A Process Typology of Knowledge Transfer Between Academics And Practitioners In Joint Product Development Projects

By

Ganesh N. Prabhu

August 1999

Please address all correspondence to:

Prof. Ganesh N. Prabhu
Assistant Professor
Indian Institute of Management
Bannerghatta Road
Bangalore – 560 076
India
Fax: (080) 6644050

Copies of the Working Papers may be obtained from the FPM & Research Office

A PROCESS TYPOLOGY OF KNOWLEDGE TRANSFER BETWEEN ACADEMICS AND PRACTITIONERS IN JOINT PRODUCT DEVELOPMENT PROJECTS*

GANESH N. PRABHU
Corporate Strategy and Policy Area
Indian Institute of Management at Bangalore
Bannerghatta Road, Bangalore 560076 India
Phone: (91-80) 6640726 (res.)
Fax: (91-80) 6644050 (off.)
E-mail: gprabhu@iimb.ernet.in

* This article is based on case data collected for the author's doctoral dissertation at the Indian Institute of Management at Ahmedabad, India under the guidance of Mukund R. Dixit (chair), Shekhar Chaudhuri and Deepti Bhatnagar. The *'P. D. Agarwal - TCI Award for Doctoral Research in Management'* from the P. D. Agarwal Foundation, India, and a doctoral fellowship contingency grant supported this research.

A PROCESS TYPOLOGY OF KNOWLEDGE TRANSFER BETWEEN ACADEMICS AND PRACTITIONERS IN JOINT PRODUCT DEVELOPMENT PROJECTS

ABSTRACT

A grounded process typology of knowledge transfer between academics and practitioners emerged from a synthesis of case study research involving forty interviews of participants involved in twelve university-industry joint product development projects. Initial combinations of contextual and technical knowledge levels of participants in relation to the actual product development project requirements were found to set four different ideal types of knowledge transfer processes in such projects. The term *contextual knowledge* refers to an understanding of the actual application context required to develop the product, while the term *technical knowledge* refers to an understanding of the actual technology to be applied to develop the product. The four identified ideal types were descriptively labeled as *Collaborative Technical Development*, *Interactive Contextual Consulting*, *Collaborative Contextual Development* and *Interactive Technical Consulting*. Each ideal type in the proposed typology, set within a proposed typology frame, represents a synergistic combination of initial conditions that led to an effective process of knowledge transfer between academics and practitioners in such projects. Given initial combinations of levels of contextual and technical knowledge of the academic and the practitioner, the ideal type descriptions and the case based illustrations of each ideal type, can be tentatively used as templates by academics and practitioners for predicting and guiding the course of knowledge transfer within their joint product development projects. Apart from contributing to a process based understanding of knowledge transfer between academics and practitioners within such projects, this research can also guide policy makers in initiating and facilitating appropriate knowledge transfer processes while structuring university-industry joint product development projects.

A PROCESS TYPOLOGY OF KNOWLEDGE TRANSFER BETWEEN ACADEMICS AND PRACTITIONERS IN JOINT PRODUCT DEVELOPMENT PROJECTS

Complementary knowledge creation and knowledge transfer between academics and practitioners can lead to industrially relevant academic research and the early industrial application of advances in academic research (Mansfield, 1991; Rosenberg & Nelson, 1994). While informal networking (Schrader, 1991) between academics and practitioners can result in occasional mutual knowledge transfer, joint product development provides an important formal context both for new knowledge creation and for mutually beneficial transfer of knowledge between academics and practitioners. Such joint product development projects usually arise when practitioners, who lack the knowledge and/or resources to develop products on their own, tap on the complementary knowledge and resources of academics to develop them (Bonaccorsi & Piccaluga, 1994).

Studies of joint product development have largely concentrated on identifying either their antecedent conditions or their consequences, rather than on the knowledge transfer process within them (Ingham and Mothe, 1998). Effective knowledge transfer during joint product development can add lasting value to both sides and can sustain the academic-practitioner relationship long after the project is over (Bailetti & Callhan, 1992). Therefore there is need for an in-depth understanding of the knowledge transfer process between academics and practitioners that links antecedent conditions to consequences in such joint product development projects (Berman, 1990).

