreign governments anxious to speed their countries' development through technology transfer. The globalization of technology is part of the general globalization of business which is revolutionizing the world economy. The globalization of technology is moving higher on the research agendas of both academics and practitioners (Gates, 1995; Granstrand, Hakanson & Sjolander, 1992; Howells, 1990; Pearce & Singh, 1992 a, b; Pearson, Brockhoff & von Boehmer, 1993).

Management Challenges in Overseas Technology Work

Despite the importance and increasing quantity of offshore technology work, there is relatively little information available about how to manage it (Cheng, 1994, Cheng and Bolon, 1994). Although there is not much literature in this area, some of what is available is excellent seminal work which deserves follow-up.

Chester (1994), for example, provides a good description of how transnational research is currently managed at his firm, Hughes Electronics. That successful system, however, may not

work in many other firms or with other technical activities, such as customer support. Reports such as Chester's, then, have the advantage of providing specific and concrete advice for managers, but that advice may not generalize. In addition, there is no system for considering the degree to which the advice will generalize, nor is a comprehensive approach to the management of overseas technology units provided.

Ransley and Rogers (1994) have come at these issues from the opposite direction. They have compiled the advice on "Best R&D Practice" from four different consulting firms to provide a set of universal guidelines for effective practice. This is undoubtedly good general advice, but these guidelines will probably take quite different forms when adjusted for application to specific industries, firms and types of technical work. Such approaches have, then, the advantage of providing a comprehensive approach to the management of overseas technology units, but lack the detailed analysis necessary to identify different kinds of situations and the different kinds of management approaches which are needed in them.

Cheng and Bolon (1994) have suggested another approach. They propose that advice about transnational technology management should first differentiate among the kinds of technology unit, and then provide advice tailored specifically to each type. This approach has the advantages but not the shortcomings of the two approaches mentioned in the preceding paragraphs. By providing a complete list of the different kinds of technology units, a comprehensive picture of overseas technology management is provided. General advice of the type provided by Ransley and Rogers (1994) would be that which applies across the board to the general management of the different types of technology units. In addition, the overall system of unit classification would clearly show the situations in which specific, concrete advice is and is not appropriate.

Some work has already been done which is consistent with the approach suggested by Cheng and Bolon (1994). A number of writers have identified different types of technical units and provided information about management, and other issues, for each of the types (Cordell, 1973; Behrman & Fischer, 1980; Hakanson & Nobel, 1993 a, b); Hewitt, 1980; Hood and Young, 1982; Pearce & Singh, 1992 a, b; and Ronstadt, 1977, 1978, Cheng, 1994). Some refinement of this work is necessary, however, if it is to be the basis for a systematic set of advice about the management of overseas technology units.

Most fundamentally, a single, generally accepted taxonomy of the different types of overseas technology units is needed. That taxonomy will provide a comprehensive system for sorting out which advice fits where and for organizing the literature in the area. It will provide a platform upon which generalizations about the management of overseas technology units can be based.

A further requirement is that the concepts used to define the categories in the taxonomy need to be sympathetic to the discussion of management. Most papers which identify different kinds of overseas technology unit do consider management issues, but not necessarily in much depth and not usually as the main focus of the discussion. They more often focus upon such concerns as the strategic reasons for establishment, where unit outputs are utilized and the technical functions of the units. As a result, the concepts used to define the different kinds of overseas technical units are not particularly attuned to discussions of management. If the management of such units is to be considered systematically, the unit types should be defined in an appropriate way. As will be seen below, this paper will propose such a system of definition.

Another requirement is for a more logically rigorous system for defining and labelling the different unit types. A system for classifying overseas technology units should be based upon a

small set of clearly defined dimensions that have relevance to management. In the literature cited above, there has been no attempt to define such a set of basic dimensions. This has led to a number of classification systems and has contributed to the inability to reach agreement on other issues. There is also considerable variety in the labels which have been used in the various systems. It will become evident later in this paper that different labels used by different authors sometimes refer to essentially the same kinds of units. Further, within individual classification systems, the labelling systems are sometime inconsistent. In the Cordell (1973) paper, for example, the terms in the label "Support Laboratory" refer directly to the technical function of the unit, but make no reference to how it is managed. This is in contrast to another of his labels, "International Interdependent Laboratory", which makes no reference to the technical function but does refer to the method of management. A system for classifying overseas technology units should have labels which are logically related to each other and clearly related to the basic dimensions of the taxonomy.

In addition to being conducive to discussions of management and having clear and consistent dimensions and labels, a system for classifying overseas technology units should also encompass the taxonomies already available in the literature. The taxonomies of past studies provide descriptions of various kinds of units, which should fit into any new system of classification.

Pearson et al (1993) broached the need for a single, generally accepted, system for classifying overseas technology units. They suggest establishing common ground among the different lists that already exist by showing the correspondences among their different categories (summarized in their Table 1, p. 252). This proposal, although an excellent initiative, covered only four of the available taxonomies and suffered from some questionable proposed category correspondences.

The purpose of this paper, then, is to develop an improved system for classifying overseas technology units. This new taxonomy will provide a systematic basis for understanding the management challenges of overseas technology units. This new taxonomy will have a more carefully defined system of basic dimensions and labels than has been found in past

A Management-Oriented Taxonomy of Overseas Technology Units

First, some terminology. The organizational units being discussed here are called "technology units", in order to include research, development and support units. The term often used in the past, "R&D Labs", excludes support. The term "laboratory" is also dropped since many units (eg. units giving customers technical support for software) do not have the character of laboratories.

