



UNIVERSITY OF OSLO

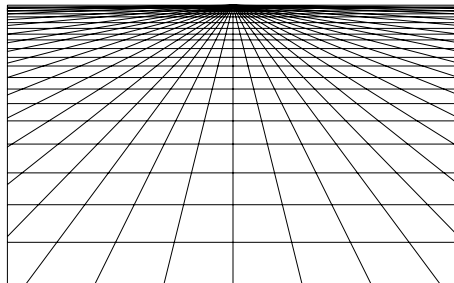
FACULTY OF SOCIAL SCIENCES

TIK



Bureau d'économie
théorique et appliquée
(BETA)

Centre for technology,
innovation and culture
P.O. BOX 1108 Blindern
N-0317 OSLO
Norway
<http://www.tik.uio.no>



ESST

The European Inter-University
Association on Society, Science and
Technology
<http://www.esst.uio.no>

**When Absorptive Capacity Meets Technology Transfer:
Transferring of an E-Learning system to Russia**

Lars Reitan
University of Oslo/University Louis Pasteur
From Theories of Innovation to Technological Policies
2004 - 2005

Word count: 24066

Acknowledgements

I would like to thank Julia Ferkis and Frode Lærum at The Moscow centre for their valuable support and encouragement. In addition I would like to thank Professor Patrick Llerena for supervision and words of advice in the making of this master thesis. Last but not least a special thanks to my fellow students for making this into a special year.

Content

Content	2
Abstract:	4
1.0 Introduction	4
2.0 Technology and technology transfer	6
2.1 Technology	7
2.2 Technology transfer	9
2.2.1 Traditional technology transfer model	10
2.2.2 New model of technology transfer	11
2.3 Technology transfer mechanisms and channels	12
2.4 Transferring context	14
2.5 The time dimension of technology and transfer	16
2.6 Technology transfer strategy	18
2.7 Technology transfer indicators	19
3.0 Diffusion of technology	21
3.1 Knowledge and technology within the organisation	22
4.0 Absorptive capacity	23
4.1 Capacity to recognise valuable external knowledge	25
4.1.1 From individual to organisational absorptive capacity	26
4.2 Capacity to disseminate new knowledge	27
4.2.1 Internal Communication	29
4.2.2 Path dependence	30
4.3 Capacity to exploit new knowledge	32
4.4 The relative absorptive capacity	33
5.0 Context: Changes in Russia	34
5.1 Changes in political structures	35
5.2 Administrative changes	35
5.3 Economic changes	36
5.4 Social changes	37
6.0 The Moscow Centre	37
6.1 Information exchange	39
6.2 Research collaboration	40
6.3 Expert exchange	40
6.4 The e-learning project of the Moscow Centre	41
7.0 Method	42
7.1 Case definition	42
7.1.2 Conceptual framework	43
7.1.3 Initial Preparations	46
7.2 Data collection and data management	46
7.2.1 Data sources	46
7.2.2 Sampling procedure	47
7.2.3 Data management	49
7.3 Analysis	50
8.0 Results and discussion	52
8.1 Capacity to recognise relevant external knowledge	56
8.1.1 Technology content	56
8.1.2 Transfer channel	59
8.2 Capacity to disseminate new knowledge	62
8.2.1 Technology content	62
8.2.2 Transfer mechanism	63

8.2.3 Transfer channel	66
8.3 Capacity to exploit new knowledge	67
8.3.1 Transfer mechanism	67
8.3.2 Technology content	70
8.3.3 Context variables	71
8.4 Path dependence	73
8.4.1 Technology content	73
8.4.2 Technology change over time	75
8.5 Relative absorptive capacity: Learning dyad	76
8.5.1 Transfer mechanism	76
8.5.2 Technology change over time	78
8.5.3 Context variables	79
9.0 Conclusion	80
10 References	85
11 Appendix	88
Appendix #1 List of tables	88
Appendix #2 Organisational chart of The Moscow Centre	88
Appendix #3 Coding Frame	89

Abstract:

This master thesis aims at using the theoretical framework of absorptive capacity as suggested by Cohen and Levinthal (1990) to account for the underlying dimensions critical in a technology transfer process. Technology transfer is a complicated and dynamic process in which technology moves between the transferring partners. The nature of the technology and the capacities of the involved organisations appear to be important in accounting for the transfer. The research applies the use of absorptive capacity as a process indicator. The research project is a qualitative case study of the transferring of an e-learning system from Norway to Russia initiated by the Moscow Centre for Medical Studies affiliated to the University of Oslo. The Study revealed several underlying dimensions critical for the transfer process. The e-learning system could not be seen as independent of organisational parameters and a black boxing of the technology seems undesirable. Different dimensions appeared to be important at different stages. Therefore, there is an ongoing alteration of technology in the technology transfer process. A complex entwined structure indicates that considerations of qualitative dimensions are important when securing successful transfer of complex technology with socially embedded knowledge.

Keywords: *Absorptive capacity, Technology transfer, Social technology, Process indicator, Qualitative research, Underlying dimension*

1.0 Introduction

Technology is a vital part of our daily life. It influences our work and moves back and forth in society creating new opportunities for change and development. Technology transfer is a multi-faced process involving a variety of technologies, partners and subjects. Technology is transferred between organisations and across borders. The transfer itself may have a profound impact on the adoption and diffusion of the technology. Therefore, this thesis seeks to address the importance of the transfer process and how the underlying dimensions interacts and shapes the process.

A centre at the University of Oslo has been working with technology transfer between Norway and Russia since 1993. The centre works in a variety of fields. In recent years there has been an increasing focus on the use of new learning systems and their use in international collaboration.

The Moscow Centre is a cooperation project between The University of Oslo and the Russian Academy of Science and the Sechenov Academy. It works in a variety of fields and in a variety of sectors focusing primarily on research collaboration, information exchange and personnel

exchange within the field of medical science. A broader description of the centre and its activities will be given later in the text. Last year the centre began working on what is to become an e-learning system for use in radiology. An e-learning system is a computer aided interface which includes structured databases and user information (Martin, Massy, Clarke 2003). The e-learning system has many applications, but is focusing primarily on two fields: as a learning tool for physicians and as a tool for data access. Transferring an e-learning system to Russia marks an interesting development in the centre's activities. It is important to note that the e-learning system is not completely independent of all centre activities. Therefore, other centre activities are briefly included in the text.

There has been a tremendous development in the computer and software industry over the last twenty years resulting in the construction of a large array of learning computer interfaces. E-learning systems are interesting from a technology perspective by having both hardware and software features. The perceived nature of technology may have a great impact on how technology transfer is described.

E-learning systems have gained popularity in Europe and have been thought to be heralding a new way of work. It is one of the fastest growing knowledge technologies and an important factor in transforming the education and corporate training. A focus on computer interfaces has begun to be present in Russia and attempts have been made to survey its potential in the realms of medicine. Russian medicine is to some extent different from the Norwegian. Therefore, its application in the Russian context is ambiguous.

In the literature various applications have been suggested but e-learning has gained popularity particularly in the business and management sector (Martin, Massy, Clarke 2003). In the process the contents of learning was thought to be universal and adaptable to most contexts. However,

despite the excitement and rhetoric generated by the e-learning approach as a new way of learning the promised growth and market penetration has not reached the predictions. Being developed in the USA the e-learning systems were originally adapted to fit a particular industry and learning culture. However, it is uncertain whether it can be transferred problem free to other contexts. Successfully adopting and diffusing new e-learning systems appears to vary with the type and context of the organisation.

In an attempt to map the organisation's ability to adopt and diffuse new ideas and technology I will focus on the theoretical field of absorptive capacity through the framework proposed by Cohen and Levinthal (1990). Absorptive capacity refers to the overarching capacity of an organisation to identify relevant external knowledge, disseminate it and use it for the best of the organisation (Cohen, Levinthal 1990).

The general question to be addressed concerns the factors that are likely to help or hinder the adoption, diffusion and exploitation of e-learning on an organisational level when transferred from Norway to Russia. More specifically: which dimensions of absorptive capacity and technology transfer appear to be critical when transferring an e-learning system to Russia through the Moscow Centre? I will start to address the question by accounting for the conception of technology and the process of technology transfer. From there I will proceed to lay out the framework of absorptive capacity. This thesis attempts to use the framework of absorptive capacity to map the potential changes in a technology transfer process.

2.0 Technology and technology transfer

Organisations need to change to adapt to the ever changing business landscape. New technology and new ways of organising are arising from the common effort of the organisations and their

desire to thrive. In order to do so organisations need to work on their own assets and build capabilities to equip the organisation with the necessary tools for survival. This is often in the form of technology acquisition. The rising level of technology can be seen as the foundation of quality upgrades, efficiency improvement and subsequent driver of productivity growth of economies (Tihanyi, Roath 2002).

In the increased competition and the challenges arising from a globalised world, organisations have become increasingly dependent on the ability to research a variety of sources for information. Both internal and external sources are important. External sources can be used in a variety of ways. But when acquiring information from outside sources some sort of transferring process is taking place. Research on technology transfer has increased during recent years (Autio, Laamanen 1995).

2.1 Technology

Considerable effort has been made in defining the various concepts related to the technological development. As a consequence definitions have accordingly been revised to adapt to the changes in the research fields. Social science is soaked in assumptions about technology which often elicits contradictory definitions. Hence, establishing clear definitions and additional terminology is necessary to provide the research with validity and reliability. Technology can have many properties and the definitions will vary dependent on the study in which it is used.

On a basic level technology refers to the knowledge of skill or a science of skill and techniques (Autio, Laamanen 1995). Traditionally technology has been conceived as various technical devices and their subsequent use (Tihanyi, Roath 2002). The technology is flexible, universally applicable and replacable. However, technology need not refer to hardware per se. It can be seen

as a device in wider context, which include information, know-how, trade secrets, organisational structures and social networks (Tihanyi, Roath 2002). Consequently technology is more local, embedded and specific. Thus, technology can be represented along an explicit/tacit continuum, which gives it different characteristics. The explicit/tacit division follows Polyani's (1967) distinction between 'know what' and 'know how'. This will be further explained later in the text.

Assuming that technology can be conceived along an explicit/tacit continuum, technology can be seen as having a large knowledge component that extends beyond the mere technological features, which includes tacit knowledge (Autio, Laamanen 1995). In defining technology it is important to identify the external factors and tacit knowledge components that are affecting the technological development (Autio, Laamanen 1995). When attempting to find indicators and measuring devices in inter-organisational technology transfer it is necessary to take into account the process of transfer and the interaction that occur between the parties. The interaction can be conceived as being either technical or social dependent on the perspective applied (see table 1).

Table 1
Technology and technology transfer continuum:

	Information/explicit	Knowledge/tacit
Units of analysis	Technique	Capability
Characteristics of technology	Flexible/replaceable/reversible/ Generic	Local/cumulative/specific/ Path-dependent
Nature	Static	Dynamic
Access	Open	Limited
Concept	Transaction	Investment
Economic focus	Price	Dynamic externalises
Transferring mechanisms	Arm's length	Various forms
Transfer cost	Low	Potentially very high

Adapted from Tihanyi, Roath (2002), Technology transfer and institutional development in central and Eastern Europe (table 1).

Sharif and Ramanathan (1987) argue that technology as a concept can be divided into four main components, technoware, infoware, humanware and orgaware. The four categories try to capture a wider conception of technology. The technoware refers to the technological component or the device in question. The device has certain characteristics that include an informational aspect, or

infoware. The humanware refers to the available human resources and their characteristics. This opens for that the tacit knowledge among the humans is a component of technology. The humanware exists within a framework, or the orgaware. The orgaware deals with how the technology device interacts with the framework of an organisation. All in all this approach covers the technology in a wider conception and acknowledges the importance of the context of the technology and the framework in which it exists.

2.2 Technology transfer

The definition of technology and the transfer process has implications for how technology is transferred between the sender and receiver organisations (Tihanyi, Roath 2002). Technology transfer can be as simple as a shift of explicit information and devices from one organisation to the other, or it could be a complex process of information and knowledge exchange involving tacit features. The complexity of advancing technology, variations in government policy and rapid changes in organisational structures all present challenges to technology transfer (Tihanyi, Roath 2002).

Technology transfer can be conceptualised in different ways. I will for the sake of argument and given the limited scope of this assignment focus on technology transfer as the active process during which technology passes from one entity to another (Autio, Laamanen 1995). The conceptualisation of technology transfer differs. However, two main traditions stand out. This is often referred to as the linear traditional technology transfer model and the parallel modern technology transfer model (Autio, Laamanen 1995). Given the time and space constraints in this assignment I will use these two groups only.

Following the modern models for technology transfer knowledge is entwined with the technology. The linear transfer conception assumes a juxtaposition of technology and knowledge, rendering them as two different constructs. Autio and Laamanen (1995) argue that technology has a large knowledge component. Therefore, technology from the modern perspective has to be seen in conjunction with knowledge.

The traditional view assumes no changes in the technology during the transfer process often referred to as black-boxing (Asdal, Myklebust 1999). Technology is 'open' and neutral. The modern view emphasise on a more interactive process in which technology is shaped and changed in the process (Asdal, Myklebust 1999). The technology contains unknown context bounded features.

2.2.1 Traditional technology transfer model

Within the traditional view on technology transfer Amesse and Cohendet (2001) identify four properties of technology. Firstly, the literature assumes clear boundaries of the organisations in question. The division between internal parts of the organisation and external parts is clear cut. Secondly, the innovation process and the development of technology is strongly localised within the organisation. The R&D functions are strategically located close to the main body of the organisation. Thirdly, there is a strong division between the creation of the technology and the commercialisation of it. Fourthly, there is a substantial time lag between the creation of the technology and the reproduction of it in home organisation subsidiaries, and in external organisations. The process is linear and is based on the idea of a cumulative development from a scientific to industrial development (Asdal, Myklebust 1999). From this viewpoint there is little or no consideration of the properties of the technology itself as it passes unchanged from one entity

to the next. Once the R&D department is finished with it the technology is perceived as completed and does not develop any further.

2.2.2 New model of technology transfer

Increasingly complex technology and a faster moving market have blurred the lines between production and the use of knowledge and technology (Amesse, Cohendet 2001). This has resulted in a blurring of the boundaries between intra- and inter-organisational technology transfer, which challenges the traditional view of technology transfer. The development of new technology is not necessarily confined within the R&D units of organisations, but may be the product of work within a wider selection of organisation subunits. As technology need not refer to hardware, the development process can occur outside of laboratories and R&D units. Also, with a more intangible conception of technology the creation of it and the commercialisation may be entwined and there may be less of a time lag between completion and reproduction. The traditional and linear model emphasise on a clear division between theory and practice, whereas the new technology models assumes a close relationship between the technological knowledge and the related practices (Asdal, Myklebust 1999). Given less time delay from completion to market introduction a parallel development process is necessary (Amesse, Cohendet 2001). Parallel development assumes that parts or modules of the technology can be developed alongside one another. As opposed to the linear model, this process does not necessarily assume that the technology has to be finished in order to proceed in the development process.

The new model entails certain aspects of social interaction with the technology. Social constructionists have argued that this social interaction actually shapes and construct the technology itself. This is often attributed to the scientific tradition of Social Construction of

Technology, SCOT (Kuper, Kuper 1996). Social impact is likely to have an impact in most processes that include human beings. However, the nature and degree of impact is disputed.

The traditional view on technology transfer assumes a completed technology conception and it is thus more tangible in nature. The more intangible nature of technology the less completed it may appear. From the 1990ties and onwards it has been argued that we are entering a knowledge based economy. Amese and Cohendet (2001) argue that the new knowledge based economy has brought about changes in how technology transfer is perceived and emphasises on the social dimension of the process. To the extent that 'hard' technology is transferred in the contemporary world it is crucially dependent on the transfer of tacit knowledge components, which can only be transferred in tight collaboration between the different parties in the development and transferring process (Dyker 2001).

