

## **IMPROVING DESIGN WITH OPEN INNOVATION: A BENDABLE MANAGEMENT TECHNOLOGY**

This paper opens the black box of the management concept of open innovation by analyzing how the Device Development unit in the medical company, Novo Nordisk, translates open innovation into practices in 14 projects with different outcomes. A literature review produced three groups of activities that can support open innovation: network building, an improvement in knowledge flows and exchange, and the exchange of technology and licenses. The analysis shows that the commercially successful projects did apply many of the recommended practices from open innovation, even if some of them originally began as internally focused projects. Only one successful project out of six actually established a new business model, which many authors consider to be an integrated part of the open innovation approach. The analysis also shows that even projects that applied many or even most of the open innovation approaches recommended in the prior literature did not automatically become commercial successes.

The concept of open innovation is proposed as a suitable and relevant strategy for companies that want to remain competitive (Chesbrough 2003; Gassmann 2006; Pisano 2006) because it provides them with new ideas and knowledge, improves the quality of their products, and decreases their time to market for new products. Despite its popularity, and although research indicates that there are many struggles involved its realization (Slowinski and Sagal 2010), there has been limited research into the way in which companies translate this management technology into new practices.

The literature on open innovation suggests that open innovation is a managerial practice (Dahlander and Gann 2010), although the concept seems to have many meanings (Euchner 2010). This exploratory (Drenth, Thierry, and Wolff 1998, p. 15) paper is aimed at understanding how the management concept of open innovation is transformed through local translations into local practice and then mobilized. Interviews with managers and project managers in Novo Nordisk provided evidence that the company struggled to apply an open innovation approach; we saw various examples of how the project managers tried to translate the concept of open innovation.

In this study, we analyzed research on open innovation, based on references used in courses on open innovation taught at four leading business schools and from a search for the term "open innovation" in the EBESCO database and in leading, high-ranked journals, including *Research-Technology Management*. Abstracts used for initial screening produced 163 articles; upon further examination, 80 articles were selected for further use. Extracts of open innovation practices from these articles are reported in Appendix A.

## **PRIOR RESEARCH ON OPEN INNOVATION**

Open innovation is a popular and emerging topic. A Google search in February 2011 produced 8,770,000 hits, and by 5 August 2011 this number had increased to 17,300,000. Yet there is a dearth of research on the way in which firms organize to implement open

innovation (Bianchi et al. 2010) and how they translate open innovation into managerial practice. Chesbrough (2003) can be considered a recent primary reference on open innovation, but the concept has recently been reinvigorated by special issues and articles on the topic (e.g. Laursen and Salter 2006; Gassmann 2006; Chiaromonte 2006; Gassmann and Reepmeyer 2005; Gaule 2006; Gruber and Enkel 2006; West and Gallegher 2006; Chesbrough, Vanhaverbeke and West 2006; Lichtenthaler 2008a and 2010b; Van De Vrande et al. 2009; Enkel et al. 2009; Gassmann, Enkel and Chesbrough 2010).

It could be claimed that the phenomenon of open innovation has been present for many years in innovation research and in practice. Over 75 years ago, Schumpeter (1976) pointed to the relationship between innovation and entrepreneurship, but Von Hayek (1945) was the first to address the need for open innovation approaches, describing them from a macro-level perspective, based on his view that knowledge is unequally distributed in society. A firm's decision to search for a new technology outside the organization was modeled by Nelson and Winter (1982). Others predicted the end of an era in which laboratories and R&D departments are leading forces for innovation, but would still be critical because they enhance the firm's ability to use external knowledge (Rosenbloom and Spencer 1996).

In order to identify the main features of open innovation, a review of prior research was undertaken in four steps. We first checked course syllabuses dealing with open innovation from four leading international business schools. Second, database searches

were undertaken for publications in which the term "open innovation" was in the title or served as a subject, and were checked against existing reviews on open innovation. We then read the abstracts of the first 163 identified articles, thereby reducing the number to 80 relevant articles. Finally, we used an open coding approach to identify general categories of open innovation from reading prior research on open innovation and tested these categories by classifying the identified publications. Classification was undertaken independently by each researcher and later crosschecked for consistency among the three of us.

Fundamentally, open innovation is concerned with the opening of the innovation process involving flows in two directions: "inbound open innovation, which is the practice of leveraging the discoveries of others" and outbound open innovation, by which firms "look for external organizations with business models that are better suited to commercialize a given technology than the firm's own business model" (Chesbrough and Crowther 2006: p. 229). The flow can go both ways as outflows of knowledge (technology exploitation) and inflows of knowledge (technology exploration (Vrande et al. 2009)). Firms might behave differently according to their specific needs; some of them need to identify external knowledge, and others are trying to commercialize their innovations in the market (Simard and West 2006). Dahlander and Gann (2010) distinguish between the dimensions of acquiring-sourcing and selling-revealing.