The new taxonomy of overseas technology units is based upon three dimensions: (1) The type of technical work done by the unit - research, development, support, (2) The other organizational functions with which which the technology unit collaborates in carrying out its work - marketing, manufacturing, none, and (3) The geographical area over which collaborating units are spread - local, cosmopolitan. The primary reasons for choosing these as the basic dimensions is that they focus on the nature of the technical work being done and upon the collaboration context in which it is performed. This clear focus should facilitate the discussion of management issues and provide a framework for organizing findings already available in the literature.

The first dimension, type of technical work done, is based upon commonly accepted definitions. Research is the process of discovering new scientific knowledge which has the potential to act as a platform for the subsequent development of commercially viable products and manufacturing processes. There is no expectation that the outputs of research will have immediate commercial value. Development is the process of creating new products and processes

which do have commercial value, from currently available platforms of scientific knowledge. There is no intention that the outputs of development will advance fundamental science. Support is the process of adapting an already established product or process technology to some particular condition. There is no intention that the outputs of support will lead to fundamentally new products or manufacturing processes. Support can take such forms as the modification of a product for a particular market, and the advising of purchasers of a technology on its use.

The second basic dimension specifies the other functional units with which the technology unit collaborates in carrying out its work, as shown in Figure 1. In that figure, three circles represent the three organizational functions which are most often mentioned as collaborating in technology work; marketing, manufacturing and technology (called R&D by many authors). The intersections of the circles represent collaborations between and among the different functions. For example, area B represents collaboration between the technology and manufacturing functions, without the involvement of marketing. Area E represents the collaboration of all three functions. The areas which do not intersect with other circles represent activities which are done with essentially no collaboration with other functions. Area A, for example, represents activities of the technology function done without either marketing or manufacturing. In Figure 1, then, four categories of collaboration by technology units are represented: technology collaborating with marketing, technology collaborating with manufacturing, technology collaborating with both marketing and manufacturing and, technology alone with no collaboration.

Also shown in Figure 1 are commonly used terms for work involving the technology function. Lines connect these to the appropriate areas in the circles. Process Development and Manufacturing Support both involve the collaboration of technology and manufacturing. Product

Development and Marketing Support both involve collaboration between technology and marketing. Full development is associated with Area E, involving collaboration of all three of technology, marketing and manufacturing. This represents the ideal case for many development projects. The three functions work concurrently to develop a new product and its manufacturing process using available technology platforms. The term "Full Development" is being coined here to help make some important distinctions. Full Development involves three-way collaboration. Development involving only two functions is called either product or process development. The term "development", alone, refers to development generically, with no mention of collaboration. In Figure 1, research is shown as involving no collaboration with marketing and manufacturing. That representation will be discussed further, below.

If the two dimensions just defined, type of technical work and collaborating functions, are crossed, twelve types of technology work are given, as shown in Table 1. Also included in Table 1, in the appropriate cells, are the commonly used terms for technology work which appeared in Figure 1. The cells in Table 1 with names represent technical work activities which are widely discussed by practitioners and academics. Those without names are more problematic.

Cell 8, for example, which represents development work carried out by the technology function without collaboration, has no commonly accepted term associated with it. This is because development work, by definition, is the activity of creating products and processes for marketing and/or manufacturing. Implicit in the definition of development is a statement about collaboration with certain other organization functions. It is, therefore, a logical impossibility to have development work which does not involve some collaboration. Analogous reasoning explains why Cell 12, support work without collaboration, also does not have a label.

A slightly different logic explains the lack of a label for Cell 11, support work done in simultaneous collaboration with marketing and manufacturing. Support work, by definition, involves working with marketing or with manufacturing to adapt their particular technologies to a particular circumstance. The changes involved in these adaptations are usually so minor as to not need full three way collaboration. Product and process changes which are significant enough to require full three-way collaboration fit under the label of development.

Cells 1, 2 and 3, all involving research, are also without labels. Research is the discovery of new platforms of scientific knowledge which can be used as the basis for developing new products and processes. As long as the platform of scientific knowledge is being constructed, the activity is called research. If the focus turns to using that platform to create commercially viable products and processes, the activity is called development. In the development process, an important role of technology people is to bring into play the platforms of scientific knowledge to which they have access. In these definitions, then, the technology function works alone to discover the platforms of scientific knowledge. In this sense, research, by definition, is done without collaboration with marketing or manufacturing, and Cells 1, 2 and 3 are logical impossibilities.

Thus, some cells in Table 1 lack names because they are never discussed. They are never discussed because they are logical impossibilities, given the definitions of research, development and support. In short, a twelve category classification of technology units based upon the dimensions; (1) type of technical work and, (2) functional collaborations; is impossible because the two dimensions are not logically independent.

In the interest of logical consistency, then, it is necessary to create one dimension of the two that are not independent. The new dimension can be called "Technical Activity" and consists of

six categories, based upon the cells in Table 1 which have names. This dimension can be crossed with the third dimension proposed here as the basis for a taxonomy of overseas technology units.

The third dimension, geographical area over which collaborating units are spread, has two levels, local and cosmopolitan. Local Spread occurs when the collaborating units are all located in the same host country. An example would be process development involving manufacturing and technology people, located in a single facility housing manufacturing and technical activities. Another example would be manufacturing support involving several manufacturing facilities, located in the same host country, being supported by a single technology unit housed in one of them. Cosmopolitan Spread refers to the situation in which the units being coordinated are dispersed over a large geographic region (eg. Europe or the Americas) or even globally. An example of this would be a Full Development project involving technical people from the home country, manufacturing people from another country and marketing people from a third.

When the Technical Activity dimension is crossed with the Geographic Area dimension, the taxonomy in Table 2 results. That taxonomy is based upon clearly defined basic dimensions which make reference only to the type of technical work of the unit and the collaborative context of that technical work. Table 3 provides definitions of the twelve categories shown in Table 2.