This article provides an understanding of this linkage by proposing an empirically derived process typology of four ideal types (Doty & Glick, 1994) of knowledge transfer between academics and practitioners participating in joint product development projects. The proposed four ideal process types of knowledge transfer between academics and practitioners were synthesizing from case study research (Eisenhardt, 1989) involving in-depth interviews of forty participants implementing twelve joint product development projects. Each ideal type in the proposed typology represents a synergistic combination (Doty & Glick, 1994) of initial conditions that led to an effective process of knowledge transfer between academics and practitioners in such projects. This research proposes that initial combinations of levels of contextual and technical knowledge of the academic and the practitioner in relation to the requirements of the product development project sets different knowledge transfer processes between them in such projects. Given initial combinations of levels of contextual and technical knowledge of the academic and the practitioner, the ideal types can be tentatively used as templates by the participants for predicting and guiding the course of knowledge transfer within their joint product development projects. Apart from contributing to a process based understanding of knowledge transfer between academics and practitioners within such projects, this research can also help policy makers initiate and facilitate appropriate knowledge transfer processes while structuring university-industry joint product development projects.

METHODOLOGY

The process typology of knowledge transfer between academics and practitioners proposed in this article is based on case data collected for a larger study of the overall process of initiation and implementation of joint product development projects involving universities and firms. Universities for the purpose of this research were considered as independent, autonomous not-for-profit technological institutions involved in technological research and development. Process data for developing a process model of such joint product development projects was developed from grounded (Glaser and Strauss, 1967) idiographic (Tsoukas, 1989) case research (Yin, 1984). The longitudinal processual method of case research (Burgelman, 1983) was adopted to develop multiple qualitative process case studies with the joint product development project as the unit of analysis. Multiple cases provided greater scope for attempting analytical generalization (Yin, 1984) compared to a single case. Twelve projects initiated by six firms and implemented jointly with seven universities were selected from a list of over eighty collaborative product development projects made available by a development financial institution that funded such projects. A variety of projects were selected in terms of firm, university and project characteristics to enable replication and comparison, thus building external validity (Eisenhardt, 1989) and expanding the domain of generalization (Yin, 1984). Primary data was collected through in-depth semi-structured and open-ended personal interviews of about an hour to two and half-hours with forty key project participants - both academics and practitioners. These interviews traced the entire project process including the knowledge transfer process. All interviews were transcribed (167 pages) and supplemented by personal observations, communications, records and reports (Yin, 1984).

The Miles and Huberman (1984) 'categorization and theme analysis' technique was then used to develop project cases from the interview and background data. Draft project cases were read, corrected and cleared by the firms in consultation with their collaborating university. The project cases were written within a common format so that causal patterns over time within cases and general patterns across cases could be analyzed. These project cases served as inputs for the inductive development of the process typology of academic-practitioner knowledge transfer in joint product development projects presented in this article.

PROCESS TYPOLOGY OF KNOWLEDGE TRANSFER

A synthesis of case data developed as detailed above, showed that types of knowledge transfer processes in such product development collaborations were *pivoted* on the initial combinations of levels of *contextual knowledge* and *technical knowledge* possessed by academics and practitioners in relation to the requirements of the product development project. The term *contextual knowledge* refers to an understanding of the actual application context required to develop the product, while the term *technical knowledge* refers to an understanding of the actual technology to be applied to develop the product.

Obviously as defined, adequate levels of both contextual knowledge and technical knowledge are required to actually develop the product. However individual members of product development teams, who initially lack adequate levels of either contextual or technical knowledge or both, can develop their knowledge base through learning while implementing the product development project. Knowledge transfer between participants is another mode for product development team participants to develop their knowledge base. Here we propose a process typology of knowledge transfer that takes place between academics and practitioners participating in joint product development projects.