2.3 Technology transfer mechanisms and channels

Inherent in a transferring process is the presence of a transfer vehicle and pipeline (Teece 1977). The technology transfer mechanism refers to the *form* of interaction between the entities involved in the transfer. Autio and Laamanen (1995) identify two main categories of transferring mechanisms, which are process mechanisms and output mechanisms. The two categories establish a difference between ongoing development activities and the results of development activities. Whereas the process mechanisms are related to the services and organisational arrangements, the output mechanisms are concerned with the direct output of the research and the transferring process. It is reason to believe that the various interfaces existing between organisations will have an effect on the technology itself.

The transfer channel refers to the *link* through which technology flows (Autio, Laamanen 1995). A technology transfer channel is any form of link through which technology can be transferred placed on a formal/informal continuum (Rogers 2003). Formal channels are for example exchange of personnel, formal cooperation schemes, system and equipment exchange and financial transactions between partners. More informal channels can be social networks, participation in symposia and informal contact between personnel and so on (Kvinge 2004). An organisation will have a number of potential technology transfer mechanisms and channels. The nature and number of those mechanisms and channels varies dependent on the makeup of the organisation (Rogers 2003.). In order to facilitate transfer in and out of the organisation it is necessary to adapt proper mechanisms and channels. Therefore, the organisation is reliant on these channels as they are the major connection point to the outside world.

As noted above the traditional models of technology transfer assumes that the technology moves unchanged between the involved entities. The traditional literature tends to black-box the transferring process assuming that the technology remains unchanged by intervening factors. Given a non-changing technology considerations of the nature of mechanisms and channels appears less interesting as they will have a limited effect on both transferring and technology. However, through the modern school of technology transfer, more weight is being added to the intangible elements in the process (Rogers 2003). Autio and Laamanen (1995) argue that a technology transfer mechanism is *any* form of interaction between two or more *social* entities during which technology is transferred. Whereas the traditional technology transfer research has focused on technology transfer where the technology remains unchanged by the transferring process, Autio and Laamanen (1995) observes a shift towards a more interactive transfer process in which the technology is affected by the transfer process.

The distribution of access points is vital to the transferring process. By having many alternative transfer mechanisms and channels the organisation increases the number of potential transfers. However, if an organisation has fewer of them the capacity of the existing access points become increasingly important. It is important to keep in mind that having various transfer channels and mechanisms do not necessarily entail successful usage. The nature of the mechanisms and channels available is both organisation dependent and context dependent (Rogers 2003). An organisation exists in an environment, which greatly influences the inner workings of it.

2.4 Transferring context

The contextual environment such as laws, regulations, rules, norms and customs may affect the technology transfer and/or the application of the technology once it has been transferred (Tihanyi, Roath 2002). Therefore, the institutional environment plays an important role in the transferring between the involved parties. Abramovitz (1986) argues that the social capabilities of countries are important. Especially for those countries that are catching up on the leaders. These capabilities are dependent on the present infrastructure such as education system to provide the country with an able workforce. In addition will the structural features of the country such as legislative institutions, financial institutions and other have an effect (Lundvall et al. 2002).

From this perspective the institutional context can be seen as the national system of innovation (Lundvall et al. 2002). The national system of innovation is considered to be the set of exogene factors that condition and mediate technological change and economic development (Lundvall 2002). The notion of national system of innovation is a way of making a framework in which the contextual features surrounding an organisation can be ordered. Abramovitz' notion of infrastructure appears somewhat similar to the notion of national system of innovation. National systems of innovation differ substantially (Lundvall 2002). Changes in regulatory devices show

that the environment influences the technology transfer (Tihanyi, Roath 2002). This makes it into a two-way process. Therefore, creating institutional environments that are favourable is imperative for the relevant authorities (Thanyi, Roath 2002).

Changes over time in the system and/or rapid radical change may make the situation unclear for outside organisations. Thus, it becomes important to be sensitive to contextual systemic features when considering technology transfer. Any technology transfer project should be solved in coordination with local governments to reduce the risk associated with market entry under unstable conditions (Rogers 2003).

The national system of innovation opens for the possibility of effects beyond the parties involved as the transferring parties are situated within a wider system. Thus, the process is not solely local. As there are potential effects within the particular industry and on national levels, technology development cannot be limited to the actions of the transferring parties. It becomes increasingly difficult to assess the cause and effect within a single transfer process as the process itself is dependent on external factors often to be found in the context of the organisation. Empirical data collected in the study of national innovation systems suggests that the success of innovation, their diffusion rate and subsequent productivity increase can be attributed to a variety of factors beside formal R&D (Freeman, Soete 1997). Organisation differences, interaction with the market and related organisations have contributed to the increase in innovation and the diffusion and their subsequent use.

The studies of national systems of innovation have given little attention to the subsystems related to human resource development (Lundvall et al. 2002). The needs in this subsystem will be the subject for social innovations in the near future as large parts of the overall system peculiarities are rooted in this subsystem (Lundvall et al. 2002). The challenges of the knowledge based

economy have increased the service specialising in producing, and selling knowledge. The production of more intangible technology is increasing and understanding how such businesses operate within and across national borders is vital for the understanding of the future economics (Lundvall et al. 2002).

2.5 The time dimension of technology and transfer

In the traditional view of technology transfer the technology moves unchanged through the mechanisms and channels. This is a potentially time consuming process. The traditional view acknowledges that there is a time lag between completion of the technology and market introduction. However, the traditional view assumes that technology does not change over time in the transferring process. The black-boxing of technology causes it to remain static even though the transfer itself may be time consuming.

From the modern perspective the picture looks different. During the early phases of technology transfer Autio and Laamanen (1995) assume that the tacit knowledge dominate the transfer process. At this stage the receiver mainly seeks 'software' information that is embodied in the technology (Rogers 2003). Therefore a necessary requisite for any development is the capacity to develop knowledge about the technology in question. Following this logic, Autio and Laamanen (1995) assume that the nature of the technology changes over time and have different properties dependent on where in the transferring process it is and how that affects the people involved in the process.

Knox and Denison (1990 in Autio, Laamanen 1995) argue that technology passes through different stages before it reaches maturity. Thus, the maturity of a technology may cause it to have different properties over time. The technology transfer process differs dependent on the

technology maturity. The innovation process itself is often referred to as vertical transfer of technology (Teece 1977). Horizontal transfer refers to the transfer of technology from one phase to the next. It is reason to believe that the maturity of the technology will differ dependent on which phase in the transfer it is. Therefore, the technology may need different types of transferring mechanisms to enable transfer at different stages. Moreover, horizontal transfer may require the cooperation of different units within the organisation. In the old conception of technology transfer once the technology left the R&D department it was considered to be completed. The linear model assumes that the completed technology is passed on as it is, and thus other parties later in the process chain do not interact with the technology. By assuming a parallel conception of innovation the technology will necessarily interact with other parties of the process chain (Rogers 2003). Sometimes it is necessary to transfer technology between organisations in order to proceed from one phase to the next. Thus, the mechanism and channel becomes important to facilitate this type of transfer. The content of the technology, its change over time and the impact of context variables makes technology transfer into a complex phenomenon.

Assuming a black-box strategy where the technology remains static or unknown throughout the transferring process there is no need to be sensitive to whether the technology has different properties at different stages. Furthermore, a consideration of the different phases will not yield knowledge about the potential applicability of different transferring mechanisms at different stages of the transferring process. Moreover, incomplete technology will through a linear conception not be considered for transfer.

2.6 Technology transfer strategy

As noted earlier this paper conceives technology transfer as an active process in which the participating parties are actively engaged. Therefore, certain strategies are constructed to oversee the transfer as all transfer processes are potentially costly in terms of money and effort (Teece 1977). Strategies are systems for foresight to enable the organisation to generate ideas about how it is likely to behave in the future. When transferring the sending institution needs to take the receiver's capabilities into consideration to have some sort of idea about the cost of the transfer (Dyker 2001). This may require the sending institution to expend valuable time and resources on something in which the outcome is uncertain. It is commonly assumed that the cost of transferring technology is low compared to the cost of undertaking R&D (Kvinge 2004). However, Teece (1977) argues that the cost of transfer can be high when the technology is complex and the recipient organisation lacks the necessary capabilities to integrate the new technology (See table 1).

Another important consideration of technology transfer is the particular type of technology that the transferring organisation is attempting to share. The sending institution may have to evaluate the ultimate use of the transferred technology and for example the leakage of sensitive information to determine the appropriate level of the technology is question (Tihanyi, Roath 2002).

Giving up vital research secret and the potential transfer to third party organisations is a strategic consideration in technology transfer. For example legal issues may play an important role. The recipient environment may lack functioning legal system to protect the transferred technology e.g. in Russia. For example insufficiently developed legal systems against counterfeit products may have serious impact on the decision to transfer and what to transfer. In international

technology transfer cases such issues are often considered and transferring strategies should be developed in the context of the local environment (Tihanyi Roath 2002).

Given differences in technological background and differences attributed to national and cultural factors the recipient may not have the technological base to support the transfer. This may include the more intangible assets. Therefore it is imperative to examine the receiving institutions ability to incorporate the relevant knowledge and processes. Teece (1977) distinguishes between cost connected with the transfer of technological know-how and absorption cost. Assessing these capabilities beforehand may save large investments due to costly ad hoc solutions for catching up.

2.7 Technology transfer indicators

In the research of technology transfer one is in need of certain indicators for measurement. The nature of those indicators will largely determine how the transfer is conceived and interpreted (Smith 2005). Autio and Laamanen (1995) distinguish between input/output indicators and process indicators. This distinction highlights the difference between the development process in itself and the inputs and outcomes of that process (table 2).

Table 2
Technology transfer indicators

Input indicators	Output indicators	Process indicators
Research investment	Research output	New development links
Capability inputs	Commercial output	Capability transfer and utilisation
Technology input	Monetary and resource output	New development units

Adapted from Autio and Laamanen (1995) Measurement and evaluation of technology transfer (pp 665).

The traditional measuring device for research and development activity has been the input/output indicators, mainly because they are easy to measure in exact terms (Smith 2005). Research investment, like foreign direct investment (FDI) is a commonly used input indicator,

whereas royalty revenue is one output indicator. Process indicators on the other hand focus on the development that occurs in the process. The process indicators differ from the input and output indicators primarily by being more future-orientated. Instead of focusing on *how much* research investments that are used, it emphasises on *how* they are used (Autio, Laamanen 1995). This focus makes the process indicators more qualitative in nature as the knowledge intensive development process is inherently difficult to assess quantitatively. This may explain why they are less used in the technology transfer research which favours input and output indicators for accurate measurement. A transferring process is likely to start with some sort of input, which precedes a process where process indicators account for the development, which results in some sort of output of that development.

As the locus of technology development is shifting towards a more network orientated understanding of technology transfer, cooperative are models increasing in importance. Therefore, the emphasis in the evaluation research should strive to shift accordingly (Autio, Laamanen 1995). Finding universal indicators for the measurement and evaluation of technology transfer may prove to be problematic. The changing patterns of the technological innovation process itself following challenges in the knowledge based economy may complicate the issue even further (Smith 2005). Therefore, the nature of the technology that is being transferred and the circumstances under which it is transferred may have an impact on the indicators used. In a situation in which one deals with knowledge of a more qualitative nature it is important to apply indicators that will shed light on the process. Therefore, this paper will divert attention to process indicators in an attempt to illuminate the qualitative underpinnings of technology transfer. Three types of process indicators have been identified in table 2. The process indicators emphasise on the development of links between actors in the technology transfer process and the capabilities of these actors to disseminate and use the technology that flows between the partners (Autio, Laamanen 1995).

3.0 Diffusion of technology

Much has been said about the adoption and diffusion of technology. Technology transfer models deal primarily with the *transfer*, not necessarily with the diffusion and later use of the technology. Diffusion can be seen as the process by which a technology is communicated through certain channels over time within or between *social systems* (Rogers 2003). Technology is not transferred into a vacuum. Hence, consideration of the diffusion process is important. The attempt to illuminate the adoption and diffusion of technology has to elaborate on the nature of what is being absorbed and how it is being absorbed in the social context (Rogers 2003). Diffusion can occur within a variety of contexts and situations. I will for the sake of argument use the notion of an organisation as the main context.

The literature on the subject has traditionally been divided between a focus on the organisation design and a focus on organisational cognition and learning (Lam 2005). Lam (2005) argues that the main focus in the literature of organisational design theories is predominantly on the link between structural forms and the propensity to innovate through the use of new technology. The aim of that research viewpoint is to determine the effects of organisational structural variables on the innovative activity.

By contrast organisational innovation seen through the theories of organisational cognition and learning tend to focus predominantly on the processing of new knowledge and the development of new ideas for problem solving (Lam 2005). As opposed to the perspective discussed above that treats innovation as an output of certain structural features, the cognition and learning research view innovation as a process in which new problem solving skills and ideas are brought into use to foster innovation (Lam 2005). Through this perspective an innovative organisation is

one who is capable of effectively learn and create new knowledge (Nonaka 1994). This perspective encompasses a social dimension through the notion of collective action. The knowledge in the organisation is the prerequisite of their ability to diffuse new technology.

3.1 Knowledge and technology within the organisation

The knowledge within an organisation is multifaceted, complex and dynamic. What constitutes knowledge has been widely debated within philosophy (Fuller 2002). Drawing upon the work of Polanyi (1967) and contemporary theorists in organisational research such as Nonaka (1994) this paper assumes that there are different types of knowledge that are relevant for organisations in a transfer situation. Polanyi (1967) regards knowledge as both static and dynamic referring to knowledge per se and the process of knowing. Both categories are important for the understanding of technology transfer. Epistemological stances, like Polanyi (1967) argues that knowledge can be translated into 'know what' and 'know how', often referred to as a division between explicit and tacit knowledge (see table 1). 'Knowing what' can be accounted for in quantitative terms, for example through increases in formal competence among employees. The 'knowing how' is as a consequence of the more intangible and tacit nature of competence, difficult to assess quantitatively. Thus, when measuring 'know how' qualitative indicators need to be applied through a focus on process indicators (Autio, Laamanen 1995).

The innovation process can be seen as resulting from the process of learning and knowledge creation. New problems are defined and new knowledge is developed to address the problem (Lam 2005). Central to the process of organisational learning and knowledge creation is the translation of individual insight and knowledge into organisational knowledge and subsequent capabilities (Cohen, Levinthal 1990). Following Polanyi (1967) knowledge is social and this socially conveyed knowledge mixes with the individual's experience of reality.

Collective knowledge can be seen as the accumulated knowledge within the organisation stored in rules, procedures and shared norms, all under an umbrella of an organisational culture (Hatch 1997). This includes both the individually situated knowledge and the collective knowledge. Walch and Ungson (1991 in Lam 2005) argue that the collective knowledge resembles the memory or collective mind of the organisation thus making it into a cohesive entity.

4.0 Absorptive capacity

Given the complex nature of the transferring process and the importance of the diffusion, dissemination and subsequent usage of technology, any researcher is in need of a sensitive theoretical framework to capture the process. Assuming a difference between explicit and tacit knowledge the methods for acquisition and accumulation of the two types may differ. Even though we assume a conceptual distinction between tacit and explicit knowledge they need not be divided into those categories in practice. Nonaka (1994) argues that organisations generate knowledge through the dynamic interaction of the two types of knowledge. Alternatively, the organisation constitutes a special context in which the explicit and tacit modes of knowledge are selected on the basis of interaction with the external economic reality and then stored in organisational routines (Hatch 1997). The quality of the interaction with the external environment and the interaction of the explicit and tacit types of knowledge may enhance organisation performance. Organisations may differ in their capacities for fostering this interaction and their relative importance to the organisation may also differ dependent on the organisation environment. This capacity is often referred to as absorptive capacity in the literature (Cohen Levinthal 1990, Dyker 2001, Lane, Lubatkin 1998). I will in this thesis apply the theoretical framework of absorptive capacity in an attempt to shed some light on the inner workings of technology transfer.

The process of technology acquisition and subsequent transfer is often dependent on outside sources of knowledge. Therefore, it is imperative to be capable of exploiting this knowledge and integrate it as a component of the overall capabilities of the organisation (Cohen, Levinthal 1990). This ability is largely a function of the level of prior related knowledge. An organisation uses its prior related knowledge to acquire new knowledge that can be used in conjunction with the old, and create new opportunities for the organisation.