A Comparison of the Taxonomies

The taxonomy shown in Table 3 can be compared to the taxonomies listed above which are already available in the literature (Cordell, 1973; Behrman & Fischer, 1980; Hakanson & Nobel, 1993 a, b); Hewitt, 1980; Hood and Young, 1982; Pearce & Singh, 1992 a, b; and Ronstadt, 1977, 1978, Cheng, 1994). As mentioned earlier, this new taxonomy should provide a comprehensive system for encompassing the various types of overseas technology units.

Table 4 shows all the categories in the new taxonomy and in the eight taxonomies in the literature. The rows of the table show the categories in the various taxonomies which correspond to each other. Blank spaces and the double appearances of some category names show areas of imperfect fit. What follows are brief notes about each of the taxonomies.

Cordell (1973) gave labels to two types of overseas technology units, "Support Laboratories" and "International Interdependent Laboratories". He also talked about product and process development but did not formally label units doing those kinds of work. As mentioned above, Cordell's labelling shows one of the inconsistencies found in several later taxonomies. The label "Support Laboratory" makes reference to the technical function of the unit but not to the way in which it is managed. The label "International Interdependent Laboratory" makes reference to the method of management but not to the technical function of the unit.

Ronstadt (1977, 1978) did an empirical study of seven US multinationals which collectively had 55 technology units overseas. His taxonomy has four categories. (1) Transfer Technology Units (TTU's) support the transfer of manufacturing technology to a foreign subsidiary and provide technical services to customers. (2) Indigenous Technology Units (ITU's) develop new or vastly improved products for the local market in the host country. These products are not the direct result of technology provided by the parent organization. (3) Global Technology Units (GTU's) provide products and processes for consumption and/or use in the major world markets of the multinational. (4) Corporate Technology Units (CTU's) do long term exploratory research for use by the corporate parent. Although Ronstadt defined Indigenous Technology Units purely in terms of product development, his discussion of them alludes to the development of new manufacturing processes as well. Although Ronstadt failed to discuss systematically the basic

dimensions he used to classify the units, he did discuss a number of other issues with considerable insight. Those discussions covered the types of technical work done in overseas units, methods of management, degree of dispersion of output (geographic and corporate), corporate strategy in international technology unit deployment, and communication patterns surrounding the units.

Behrman and Fischer (1980) studied 206 off-shore technology units owned by thirty-one American and sixteen European firms. In organizing their findings, Behrman and Fischer first identified three different market orientations of multinational firms. For each of these market orientations, they identified a particular kind of foreign "R&D" associated with it.. However, they did not provide specific names for the different kinds of technology units. The marketing strategy names associated with the different kinds of units are, therefore, used in Table 4 to name the technology unit types. Behrman and Fischer also did not provide a taxonomy based upon clearly defined dimensions with corresponding and consistent category names. They did, however, provide considerable insights on the issues discussed by Ronstadt (1977, 1978).

Hewitt (1980) identified four major types of R&D done in overseas units. "Product Adaptive R&D" and "Process Adaptive R&D" adapt existing products and processes strictly for local use in the host country. "Local Original R&D" creates new products aimed at the host country market. "Global Original R&D" occurs when new products are developed for the world market. Hewitt implied that Global Original R&D included both development and research, so Global Original R&D is shown corresponding to two categories in Table 4. Hewitt also provided an insightful discussion of many of the issues discussed by Ronstadt (1977, 1978).

Hood and Young (1982), discussed the R&D strategies of US multinationals, using a three category taxonomy which was an extension of Cordell's (1973). The three categories are: (1)

Support Laboratory - technical service centre, translator of foreign manufacturing technology; (2) Locally Integrated R&D Laboratory - local product innovation and development as well as transfer of technology; (3) International Interdependent Laboratory - research centre, close links with international research programme, may or may not interact with foreign manufacturing affiliate. Again, there are inconsistencies in category labelling and in the use of the dimensions upon which unit definitions are based.

Pearce (1989) and then Pearce and Singh (1992 a, b) adopted Hood and Young's (1982) taxonomy in their extensive empirical work. In their discussions they flesh out the definitions of the three types of units to give clear definitional status to considerations captured in the category names of Hood and Young, but not given prominence in their conceptual definitions. For example, Locally Integrated Laboratories are defined by Pearce and Singh (1992b, p. 241) as including units with "feedback from local marketing personnel and engineers". Such feedback is implied by the title and is implied by the Hood and Young (1980) discussion of this category, but is not clearly included. Pearce and Singh provided extensive empirical data and some conceptual refinements but their taxonomy included the difficulties that plagued earlier taxonomies.

Hakanson and Nobel (Hakanson, 1992; Hakanson and Noble 1993 a, b) studied Sweden's 20 largest multinationals, with interviews and questionnaires. One question asked respondents to rate the importance of 21 "factors and considerations" in the decision to establish or maintain R&D units. A factor analysis of the responses gave four factors which Hakanson and Nobel called "motives" for the establishment of the units; production support, market proximity, political factors and monitoring research. Using these factors, a cluster analysis of the 151 technology units in their sample found five groups. Four of the five groups had clear associations

with the factors from the factor analysis and so units in those clusters were given the same labels as the factors; market proximity (32 units), political factors (29 units), production support (21 units) and monitoring research (13 units). However, 56 units showed no clear association with any one of the factors. Hakanson and Nobel concluded that these units engaged in a number of different technology activities and therefore did not have a strong preferential association with any one of the four types. They labelled such units "multi motive". The category correspondences for Hakanson and Nobel shown in Table 4 are based upon an examination of the factor analysis items which had the closest associations with each of the unit types produced in the cluster analysis. The Hakanson and Nobel study did not resolve the issues of taxonomy labelling and basic dimensions seen in earlier studies.