A typology frame establishing four ideal types (Doty & Glick, 1994) of knowledge transfer between academics and practitioners in joint product development projects was developed through a process of induction from the empirical case data (Eisenhardt, 1989). The typology frame is presented in Figure 1 along with short ideal type descriptions of *initial conditions*, the *primary* and *secondary* knowledge transfer processes and the *outcomes* of each of the four ideal knowledge transfer types. Each ideal knowledge transfer type has been named with a descriptive term based on the nature of the *primary* knowledge transfer process between academics and practitioners in that type. The four ideal knowledge transfer types are named: Type One: *Collaborative Technical Development*, Type Two: *Interactive Contextual Consulting*, Type Three: *Collaborative Contextual Development* and Type Four: *Interactive Technical Consulting*.

Insert Figure 1 about here

A detailed matched description of *initial conditions*, *primary* and *secondary* knowledge transfer processes and *outcomes* in each of the four ideal types of academic-practitioner knowledge transfer processes are now presented. Following each description a specific example of a knowledge transfer process that closely matches the specific type is provided to illustrate the type. Though the four ideal types of knowledge transfer process were drawn from a synthesis of the knowledge transfer process observed in all the twelve projects studied, the actual knowledge transfer mechanisms adopted in specific cases depended on the firm's context and project technology. Therefore, to provide greater clarity, to control for firm and university related variables and to facilitate comparison, the four examples given in this article are *all* drawn from projects implemented by *one* firm (operating in *one* industry) with *one* university. This pair of organizations exhibited all four knowledge transfer types within their set of five joint product development projects. An introduction to this firm, its collaborating university and the nature of the joint projects between the two is provided.

The firm is an alloy steel foundry in a developing country in south Asia. It specializes in valve castings and is the largest valve casting manufacturer in the country and among the largest in the world. As foundry is a sunset industry in developed countries, investments in this industry are higher in developing countries, especially in Asia. The firm simultaneously worked on five different joint product development projects over a period of two years with six professors of an autonomous government supported technological university rated among the best universities in the world. The firm's foundry is located in a rural town midway between the two cities in which the firm's head office and the university were located respectively (400 kilometers from each other). All five projects were initiated to help the firm go for a technology driven capacity expansion using new technologies and systems to improve quality and productivity. Alloy steel castings are high technology items and the firm enjoys a niche market, producing a range of exotic alloys that no other foundry in the country can make. Both the firm and the university placed high importance to knowledge transfer, and all five projects were characterized by a high level of interaction between academics and practitioners, despite the distances between their locations (Mansfield, 1991).

Ideal Type One: Collaborative Technical Development

Description. The first ideal process type of knowledge transfer between academics and practitioners in joint product development projects synthesized from case data has been given the short descriptive phrase *Collaborative Technical Development.* This descriptive phrase is derived from the nature of the primary knowledge transfer process in this type - the collaborative development and simultaneous transfer of new technical knowledge by academics and practitioners while implementing the joint product development project.

The *initial condition* in this type is that both the academic and the practitioner have adequate contextual knowledge to implement the project. However, both individually and jointly have inadequate initial technical knowledge to implement the project, but see the potential to develop it jointly. The *primary process* in this type of knowledge transfer is that both academic and practitioner utilize their contextual knowledge and jointly develop new technical knowledge while implementing the project. A *secondary process* in this type of knowledge transfer is that both transfer complementary contextual knowledge to each other during project interaction. The *outcome* of the process is the creation of new technical knowledge embodied in the new product (Madhavan & Grover, 1998) and development of technical knowledge for both academic and practitioner.