To look into and to assess the absorptive capacity of an organisation we are in need of a framework to systemise the different dimensions of the construct. Originally Cohen and Levinthal (1990) separate between (1) the demand for relevant knowledge, (2) appropriability conditions of the knowledge and (3) the technological opportunity conditions.

Zahra and George (2002) suggest a division between potential and realised capacity. Potential capacity refers to the acquisition and assimilation, while realised capabilities refer to the transformation and exploitation of knowledge.

To address the different dimensions of absorptive capacity I will try to propose a structure to the framework. Given the limited scope of this assignment it is necessary to structure it to be able to generate a cohesive argument. Firstly, I will argue that the demand for relevant knowledge is closely related to the capacity to recognise valuable knowledge in the external environment. Thus, this knowledge represents a potential, which the organisation has to recognise in order to benefit from. Secondly, the appropriability conditions and the realised capacity of an organisation can be seen as a function of the dissemination of knowledge in the organisation. And thirdly, the technological opportunity conditions and their realised capacity can be seen as linked to the capacity to benefit from and commercialise new knowledge.

4.1 Capacity to recognise valuable external knowledge

The first dimension in the absorptive capacity framework deals with the identification of knowledge. This can be many different things, but for the sake of argument Cohen and Levinthal (1990) define this as the dynamic capacity to identify and acquire external knowledge about relevant topics.

The demand for relevant knowledge relates to the ability to recognise relevant valuable external knowledge, which may provide the organisation with new insight and subsequent improved absorptive capacity and with it, organisational performance. If an organisation manages to gain and use new knowledge which can enhance their work, it is a reflection of a higher absorptive capacity.

Two criteria are imperative for this process; the possession of basic knowledge in the relevant field and some diversity of knowledge to permit effective and creative use of the new knowledge (Cohen, Levinthal 1990). Basic knowledge in the relevant field is important to provide the organisation with an understanding of traditions and processes on which the relevant field is built, and thereby enable understanding of the importance of the new knowledge for its own operations. Diversity is important in connection to the integration and use of the new knowledge forming new links and creating novel fields of knowledge (Zahra, George 2002). Creativity is important to the process of disseminating and usage of the newly acquired knowledge.

The development of an effective absorptive capacity depends on the intensity of effort (Cohen, Levinthal 1990). Merely exposing individuals or organisations to relevant knowledge need not yield increased skills. Therefore, the more deeply the knowledge is processed the more likely it is to be retrievable and usable (Reisberg 2001). This is somewhat similar to Zahra and George's (2002) distinction between potential and realised capacity.

4.1.1 From individual to organisational absorptive capacity

When an organisation has the necessary prior knowledge to recognise and value the external knowledge, what it needs to do is to acquire and disseminate it (Cohen, Levinthal 1990). The absorptive capacity of an organisation is dependent on the absorptive capabilities of its members (Cohen, Levinthal 1990). However, the absorptive capacity of an organisation is more than the sum of the individual capabilities within it (Cohen, Levinthal 1990). As the absorptive capacity of an organisation includes considerations about the use of knowledge, the absorptive capacity does not depend merely on contact with the external environment but also on the ability to connect the organisation units. Thus, the connectivity adds value in the organisational context which would not develop if we conceive the individuals as atomistic entities. However, it is important to keep in mind that the capabilities can be lower as a consequence of coordination loss within the organisation (Hewstone, Stroebe 2001). Nevertheless, whether higher or lower an organisation represents something qualitatively different than just the mere sum of its members.

The ability to identify relevant external knowledge does not depend exclusively on the parts exposed to the external environment and the organisation's interface with the external world. As important is the transferring of knowledge within the different units of the organisation through the parallel conception of technology change and horizontal transfer. Many of these units may lack direct contact with external environments. Thus, the internal communication is critical to the distribution of knowledge and subsequent use of it. Logically organisational structure may be of importance to provide the organisation with a useful interface for knowledge transfer and dissemination. Lam (2005) argues that the structural view on organisational innovation emphasises on the link between organisational structure and propensity to innovate. This propensity to innovate is strongly linked to the innovative capabilities of that organisation. However, from a

learning perspective the interface to the external world is formed by the increased capabilities of the individuals and the organisation.

4.2 Capacity to disseminate new knowledge

The dissemination process refers to the organisation's ability to fuse the newly identified knowledge with the existing knowledge base of the organisation. This dimension highlights the way in which the organisation and its individuals learn with the newly acquired and assimilated knowledge (Cohen, Levinthal 1990). The transformation process is associated with the ability to transform or translate new knowledge that may have an initial low level of fit with the existing knowledgebase of the organisation. Through this process the organisation is able to alter the way in which it acquires knowledge and thus, enhance the existing base for absorption.

This process has three sub categories (Martin, Massy, Clarke, 2003). The speed in which the acquisition takes place, the intensity of the acquisition and the direction of the acquisition do all play an important role in the process. Speed is critical as it indicates how fast an organisation is able to acquire new knowledge. Research in cognitive psychology has suggested that being somewhat familiar with the topic or process of a novel task, significantly increases the speed of learning in related fields and reduces the number of failures (Hewstone, Stroebe 2001). Cohen and Levinthal (1990) call this basic knowledge. The intensity of effort and the direction of the acquisition refer to the level of intentional goal orientated activities. When one is acquiring new knowledge paying attention to it in the acquisition phase is important, as well as the considerations concerning its anticipated use for the organisation.

When acquiring new knowledge this knowledge should be somewhat connected to the existing knowledge base. Several studies in for example cognitive psychology has shown that learning is

best when the new knowledge is related to prior knowledge and integrated in the existing knowledge structure (Reisberg 2001). It is reason to believe that this also applies for organisations. The appropriability of the knowledge in connection to the existing knowledge base will, according to Cohen and Levinthal (1990), enable an organisation to capture the profit connected to the innovative activity. For an organisation that works within a given domain, the appropriability of the new knowledge in connection to the existing prior knowledge will have a positive effect on the absorptive capacity of the organisation (Cohen, Levinthal 1989).

For the sake of argument one can distinguish between three different methods for acquiring external knowledge. It can be either passive, active or interactive, which each provide different types of knowledge. Passive acquisition occurs when an organisation acquire explicit knowledge without direct involvement of personnel, active acquisition is when personnel is involved and interactive acquisition is when a two way communication occurs (Lane, Lubatkin 1998). This active/passive distinction should not be confused with the distinction between active and passive technology transfer. This thesis focuses on the active transfer conceiving it as a transfer with intent. This is combinable with the three different methods of acquiring external knowledge as they all may exist during a transfer with intent.

The knowledge available includes technical information from journals and instructions, outside reports etc. More active forms of acquisition require more use of organisation resources. This occurs mainly in arms-length relations such as bench-markings (see table 1). The acquisition of knowledge through arms length relations is limited to the observable part of another party's knowledge (Lane, Lubatkin 1998). Given that the knowledge is articulated means that the knowledge is not rare, costly to imitate or unequally traded between different entities. This type of knowledge will not provide the organisation with unique knowledge that may guide novel capability development. However, it is dependent on the definition of technology. The traditional

device orientated conception of technology there is little room for extra features. Through the framework of Sharif and Ramanathan (1987) it is possible to isolate intangible features of the technology that cannot be easily imitated. Therefore, to be able to acquire a broader scope of knowledge one is in need of interactive acquisition. This requires a close relationship between the entities involved in which more tacit components of the knowledge are transferred (Dodgson 2000).

4.2.1 Internal Communication

The distribution of the knowledge that is absorbed may greatly influence the use and exploitation of it. Given the unequal access to the external environment communication systems become critical. They may be formalised through reporting systems, or informal and individual dependent systems. One obvious problem in designing communication systems is the potential uneven distribution of competence and expertise in the organisation. In many cases some individuals function as gate keepers. Gate keepers are people who have access to unique assets, which is of importance to the community. Barabási (2002) distinguishes between hubs that have critical gate keeper features and nodes that have some important links.

If the organisation consists of several subunits (nodes and hubs) with different backgrounds the absorptive capacity as a whole may have to balance between the efficiency of the internal communication and the different units' ability to absorb knowledge originating from other subunits within the organisation. A shared language and symbols may help facilitate this (Hatch 1997). Overlap in knowledge between the individuals may be desirable from a communication perspective, but on the other hand, less overlap does indicate a broader span of knowledge and subsequent absorption field. Some overlap is important to enable the individuals to communicate efficiently. All in all the balance between similarity and diversity may equip the organisation to

create new knowledge far beyond the scope of any of its individuals. The formal structures and the negotiated informal structures may be either centralised or distributed in nature. This will have an effect on how knowledge flows within the organisation and to its outside links.

4.2.2 Path dependence

Cohen and Levinthal (1989) argue that an organisation's absorptive capacity is a function of relating new knowledge with prior internal knowledge. This suggests that the utilisation of knowledge has an effect on the absorptive capacity over time. Accumulating knowledge in one period will create a bigger knowledge base and permit enhanced accumulation in the next (Cohen, Levinthal 1990). By gaining capabilities in a new area the organisation may be more ready to accumulate in associated fields. The increased knowledge accumulation over time will enable the organisation to understand and evaluate a larger array of knowledge, which affects the foresight and permits the organisation to more accurately gauge the nature of the market and the possible impact of the new knowledge and technology. Thus, Cohen and Levinthal (1990) argue that the absorptive capacity is cumulative and path- and history-dependent. The changes that occur over time may be related to the changing nature of technology. By undertaking research in certain areas an increase in the related absorptive capacity may appear. Orientating the research in certain fields will over time steer the research into a particular direction based on the accumulation of related knowledge enhancements. Thus, we may observe a path dependent development in which new capabilities are likely to develop along the path chosen. If we assume that technology changes over time as well, this change in conjunction with the competences of the organisation may facilitate work in related fields on the expense of novel unrelated fields. As noted earlier, having some initial knowledge about an unfamiliar task may greatly improve the speed and intensity of learning. This may lead to trajectory orientated R&D and subsequent path dependent dissemination of knowledge.

The cumulative quality of the absorptive capacity tends to confine organisations to certain trajectories or domains. Thus, developing capacity in novel fields is potentially very costly in time, effort and resources (Teece 1977). This may produce a situation of organisational inertia where the cumulative nature affects the expectation formation of the organisation and thus, limits the scope of the absorptive capacity. This self reinforcing behaviour may also be the result of the limiting influence on organisation goals and aspirations. If an organisation has developed capabilities in one particular field it is more likely to be sensitive to the development of that field, and may therefore adjust its aspirations to that. Thus, if the organisation has a high absorptive capacity it is more likely to be more proactive and independent on current performance as it has a broad scope of capabilities. The explorations need not be dependent on their current performance and thus, may extend beyond their core competences. On the other hand organisations with a lower absorptive capacity may be more reactive in their response and confine their activities to their aspiration level (Cohen, Levinthal 1990). This argument implies that the organisation's behaviour in terms of high or low activity should remain stable over time. Low activity will hinder the development of the absorptive capacity and with it subsequent potential growth.

However, if one applies a discontinuous approach to the learning process, an organisation is not necessarily fixed in either high or low intensity. The implementation of new radical knowledge may significantly alter the way in which organisations process or use information. Thus, one new type of knowledge may allow for more utilisation of prior resources or may connect previously unconnected fields of knowledge within the organisation, which in turn alter its absorptive capacity.

4.3 Capacity to exploit new knowledge

The last dimension deals with the exploitation of the knowledge. Cohen and Levinthal (1990) put emphasis on the practical application of knowledge. It refers to the systematic and sustained use of knowledge and the capability to use it to create new fields of use in the market. An organisation needs to be capable of using the acquired knowledge for its own benefit.

The technological window of opportunity associated with absorptive capacity is connected to the quantity of technology available in society and the quantity available to the organisation dependent on their absorptive capacity level (Cohen, Levinthal 1990). There may exist opportunities that the organisation is not able to make use of as capability in the relevant field is too low. This has implications for the demand and appropriability of the knowledge. The technological opportunity is also connected to the potential reward in different domains (Cohen, Levinthal 1990). Some knowledge is more valuable than other. The realisation of the knowledge has to do with the organisations ability to make the most of its routines and processes. It allows it to understand and process information about the relevant knowledge from the external sources. Ultimately the dimension deals with usability of the new knowledge for the organisation. The question is whether the organisation is able to use it to facilitate its needs.

Cohen and Levinthal (1990) argue that an organisation's absorptive capacity in many cases is a by-product of the spendings in R&D. Assuming that the R&D activities contribute to the absorptive capacity, the strategies that have been chosen are often selected to foster growth. Thus, the ability to exploit and commercialise the new knowledge is often a part of a wider strategy. Nevertheless, Cohen and Levinthal (1990) stress that some organisational slack is critical for the development of the absorptive capacity. Therefore, it need not be articulated through strategies. Freeman and Soete (1997) argue that the success of innovation, diffusion and

exploitation can be attributed to factors outside formal R&D. The human resource development is critical to the capacity to exploit new knowledge (Lundvall et al. 2002).

4.4 The relative absorptive capacity

Cohen and Levinthal (1990) focus on the ability to evaluate, assimilate and utilise new external knowledge. However, their definitions suggest that organisations have equal capacity to learn from all other organisations (Lane, Lubatkin 1998). Lane and Lubatkin (1998) argue that the organisation level absorptive capacity is a learning dyad construct and label this relative absorptive capacity. Instead of viewing the absorptive capacity as firm specific Lane and Lubatkin (1998) argue that an organisations ability to learn and absorb is jointly determined by sender and receiver. To address this expansion of the theory, Lane and Lubatkin (1998) add three new dimensions. Learning from a partner in a dyad relationship depends firstly, on the type of knowledge offered by the sending organisation. Secondly, it depends on the similarity between the two partner's competences and organisational structures. The absorptive capacity of each of the partners needs to have a certain degree of fit in order to gain anything from the cooperation. Thirdly, the receiving organisation needs to be familiar with the sender organisation's set of organisational challenges and pitfalls.

In a collaboration dyad the greater the difference between the two partners, the greater the learning potential (Dodgson 2000). The knowledge overlap between the two will determine how much they can learn from the other. Some overlap is necessary for them to understand each other and the smaller this overlap the greater the potential for miscommunication and coordination loss (Dodgson 2000). Therefore, the absorptive capacity of the two entities in the dyad and the transferring of knowledge between them will depend on the degree of overlap. The

risk of miscommunication can be lowered by engaging in long term partnerships (Dodgson 2000).

On the other hand forming a long term relationship increases the likelihood of the two entities mirroring each other and thus lowering the potential for gaining knowledge (DiMaggio, Powell 1983). They argue that the duration of the relationship needs to be adjusted to the nature of the task at hand. Long term relationships should be formed to assist incremental improvements and complicated learning (DiMaggio, Powell 1983). Whether there is a short or long term relationship Dirks and Ferrin (2001) argue that most alliance failures are due to relational aspects such as cultural differences and lack of trust. Therefore, it is vital to the success of any alliance to identify the potential opportunities and pitfalls both in terms of people and systems (Dirk, Ferrin 2001).

I have now given a comprehensive overview of the relevant theoretical landscape. Having argued that understanding of the context is vital, a short introduction to the changes in Russia and the development of the centre is called for.

5.0 Context: Changes in Russia

Russia has undergone tremendous changes over the past fifteen years. The glasnost and perestroika politics of Gorbachev and the breakdown of the Soviet Union has altered the political and administrative landscape and brought about profound changes. The changes are ongoing and Russia remains in a state of flux (Remington 2004). Although the disintegration of the Soviet Union marked the end of a 70-year endeavour to achieve modernisation and industrial development outside the framework of the capitalist world system, the Russian Federation is still struggling with the restructuring of internal political and economic power, as well as with the question of Russia's place in the world and its relationship to the western system. Indeed, Russia

is currently in the midst of period of political, economic and social transformation. This provides an interesting context for technology transfer and the scrutiny of the absorptive capacity.

5.1 Changes in political structures

More than a decade has passed since the onset of the great transition in Russian political and administrative bodies. Politically there was a shift from a communist single party rule towards a multi party democracy. Mikhail Gorbachev took office in 1985 and ushered a number of political reforms under the glasnost framework. Gorbachev initiated radical reforms, which ultimately undermined the Soviet system causing it to collapse in late 1991.