Cheng (1994) proposed a taxonomy of technology unit types by combining those of Pearce (1989) and Ronstadt (1977). He did not resolve the issues of dimension definition and labelling consistency but did provide a composite of some earlier taxonomies.

An overview of Table 4 shows that the new taxonomy, which includes twelve categories and is based upon a relatively few clearly defined dimensions, encompasses almost all of the categories proposed in earlier work. However, there are three categories in the new taxonomy for which there have been no empirically observed examples in the previous literature and there are two types of units proposed in past studies which do not correspond to any of the categories in the new taxonomy. These apparent anomalies deserve consideration.

Table 4 shows that the three types of units in the new taxonomy which lack corresponding examples in the past literature are : (1) Local Research - units doing research with only local collaboration, (2) Cosmopolitan Marketing Support - units providing marketing support through

collaboration with marketing operations dispersed regionally or globally, and (3) Cosmopolitan Manufacturing Support - units providing manufacturing support through collaboration with manufacturing operations dispersed regionally or globally.

The lack of Local Research Units can be explained by the nature of research, as defined above. Research is an activity carried out in collaboration with other researchers, not through collaboration with marketing or manufacturing. A research unit established at an overseas location will not normally find it necessary to collaborate with local marketing and manufacturing units. It will collaborate primarily with the other research units of the firm, which will be located in the home country and/or in other offshore countries. Those who have discussed overseas research units from Cordell (1973) to Chester (1994) have pointed out the lack of local collaborations by overseas research units, and the presence of cosmopolitan networks of collaboration among such units.

The lack of Cosmopolitan Support Units (market and manufacturing) can be explained by the localized nature of support work. Support units solve problems that occur in particular, localized markets or manufacturing operations. Typically, good access to the technology and people being supported is also necessary for effective and timely support. As a result, it is impractical to support, from a single site, manufacturing and marketing activities which are regionally of globally dispersed. Therefore, organizations do not typically establish support units to service large regions or the globe. Since support units support local marketing and manufacturing, the majority of support collaborations are local.

However, this state of affairs may be changing. With improved communication, by air transportation and modern telecommunications, it is becoming more feasible to provide support

from a distance, ie. without setting up support units at the local level. This trend makes it more feasible to have cosmopolitan support services. The rise of 1-800 customer support lines among software companies comes to mind in this context. It may be that Cosmopolitan Support Units had not appeared at the time when the older taxonomies were proposed. More recent data would be needed to check for their occurrence. Some more recently gathered data, such as those of Hakanson and Nobel (1993 a, b), were collected using conceptual frameworks based upon the older taxonomies, and so might also have missed the appearance of Cosmopolitan Support Units.

The second kind of discrepancy shown in Table 4 is the two types of technology unit reported by Hakanson and Nobel (1993 a, b) which do not have corresponding categories in the new taxonomy: multi motive units and units established for political reasons. The resolution of this apparent anomaly can be found in Hakanson's and Nobel's own discussion.

Multi motive units perform more than one technology function, for example, doing both Local Market Support and Cosmopolitan Product Development. Their multi motive nature does not mean that they do a kind of work not included in the new taxonomy. It means that they do more than one kind. They are classified separately because of the particular way that Hakanson and Nobel (1993a, b) collected and analysed their data. The occurrence of multi motive units suggests that a distinction should be made between technology units and technology facilities. A technology unit can be defined as a formally established organizational unit which is mandated to perform only one of the types of technical work shown in the first column of Table 4. One unit, one type of work. The other characteristic of a technology unit is that all of its members normally work at a single geographic location. In contrast, a technology facility is a particular physical space which houses people doing technology work. A technology facility may house one or more

technology units. Future research should allow respondents to report the different kinds of technology units which are found within a particular technology facility. The taxonomy developed here and shown in Table 4 classifies technology units, not technology facilities. This discussion of multi motive units shows the value of a taxonomy based upon clearly defined dimensions. Findings which may have seemed confusing when a rigorously defined taxonomy was absent can be understood clearly when one is present.

The other kind of unit reported by Hakanson and Nobel (1993 a, b), but not apparently accommodated in the new taxonomy, is the politically motivated unit. For example, a government may require a transnational firm to locate a technical unit in its country as a condition for being given access to its markets. Hakanson and Nobel (1993 a, b) point out that, although such units come about for political reasons, they are normally assigned some "legitimate" technology role in the firm's technology strategy. Those legitimate technology roles should be classifiable in the new taxonomy. The political reasons for the establishment of a technology unit can be discussed along with other issues having to do with the reasons for establishing overseas technology units, but not as issues having to do with the classification of such units. Again, we see the value, for sorting out issues, of having a taxonomy based upon clearly defined basic dimensions and with category labels related to those dimensions in an intuitively clear way.

This comparison of the various taxonomies of overseas technology units has shown that the new taxonomy can encompass the other taxonomies. All the categories proposed earlier fit into the new taxonomy. Two categories which, at first, appeared not to fit, were found on examination to have a logical relationship to it. This confirms that the new taxonomy can perform one of the roles for which it was developed, to provide a comprehensive framework within which

different kinds of overseas technology units, and the management advice appropriate to each, could be fit in a systematic way.

Another feature of the new taxonomy is its system of labels. The inconsistent labelling of some other taxonomies was alluded to above and examination of Table 4 shows that a variety of labels have been used in the past. In the new taxonomy, the labels make clear reference to the two dimensions on which the taxonomy is based. The geographical area over which collaboration occurs is referenced with local - cosmopolitan. The type of technology work being done is referenced with terms such as process development and market support. These terms also convey the organizational functions with which collaboration takes place. The category labels for research do not indicate any collaboration partners because marketing and manufacturing do not become involved in research, as defined here. This consistent labelling using commonly employed terms should facilitate the use of the new taxonomy.