Example. The following example describes the *Collaborative Technical Development* type of knowledge transfer process between academics and practitioners in a joint project that involved the development and introduction of radically new mechanized technology and group technology applications in the fettling (cutting) operations of the firm's foundry to improve productivity. Fettling operations are usually manually handled in Asian foundries resulting in low quality and productivity. The improved techniques included adapting new types of sophisticated machines and robotics with group technology for fettling operations. The engineers at the firm had adequate contextual knowledge (through several years of experience) of a range of alloy materials and their behavior under various types of manual fettling operations. However they had inadequate contextual knowledge of mechanized fettling, robotics and group technology to develop new technology and adaptations on their own. They learnt it during the joint project. The university professor was an expert in foundry technology (including fettling) and also had adequate contextual knowledge of machines, robotics and group technology that was sought to be adapted for the fettling operations. However he had comparatively inadequate contextual knowledge of the behavior of the range of alloys made by the firm under fettling operations and developed this knowledge base during the project. The engineers at the firm and the professor jointly lacked adequate technical knowledge initially to apply these sophisticated machines and methods to fettling operations as they were pioneering applications. The chief executive officer of the firm said; "The fettling and group technology applications that we are attempting to develop are unique concepts in the world."

The project required studying fettling operations at the firm and examining sophisticated metal cutting techniques and group technology innovations developed elsewhere for their economical application to fettling operations at the firm. It involved an extensive search of technical literature for results of similar applications and jointly working towards developing feasible adaptations for the firm, through trial and error. The engineers contributed to building the required database on fettling operations. The professor contacted other scientists who had developed new cutting techniques and got them interested in working jointly with him for adapting their techniques to fettling operations. The engineers and the professor jointly created the required technical knowledge during the course of the project by exploring as well as applying and utilizing their complementary contextual knowledge. The engineers and the professor both developed new technical knowledge. Commented the professor before the project; "It will be a new pathway for work in the fettling area." Simultaneously the two sides also transferred complementary contextual knowledge to each other during project interaction through presentations of technological options, joint experiments and discussion of results. The product (systems developed) embodied new technical knowledge.

Ideal Type Two: Interactive Contextual Consulting

Description. The second ideal process type of knowledge transfer between academics and practitioners in joint product development projects synthesized from case data has been given the short descriptive phrase *Interactive Contextual Consulting.* This descriptive phrase is derived from the nature of the primary knowledge transfer process in this type - interactive consulting based transfer of contextual knowledge by academics to practitioners while implementing the joint product development project.

The *initial condition* in this type is that the academic has adequate contextual knowledge but inadequate technical knowledge to implement the project. On the other hand the practitioner initially has adequate technical knowledge but inadequate contextual knowledge to implement the project. The *primary process* in this type of knowledge transfer is that the academic applies contextual knowledge for the product development project and simultaneously transfers contextual knowledge to the practitioner during project interaction. A *secondary process* in this type of knowledge transfer is that the practitioner provides technical knowledge for product development and transfers technical knowledge to the academic during project interaction. The *outcome* of the process is that the academic gains technical knowledge and the practitioner gains contextual knowledge. However there is no creation of new knowledge but cross-fertilization leads to new knowledge creation avenues for both academics and practitioners.

Example. The following example describes the *Interactive Contextual Consulting* type of knowledge transfer process between academics and practitioners in a joint product that involved the development of new alloys for specialized steel alloy casting applications in the firm's foundry through micro-alloying techniques. Micro-alloying involves adding minute quantities (100 parts per million) of other rare metals to steel to improve its mechanical properties by changing its composition and structure - leading to a wider range of products with improved mechanical properties using economical basic metal compositions. The project required extensive trials and experimentation for determining the precise proportions of micro-alloys and the best method of adding them to the molten metal before casting to yield significantly enhanced properties. The chief executive of the firm commented, "Micro-alloying is not unique; the Russians have done it; but we need to do it for each plant - it has to be customized."