The considerable power wielded by the president in the Russian federation has created an environment of mutual hostility between the executive and legislative branches that were not present in the Soviet times (Remington 2004). However, Putin's rise to power has created a more favourable climate as the branches are showing signs of adjustments. Nevertheless, it is difficult to assess the long term effect of this. The shifting political climate creates an unstable field of operation for foreign operators. The various degree of opportunism among personnel in key positions provides an uncertain environment.

5.2 Administrative changes

On the administrative level there has been a change from a hyper centralised communist state towards a decentralised federation. This has altered the way the public sector is organised with potential consequences for public sector organisations. However, the system remains highly centralised and it is debatable whether the fall of the Soviet Union actually changed the formal administrative landscape. The splitting of the Soviet Union into a federal Russian state radically

increased the number of administrative bodies. However, Russia is still a highly centralised state and the state wields a considerable bureaucratic apparatus. Corruption is widespread and extends into the fields of education and science (The Moscow Times 2003). Contact with key officials is still vital for anyone who wishes to work in Russia.

5.3 Economic changes

Following the dissolution of the Soviet Union the economic restructuring became one of the main priorities of the government resulting in a massive privatisation of state run enterprises. However, poor management of the privatisation caused the frail Russian economy to deteriorate even further (Remington 2004).

To restructure the soviet administrative system in the early 1990ties the Yeltsin administration employed a shock program during witch existing Soviet institutions were abandoned to effect a transition to capitalism. Many research institutions lost large parts or all of their income, which created severe problems. The main issues were the introduction of market prizes and privatisation of state property. The lack of functional legal structures of a market economy resulted in several problems for the Russian economy and rise of opportunism. In 1998 the system collapsed and the Russian state had to declare itself temporary incapable of serving its debts. It ultimately devalued the Ruble, which in effect wiped out the emerging middle class who had their savings in Rubles. Many private enterprises went bankrupt in the wake of the collapse and it created significant problems for private initiative in the following years.

5.4 Social changes

The poor state of the Russian economy did result in severe problems in paying wages, which made it very difficult to earn a living including in science related positions. Large groups of Russian scientists and research personnel left Russia to find work in the west. This has depleted the Russian research institutions of key personnel and valuable resources. In the mid 1990ties Russia experienced severe brain-drain, which threatened the world leading status of many Russian research institutes. Scholar work has traditionally carried a lot of prestige in Russia and was held in high regard by the people and the government. The Soviet Union had a very high R&D budget. After the collapse of the Soviet Union spendings were significantly reduced. Scholars retained their prestige but not their income. Many were forced to take jobs as cab drivers and other types of manual labour to pay their bills. This hardship combined with a very proud research community may have accelerated the outward flux of Russian scientists (The Moscow Times 2003).

6.0 The Moscow Centre

In 1993 The Centre for Medical Studies in Moscow was established by the senate of the University of Oslo to promote and facilitate the cooperation in the field of medicine between Russia and Norway. In its early days the centre was focused on the provision of financial resources to try to slow the brain-drain taking place in the early 1990ties (Annual reports). Russia represents an enormous potential in terms of resources and skill. Acknowledging that Norway has to deal with the presence of Russia the initial idea was to build a long term relationship to facilitate research collaboration. In the initial phases it was obvious that money was needed.

The main focus point of the centre is on research and scientific collaboration between researchers in Russia and Norway. The centre applies a low-cost profile only paying for the

necessary equipment. The low cost profile is further established through the use of cheap vehicles for information exchange for example through organising symposia with Russian and Norwegian lecturers together. Lecturers on the symposia are not paid and the symposia can accommodate a large number of participants making them rather cost effective means of information exchange. The centre pays the wages for the Russian scientists. Thus, it provides the Russian research partners with badly needed financial stability.

The Russian fellows assist with the organisational and administrative work. The responsibilities for the daily running of the centre are held by the senior researcher, Professor Jurij V. Kozlov, whereas the scientific activities are run by Professor Sjur Olsnes from The Norwegian Radium Hospital. See the organisation chart in the appendix 2 for further detail. The centre is involved in a variety of fields in Russia. The activities of the centre can be divided into three categories, Information exchange, research collaboration and scientist exchange.

Recognising the demand for funds in the Russian Research community, the centre was originally based on a humanitarian profile, *Working to avoid depletion of talented young researchers and maintain the high level of scientific work by providing funds and equipment. This will sustain the research and the research cooperation between Russia and Norway.* (Mission statement, annual report 1994). Following the collapse of the Russian economy it became increasingly difficult to fund the research facilities and pay salaries to the researchers. Initially the centre aimed at slowing the flow of researcher by providing funds and equipment provided that the researchers stayed in Russia.

The problem with brain drain is not as eminent as before. Norway might benefit from the pool of excellent and experienced researchers, as there is a lack of skilled personnel in Norway. Interestingly enough the centre set out to provide Russia with research funds from a humanitarian perspective, and may end up being the beneficiary of the fellows that have been

trained with support from the centre. This two way relationship can be seen as a shift in focus of the overall strategy of the centre. The new centre strategy aims at expanding the number of researchers to expand the current field of operation. *'The centre works to promote the research and exchange of knowledge and skill in medicine and health related issues between Russian and Norwegian medical communities.'* (Mission statement, annual report 2004).

One main expansion of the centre activities in the years to come is the development and use of an e-learning system in radiology. The centre hopes that the e-learning system can facilitate the goals of a two way relationship between the Russian and Norwegian parts of the centre. The e-learning system cannot be seen as independent of the other centre activities (annual reports). Therefore, it is vital to give a brief overview of the main activities to understand the entwined nature of its work. The e-learning system is not a completely new branch of work but is developed in close interaction with the centre activities.

6.1 Information exchange

To expand the research contact and networks between Russia and Norway the centre organises medical symposia in Russia that are open for both Russian and Norwegian scientists. The centre collaborates with the leading institutions in Russia, which includes the Sechenov Moscow Medical Academy, The Russian institute of Public health and The Russian Academy of Sciences. These are all world class institutions. The symposia are organised in tight collaboration between the Russian and Norwegian planning committee. The topics for the symposia vary and fathom a broad spectrum of medical topics. So far (2004) about 9.500 Russian physicians and other medical personnel have attended the symposia organised by the Moscow Centre, and roughly 300 Scandinavian and European specialists have presented lectures for the centre (annual reports).

6.2 Research collaboration

In order to benefit from the information exchange activities one major focus for the centre is to facilitate research collaboration between Norwegian and Russian scientists. The Russian researchers remain formally employed by the Russian Academy of Science, while the University of Oslo pays most of their salaries. The publications are officially joint publications which have resulted in a large number of publications. The centre aims at being a facilitator for research collaboration and great care is taken in pairing up scientist and research fellows. So far (2004) the centre has been involved in the publishing of 148 scientific articles in a variety of internationally acclaimed journals, for example Nature, and has published seven books altogether. An increasing number of publications and a considerable number of presentations in international forums demonstrate the high quality of the work performed by the centre scientists.

6.3 Expert exchange

The centre has a joint pre and post-graduate exchange program with the Sechenov Academy. Initiated in 1997 the centre finances and coordinates two/three months' exchange trips to Norway for Russian medical students and young researchers. The centre oversaw the visit of a Norwegian student group in 2004 and hopes to make this into a more permanent exchange program. There is a continuous shift among the researchers where new candidates are selected and some replaced each year. Originally in 1993 the centre supported four research fellows. This has later been expanded and at present the centre supports 15 research fellows. All in all the centre has funded 130 researcher working years in Moscow.

6.4 The e-learning project of the Moscow Centre

The Moscow Centre aims at transferring an e-learning system for radiology teaching among students and physicians. It is constructed as an interactive learning device, in which cases from a database is used. This database is when completed likely to include large samples of cases and patient groups that are very limited in Norway. Thus, it is likely to be of interest to Norwegian radiologists as well as it provides new possibilities for research collaboration. Its use in clinical training may have a potentially high penetration reaching a large number of practitioners, which may induce further exchange between Russia and Norway.

Organisations seek new ways of organising and managing their knowledge assets and are increasingly deploying information technology solutions to do so (Fuller 2002). The introduction of new devices to enhance the knowledge flow can be seen as a part of a strategy designed and implemented by the organisation to overcome problems standing in the way of their overall objectives (Porter 1980).

Implementing effective e-learning systems will require a blending of generic technical knowledge with the contextualised local knowledge of the users (Martin, Massy, Clarke 2003). Development of an e-learning system and fitting it to the espoused collaborative and communicative objective depends on the understanding of the tacit knowledge and the knowledge flow within the organisation. A critical factor in the transfer of technology is the extent to which the technology is understood by the receiver (Teece 1977). The e-learning system is intended to facilitate the information exchange between Russia and Norway. This information exchange may induce research collaboration. The Moscow Centre hopes that the system can lead to increases in expert exchange as a consequence of better competence in computer based radiology.

E-learning technology was largely developed in the USA to fit its unique business system and educational context (Bower 2003 in Martin, Massy, Clarke 2003). The US context is in many cases a lot more different than it appears. The commercial focus in the US is not applicable to the Russian context, and may not be applicable to e-learning systems for the use in the training of radiologists. Therefore, transferring of e-learning systems without paying attention to the cultural context in which you transfer it to may prove to be problematic. Quite often the technology is treated as a neutral agent. The e-learning system in question was originally developed for use in Norway and is being translated to fit the Russian institutions. As the e-learning system is in its infancy it is unclear how much has been done to address differences between Norway and Russia. The database can be found at <http://www.radiologi.net>.

Therefore, based on the theoretical discussion the Moscow Centre fits well as a study entity and forms a good case through which the theories of absorptive capacity and technology transfer between Russia and Norway can be applied.

7.0 Method

7.1 Case definition

Many opportunities for organisational research cases are available. According to Miller (1991) finding good cases for research depend on three factors. First, it is good to look for occasions of unexpected or unintended change in the underlying structures, such as power hierarchy, technology or human resources. These factors bring about social reactions within the entity of scrutiny and the nature of the changes can be an interesting subject for generating new knowledge with reference to existing theory. The Moscow Centre is in a state of flux and is actively adapting to the changing nature of Russia. The introduction of the e-learning system marks a change in the way the cooperation between the Russian and Norwegian scientist will

work together and may bring about changes in the distributed power. The e-learning system may in the future give Norwegian scientist access to data that is unavailable in Norway. Furthermore, the introduction of the e-learning system may have a profound impact on the centre's ability to facilitate Russian/Norwegian research collaboration.

Secondly, organisations that go about their workings differently than the standard and common practice in their field are good cases. They give the opportunity to study the impact and performance of new ways of operating that are unlikely to appear in the traditional organisations. The Moscow Centre is relatively unique in its structure and there are few other organisations that do similar work in Russia. Therefore, the centre may function as an interesting case for the study of uncommon organisational practices.

Thirdly, research through the use of the prior factors is likely to yield new knowledge that can be used to generate new types of organisations. By the use of the knowledge that has been generated it is possible to learn about alternative ways of organising. Given the uncommon organisation and function of the centre studying it may shed light on interesting topics related to the workings of international organisation collaborations in Russia.

7.1.2 Conceptual framework

According to Robson (1993) a case study is the empirical investigation of a particular contemporary phenomenon within a real world context through the use of multiple sources of evidence. Thus, the methodological device covers a wide variety of approaches and is defined solely in terms of its focus on the specific case in its own context. Given the number of possible approaches, the case study framework is quite loose in nature (Robson 1993). However, as case studies are used for a wide range of purposes they need not be loose. One of the great strengths

of the approach is its flexibility. In principle a case study can be tightly pre-structured or un-structured. However, it depends on the purpose of the study. Robson (1993) argues that if the main focus of the enquiry is exploratory, where there is little or no knowledge about the case, a looser approach is recommended. In the case of a more confirmatory approach, where such knowledge is available, detailed pre-structuring of the enquiry can be used.

Absorptive capacity has traditionally been measured through the use of input and output indicators (Cohen and Levinthal 1989). Under such condition a loose case study seems to be of limited value. However, the study of the dimensions of absorptive capacity appears to be underdeveloped, and there are few qualitative studies on the subject (Lane, Lubatkin 1998). Therefore, in the study of absorptive capacity at the Moscow Centre, I will argue that the case is of an exploratory nature, in which a tightly pre-structured case study is not desirable. The theoretical framework suggested in the literature review indicates a clear focus on the process orientated features of absorptive capacity when put in the context of technology transfer. Therefore, measurement of the variables needs to use qualitative method devices. It is important to keep in mind that absorptive capacity in relation to technology transfer is a multidimensional process with nothing clearly measurable about many aspects of the underlying processes (Smith 2005). Certain parts of the theoretical framework can be argued to be indicators for inputs and outputs, for example the capacity to identify relevant external knowledge. This is in a technology transfer context orientated towards the start of a process and as the baseline of the transferring plan. However, by integrating the remaining parts of the theoretical framework it becomes more process orientated and functions more as a set of process indicators than a set of input/output indicators (see table 2). Seeing absorptive capacity as a coherent framework will render it more as a process indicator construct. Martin, Massy and Clarke (2003) suggest that the framework of absorptive capacity is a theory of variance constrained by a number of contextual moderating variables which need to be taken into account to identify the conditions under which the theory

is likely to hold or not. In this assignment an attempt has been made to map the contextual and moderating factors of technology transfer to provide the framework of absorptive capacity with a set of conditions. These conditions are thought to shed light on the underlying dimensions of absorptive capacity (see table 2).

Cohen and Levinthal (1990) argue that the absorptive capacity of an organisation is path dependent. This suggests that the capacity varies as a consequence of the undertaken work. Thus, the absorptive capacity is altered in process and the nature of the capacity is dependent on how the process evolves. Therefore, it is reason to label absorptive capacity as a process indicator. Furthermore, Lane and Lubatkin's (1998) argument that the absorptive capacity is relative and dependent on the relationship between the involved parties, takes a clear process orientated view. They suggest that the absorptive capacity is a reaction to the interaction process that takes place between the specific collaboration partners (see table 1).

It is imperative to emphasise that this research project is not attempting to formally assess whether the Moscow Centre nor the Russian counterparts have a high or low absorptive capacity or whether it rises or falls as a consequence of their work. The main focus in this research project is to identify those dimensions that appear to be critical in relation to technology transfer.

Neither learning nor the capabilities which result seem to be measurable in any direct way (Smith 2005). Therefore, I will use the absorptive capacity as a process indicator to highlight dimensions critical for the transferring process.

Based on the foregoing discussion and the proposed theoretical framework this assignment seeks to address the following question:

Which dimensions of absorptive capacity and technology transfer are critical when transferring an e-learning system to Russia through the Moscow Centre?

Sub-question:

Is the framework of absorptive capacity relevant when transferring e-learning systems?

7.1.3 Initial Preparations

Prior to the research initial piloting studies were performed through a series of discussions with centre personnel via e-mail to map the organisation and identifying potential research fields. The Moscow Centre is involved in several projects in different parts of Russia. The administrative staff is located in Norway and most of the research personnel is located in Russia. For various reasons such as language, problems time constraint and geographical distance, none of the Russians were participating in the study. This will certainly have an effect of the generalisability of the findings and the overall validity and reliability of the research. However, as this is a qualitative research project seeking to find indicators of the underlying dimensions of absorptive capacity in relation to technology transfer, the research focus may yield some insight into the process as generalisability in qualitative studies per definition is limited.

7.2 Data collection and data management

7.2.1 Data sources

The collection of data is the crucial operation in the designing and execution of good research (Miller 1991). The quality of the collected data determines the quality of the research (Robson

1993). The selection of instruments for data collection in a case study needs to be chosen for their relevance to the research question.

To gain insight into the complex nature of absorptive capacity a series of semi-structured interviews were carried out at the Moscow Centre premises in July/August 2005. Semi-structured interviews are interviews with a loose interview guide that can be modified to fit the interview session (Robson 1993). Through this approach all of the respondents are asked roughly the same questions. However, they may vary a little to adapt to the situation. This may cause problems for the internal validity of the interviews as data may vary. However, given the loose structure of the research and the tacit components of the framework, it is necessary to allow for some slack, which is critical when doing qualitative studies (Robson 1993). The interview is a flexible and adaptive method for eliciting information. Due to their loose structure and adaptability to the situation provided, the study with the necessary fit in terms of method device. The sample consists of n=4 people. All of the respondents are based in Norway. The Russian associates were not involved due to time and resource constraints. The respondents signed a letter of informed consent prior to the interviews and will remain anonymous throughout the research.