The Taxonomy and the Management of Overseas Technology Units

This new taxonomy of overseas technology units has been developed to provide an improved platform for understanding the management of such units. One objective was to provide a system into which very specific advice could be fit. Another was to provide a framework that lends itself more readily to discussions of management than did past taxonomies. The capacity of the new taxonomy to do both of those things will now be considered.

The ability to provide places for specific, concrete advice will be demonstrated through the example of Chester (1994). One organizing technique which Chester discusses is "technical networking". The technical network at Chester's organization, Hughes, is company wide and cuts across national and organizational boundaries. The network is, therefore, very clearly aimed

at enhancing cosmopolitan collaboration. Further, the description of the network mentions only people with a technical orientation. Marketing and manufacturing people are not included directly, if at all. The network is organized around technical specialties. This suggests that the network is very much focused upon research activities, although development work is not specifically excluded. Hughes' technical network is, then, a technique for managing Cosmopolitan Research Units. Now that the Hughes system has been given a place in the taxonomy, further questions can be asked. If one wished to use technical networks for cosmopolitan development as well as cosmopolitan research, how should they be different? How will the marketing and/or manufacturing people be included, for instance? It is thus seen that fitting the technical network into the taxonomy puts it into perspective, so that its limitations are apparent. That perspective also helps us ask very specific questions about how the management technique can be generalized to other technology unit types.

The new taxonomy, since it is partially based upon the collaboration context of overseas technology units, provides a good framework for considering challenges in collaboration management. For example, the collaborations which have to be managed in a Local Manufacturing Support Unit are quite different from those in a Cosmopolitan Research Unit. In the former, collaboration is almost exclusively with the local manufacturing personnel. There can be regular face-to-face meetings between technical and manufacturing people. The manufacturing technology is readily available to both groups for examination and alteration. There is a good possibility that most of the manufacturing and technology people are citizens of the host country so that cultural clashes based upon country of origin may not be a serious issue. However, clashes based upon the different cultures of organizational functions (manufacturing vs.

technology) may be more of a problem. In contrast, Cosmopolitan Research Units must collaborate with technology units located in other countries. That means fewer face-to-face meetings, less access to the technology itself, and more dependence upon electronic means of communication. In this context, cultural clashes based upon country of origin may be more problematical than cultural clashes based upon organization function, since all of those involved in such collaborations are from the same function, technology. When considering cultural clashes, Cosmopolitan Full Development may be the worst possible scenario. It requires collaboration among three different functional groups and among people from different countries. These examples show that the new taxonomy has built into it, intrinsically, the bases for discussions about the challenges of collaboration management. This is one way in which it facilitates the consideration of the management issues of overseas technology units.

Conclusions

This paper has presented a new taxonomy of overseas technology units which provides a systematic and comprehensive structure around which issues in the management of such units can be organized. The new taxonomy provides a structure into which specific, concrete mange advice can be fitted in a logical way. The use of collaboration context in defining the basic dimensions of the taxonomy makes it compatible with the discussion of management issues and even provides a starting point for the consideration of those which consider inter-unit collaboration. The improved taxonomy provides a platform for a more effective understanding of overseas technology units and their management.

REFERENCES

Behrman, J. N., & Fischer, W. A. (1980) *Overseas R&D Activities of Transnational Corporations*. Oelgeschlager, Gunn & Hain Publishers, Cambridge, Mass.

Cheng, J. L. C. (1994) Managing innovation in US and Japanese overseas labs: The effects of corporate, scientific and local cultures on R&D performance. *Presented at the Annual Convention of the Academy of Management*, Dallas, Texas.

Cheng, J. L. C., Bolon, D. S. (1994) The management of multinational R&D: A neglected topic in international business research. *Journal of International Business Studies, 1*, 1-18.

Chester, A. N. (1994) Aligning technology with business strategy. *Research-Technology Management, 37(1)*, 25-32.

Cordell, A. J. (1973) Innovation, the multinational corporation: Some implications for national science policy. *Long Range Planning*, Sept. 22-29.

Dussauge, P., Hart, S., & Ramanantsoa, B. (1992) *Strategic Technology Management*. New York: John Wiley & Sons.

Gates, S. (1995) *The Changing Global Role of the Research and Development Function*. The Conference Board.

Granstrand, O., Hakanson, L., & Sjolander, S. (eds.) (1992) *Internationalisation of R&D and Technology*. New York: John Wiley & Sons.

Hakanson, L. (1992) Locational determinants of foreign R&D in Swedish multinationals. In Granstrand, O., Hakanson, L., & Sjolander, S. (eds.) *Internationalisation of R&D and Technology*. New York: John Wiley & Sons.

Hakanson, L., & Nobel, R. (1993a) Foreign research and development in Swedish multinationals. *Research Policy, 22*, 373-396.

Hakanson, L., & Nobel, R. (1993b) Determinants of foreign R&D in Swedish multinationals. *Research Policy, 22*, 397-411.

Hewitt, G. (1980) Research and development performed abroad by US manufacturing multinationals. *Kyklos, 33*, 308-326.

Hood, N., & Young, S. (1982) US multinational R&D: corporate strategies and policy implications for the UK. *Multinational Business*, Vol. 2, 10-23.

Howells, J. (1990) The location and organization of research and development: new Horizons. *Research Policy, 19, 133-146.*

Pearce, R. D. (1989) *The Internationalisation of Research and Development by Multinational Enterprises*. New York: St. Martin's Press.

Pearce, R. D., & Singh, S. (1992a) *Globalizing Research and Development*. New York: St. Martin's Press.

Pearce, R. D., & Singh, S. (1992b) Internationalization of research and development among the world's leading enterprises: Survey analysis of organisation and motivation. In Granstrand, O., Hakanson, L., & Sjolander, S. (eds.) *Internationalisation of R&D and Technology*. New York: John Wiley & Sons.