The firm's engineers had adequate technical knowledge to conduct trials on their own. They also had adequate technical knowledge of the nature of specialized products that were to be developed with micro-alloys. However, experimentation at the firm was difficult and expensive, as it would have meant wastage of three metric ton loads for each trial run. The firm's engineers also lacked adequate contextual knowledge on micro-alloy experimentation to develop an economical experimental plan. The university had a fifty-kilogram capacity furnace for alloy steels and could conduct the experiments more economically. The university professor also had adequate contextual knowledge in conducting economical experiments for foundry technology development. He however had inadequate technical knowledge of the specific applications for which the firm was developing micro-alloys. He said, "I wanted to work in this technology area (micro-alloying). Though we had the literature on this subject, we had not done any work in this area before."

The firm provided the raw material to the university for experimentation. The firm's engineers also provided the required technical knowledge regarding micro-alloy applications to the university professor. Based on the results of the university's laboratory experiments, the firm's engineers followed up with larger scale trials at their factory and gave feedback to the professor. Some university students (engineers) also worked on the project along with the professor. Regarding interaction and the knowledge transfer process, the professor said, "They phone us every week or so. They are very curious. They courier samples to us and we then fax them the results. We meet at common forums like conferences, exhibitions etc. They come here every month to interact with us. Our engineers (students) have visited their plant half a dozen times." The coordinator of this project at the firm said, "We have close interaction. (Professor) does the trials and analysis and gives feedback. We do some testing here and give him feedback. They also send us technical literature on micro alloying." The professor gained technical knowledge in micro-alloying applications while the firm's engineers gained contextual knowledge in economical experimental designs. The project interaction created relevant knowledge bases on both sides that could lead to new knowledge creation avenues. "We have enlarged our research activities in a new area", said the professor.

Ideal Type Three: Collaborative Contextual Development

Description. The third ideal process type of knowledge transfer between academics and practitioners in joint product development projects synthesized from case data has been given the short descriptive phrase *Collaborative Contextual Development.* This descriptive phrase is derived from the nature of the primary knowledge transfer process in this type - the collaborative development and simultaneous transfer of new contextual knowledge by academics and practitioners while implementing the joint product development project.

The *initial condition* in this type is that both the academic and the practitioner have adequate technical knowledge to implement the project. However both individually and jointly have inadequate initial contextual knowledge to implement the project, but see the potential to develop it jointly. The *primary process* in this type of knowledge transfer is that both academic and practitioner utilize their complementary technical knowledge and jointly develop new contextual knowledge while implementing the project. A *secondary process* in this type of knowledge transfer is that both transfer complementary technical knowledge to each other during project interaction. The *outcome* of the process is the creation of new contextual knowledge embodied in the new product (Madhavan & Grover, 1998) and development of contextual knowledge for both academic and practitioner.

Example. The following example describes the *Collaborative Contextual Development* type of knowledge transfer process between academics and practitioners in a joint project that involved the development of software for gating designs and improvements in pouring techniques for producing superior quality castings in the firm's foundry. A gating is a thin channel in the sand mould of the casting through which molten metal flows into the hollow of the mould. The gating design is critical, as it determines the flow and settling of molten metal in the mould that in turn determines the strength and durability of the casting. Every casting shape needs a unique gating design. The method of pouring molten metal also impacts the pattern of flow inside the moulds and therefore on the quality of the casting The project required the study of the flow of molten steel in complex three-dimensional moulds and the development of sophisticated software for customized gating design. The chief executive of the firm said, "Gating system design has to be developed uniquely for each foundry.... We need to redesign the process of casting and bring in computer control systems and simulations in gating design, as improper gating causes a lot of casting defects. We did not have the in-house facility for developing these systems." The professor said, "There has been a lot of work in the science of the flow of metals but the translation of this work to the field is a highly challenging task. So we took up this opportunity."

The engineers at the firm had adequate technical knowledge on developing gating designs and also had adequate experience of gating design effects on molten metal flows. However they needed to develop the contextual knowledge required for building a comprehensive and systematic database on gating design and using it to develop the customized software. The project coordinator at the firm said, "Till now we have been doing gating design using our own knowledge and expertise. Now we are using computers to simulate the flow within moulds..... to know how the flow takes place inside the mould and how the metal behaves. So we are studying the flow of metal by simulation.....We have done a large collection of data. We have grouped the items. We have some 5000 items. We are developing a gating design library and a software for gating design." The chief executive said, "Software for gating system design have not been designed as yet anywhere."