A large number of text documents were collected to gain further insight into the centre and its activities. All of the annual reports from 1993 to 2004 were provided by the centre. In addition the evaluation report from The Norwegian Research Council was analysed. Various public papers and newspaper articles were used as a supplement.

7.2.2 Sampling procedure

The sampling of the interview subjects and text documents were done through the use of purposive sampling (Robson 1993). This refers to collecting data that have the appropriate

combination of the parameters in the research. Hence, information that is likely to yield data relevant to the case. This makes it unavoidably into a convenience sampling strategy as data in reality is chosen on the basis of access under the given conditions (Flick 2002). However, given the limited time and resources available to the researcher this was the best available solution. Morse (1998 in Flick 2002) argues that a set of criteria for a 'good informant' exist across the different sampling strategies. This includes informants who have knowledge and experience of the issue at hand, are capable of reflection and are articulated. All of the respondent have these qualities. Thus, undesirable sampling strategy need not threaten the validity of the research.

The reliability relies crucially on the characteristics of the data collection instrument, whereas a case study also relies on the trustworthiness and sensitivity of the researcher rather than on the data collection technique per se (Robson 1993). Therefore, triangulation is important.

Triangulation refers to the combination of different methods of enquiry to validate the results from the individual methods (Flick 2002).

Triangulation was provided by extensive text analysis of annual reports, evaluations and public papers. By getting an overview of the activities at the centre through quantitative measure like budgets, publications and such, provide the research with insight into the workings of the centre. This information was not immediately available from the interviews and provided the research with a good supplement, which increases the validity of the overall findings.

The knowledge residing in an organisation includes both easily communicated explicit knowledge and tacit knowledge, which is considerably more difficult to define and identify. This is due to its interconnections with other aspects of the organisation such as processes and social context. The process of technology transfer includes knowledge of both explicit and tacit nature, which has an impact on the absorptive capacity in relation to technology transfer (see table 1).

7.2.3 Data management

To ensure validity and reliability of the collected data it is imperative to structure and systematise the data in a coherent way to enable storage and retrieval for future analysis (Huberman, Miles 1994). The collected data needs to be accessible. In most qualitative research, and in this thesis, the researcher functions as the research instrument and data collector. This may affect the validity and reliability of the findings. Therefore, the researcher needs to ensure that the data is made explicit and accessible to rule out potential bias. All of the interviews were taped and transcribed shortly after completion to retain as much information as possible. By doing so the researcher is less dependent on personal memory and the transcriptions function as a reference to check the field notes. It also enables the researcher to retain data for further analysis at a later stage.

In general, making data accessible and documenting the collection, depend on two underlying processes (Huberman, Miles 1994). Firstly, it involves data reduction. To make the data more accessible it is necessary to reduce the original raw material to a manageable size. Condensing field notes and transcribing interviews were done to provide the researcher with the necessary overview over the data. If one is swamped in data, there is a possibility that vital information will pass unnoticed, which may hamper the research and threaten validity and reliability. Having said that, data reduction can be a threat to validity and reliability if the condensing leads to eliminating of vital information. Therefore, it is imperative to confirm data redundancy by using several sources ensuring triangulation.

Secondly, to further help the researcher getting an overview of the data the processed data needs to be organised into a compressed assembly of information. Grouping together similar information and constructing categories are vital to uncover tendencies in the data. Codes are

developed on the basis of underlying tendencies. These are the initial steps towards creating a coding frame that permits analysis of the data.

After completing the interviews the transcriptions were read carefully several times to disclose underlying themes or issues in the attempt to create some overarching features for the construction of a coding frame. Statements were tagged to provide the researcher with clues about frequency and similarity to produce codes for grouping together information in order to reduce the amount of data.

7.3 Analysis

Valid analysis is dependent on good sampling procedures and good data management which produces data that is focused enough to permit viewing of the full data set in one coherent framework often referred to as the coding frame (Huberman, Miles 1994). This enables the researcher to see what type of analysis that needs to be performed. Also it provides the link between the theories postulated on the basis of the literature review and the collected data.

The analysis seeks to verify the level of fit between the theory and the data. In this process it is imperative to be aware of potential pitfalls and sources of error. The less rigorously structured the interview session, the more it relies on the skill and sensitivity of the interviewer. This inevitably raises concerns about the reliability of the findings as biases are difficult to rule out. To collect data from individuals in the relevant social context reliability and validity of the enquiry rests on the sensitivity to intra-individual processes as well as inter-individual processes in the interview session (Kirk, Miller 1986).

To address the problem of potential data overload it is vital to have a good data reduction device to quickly reduce the data to avoid overload. The initial transcriptions include an abundance of information. The initial data set consists of a total of 267 text fragments or codes. Deciding what is redundant and what is not is a tricky task and relies largely on the researcher and the constructed framework. Thus, in the beginning the coding frame consisted of many overarching themes with underlying categories achieved through open coding. Open coding refers to the attempt to group data in the forms of concepts (Flick 2002). This results in a large number of codes which have to be further condensed to provide the researcher with useful codes. This can be achieved through axial coding of the data, which seeks to refine and differentiate the categories from the open coding (Flick 2002). The axial coding initially produces 9 concepts that were later condensed to 5, with a total of 61 underlying codes (see appendix 3 for details).

All of the interviews were carried out in Norwegian to avoid inter-language confusion. Therefore, the coding frame was also done in Norwegian. A condensed and translated version of the coding frame is available in the appendix 3.

Nevertheless, perfect control over the researcher's influence on the process is virtually impossible. In the real world many social variables are found to be interrelated. The cause and effects are hard to disentangle. Co-occurrence need not necessarily signify correlation or causal relationship. Any assumed correlations must be carefully scrutinised and checked through the different method devices in the triangulation. This means that individual biases and ideological differences inherently reside in the different methodological approaches used in the research (Miller 1991). Hirsch (1976) argues that raw data does not exist, and that the material collected from an inquiry will be, in some way or the other, influenced by the context. Mapping the dimensions of absorptive capacity has to tackle a multi faced construct. Therefore, the validity and reliability of the data that are collected is meaningful only with reference to theory (Hirsch

1976). A theory in the qualitative tradition that requires all observations to be identical is rarely appropriate and is only expected in highly artificial structured situations. Therefore, validity and reliability of this research project relies essentially on rigorously described methodological procedures that by definition are not perfectly controlled.

8.0 Results and discussion

The analysis has provided the researcher with valuable insight into the process and provides a good foundation for discussion. Huberman and Miles (1994) suggest a five point audit structure to assess the results and quality check them prior to the discussion.

(1) The findings are grounded in data as the sampling appears to have sufficient validity and reliability. The interviews yielded good data, which was relevant to the theories postulated in the literature review of this thesis. The subjects responded well to what appeared to be a familiar interview session as most of the respondents had been interviewed before.

(2) The category structure appears to be appropriate. The answers given seem to conform to the suggested category division. Quite early in the analysis the three main themes in absorptive capacity emerged (see table 3). These themes corresponded well to the initial framework in the literature interview. Thus, the researcher chose to use these three categories as a basis for the coding frame. The respondents signalled that they were unfamiliar with a wider conception of technology and technology transfer. However, the respondents provided the researcher with very good accounts for it through the interview. The respondents labelled it differently, but once prompted on the matter all of the respondents understood a wider conception of technology and technology transfer. Several dimensions of technology transfer appeared to be critical to the absorptive capacity. Technology transfer channels and mechanisms appear to be critical in the

transferring to Russia. The Russian society differs significantly from the Norwegian on several fields, particularly in terms of gatekeeper importance, organisational structure, and not to mention corruption. Corruption is a major threat to the efficiency and success of technology transfer to Russia. The analysis revealed five main dimensions of absorptive capacity that were salient at the Moscow Centre (see table 3). The original three fold structure suggested by Cohen and Levinthal was expanded by adding path dependence and relative absorptive capacity as independent dimensions. Cohen and Levinthal (1990) acknowledge that path dependence is important but it is not singled out as a dimension. To tie the dimensions of absorptive capacity to technology transfer several subcategories were added from the coding of the interviews and document analysis. These subcategories elaborate on the features of technology transfer that are important in relation to absorptive capacity. The dimensions of technology transfer appear to have different importance dependent on the stages in the technology transfer process.

Table 3

The dimensions of absorptive capacity and the most important underlying features

Capacity to recognise relevant external knowledge	Capacity to disseminate new knowledge	Capacity to exploit new knowledge	Path dependence	Relative absorptive capacity: Learning dyad
Technology content	Technology content	Transfer mechanism	Change over time	Transfer mechanism
Transfer channel	Transfer.mechanism Transfer channel	Context variables	Technology content	Change over time Context variables

(3) The initial structure of the categories suggests that the inferences are logical. The clear structure and the commonsense appearance make the structure believable.

(4) The degree of researcher bias appears to be low. Given the loose structure of the interviews and the unfamiliarity of the topic, the researcher was forced to provide the informants with additional information during the interview. Thus, the interviewer impact may have had an effect on the answers. However, without this prompting and information the interviews may have included a large amount of redundant material as a consequence of poor understanding.

Triangulation checks revealed similarities across data sources indicating less bias in the particularly bias prone semi-structured interviews.

(5) Several strategies have been used to increase credibility of the data. Respondents were allowed to freely express their views and the use of unobtrusive methods (semi-structured interviews) and provided good first hand accounts. The coding of the data revealed several similarities in the responses, particularly concerning underlying themes and constructs. The decision to use axial coding in the coding frame has increased the precision of the data, which increases the credibility. Moreover, the triangulation through the use of documents further strengthened the initial assumptions and provided depth to the analysis.

The analysis revealed that the e-learning system could not be separated from the centre activities. Therefore, several of the other activities are discussed in connections that appear to be relevant. The transferring of an e-learning system through the Moscow Centre presents a challenge to the traditional conceptions of technology and technology transfer. By looking at the process features of the organisation the analysis revealed underlying features that go unnoticed through the traditional view.

Amese and Cohendet (2001) argue that the increasingly complex technology and faster moving markets cannot be accounted for within a traditional transfer concept. By assuming that technology is not limited to hardware Amese and Cohendet (2001) suggest that technology must be understood in connection with the social world in which it exists. The e-learning system appears to be deeply rooted in the social world of the Moscow Centre.

By adding a social component to the technology the main attempt is to address the presence of a context for the technology. New types of technology, particularly IT and computer interfaces are

to some extent bridging the gap between the mere device orientated technology view and the socially constructed technology. The possession of higher mental capabilities has traditionally given humans their unique nature and yet it is these capabilities computers are designed to simulate, for example by mimicking cognitive processes. The social sciences presuppose that humans possess something that is by nature lacking in technology. It would seem as if computers literally think, in the sense that planes literally fly, social science will lose its reason for being (Fuller 2002). This would mean that social science has no proper domain of inquiry (i.e. humanity has no essence) as technical features are equal to humans. On the other hand it could mean that certain parts of computers are intertwined with the social life rendering parts of the technology inherently social. Computer aided interfaces, like e-learning systems, can either provide the means for attaining knowledge or be themselves bearers of knowledge. This indicates a functional aspect of the technology. Such technology can function as a tool for enhancing human performance or as a standard to evaluate human performance.

By simply treating e-learning systems as a device we would miss what is the fundamental characteristic of e-learning systems: its interactive nature with the users. Therefore, black boxing the technology will not yield information about its nature and how it will work *with* the users. Acknowledging that technology entails a social intangible asset suggests that technology is relative to its users who add the social aspect through interacting with the technology. Therefore, it is reason to believe that technology is transferred in a unique transfer context that may be difficult for other to duplicate. The relationship between the transferring partners may alter it, highlighting a qualitative extra variable provided by the dyadic relationship (Lane, Lubatkin 1998).

The e-learning system is still in its infancy and is in the process of being developed to fit the Russian environment. Knox and Denison (in Autio, Laamanen 1995) suggest that technology passes through different stages to reach maturity indicating that the technology has different

properties in time. The framework of absorptive capacity suggests that different dimensions of technology transfer are important at different stages in the transfer process. The framework suggested by Cohen and Levinthal (1990) is displayed over a time continuum. The capacity to identify relevant external knowledge will logically precede the dissemination of acquired knowledge, which comes before the capacity to use the disseminated knowledge. In addition Cohen and Levinthal (1990) argue that absorptive capacity is path dependent and cumulative. This suggests that the framework of absorptive capacity needs to acknowledge technology change through the transfer process and that the different dimensions of absorptive capacity are process indicators when used in the context of technology transfer.

8.1 Capacity to recognise relevant external knowledge

In the initial stage of the technology transfer the capacity to identify relevant external knowledge appears to be important. The ability to detect depends on a sensitive detection system or interface with the outside world. As the technology in question can be thought to have both tacit and explicit qualities the detection system needs to have capabilities that fit the challenge posed by the new technology. The Moscow Centre is in need of certain tools to address this need. The analysis identified two main features that appear to be critical for the identification of relevant external knowledge, the content of the technology and its fit with the organisation capabilities, and the transfer channel.

8.1.1 Technology content

When identifying relevant external knowledge the type and content of that knowledge appears to be a vital dimension (Cohen, Levinthal 1989). The organisation needs to be culturally sensitive to detect the relevant knowledge.

The respondents acknowledge that Russia has traditionally had a strong and viable research community, and is and has been the world leader in several fields. In addition Russia has developed a number of leading edge product and process technologies (Dyker 2001). However, it appears to be a lag in the area of organisational technology. The respondents seem to be aware of it and there are signs of an increasing awareness of external knowledge concerning new organisational technology. To understand the new challenges of the knowledge economy it is important to see how the national research organisation responds to the trends as some national systems for historical reasons are better prepared to cope with the changes than others (Lundvall et al. 2002). Building the new knowledge into the existing capability base will, according to Cohen and Levinthal (1990), influence the capacity to identify new external knowledge. However, little research has been done on the impact of management efficiency and management differences on the transferring of management technology (Dyker 2001).

One of the respondent points out that the Russian research facilities were traditionally not well equipped with high tech equipment. In initial phase of the Moscow Centre the Russian counterparts received a lot of laboratory equipment from Norway. The lack of funding in Russia at the time was causing severe shortage on even the most basic equipment. However, even though the equipment may seem crude, the research that was done was and still is very advanced, indicating creativity and intensity of effort. Traditionally the Russian research facilities appeared to be quite low-tech in the eyes of the respondents and the management of the laboratories were quite old fashioned.

It is unclear whether the Moscow Centre is aware of the organisational component in e-learning and its potential effect on organisational life. Zakharov (1996) argues that Russians have tended to be rather suspicious about the usefulness and the workings of information technology. Certain myths concerning prohibitions of such a kind of communication device and its usefulness

outside computer specialist environments is hard to overcome (Zakharov 1996). However, one of the respondents point out that the Russians at the centre are quite fond of technological devices and are up to date on what is available, displaying signs of both basic and diverse knowledge. It is reason to believe that the researchers have become less prone to stereotypes about the technology in the last ten years. When Zakharov wrote the article the Soviet times, and Soviet state of mind appear to have been closer than they appear today. Therefore, it is reason to believe that the Russians involved have gained some distance to the Soviet scepticism and new knowledge about e-learning principles. They appear to use this to actively acquire new knowledge from external sources.

Cohen and Levinthal (1990) argue that creating a functional interface to absorb external knowledge is dependent on having some basic knowledge in the field and some diversity of knowledge. Fagerberg and Godinho (2005) argues that catching up depends on the ability to utilise new technology with the means available. These means must reach a sufficient level in order to function. Verspagen (1991) warns against a low-growth trap, where investment in technology have to be substantial at first to reach a certain level of technology before the catching up can occur. Making this substantial investment may be difficult.