Pearson, A., Brockhoff, K., & von Boehmer, A. (1993) Decision Parameters in global R&D management. *R&D Management, 23*(3), 249-262.

Ransley, D. L., & Rogers, J. L. (1994) A consensus on best R&D practices. *Research-Technology Management*, March-April, 19-26.

Ronstadt, R. C. (1978) International R&D: The establishment and evolution of research and development abroad by seven US multinationals. *Journal of International Business Studies, 9*, 7-24.

Serapio, M. G. (1993) Macro-Micro analyses of Japanese direct R&D investments in the US automotive and electronics industries. *Management International Review*, *33*, 209-225.

FIGURE 1

PATTERNS OF COLLABORATION IN THE WORK OF TECHNOLOGY UNITS

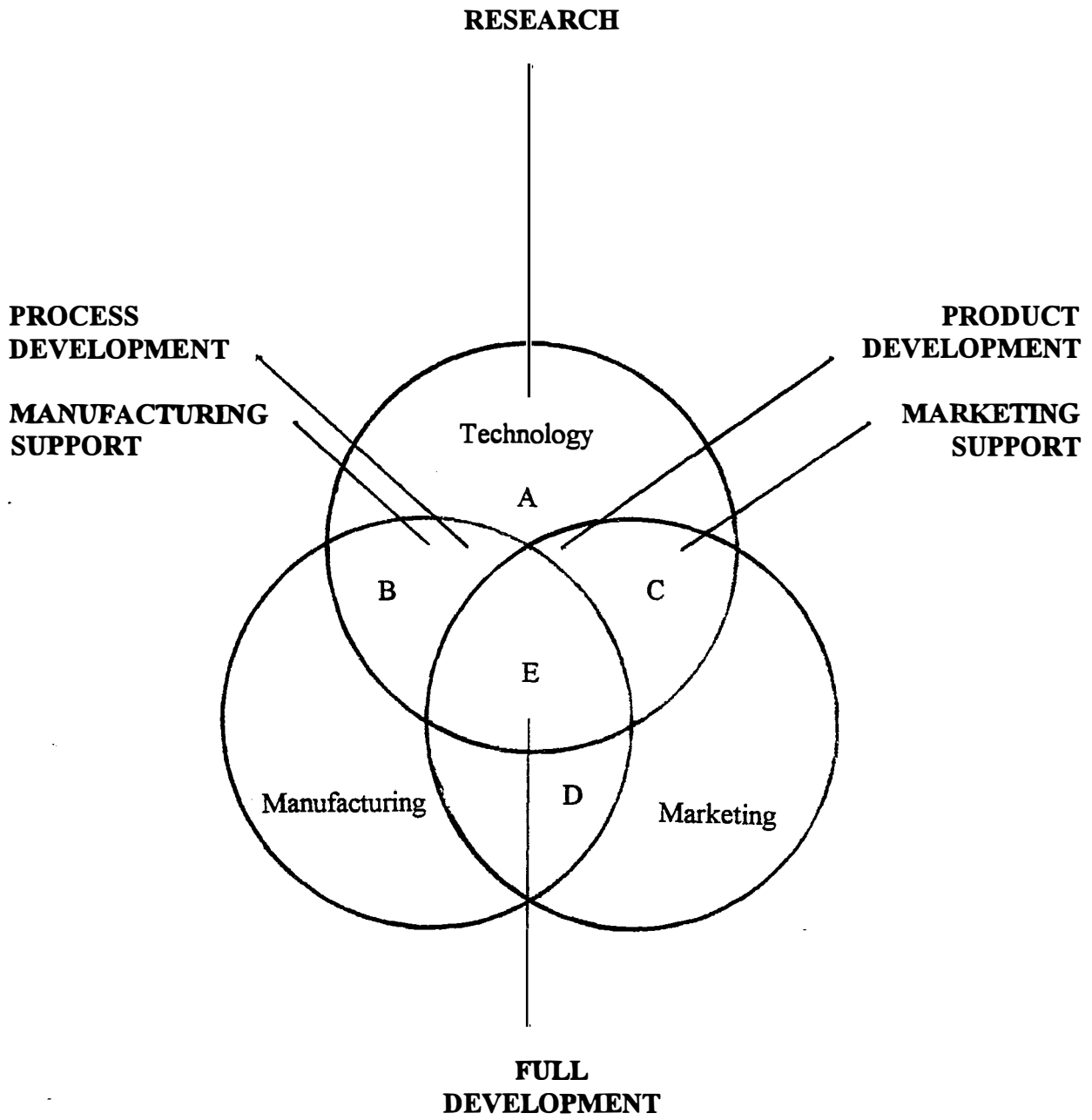

TABLE 1

A TAXONOMY OF TECHNOLOGY UNIT TYPES BASED UPON TYPE OF TECHNICAL WORK AND COLLABORATING FUNCTIONS

Type of Technical Work	Functions Collaborating with Technology Units			
	Marketing	Manufacturing	Marketing & Manufacturing	None
Research	1	2	3	4 Research
Development	5 Product Development	6 Process Development	7 Full Development	8
Support	9 Market Support	10 Manufacturing Support	11	12

Notes. Each numbered cell represents a particular kind of technical work done in collaboration with a particular organizational function. For example, Cell 5 represents development work done with no collaboration with the marketing function. Cell 4 is research work done without collaboration with marketing or manufacturing. In some cells there are labels. These are the commonly used terms for the activities represented by those cells.