The professor had adequate technical knowledge and experience in the study of metal flows and simulation but needed to develop the contextual knowledge to build the required database on metal flow and the customized software. He said, "Building the complex shaped moulds itself is a challenge in mechanical engineering...... For me this study is a wonderful opportunity and some of it is path breaking work internationally. Others may have done similar work but it is not published so we have to do it ourselves and develop the expertise." The project coordinator at the firm said, "(Professor) with his theoretical knowledge can get new ideas but they cannot be implemented at (the university). Over here, we can experiment practically and see if the laboratory predictions match with reality.... We are using his experience. This interaction has helped us in going for more experimentation." The professor and his students studied present gating designs and pouring practices critically and checked patterns of metal flow and defects in castings. They also built a variety of transparent plastic moulds of various sizes and dimensions in which they studied the flow of water as a substitute for molten steel using high-speed video cameras.

Describing the knowledge transfer process, the project coordinator at the firm said, "On studying the gating system design, we found that the design needs to be modified in some cases. We found differences between actual and calculated parameters. We changed it and reworked the design and there was a definite improvement. On the pouring side we have improved the ladle spout design. (Professor) gave guidelines for improving the pouring cup design. We show the video films to our workmen to make them see what they do and so realize their mistakes themselves. This is very effective." The chief executive said, "We video taped a hundred pourings and their cut sections and showed it to our entire group of people. It was a revelation for them. Then they said that maybe our previous methods were wrong. Once conviction came on that front, then the second hurdle was to show that the new method is better. So we did a number of castings in both ways and compared the results on video. A picture is better than a thousand words. They were convinced. So by demonstration we are getting people to accept changes." The project coordinator continued, "Then they (workers) come up with suggestions on their practical difficulties that caused those mistakes. So then we provided facilities related to their problems." Both sides developed contextual knowledge.

Describing the process of complementary technical knowledge transfer, the professor said, "When I make presentations there, they form groups to attend them - between five to twenty-five people attend. Many of their engineers attend presentations even if they are not directly involved with the project. Technology transfer is through oral and written communication and demonstration of feasibility. We pass on notes to them, make presentations with transparencies. Also they give feedback. It is highly interactive with demonstrations of packages etc. We send regular communications show processes on video and photographs. They ask questions and put forward their views, send me their drawings. We analyze and codify them and sent them back. So the technology transfer and training is fairly extensive and intense over time." The software and gating design library embodied new contextual knowledge.

Ideal Type Four: Interactive Technical Consulting

Description. The fourth ideal process type of knowledge transfer between academics and practitioners in joint product development projects synthesized from case data has been given the short descriptive phrase *Interactive Technical Consulting.* This descriptive phrase is derived from the nature of the primary knowledge transfer process in this type - interactive consulting based transfer of technical knowledge by academics to practitioners while implementing the joint product development project.

The *initial condition* in this type is that the academic has adequate technical knowledge but inadequate contextual knowledge to implement the project. On the other hand the practitioner initially has adequate contextual knowledge but inadequate technical knowledge to implement the project. The *primary process* in this type of knowledge transfer is that the academic applies technical knowledge to the product development project and simultaneously transfers technical knowledge to the practitioner during project interaction. A *secondary process* in this type of knowledge transfer is that the practitioner provides contextual knowledge for product development and transfers contextual knowledge to the academic during project interaction. The *outcome* of the process is that the practitioner gains technical knowledge and the academic gains contextual knowledge. However there is no creation of new knowledge but cross-fertilization leads to new knowledge creation avenues for both academics and practitioners.