A lack in resources and managerial problems may very well affect the ability to identify and utilise new technology. The use of limited equipment may induce a lock-in in a low tech profile. The potential low growth trap for the centre is related to the need for substantial investment in resources and effort to reach a certain level of competence in e-learning. Lack of money and resources may produce something similar to the low growth trap as e-learning capabilities are costly to develop when the initial technology base is low (Martin, Massy, Clarke 2003).

The basic knowledge in management appears from the perspective of the respondents to be low. By assuming a conception of technology that is not limited to devices the suggested problems may not be attributed to catching up or the overall low-growth trap. Following Sharif and Ramanathan's (1987) technology concept the problem can be related to the orgaware component. The Russians clearly possesses good capabilities in terms of technoware knowledge and infoware knowledge. However, how to identify the applications of new knowledge and the ability to identify potential changes that needs to be done in terms of organisational adjustments may be problematic. The Russian research community is not necessarily catching up in terms of skill, but in funding.

By engaging in a two-way collaboration the centre is able to spot potential pitfalls early in the process as the centre employees appear to have the basic knowledge needed to recognise the relevant knowledge they need. It may be low, but nevertheless present. As the centre tries to entrench a more cooperative strategy instead of a charity profile this technology transfer is a good example of the new focus. Thus, the technology flow between the parties is more diverse and the parties have become better at gauging the needs of each other and therefore identified a good opportunity in Russia for the e-learning system. Therefore, the technology content may be of crucial importance to the dimension of absorptive capacity when identifying new knowledge for transfer.

8.1.2 Transfer channel

The respondents think that well connected individuals are critical for gaining access to the relevant information. Contact with the west was not widespread in the Soviet era and few Russian scientists had a network in the west. Russia appears to be unknown terrain. The deputy chairman Professor Olsnes started to work with Russian scientists in 1968 on various medical

research projects. Some of these scientists were recruited in the centre start-up in 1993. Among these was the senior researcher Professor Kozlov in Moscow. Many of the Russian scientists were considered to be system critical and were not members of the communist party. One of the respondents specifically pointed this out to exemplify that these were people of principle and therefore less prone to behave opportunistic. Corruption and opportunism was widespread during the communist period and this culture has been quite salient in the contemporary administrative landscape (The Moscow Times 2003). When the plans for the Moscow Centre were laid contact with 'untainted' researchers was critical to avoid problems related to individual opportunism and corruption. Dogdson (2000) argue that trust is important in transferring situations. Having these gate-keepers has, according to the respondents, helped the centre steer clear of potentially dodgy projects. The key personnel were sufficiently well connected to avoid potential corruption. This has made the centre dependent on these individuals and has to trust their judgement and moral standard when identifying research opportunities (Dirks, Ferrin 2001).

The respondents emphasised that the informal links between Russian and Norwegian scientists were critical for the identification of potential research collaborations. The main centre activities are run from Russia as a Russian institution. However, the Norwegian branch is actively involved producing a two way structure. Many of the Norwegian staff members have extensive experience with Russia through speaking the language and having lived there for several years. Through the cooperation the centre as a whole is adapting to the needs of international research collaboration. The development of an e-learning system is motivated by both the low cost of its maintenance, but also the increased knowledge about their use and usefulness (annual report 2004). This can be viewed as broadening the horizons and expanding the absorptive capacity into a field that is likely to be important in the future, for example e-learning. Zakharov (1996) argues that the Russian research community has been reluctant in acknowledging the use of IT systems outside the realm of computer science. The information about non-technicians engaging in successful use of the

technology caused astonishment and even mistrust. Zakharov (1996) identifies a lack of capacity in seeing the usefulness of that type of technology in a wider context.

Cohen and Levinthal (1990) argue that the capacity to identify relevant new knowledge is a function of the prior related knowledge. By assuming this Cohen and Levinthal make the construct dependent on the interface the organisation uses to gain access. It indicates that the link through which knowledge is identified is a vital dimension of absorptive capacity. All of the people involved in the Moscow Centre in the beginning are professionals in their fields making them share both professional language and symbols. In the administrative staff of the centre some well connected individuals managed to gain access to the very top of Russian and Norwegian governments, which had a great impact on securing the financial flow. Securing the centre infrastructure quite early in the process enabled it to effectively initiate its work. It also facilitated the proceedings from individual capabilities to organisational absorptive capacity. This was dependent on the successful use of the transfer channels.

Zakharov's (1996) predictions appear to be less valid in the context of the Moscow Centre. The development of the e-learning system is an interesting example in the centre work. The centre has through its connections in Russia identified an unused potential in the training of radiology. This can be attributed to the increased knowledge about international training systems and the need for effective systems in Russian education and research. Thus, it signifies a high social capability to assess the need for improvements in the Russian system (Abramovitz 1986). Moreover, it is a reflection of the centre's ability to identify relevant new external knowledge. Given the capabilities present in Russia there is a strong base for developing and building strong R&D collaborations between Russia and advanced industrial economies. Cohen and Levinthal (1990) argue that three criteria are critical for the identification of relevant knowledge. These are possessing basic knowledge, possessing knowledge diversity and ability for deep processing. The

centre has through the identification shown that it is aware of the potential in radiology and is able to successfully communicate this potential and develop it to its needs. This indicates a certain level of creativity and diversity. Both the respondents and accounts from the annual reports suggest that the matter is being thoroughly scrutinised to detect potential pitfalls, which indicates a good deep processing capability. Cohen and Levinthal (1990) suggest that it is important to embed the new knowledge in the ground rules of the organisation.

In overall the nature of the technology channel appears to have an effect on the capacity to identify new knowledge and appears to be an important dimension of the capacity to identify relevant external knowledge, which later can be transferred.

8.2 Capacity to disseminate new knowledge

Following the identification of relevant external knowledge the capacity to disseminate the new knowledge is the next step in the transfer process. When transferring the identified knowledge into the organisation several dimensions appear to be important. The processes and tools used to achieve this were closely linked to the content of the technology, the transferring mechanisms and the transfer channels.

8.2.1 Technology content

The respondent clearly identified several processes that took place in transfers initiated by the centre. The interactive content of e-learning systems requires a horizontal transfer in order to develop it. Autio and Laamanen (1995) argue that one is in need of process indicators when trying to account for *how* instruments are used instead of *how much*. The e-learning system is developed to fit certain needs and there is awareness among the centre employees that a focus on the development process is imperative. Being interactive the content of the e-learning system will

have an impact on the dissemination of the technology and embedded knowledge. How the instruments were used was closely linked to the perceived fit with the existing knowledge. Therefore, the centre evaluates the technology content to see whether it fits the centre activities.

Cohen and Levinthal (1990) argue that the appropriability or fit of knowledge will enable the organisation to capture the potential in the new external knowledge. In other words, they need to understand what it is about (Teece 1977). The respondents emphasise that they are excited to see the reaction to the new technology. Having surveyed the different possibilities for the e-learning system the centre has identified a use for it concerning radiology in Russia. The appropriability of that knowledge is related to how well it fits into the existing work and whether it fits with the potential and realised capabilities. The potential capacity refers to the ability to understand the contents of the technology. The realised capacity refers to the ability to use this understanding as a foundation for dissemination. E-learning systems are relatively new to Russia. However, the technology is not completely alien, or as one respondent put it: 'not from outer space to the Russians'. All in all the fit of the technology and its content appears to be an important dimension of the capability to disseminate new knowledge.

8.2.2 Transfer mechanism

The respondents argue that much of the work concerning transfer through the centre is dependent on the form of interaction between the Russian and Norwegian parties. This form of interaction is referred to as the transfer mechanisms (Autio, Laamanen 1995). Usually the interaction will be person based interaction and in most cases the well connected individuals. How the interaction moves from the person orientated communication to organisational communication is important. The centre works closely with the individual scientists and is matching them up with other centre researchers actively involving the younger researchers

(annual reports). They are doing so to induce exchange of competences and embed their knowledge socially.

Autio and Laamanen (1995) argue that process mechanisms are related to the services and organisational arrangements, meaning that how the organisation goes about its work is important for how the mechanisms work. The widespread use of symposia has given the centre personnel the opportunity to meet face to face a few times a year (annual reports). Cohen and Levinthal (1990) argue that moving from the individual level to the organisational level requires effort, which is clearly reflected in the frequent meeting activity.

By suggesting that social interaction and group dynamics shape the collective intelligence of the organisation Lam (2005) argues that it provides us with good insight into the dynamics underlying the capabilities of the organisation, and the capabilities necessary for technology transfer. This collective intelligence needs to be somewhat shared between the individuals of the organisation and have a considerable amount of overlap to provide the organisation with a working template for action (Dodgson 2000). Given the long collaborative history between some of the key figures of the Moscow Centre it is reasonable to believe that the centre is sensitive to the need of a functioning centre organisation. The interactive work of the centre is performed to facilitate potential and ongoing research collaboration. The organisation's capacity to interpret information and utilise it, depends largely on the collective problem solving skill of the organisation. However, other studies suggest that the organisational interpretative capabilities and systems can create blind spots concerning available information and thus block organisational innovation. Therefore, organisational cognition can both facilitate and hinder the development process. It is at the moment unclear whether cultural differences will have a serious impact on the successful application of the e-learning system. Certainly the unequal access to the developers can have an impact on the process. However, the overlap between the two may reduce the problem.

The organisational structure is according to the respondents unique in Russia with its emphasis on two-way collaboration and low cost profile. The structure is according to the respondents very effective and has been a great success. This is also reflected in the annual reports exemplified through increases in publications and projects. Lam (2005) argues that the structural school of organisational innovation studies focuses on the link between organisational structures and innovative capabilities. This should suggest a clear boundary between the organisation and the external environment. By having this unique organisational make-up the centre is able to gain access to resources that may otherwise have been unavailable. By acting as a cohesive entity towards Russian and Norwegian authorities the centre has successfully created a good field of operation.

The researchers affiliated to the centre are according to the annual reports and the respondents internationally acclaimed scientists and the tight person based collaboration should indicate a good basis for further development. The scientific community in both Russia and Norway entail many informal contacts, and the centre employees belong to a variety of networks, which are critical for their work. The cognitive perspective suggests a link between the cognitive make-up and subsequent learning for successful innovation. It is difficult to assess whether the success of the centre is attributed to its structure or the cognitive makeup. Both appear to be of importance. Teece (1977) argues that when unusual problems are encountered the in-house capabilities are likely to be of value. However, the link between structural capabilities and learning seems to be somewhat underdeveloped (Lam 2005). Having potential capabilities need not mean that they will automatically benefit from them. In Lam's comprehensive review of organisational innovation neither the structural view nor the cognitive view dwell much with the relation between propensity and capability. As noted earlier the extreme hierarchy of the Soviet Union can have produced a certain amount of residual inertia. Lane and Lubatkin (1998) distinguish between

passive, active and interactive acquisition of external knowledge. The centre aims at working actively with its partners in developing the e-learning system to overcome passive learning tendencies. At the moment there is little explicit knowledge being transferred as the system is not ready yet. Thus, passive knowledge transfer would be of limited value.

8.2.3 Transfer channel

Much of the transferring and disseminating of knowledge and technology in the realms of the centre is done through the use of social networks. Autio and Laamanen (1995) argue that technology transfer takes place between social entities. The distribution of the key personnel, or hubs as Barabási (2002) would have called them, seems to be critical to the centre projects. As noted the Norwegian staff have considerable knowledge and experience concerning Russia and their cultural sensitivity appears to have had a positive effect on the degree of success of centre projects.

The respondents assumed that the success of the e-learning system transfer is dependent on the degree of fit with existing organisational routines and culture. Therefore, the existing communication channels appear to be embedded in the organisational culture. Cohen and Levinthal (1990) argue that an organisation needs to have some prior knowledge in order to understand how to disseminate it in its own organisational structure. The e-learning system that is being transferred has to be translated and adapted to the Russian context and create channels that will work in the local context. Therefore, serious cooperative effort has been put into the development process. Arguing on the basis of a vertical/horizontal conception of technology, the transferring of parts of the e-learning technology in early stages is essential for the overall success of the transfer, and may entrench the existing channels. Methe and Penner-Hahn (1998) argue that organisational learning entails a distinction between content learning and process learning.

When an organisation is acquiring content knowledge it does not necessarily entail process learning. However, when it is in the process of acquiring process knowledge it often entails the learning of content. The process knowledge is more tightly linked to the individuals within the organisation and thus, needs to be disseminated in the organisation in order to utilise it. Therefore, it is important to translate this knowledge into organisational routines that have a functional set of channels for communication and transfer (Methe, Penner-Hahn 1998). In overall the transfer channels appear to be of importance at this stage of the technology transfer.

8.3 Capacity to exploit new knowledge

The last stage in the transfer process concerns the ability to exploit the newly acquired knowledge. To use the technology the organisation must rely on the transfer mechanisms, the contents of the knowledge and the context variables surrounding it.

8.3.1 Transfer mechanism

The interactive nature of the Moscow Centre is according to the respondents important for the utilisation of knowledge. The annual reports suggest that the most important mechanisms are the human resources and the informal networks of the centre personnel. The building of networks and recruitment through gate keepers has created a good working template. They work with collaboration projects through a low cost profile, which means that the relative amount of money that goes into the research work is low and the output high. Despite a small scale work profile and little money used the centre has been remarkable productive reaching a vast number of people. For example it is reason to believe that 9500 physicians that have participated in the symposia have learned something and are actively using this knowledge to improve their work as physicians. It is reason to believe that the mechanisms displayed by the centre works well in exploiting the content of its knowledge base. It is at the moment unclear whether the centre will

be successful with the exploitation of the e-learning system as it is not finished and therefore not in a position to be fully exploited.

The Moscow Centre has through its work shown that it is capable of reaching a broad audience through limited resources indicating low R&D spendings. The respondents are excited about what the e-learning system can accomplish in terms on work penetration and increased production of for example publications. It is reason to believe that the ability to use the new interface provided by the e-learning system will work as the centre has displayed good capabilities in exploiting cheap interfaces. The capacity to use the e-learning system will depend on the usability of the acquired knowledge about e-learning. The respondents anticipated that the successful diffusion and use of the e-learning system would be dependent on more than the mere technological R&D orientated features. The findings at the centre question the assumed link between R&D spendings and innovative activities.

From studies of the Japanese catch up in the 1950ties and 1960ties the initial success was attributed to the copying and imitation of foreign technology (Freeman, Soete 1997). However, it became evident that this could not explain the outperforming of USA and Europe in terms of processes and products. Japan raised its annual R&D spendings to a level higher than USA and Europe, and thus the Japanese performance was explained in terms of R&D intensity (Freeman, Soete 1997).

Experiences from the former Soviet Union and Eastern Europe indicates that committing resources to R&D and innovation projects does not necessarily entail successful innovation, diffusion and increases in productivity (Freeman, Soete 1997). The Soviet Union had an enormous R&D budget, which were substantially larger than the Japanese, but with significantly lower productivity (Freeman, Soete 1997).

Therefore, Freeman and Soete (1997) argue that it was evident that qualitative factors affecting the national systems need to be taken into consideration as well as quantitative indicators. The Soviet innovation system was marked by relatively weak links between social, technical and economic features (Dyker 2001). The respondents acknowledge that administrative barriers still remain. In addition the incentives to increase performance efficiency were low, which retarded innovation at enterprise level (Gomulka in Freeman, Soete 1997). After the collapse of the Soviet Union this residual inertia may have contributed to the problems occurring in the national innovation system. The centre and its profile has aimed at working on the enhancement of international research links to increase the available knowledge base and improve the deteriorating Russian health system with relatively cheap but effective methods of knowledge and technology acquisition. The e-learning system in cooperation with the Moscow Centre personnel may facilitate this process through the successful exploitation of their capabilities. Training of the Russian personnel is considered to be vital among the respondents, supporting Lundvall et al. (2002) who argue that human resource capabilities are an important requisite of technology transfer.

The increased contact between Russian and Norwegian scientists has according to the annual reports resulted in many interesting research projects, which have been of importance in both Russia and Norway. Thus, the centre has provided the researchers with an opportunity to benefit from each other. The annual reports show a steady rise in the number of publications and activity in general. Following Zahra and George (2002) the effective exploitation of knowledge or technology requires the successful realisation of the potential absorptive capacity. Once the e-learning system is finished the centre needs to work in tight collaboration to utilise the possibilities of the newly disseminated technology. Therefore, the organisation needs to be aware of potential problems such as residual inertia, coordination loss and unclear cooperation

agreements. This renders the centre more capable of expanding its work in the future and it therefore a reflection of its capabilities to exploit the new knowledge. It is reason to believe that these capabilities will be of importance once the e-learning system is operative. The relative success is an indicator of the process of knowledge enhancement and research collaboration.