TABLE 2

A TAXONOMY OF TECHNOLOGY UNIT TYPES BASED UPON

TECHNICAL ACTIVITY AND

GEOGRAPHIC AREA OF COLLABORATION

Technical Activity	Geographic Area of Collaboration	
	Local	Cosmopolitan
Research	Local Research	Cosmopolitan Research
Product Development	Local Product Development	Cosmopolitan Product Development
Process Development	Local Process Development	Cosmopolitan Process Development
Full Development	Local Full Development	Cosmopolitan Full Development
Market Support	Local Market Support	Cosmopolitan Market Support
Manufacturing Support	Local Manufacturing Support	Cosmopolitan Manufacturing Support

TABLE 3

DEFINITIONS OF OVERSEAS TECHNOLOGY UNIT TYPES

Local Research The discovery of new platforms of scientific knowledge through collaboration with other technology units in the host country.

Cosmopolitan research The discovery of new platforms of scientific knowledge through collaboration with other technology units located outside of the host country.

Local Product Development The creation of new products through collaboration with (a) marketing unit(s) in the host country.

Cosmopolitan Product Development The creation of new products through collaboration with (a) marketing unit(s) located outside the host country.

Local Process Development The creation of new manufacturing processes through collaboration with (a) manufacturing unit(s) located in the host country.

Cosmopolitan Process Development The creation of new manufacturing processes through collaboration with (a) manufacturing unit(s) located outside the host country.

Local Full Development The creation of new products and manufacturing processes through collaboration with marketing and manufacturing units in the host country.

Cosmopolitan Full Development The creation of new products and manufacturing processes through collaboration with marketing and manufacturing units outside of the host country.

Local Marketing Support The support of customers in collaboration with (a) marketing unit(s) in the host country.

Cosmopolitan Marketing Support The support of customers in collaboration with (a) marketing unit(s) located outside of the host country.

Local Manufacturing Support The adaptation of existing manufacturing processes in collaboration with (a) manufacturing unit(s) located in the host country.

Cosmopolitan Manufacturing Support The adaptation of existing manufacturing processes in collaboration with (a) manufacturing unit(s) located outside the host country.

Note. Host country refers to the host country of the technology unit.

TABLE 4

CORRESPONDENCES AMONG TECHNOLOGY UNIT TYPES

New Taxonomy Categories	Past Studies and their Categories							
	Cordell (1973)	Ronstadt (1977, 1978)	Behrman & Fischer (1980)	Hewitt (1980)	Hood & Young (1982)	Pearce & Singh (1992)	Hakanson & Nobel (1993 a, b)	Cheng (1994)
Local Area of Collaboration								
Local Research								
Local Product Development		Indigenous Technology Unit	Host Marketing Company (?)	Local Original R&D	Locally Integrated Laboratory	Locally Integrated Laboratory		Indigenous Lab, Local Market
Local Process Development		Indigenous Technology Unit (?)	Host Marketing Company (?)		Locally Integrated Laboratory	Locally Integrated Laboratory		
Local Full Development		Indigenous Technology Unit (?)	Host Marketing Company (?)		Locally Integrated Laboratory	Locally Integrated Laboratory		
Local Marketing Support	Support Laboratory	Transfer Technology Unit	Home Marketing Company (?)	Product Adaptive R&D	Support Laboratory	Support Laboratory	Market Proximity	Technology Transfer Lab

Continued.....

TABLE 4 (CONTINUED)

CORRESPONDENCES AMONG TECHNOLOGY UNIT TYPES

New Taxonomy Categories	Past Studies and their Categories							
	Cordell (1973)	Ronstadt (1977, 1978)	Behrman & Fischer (1980)	Hewitt (1980)	Hood & Young (1982)	Pearce & Singh (1992)	Hakanson & Nobel (1993 a, b)	Cheng (1994)
Local Mnfg Support	Support Laboratory	Transfer Technology Unit	Home Marketing Company (?)	Process Adaptive R&D	Support Laboratory	Support Laboratory	Production Support	Technology Transfer Lab
Cosmopolitan Area of Collaboration								
Cosmo Research	International Interdepend-ent Lab	Corporate Technology Unit	World Marketing Company	Global Original R&D	International Interdepend-ent Lab	International Interdepend-ent Lab	Monitor Research	International Interdepend-ent Lab
Cosmo Product Development		Global Technology Unit	World Marketing Company (?)	Global Original R&D		Locally Integrated Lab (?)		Indigenous Lab, Multi-Market
Cosmo Process Development		Global Technology Unit	World Marketing Company (?)	Global Original R&D (?)		Locally Integrated Lab (?)		Global Technology Centre

Continued.....

TABLE 4 (CONTINUED)

CORRESPONDENCES AMONG TECHNOLOGY UNIT TYPES

New Taxonomy Categories	Past Studies and their Categories							
	Cordell (1973)	Ronstadt (1977, 1978)	Behrman & Fischer (1980)	Hewitt (1980)	Hood & Young (1982)	Pearce & Singh (1992)	Hakanson & Nobel (1993 a, b)	Cheng (1994)
Cosmo Full Development		Global Technology Unit	World Marketing Company	Global Original R&D (?)				
Cosmo Mktg Support								
Cosmo Mnfg Support								
Not Categorized							Multi motive Unit Political Factors	

Notes. Mktg -Marketing, Mnfg - Manufacturing, Cosmo - Cosmopolitan.

INNOVATION RESEARCH WORKING GROUP
WORKING PAPER SERIES

1. R.G. Cooper and E.J. Kleinschmidt, "How the New Product Impacts on Success and Failure in the Chemical Industry", February, 1992.

2. R.G. Cooper and E.J. Kleinschmidt, "Major New Products: What Distinguishes the Winners in the Chemical Industry", February, 1992.

3. J. Miltenburg, "On the Equivalence of JIT and MRP as Technologies for Reducing Wastes in Manufacturing, March, 1992.

4. J.B. Kim, I. Krinsky and J. Lee, "Valuation of Initial Public Offerings: Evidence from Korea", February, 1992.

5. M. Basadur and S. Robinson, "The New Creative Thinking Skills Needed for Total Quality Management to Become Fact, Not Just Philosophy", April, 1992.