Example. The following example describes the *Interactive Technical Consulting* type of knowledge transfer process between academics and practitioners in a joint project that involved the computer modeling of the foundry firm's inert oxygen converter to enable better process control for developing high value added alloy products. The firm's inert oxygen converter (a vessel to refine liquid metal to high purity with good mechanical properties) was only one of its kind in the country and one of the few such vessels in alloy steel foundries worldwide. The coordinator at the firm said, "We have to first develop a modeling technique for our converter. Metal refining is a dynamic process. On-line corrective facilities are required for which a computerized processing model is required." The modeling project required mathematical development and computerized simulation of the converter and the behavior of molten metal within it with graphic and numerical interfaces for the user. The model had to be customized for the firm's converter and had to incorporate context specific features. There was no comparable model developed in the country for this type of furnace vessel, though the university professor had developed models of this nature for other types of steel furnace vessels. The professor therefore had adequate technical knowledge in model development required to develop the product but lacked the contextual knowledge of the specific type of vessel to be modeled. The engineers at the firm had adequate contextual knowledge of the behavior of their inert oxygen converter but lacked the technical knowledge to model it.

Describing the project and knowledge transfer process, the coordinator of this project at the firm said, "They (the professor and his student) do the theoretical model building and testing and give us feedback. Then we test practically here and do a dry run to see that the modifications are working. Then they will bring the model here and stay here to test it and fine tune it." The professor described the interaction; "I go to the plant and request data. I study the data and suggest suitable process modifications. They (the firm) implement them and give me feedback on the results..... Our communication with (the firm) is as and when required. It is a two-way communication - I make suggestions and they give feedback. The frequency of communication is not very high, as it is not required.... Once a month interaction is sufficient...It is a joint project - a two-way interactive project. We are jointly solving problems at the industry site with some work at our laboratory." The professor transferred relevant technical knowledge of model development to the engineers at the firm who in turn provided the required contextual knowledge on their inert oxygen converter to the professor and his student. The professor said, "The primary benefit of this project is in giving confidence to my student who is working specifically on this project. My student will get confidence in seeing his work directly applied to the industry." While there was no new knowledge creation, the professor said, "The problem we have tackled is of a general nature and may have wider application in future."

CONCLUSIONS

This paper proposes a grounded process typology of knowledge transfer between academics and practitioners in joint product development projects developed inductively from empirical case research. The typology frame and the accompanying matched descriptions and examples show the internal consistency within each ideal type and differentiate across the ideal types (Doty & Glick, 1994). Given initial conditions, academics and practitioners can use the typology and ideal type descriptions as "templates" in facilitating the process of knowledge transfer in their joint product development projects. This research contributes to theory on the management of knowledge transfer in product development projects (Brown & Eisenhardt, 1995) by providing a link between the antecedent conditions, the knowledge transfer process and its consequences. It also provides methodology and direction for future research in studying knowledge transfer processes in other forms of joint projects.

As this research was of an exploratory nature, I stopped after developing the empirical base and using it for identifying the process typology. While sufficient cases were developed in this research to ensure external validity, large sample research can test the validity, accuracy, completeness and robustness of the proposed process typology. Other interesting avenues for future research are testing the typology (Doty & Glick, 1994) with other forms of joint product development projects, and comparative development of the proposed typology with other typologies of joint activity between organizations (Millar, Demaid & Quintas, 1997).

REFERENCES

Bailetti, A. J., J. R. Callahan. 1992. Assessing the impact of university interactions on an R&D organization. *R&D Management*, **22**, 145-156.

Berman E. M. 1990. The economic impact of industry funded university R&D. *Research Policy*, **19**, 349-355.

Bonaccorsi, A., A. Piccaluga. 1994. A theoretical framework for the evaluation of university-industry relations. *R&D Management*, **24**, 229-247.

Brown, S. L., K. M. Eisenhardt. 1995. Product development: Past research, present findings and future directions. *Academy of Management Review*, **20**, 343-378.

Burgelman, R. A. 1983. A process model of internal corporate venturing in the diversified major firm. *Administrative Science Quarterly*, **28**, 223-244.

Doty D. H., W. H. Glick. 1994. Typologies as a unique form of theory building: Towards an improved understanding and modeling. *Academy of Management Review*, **19**, 230-251.