8.3.2 Technology content

The respondents argue that the Russians seem to be quite interested in new technological devices and are relatively familiar and up to date on the recent developments in IT. The e-maturity of an organisation is closely linked to the overall absorptive capacity (Martin, Massy, Clarke 2003).

The introduction of e-solutions in an organisation is very popular and is often used to substitute existing analogue solutions. Evaluations of the efficiency of e-solutions have shown that it tends to be more effective than analogue solutions (Martin, Massy, Clarke 2003). If this is the case the lack of performance is attributed to the e-solution's ill fit with the organisational parameters. It is not necessarily a lack of IT competence but maybe a lack in change management competence.

The organisation's ability to use the technology is largely dependent on the ability to foster subsequent changes in organisational structures (Hatch 1997). It is at the moment unclear whether organisational parameters will cause problems. However, the respondents acknowledge that the Russian systems have shown signs of resistance and resilience to change. The challenge concerning the use of e-learning solutions is not necessarily linked to a lack of available solutions and user competence, but more a question of how to adapt the working process. Therefore, the technology content and its interaction with the organisation appear to be an important dimension of the capacity to exploit new knowledge. Moreover, it is important to keep in mind that compatibility with other user organisations and the construction of a common interface is a considerable challenge when adopting e-learning solutions. Adopting an e-learning interface that

is compatible with other interfaces already existing in Russia is a considerable challenge and developing the system in concordance with the Russians appears to be critical. Therefore, technology content appears to be an important dimension.

8.3.3 Context variables

The capacity to exploit the newly acquired knowledge to the benefit of the organisation is according to the respondents dependent on organisational constraints.

Inferred from the annual reports and the respondents the Russian national system of innovation appears to be in a state of flux. How this is going to affect the future is uncertain, but there is reason to believe that changes will alter the way it works. To address these changes development of related capabilities it is necessary to work in tight collaboration with the local authorities. This is important to the creation of useful mechanisms for successful use of technology (Rogers 2003). It is important to keep track of the changes ensuring future fit of the transferred technology. As noted earlier, the Russian system has some serious problems with personal opportunism among state employees, and a significant amount of corruption. This is affecting the access to research projects and is also a source for losing money to dead end corruption projects. As the centre is working in a variety of fields finding new and non corrupt partners and projects is vital. The unstable nature of for example legal issues can be important. For example the system needs to be approved for use in Russian education institutions. Teece (1977) suggests that one should reflect on the level of development of the recipient country's infrastructure, which is thought to be a determinant of the cost of transfer. The e-learning system is copyrighted in Norway. Therefore, the centre needs to be sensitive to retain its copyrighted privileges. Copying and counterfeit products is a challenge in Russia, and the legal system has shown problems in handling this.

The respondents were quite clear about the possibility of problems related to international issues. Development of the organisation capabilities and catching up are context dependent and a history specific process. This means that the context and historical period shape the process of change. The e-learning system may induce changes over time in the centre activities. However, the extent remains unclear. The permanence of the e-learning system as it appears today is uncertain. Exploiting the new knowledge and technology is influenced by changes in the macro environment.

As the problem with brain-drain is not as eminent as before, using brain-drain to justify the need for increased funding from the Norwegian government becomes problematic. The Norwegian Ministry of Foreign Affairs is the biggest donor of financial resources. The institutional framework in Russia may change in the future creating a different operational environment for the Moscow Centre. The initiative to change the overall project from a humanitarian profile to a cooperative research collaboration profile is done to address the possible changing nature. Thus, the centre displays a very high awareness of future needs and is well equipped to handle changes. E-learning systems are popular and the construction of an e-learning system in radiology may secure the continued existence of the centre in the potentially different future environment. The overarching focus of the transferring parties appears to have an impact on the capacity to exploit the knowledge. If the organisation does not display the necessary capabilities to understand why it works in certain domains these organisational constraints may cause problems in exploiting newly acquired and novel knowledge, in this context the e-learning system.

Therefore, the knowledge of context is a vital dimension of the ability to exploit new knowledge that has been transferred into the organisation.

8.4 Path dependence

Throughout the stages of the transfer process path dependence appears to be an important dimension. Cohen and Levinthal (1990) suggest that the absorptive capacity is cumulative. The content of technology and the changing of technology over time highlight the path dependence.

8.4.1 Technology content

The respondents argued that the Moscow Centre has tended to work within certain trajectories within the realm of medicine. Assuming a change in technology over time in the transferring process within certain domains is consistent with the path dependence of absorptive capacity (Cohen and Levinthal 1990). The path dependency assumes that the absorptive capacity is a function of relating new knowledge with prior internal knowledge. The centre has been working within the field of medicine. Therefore, most of the knowledge within the organisation is somehow connected to this knowledge base. This has an effect over time and is cumulative in nature. Cohen and Levithal (1990) warn against being locked out from new fields of knowledge not directly linked to the existing by failing to develop an absorptive capacity in those fields. This may have a negative effect on the diversity of organisation knowledge and hinder creativity. The Moscow Centre acknowledges that e-learning systems are likely to be important in the future and that it is vital for the centre to develop a base knowledge to address this change. Moreover, the changes in the Russian context sketched above have heightened the awareness for alternative fields of work.

The path dependence of technology content can be seen as the propensity to use certain types of technology and certain ways of sharing. The respondents acknowledge that most of their work is centred on their traditional field of work and the social system this produces. However, they are introducing the e-learning system with the intent of expanding its potential fields of work. Thus,

the new technology may have an impact on their content focus, making the centre less path dependent. The centre has until now been dealing primarily with soft technology or humanware and orgaware in Sharif and Ramanathan's (1987) framework. The introduction of the e-learning system can be seen as a shift in the technology culture of the centre making it adhere less to a path dependent structure. Nevertheless, the respondents argue that the key personnel are likely to remain critical in the near future. At the moment they are using their traditional channels even though the e-learning system may be radically different than any previously transferred technology.

The respondents indicate that the centre aims at building long term relations through the channels they have available to enhance the relationship. This long term focus is consistent with path dependence as it entrenches existing cooperative channels. The long term relationship between key personnel has, according to the respondents, been critical for the success of the centre projects. Thus, there is a tendency to rely on the existing channels which is a reflection of path dependence. However, the introduction of the e-learning system may indicate a high sensitivity to alternative technology contents, which may have an impact on the transfer channels. These new channels may be the by-product of the preceding long term relationship, which renders the path dependence important. Thus, path dependence appears to be a vital dimension of absorptive capacity in relation to technology content.

Cohen and Levinthal (1990) acknowledge that the overall competence of an organisation is qualitatively bigger than the mere sum of the individual knowledge components. Hence, the organisation itself retains a knowledge component that cannot be disentangled from the organisation. In this respect the organisation changes the knowledge residing in it, and changes it through its existence. This is not far from assuming that when knowledge is transferred from one entity to the other, and when it is received by the receiver, changes as it is incorporated in the

existing knowledge base of the receiver. Dodgson (2000) argues that a long term relationship will facilitate certain types of interaction, which adheres to path dependence.

8.4.2 Technology change over time

As shown in the discussion so far it is necessary to allow for technology change over time in the transfer process and the relevant absorptive capabilities. Interestingly enough the linear conception of technology transfer is more path dependent than the parallel conception. In the linear conception development occurs in stages where a technology proceeds from one phase to the next in a cumulative way.

Although Russia has been in the forefront of research and development, there has been a lack of managerial capabilities (Dyker 2001). Traditionally all Russian research organisations were state governed, and there was little diversity in managerial principles. After the collapse of the Soviet Union and the subsequent changes in the research organisations, several research organisations experienced serious problems related to poor management and organisation. The cumulateness of absorptive capacity may produce a situation in which an organisation ceases to invest in a moving field causing it to fall behind to a degree that makes catching up very difficult (Cohen, Levinthal 1990). The management and administrative environment is a great challenge in Russia. The respondents acknowledge that it can be difficult to change things as the residual inertia seems deeply rooted in Russian governmental bodies. By applying a parallel conception of technology transfer it is possible to conceive a development that occurs by enhancing parts of the system and create new ways of organising. This process will be cumulative in nature. However, it must include a change in the management technology. Therefore, for both the centre and the Russian administrative bodies change in technology over time is important in connection to path

dependence to overcome potential pitfalls. It is vital to change the management or orgaware over time to combat development lock out.

8.5 Relative absorptive capacity: Learning dyad

Having argued that the organisation represent something qualitative different than the sum of its units indicates that the make-up of an organisation provides a unique context. When transferring technology these qualitative features are likely to have an impact on the transfer itself and the organisations who participate. The respondents argued that the main dimensions were the unique nature of the transfer mechanisms, the changing nature of the technology and the context factors of the transferring partners who made the transferring dyad qualitative different than other potential transfer partners.

8.5.1 Transfer mechanism

Although not in the initial framework suggested by Cohen and Levinthal the transferring partner and the subsequent relative absorptive capacity seems to be critical. The Moscow Centre and the Russian counterpart do function as a learning dyad. The strategic alliance between the two has created a situation in which most of the technology transfers the two groups experience, is from each other. Very few other actors are involved. Thus, there is reason to believe that any changes in the absorptive capacity of both organisations are attributed to the learning dyad formed between the two. The degree of fit between the two parties appears to be the main driver of the relative capacity. Given the importance of key personnel it is reason to believe that interaction is attributed to those individuals particularly. They are uniquely present in the organisation and are relative to the learning dyad.

The respondents emphasised that the majority of the work that has been done through the centre and the Russian and Norwegian partners would not have had the same level of success outside the cooperative framework. They were quite specific in their claim that the individual contacts and long term relationship between the partners were critical to its success. They are relying on this in relation with the e-learning system transfer, as they believe it to be vital for its development. Therefore, it is reason to believe that the learning dyad is a very important mechanism when transferring through the Moscow Centre. Lane and Lubatkin (1998) argue that an organisation can speed capability development through alliances and minimise the risk concerning technological uncertainties.

Teece (1977) divides between transfer cost and absorption cost. The transfer cost is related to the cost of moving technology by the use of the available mechanisms and through the available channels. The absorption cost is related to the dissemination of that knowledge. The resources required to transfer technology internationally are considerable (Teece 1977). Therefore, it is quite inappropriate to regard existing technology as something that can be made available to all at zero social cost. Lane and Lubatkin (1998) suggest that there is an unequal learning potential between organisations meaning that organisations have greater learning potential from some special organisations. The uncertainty related to the cost of the whole transfer may cause organisations to choose partners more conservatively.

As the relationship between the Russian and Norwegian parts is well established they have a more common interface for transferring, making it less costly and risky to transfer between them. Thus, it lowers the transfer cost. However, more importantly having developed alongside each other has had an effect on their absorptive capacity, which may significantly reduce the absorption cost. As noted in table 1 absorption cost is potentially very high compared to the transfer cost. Teece (1977) argues that assessing capabilities beforehand may save large

investments due to ad hoc adoption to catch up. This is relatively easier in a close relationship. Therefore, a successful dyadic relationship with a subsequent coordination gain and heightening of absorptive capacity the relative absorptive capacity appears to be an important dimension of technology transfer.

8.5.2 Technology change over time

Lane and Lubatkin (1998) argue that absorptive capacity is dependent on the dyadic relationship. The respondents acknowledge that there has been a maturation of the relationship in the time the centre has been operational. Given a change over time in technology one would assume such a change as the social interaction of the parties is likely to have an impact on the technology development within the centre.

The respondents have the impression that the twelve year relationship has been fruitful so some extent due to the fact that they are partly different in nature. These differences produces what the respondents called 'a healthy friction' and have been effective in the creative work of the centre. Dodgson (2000) argues that the potential development requires a certain level of difference. If the organisations start to mirror each other, they loose some of the room for creativity. Dodgson also stress that long term relationships are vital for the continuous incremental development of organisation technology. Much of the work undertaken by the centre is very complex and includes work on the scientific frontier. The e-learning system is built to address the need for training and research in a very advanced field; radiology. Thus, it is vital to have a steady relationship. The long term duration has enabled the centre to change over time and adapt to both each other and the fast changing research frontier. As noted earlier, trust is vital when engaging in research collaboration (Dirks, Ferrin 2001). In international transfer situations it is vital to have established a trust relationship. The friction has created situation where the

unfinished technology is sent back and forth between the partners for further development. Teece (1977) calls this horizontal transfer and it is considered to be important in a parallel transfer process of advanced technology. As a result the technology changes as a consequence of the dyadic relationship and the technology gains new characteristics in the transfer process.

The respondents were excited to see how the e-learning system will be received by the Russians and more importantly whether it will function as a good vehicle for a real two way collaboration. If the centre manages to embed this new system into its organisation and adapt it to its use as a functional interface between Russian and Norwegian scientists there is a potentially very high reward in terms of research opportunities. The ability to disseminate the new knowledge and in this case the e-learning system will largely depend on the eventual organisational constraints (Lane, Lubatkin 1998). If the organisation is not able to provide a good infrastructure dissemination may be troublesome.

The e-learning technology may benefit both countries. However, the respondents open for that the actual benefit may be larger for the Norwegians. The Norwegian research community is not in the same league as the Russian, which represents opportunities in terms of research collaboration. Therefore, the use of this e-learning system may herald a very different work environment for the centre as it may change the way the centre uses its knowledge. Consequently the centre may change as a consequence of the dyadic relationship.

8.5.3 Context variables

An interesting topic that has not been widely discussed in this assignment is the potential third party spill-over. Given a dyadic relationship most of the effect of the absorptive capacity and its use for the technology transfer, accumulation is most likely to be local. However, as some of the

respondents note, a lot of the work done with the symposia aims at accessing a broad audience which entails large calculated spill-over. The context in which the Moscow Centre finds itself is quite complex and the introduction of an e-learning system may reach far outside the traditional realm of the centre. Therefore, the refinement that has been the product of a long and fruitful relationship may have increased the absorptive capacity to give the opportunity for a wider distribution of its work. It is a little unclear as to whether the centre actively aims at third party spill-over. However, as a consequence of the present capacity it may be the case in the near future.

9.0 Conclusion

By using the proposed dimensions of absorptive capacity to illuminate the complex nature of technology transfer, this research has indicated a potential usefulness of process indicators. When dealing with process indicators the research has shown that a dynamic understanding of technology is needed. The process of technology transfer appears to be complex and multi-phased.

The Moscow Centre's work on the e-learning system has shown that a variety of factors influence its development and are important for the transferring of technology between Norway and Russia. The traditional view on technology transfer assumes stable inputs and outputs with unchanged products and processes which yields a black-box approach to the technology development process. This equilibrium orientated view may appear to be misleading as such equilibrium is rarely observed (Autio Laamanen 1995). The horizontal transferring of the unfinished system and the differences between the two partners indicate no equilibrium. Thus, a situation with stable inputs and outputs has problems in accounting for the innovation process. Autio and Laamanen (1995) argue that the inputs and outputs are not stable, but undergo

constant change whose speed and direction is affected by the structure of the technology transfer. Therefore, it can be argued that more attention should be diverted to the process related indicators of technology transfer.

It is important to bear in mind that questioning the view of a static input/output process need not imply an abandonment of input/output related technology transfer indicators. Different indicators can always be the subject of criticism. The value of the relevant technology is created when it is being used, for example manifested through increased FDI or increased capacity for absorption. Hence, it remains a subject for subjective evaluation. Such an evaluation is often dependent on the cultural and social values of the user. Thus, the various indicators used to assess technology transfer are also phase, interface and component dependent. In the end an evaluation is based on a qualitative judgement by the researcher and therefore, susceptible to bias in some way or the other. The process orientated view in this research project has isolated several dimensions of absorptive capacity that appear to have an impact on technology transfer, and that are vital to engaging in successful transfer of a technology with a large social and tacit knowledge component.