6. S. Edgett and S. Parkinson, "The Development of New Services Distinguishing Between Success and Failure", April, 1992.

7. A.R. Montazemi and K.M. Gupta, "Planning and Development of Information Systems Towards Strategic Advantage of a Firm", April, 1992.

8. A.R. Montazemi, "Reducing the Complexity of MIS Innovation Through Hypermedia and Expert Systems", May, 1992.

9. M. Basadur and Bruce Paton, "Creativity Boosts Profits in Recessionary Times - Broadening the Playing Field", June, 1992.

10. Robert G. Cooper and Elko Kleinschmidt, "Stage-Gate Systems for Product Innovation: Rationale and Results", June, 1992.

11. S.A.W. Drew, "The Strategic Management of Innovation in the Financial Services Industry: An Empirical Study", July, 1992.

12. M. Shehata and M.E. Ibrahim, "The Impact of Tax Policies on Firms' R & D Spending Behavior: The Case of R & D Tax Credit", July, 1992.

13. Willi H. Wiesner, "Development Interview Technology: Implications for Innovative Organizations", July, 1992.

14. Isik U. Zeytinoglu, "Technological Innovation and the Creation of a New Type of Employment: Telework", August, 1992.

15. John W. Medcof, "An Integrated Model for Teaching the Management of Innovation in the Introduction to Organizational Behaviour Course", October, 1992.

16. Min Basadur, "The Why-What's Stopping Analysis: A New Methodology for Formulating Ill-Structured Problems", October, 1992.

17. Stephen A.W. Drew, "Strategy, Innovation and Organizational Learning an Integrative Framework, Case Histories and Directions for Research", November, 1992.

18. Stephen A. W. Drew, "Innovation and Strategy in Financial Services", November, 1992.

19. Scott Edgett, "New Product Development Practices for Retail Financial Services", November, 1992.

20. Robert G. Cooper and Elko J. Kleinschmidt, "New Product Winners and Losers: The Relative Importance of Success Factors - Perception vs. Reality", November, 1992.

21. Robert G. Cooper and Elko J. Kleinschmidt, "A New Product Success Factors Model: An Empirical Validation", November, 1992.

22. Robert G. Cooper & Elko J. Kleinschmidt, "Stage Gate Systems: A Game Plan for New Product Success", November, 1992.

23. Min Basadur, "Optimal Ideation-Evaluation Ratios", March, 1993.

24. Christopher K. Bart, "Gagging on Chaos", March, 1993.

25. Yufei Yuan, "The Role of Information Technology in Business Innovation", July, 1993.

26. Isik Urla Zeytinoglu, "Innovation in Employment: A Telework Experiment in Ontario", July, 1993.

27. John Miltenburg and David Sparling, "Managing and Reducing Total Cycle Time: Moles and Analysis", August, 1993.

28. R.G. Cooper, C.J. Easingwood, S. Edgett, E.J. Kleinschmidt and C. Storey, "What Distinguishes the Top Performers in Financial Services", September, 1993.

29. B.E. Lynn, "Innovation and Accounting Research", September, 1993.

30. Min Basadur and Peter Hausdorf, "Measuring Additional Divergent Thinking Attitudes Related to Creative Problem Solving and Innovation Management", November, 1993.

31. R.G. Cooper and E.J. Kleinschmidt, "Determinants of Time Efficiency in Product Development", December, 1993

32. Christopher K. Bart, "Back to the Future: Timeless Lessons for Organizational Success", February, 1994.

33. Ken R. Deal and Scott J. Edgett, "Determining Success Criteria for New Financial Products; A Comparative Analysis of CART, Logit and Discriminant Analysis", February, 1995.

34. Christopher K. Bart and Mark C. Baetz, "Does Mission Matter?", February, 1995.

35. Christopher K. Bart, "Controlling New Products: A Contingency Approach", February, 1995.

36. Christopher K. Bart, "Is Fortune Magazine Right? An Investigation into the Application of Deutschman's 16 High-Tech Management Practices", February, 1995.

37. Christopher K. Bart, "The Impact of Mission on Firm Innovativeness", February, 1995.

38. John W. Medcof, "Transnational Technology Networks", April, 1995.

39. R.G. Cooper and E.J. Kleinschmidt, "Benchmarking the Critical Success Factors of Firms' New Product Development Programs", April, 1995.

40. John W. Medcof, "Trends in Selected High Technology Industries", July, 1995.

41. Robert C. Cooper & E.J. Kleinschmidt, "Benchmarking Firms' New Product Performance & Practices", September, 1995.

42. Min Basadur and Darryl Kirkland, "Training Effects on the Divergent Thinking Attitudes of South American Managers", November, 1995.

43. Min Basadur, "Organizational Development Interventions for Enhancing Creativity in the Workplace", November, 1995.

44. Min Basadur, "Training Managerial Evaluative and Ideational Skills in Creative Problem Solving: A Causal Model", December, 1995.

45. Min Basadur, Pam Pringle and Simon Taggar, "Improving the Reliability of Three New Scales Which Measure Three New Divergent Thinking Attitudes Related to Organizational Creativity, December, 1995.

46. N. P. Archer and F. Ghasemzadeh, "Project Portfolio Selection Techniques: A Review and a Suggested Integrated Approach, February, 1996.

47. Elko J. Kleinschmidt, Successful new product development in Australia: An empirical analysis, February, 1996.

48. Christopher K. Bart, "Industrial Firms & the Power of Mission, April, 1996.

49. N. P. Archer and F. Ghasemzadeh, Project Portfolio Selection Management through Decision Support: A System Prototype," April, 1996.