Eisenhardt, K. M. 1989. Building theories from case study research. *Academy of Management Review*, **14**, 532-550.

Glaser, B., A. Strauss. 1967. *The Discovery of Grounded Theory: Strategies for Qualitative Research*. Wiedenfeld and Nicholson, London.

Ingham M., C. Mothe. 1998. How to learn in R&D partnerships. *R&D Management*, **28**, 249-261.

Madhavan R , R. Grover. 1998. From embedded knowledge to embodied knowledge: New product development as knowledge management. *Journal of Marketing*, **62** (10) 1-12.

Mansfield, E. 1991. Academic research and industrial innovation. *Research Policy*, **19**, 237-249.

Miles, M. B., M. A. Huberman. 1984. *Qualitative Data Analysis*. Sage, Newbury Park, California

Millar, J., A. Demaid, P. Quintas. 1997. Trans-organizational innovation A framework for research. *Technology Analysis & Strategic Management*, **9**, 399-418.

Rosenberg, N., R. R. Nelson. 1994. American universities and technical advance in industry. *Research Policy*, **23**, 323-348.

Schrader, S. 1991. Informal technology transfer between firms? Cooperation through information trading. *Research Policy*, **20**, 153-170.

Tsoukas, H. 1989. The validity of idiographic research explanations. *Academy of Management Review*, **14**, 551-561.

Yin, R. K. 1984. *Case Study Research: Design and Methods.* Sage, Newbury Park, California.

FIGURE 1

Process Typology of Knowledge Transfer between Academics and Practitioners in Joint Product Development Projects

Initial → *Conditions* ↓	Practitioner has adequate contextual knowledge but inadequate technical knowledge to implement project	Practitioner has adequate technical knowledge but inadequate contextual knowledge to implement project
Academic has adequate contextual knowledge but inadequate technical knowledge to implement project	Academic-Practitioner Knowledge Transfer Type 1 *Collaborative Technical Development* <u>Primary Process</u>: Academic and practitioner jointly apply contextual knowledge to product development to create new technical knowledge. Both develop technical knowledge. <u>Secondary Process</u>: Both transfer complementary contextual knowledge to each other during project interaction. <u>Outcomes</u>: Both academic and practitioner utilize contextual knowledge. Both gain technical knowledge. New product embodies new technical knowledge.	Academic-Practitioner Knowledge Transfer Type 2 *Interactive Contextual Consulting* <u>Primary Process</u>: Academic applies contextual knowledge for product development and transfers contextual knowledge to practitioner during project interaction. <u>Secondary Process</u>: Practitioner provides technical knowledge for product development and transfers technical knowledge to academic during project interaction. <u>Outcomes</u>: Academic gains technical knowledge. Practitioner gains contextual knowledge. No new knowledge creation but cross-fertilization leads to new knowledge creation avenues.
Academic has adequate technical knowledge but inadequate contextual knowledge to implement project	Academic-Practitioner Knowledge Transfer Type 4 *Interactive Technical Consulting* <u>Primary Process</u>: Academic applies technical knowledge for product development and transfers technical knowledge to practitioner during project interaction. <u>Secondary Process</u>: Practitioner provides contextual knowledge for product development and transfers contextual knowledge to academic during project interaction. <u>Outcomes</u>: Practitioner gains technical knowledge. Academic gains contextual knowledge. No new knowledge creation but cross-fertilization leads to new knowledge creation avenues.	Academic-Practitioner Knowledge Transfer Type 3 *Collaborative Contextual Development* <u>Primary Process</u>: Academic and practitioner jointly apply technical knowledge to product development to create new contextual knowledge. Both develop contextual knowledge. <u>Secondary Process</u>: Both transfer complementary technical knowledge to each other during project interaction. <u>Outcomes</u>: Both academic and practitioner utilize technical knowledge. Both gain contextual knowledge. New product embodies new contextual knowledge.