From the perspective advocated in this assignment technology cannot be disentangled for the social dimension in which it exists. Alternative ways of conceiving both technology and technology transfer may yield other answers. It is not given that the framework suggested in this thesis is applicable to other institutions and organisations. Having argued that the Moscow Centre is a very special institution, the framework applicability may be limited. However, Cohen and Levinthal (1990) aimed at isolating certain capabilities that were present in a wider context, and their suggestions appear to be applicable to the Moscow Centre.

This assignment cannot verify whether the dimensions suggested are universal and context independent. I have argued quite extensively that many of the dimensions are dependent on the specific context. Thus, further research has to be done to establish whether the dimensions are usable in a wider context.

In my view the construct of absorptive capacity suggested by Cohen and Levinthal (1990) should incorporate the importance of the learning dyad suggested by Lane and Lubatkin (1998). In the case of the Moscow Centre, the relative characteristics of the two parts seem to be critical for the workings of the centre and it is reason to believe that this will be the case when the e-learning system is finished. The lack of generalisability can be accounted for by acknowledging the vital information of the dyadic relationship that by definition cannot be duplicated. Path dependency appears to be a very important dimension of absorptive capacity. Thus, I have chosen to label it as a separate category in this research. Although Cohen and Levinthal (1990) acknowledge its importance, the case of the Moscow Centre indicates that it may be a critical dimension in relation to international technology transfer.

A broader sample of centre personnel may have revealed information that remained unknown to the researcher because of the sample characteristics. Clearly it would have been desirable to have included the Russian contemporaries, which may have yielded information that could alter the present understanding of the issue. However, being aware of the very limited generalisability of the findings this study is merely commenting on some underlying dimensions.

The framework of absorptive capacity appears to function as a framework to keep track of the changes that are occurring in a transfer process and can be used to elicit indicators relevant to the process. The research has shown that the process of technology transfer occurs over time and that different dimensions appear to be important at different stages. The framework of

absorptive capacity is itself distributed along a time continuum accounting for different aspects of knowledge absorption. Martin, Massy and Clarke (2003) argue that it is a theory of variance that is constrained by contextual features. Originally Cohen and Levinthal (1990) constructed a framework that should yield information of the overall capacity, without specifying under what conditions. Therefore, I will argue that the context of technology transfer is one context in which the absorptive capacity of an organisation is important.

The underlying dimensions illuminate the complex nature of both absorptive capacity and technology transfer when dealing with partially intangible technology. The research suggests that attention should be diverted to these dimensions in order to secure successful transfer of an e-learning system on the international arena.

In an attempt to map some more universal features of the framework one can look at the suggestions of Tihanyi and Roath (2002) who sketch out a few important issues concerning international transferring of technology. (1)The assessment of the contextual features of the country's institutional environment is critical to successful technology transfer. Therefore, the transferring parties should pay attention to the issues that affect the technology transfer and assess the impact of the short and long term effects with respect to the goals of the transferring parties. (2)The type of technology to transfer needs to be examined in relation to the contextual features of the country to assess the level of fit. The transferability of technology to transition economies is an important part of any technology transfer process. (3)The Transfer recipient capabilities will largely determine how and what type of transfer that should be used. The skills associated with the capabilities are often a product of the characteristics of the organisation and specialised training. These capabilities cannot be picked up casually or be a by-product of unrelated forms of learning. The dispositions of the capabilities are dependent on organisation and personnel. (4)The transferring organisation should develop its capabilities to continuously

monitor the exchange process to identify potential problems and resolve them before they become unmanageable. The significance of the capabilities is relative to the needs of the organisation. Too many experts and too little need, or the other way around, typically erode and devalue the capabilities developed. All in all technology transfer is a complex process in which much is still unknown.

*

10 References

- Abramovitz, M. (1986). Catching Up, Forging Ahead and Falling behind. *Journal of Economic History*. Vol. 46 No. 2, pp 385-406.
- Amesse, F., Cohendet, P. (2001). Technology transfer revisited from the perspective of the knowledge-based economy. *Research Policy*, Vol. 30, pp 1459-1478.
- Asdal, K., Myklebust, S. (1999). Teknologi, vitenskap og makt: Eksempler på effektiv "black boxing" og noen åpningsforsøk. *Makt og demokratiutredningen 1998-2003 Rapportserien*. No. 7.
- Autio, E., Laamanen, T. (1995). Measurement and evaluation of technology transfer: reviews of technology transfer mechanisms and indicators. *International Journal of Technology Management*, Vol. 10, pp 644-665.
- Barabási, A.L. (2002). *Linked: The New Science of Networks*. Perseus Publishers, Cambridge.
- Cohen, W.M., Levinthal, D.A. (1990). Absorptive Capacity: A New Perspective on Learning and Innovation, *Administrative Science Quarterly*. Vol. 35, pp 128-152.
- Cohen, W.M., Levinthal, D.A. (1989). Innovation and Learning: The Two Faces of R&D. *Economic Journal*, Vol. 99, pp 569-596.
- Di Maggio, P., Powell, W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organisational fields. *American Sociological Review*, Vol. 48, pp 147-160.
- Dirks, K.T., Ferrin, D.L. (2001). The Role of Trust in Organizational Settings, *Organisation Science*. Vol. 12 No. 4, pp 450-467.
- Dodgson, M., (2000). *The Management of Technological Innovation*. Oxford University Press. Oxford, New York.
- Dyker, D.A. (2001). Technology exchange and the foreign business sector in Russia. *Research Policy*. Vol 30, pp 851-868.
- Fagerberg, J., Godinho, M. (2005). Innovation and Catching-Up, in Fagerberg, J., Mowery, D.C., Nelson, R.R. (eds.), *The Oxford Handbook of Innovation*. Oxford University Press, Oxford, New York.
- Flick, U. (2002). *An Introduction to Qualitative Research*. Sage Publications, London, Thousand Oaks, New Dehli.
- Freeman, C., Soete, L. (1997). National Systems of Innovation, in *The Economies of Industrial Innovation*. Pinter Publishers.
- Fuller, S. (2002). *Knowledge Management Foundations*. Butterworth Heinemann. Boston, Oxford, Auckland, Johannesburg, Melbourne, New Dehli.
- Hatch, M.J. (1997). *Organisation Theory: Modern, Symbolic and Postmodern Perspectives*. Oxford University Press. Oxford.

- Hewstone, M., Stroebe, W. (2001). *Introduction to Social Psychology*. Blackwell Publishing, Oxford.
- Hirsch, E.D. (1976). *The Aims of Interpretation*. University of Chicago Press, Chicago.
- Hubermann, A.M., Miles, M.B. (1994). Data Management and Analysis Methods, in Denzin, N.K., Lincoln, Y.S. (eds.) *Handbook of Qualitative Research*. Sage Publications, Thousand Oaks, London, New Delhi.
- Kirk, J., Miller, M.L. (1986). *Reliability and Validity in Qualitative Research*. Sage Publications, Newbury Park, London, New Dehli.
- Kuper, A., Kuper, J. (eds.) 1996. *The Social Science Encyclopedia*. Routledge. London, New York.
- Kvinge, T. (2004). *Knowledge diffusion through FDI: established wisdom or wishful thinking?* Working paper, No. 31, Centre for technology, innovation and culture, University of Oslo.
- Lane, P.J., Lubatkin, M. (1998). Relative Absorptive Capacity and Interorganizational Learning, *Strategic Management Journal*. Vol. 19, pp 461-477.
- Lam, A. (2005). Organisational Innovation, in Fagerberg, J., Mowery, D.C., Nelson, R.R. (eds.), *The Oxford Handbook of Innovation*. Oxford University Press, Oxford, New York.
- Lundvall, B.Å. (2002). *Innovation, Growth and Social Cohesion: The Danish Model*. Edward Elgar, Cheltenham UK, Northampton MA.
- Lundvall, B.Å. et al. (2002). National systems of production, innovation and competence building. *Research Policy*, Vol. 31, pp. 213-231.
- Martin, G., Massy, J., Clarke, T. (2003). When absorptive capacity meets institutional and (e)learners: adopting, diffusing and exploiting e-learning in organizations, *International Journal of Training and Development*. Vol. 7, pp 228-244.
- Méthé, D.T., Penner- Hahn, J.D., (1999). Globalisation of Pharmaceutical Research and Development in Japanese Companies. Organisational Learning and the Parent-Subsidiary Relationship, in Beechler, S.L., Bird, A. (eds.). *Japanese Multinationals Abroad: Individual and Organisational Learning*. Oxford University Press, Oxford.
- Miller, D. C., (1991). *Handbook of Research Design and Social Measurement*. Sage publications, Newbury Park, London, New Dehli.
- Nonaka, I. (1994). A dynamic theory of organisational knowledge creation. *Organisational Science*. Vol. 5, No. 1, pp 14-37.
- Polyani, M. (1967). *The tacit dimension*. Anchor Books, Garden City NY.
- Porter, M., (1980). *Competitive Strategy*, The Free Press, New York.
- Reisberg, D. (2001). *Cognition: Exploring the Science of the Mind*. Norton&Company, New York, London.
- Remington, T.F. (2004). *Politics in Russia*. Pearsons Longman, New York.

- Robson, C. (1993) *Real World Research: A Resource For Social Scientists and Practitioner Researchers*. Blackwell Publishers, Oxford UK, Malden USA.
- Rogers, E.M. (2003). *Diffusion of Innovation*. Free Press, New York, London, Toronto, Sydney.
- Sharif, N., Ramanathan, K. (1987). A Framework for Technology-based National Planning. *Technological Forecasting and Social Change*. Vol. 32, pp
- Smith, K. (2005). Measuring innovation, in Fagerberg, J., Mowery, D.C., Nelson, R.R. (eds.), *The Oxford Handbook of Innovation*. Oxford University Press, Oxford, New York.
- Teece, D.J. (1977). Technology Transfer by Multinational Firms: The Resource Cost of Transferring Technological Know-How. *The Economic Journal*. Vol. 87, No. 346 pp 242-261.
- Tihanyi, L., Roath, A.S. (2002). Technology transfer and institutional development in Central and Eastern Europe, *Journal of World Business*. Vol. 37, pp 188-198.
- The Moscow Times (08.04.2003). 'The Underworld Extends to Higher Education', pp. 11.
- Verspagen, B. (1991). A New Empirical approach to Catching Up or Falling Behind, *Structural Change and Economic Dynamics*. Vol. 2, pp 359-380.
- Zahra, S.A., George, G. (2002). Absorptive capacity: A review, reconceptualization and extension, *Academy of Management Review*. Vol. 27, No.2 pp 185-203.
- Zakharov, I.V. (1996). Interactions through the network: understanding the myths to create new ways of information exchange, *Radiation Protection Dosimetry*. Vol. 68 No. 3/4, pp. 293-296.

11 Appendix

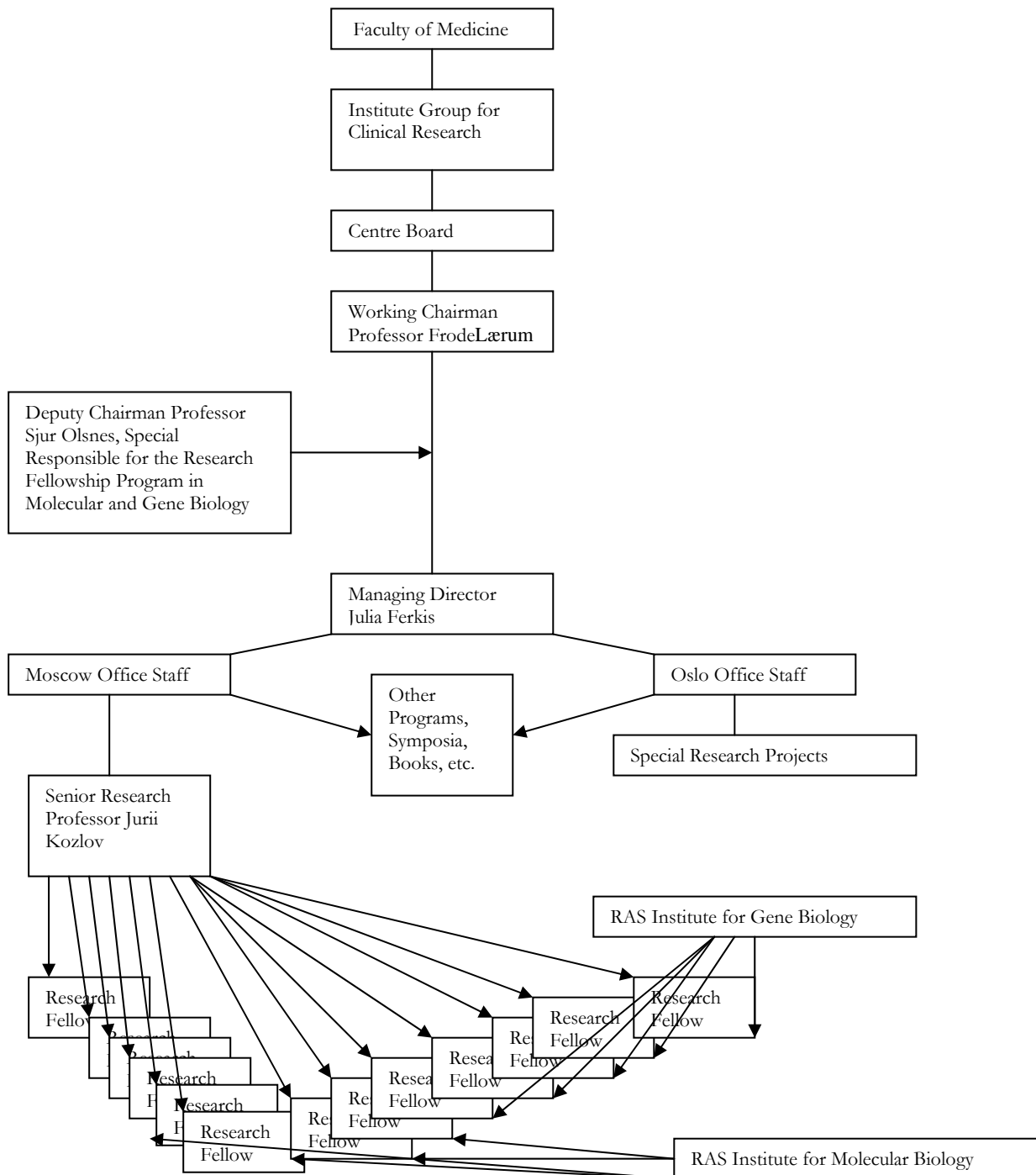
Appendix #1 List of tables

Table 1, pp 5

Table 2, pp 16

Table 3, pp 50

Appendix #2 Organisational chart of The Moscow Centre



Appendix #3 Coding Frame

Dimensions:	Technology transfer models	Transfer mechanism	Transfer channel	Technology content	Technology change over time	Context variables
Capacity to recognise relevant external knowledge	Relative importance of transfer partner	Formal/informal Number of potential links Social sensitivity to potential links Service and organisational arrangements	Gate keepers- access to relevant information Personnel links Social networks Cooperation schemes System and equipment exchange Financial flow	Knowledge economy Prior experience Gate keepers	Adaptability Number of potential links Degree of organisational slack	Knowledge economy Degree of corruption
Capacity to disseminate new knowledge	Requires process indicators	Centralised VS decentralised	Social networks Distribution of links Cultural sensitivity	Prior experience Degree of fit with existing competences	Dependent on organisational constraints	Shared language and symbols
Capacity to exploit new knowledge		Market access (access to publish in international journals) Participation at international conferences	Financial flow Financial guaranties Financial stability over time Cooperation schemes Formalisation of strategic agreements	Degree of dissemination in the organisation Degree of competitive advantage given by the new knowledge	Salience of new technology	Institutional framework National system of innovation Social networks (finding the right people) Degree of corruption
Path dependence	A traditional transfer model concept may increase path dependence	Peer recognition Type of international publication forum	Usage of existing channels Sensitivity to alternative channels	Tradition Social systems Technology culture	Research priorities	Research culture
Relative absorptive capacity: Learning dyad	Relative importance of transfer partner	Degree of fit with the transferring partner	Availability to the transferring parties		Maturation of relationship between partners	Third party spillovers