The Not-Invented-Here syndrome, whereby members of an organization do not accept outside knowledge, prevent organizations from acquiring and absorbing knowledge from

outside (Katz and Allen 1982). Others have highlighted the importance of investing in internal research in order to develop the needed absorptive capacities to utilize external technology (Cohen and Levinthal 1990). Focusing on the external side, Von Hippel (1988) identified four external sources of useful knowledge: suppliers and customers; university, government, and private laboratories; competitors; and other nations. Prandelli and Sawhenhey (2008) describe the processes that emerge when the boundaries of a firm's knowledge and its intellectual rights are not clearly defined. The role of knowledge brokers and their importance not only for idea generation but also for innovation in general is now well documented (Hargadon and Sutton 1997 and 2000). Proctor and Gamble's R&D department has moved from an internal research and development function to a Connect and Develop (C&D) unit (Huston and Sakkab 2006). Gambardella (2005) describe the market for technology that can overcome three market failures: R&D duplications, externalities in potentially public R&D outcomes, and deviations from marginal cost pricing in the downstream product markets. They encourage companies to produce more general technologies ranging over a breadth of industries. The licensing of technology often implies a trade-off as "licensing revenues must be balanced against the lower price–cost margin and/or reduced market share implied by increased competition from the licensees" (Fosfuri 2006, p. 1146).

Our analysis of the literature on open innovation found that the overall theme was the need for openness, and that it incorporated three subthemes.

- a) the need for new organizational forms of collaboration (often described as networks) and new forms of business models, both supported by systems and

incentives;

- b) a need for open, flexible knowledge searches and exchanges, the openness to attain knowledge from outsiders, and the ability to exploit the knowledge;
- c) open-network approaches for the acquisition of new technologies and intellectual properties (IPs), and the ability to use these approaches.

The three subdomains and their underlying features are condensed in Table 1, and are found to be in line with prior research (Giannopoulou, Yström, and Ollila 2011).

The underlying detailed factors identified in prior research are shown in Appendix A.

<b>I) Networks</b>	<ul style="list-style-type: none"><li>a) Organization structures and systems support collaboration with both outsiders and insiders.</li><li>b) Reward and performance measurement systems support an open innovation approach.</li><li>c) Collaboration is taking place among team members and organizational units and does actually function.</li><li>d) The project establishes a new business model.</li></ul>
<b>II) Knowledge flows</b>	<ul style="list-style-type: none"><li>a) The organization and project supports knowledge exchange and integration of knowledge and has the needed absorptive capacity.</li><li>b) The organizational and project norms and culture support the use of external knowledge (identification, exploration, exploitation, and retention of knowledge).</li><li>c) The organization and project uses technology scouting, watching, and mapping.</li><li>d) The organization and project have and use a system or processes for knowledge transfer.</li></ul>
<b>III) Technologies and market for technologies</b>	<ul style="list-style-type: none"><li>a) There are mechanisms and processes that support selling, buying, or acquiring technology, R&amp;D, IPs, or licenses.</li><li>b) These transfer methods are known and used within the project.</li><li>c) These technology transfer mechanisms are used successfully within the project.</li></ul>

Table 1: Main features of the management technology for open innovation derived from our review of previous research.

According to the literature, the elements of the open innovation approach outlined in Table 1 require that structures, processes, values, and norms all support, each in its own way, the various activities required for an company to be fully involved in open innovation.

In their “Want/Find/Get/Manage’ model, Slowinski and Sagal suggest steps to utilize open innovation methods, which seem to be based on the assumption that it is possible to identify the needs, as well as the steps to reach the goals. But linear approaches are often a poor fit with innovation (Akrich, Callow, and Latour 2002a and b). As one of the most active advocates for open innovation, Chesbrough has pointed to the need for a flexible application of the open innovation methods, required to accommodate the uncertainties regarding markets and technologies, by what he calls a "poker" approach (2004, p. 24). The goal of this paper is not to evaluate whether or not Novo Nordisk followed a specific method; rather we investigate the various ways of utilizing the concept of open innovation in our attempt to make sense of the concept (Christiansen and Varnes 2009).

## **DEVICE DEVELOPMENT IN A MEDICAL COMPANY**

Novo Nordisk and its device division, especially its department for device innovation, was willing to participate in this research because open innovation strategies have been used to reinvigorate its innovativeness processes. This study is based on interviews with project managers and senior managers in the company. Data obtained through interviews

were triangulated with observations; the device department was visited at various intervals and during special events, and one of the researchers had a desk in the company for five months.

The history of Novo Nordisk dates back some 80 years, when the founder decided to produce insulin; the process for its industrial production had just been discovered in Canada at that time. The founder's legacy of making a positive difference in people's lives by defeating diabetes is still the core vision of the company. Novo Nordisk is a worldwide leader in diabetes care, possessing the broadest diabetes product portfolio in the industry, including advanced products within the area of insulin delivery systems, haemostasis management, growth hormone therapy, and hormone replacement therapy. The company has its headquarters in Denmark; a presence in more than 179 countries; and more than 31,300 employees, approximately 60% of whom are located outside Denmark. For the last ten years, Novo Nordisk has achieved impressive financial results compared to the pharmaceutical industry and has achieved double-digit sales growth.

Producing devices with a high quality of design quality is considered a critical task at Novo Nordisk, as the Vice President of Innovation and Development explains:

Design is a strategic tool at Novo Nordisk. First of all, we use it to distance ourselves from our competitors. Novo Nordisk uses product design. Product design is developing material products whose starting point is the user's need. This could be a vacuum tanker or a vacuum jug or even a NovoPen. Novo Nordisk is one of world's



leading firms in treating diabetes. Design is what makes a decisive difference in how we stand compared to our competitors. For us, it's a business advantage to be ahead of our competitors because we provide superior services and products. Our patients and users get a better and higher quality product, and a better quality of life from using it. Novo Nordisk made its first insulin pen in 1985. We solve many problems with a thoughtful design. It has to look good, function well, and give people a sense of quality, so they have faith in the product. It has to make our employees proud of making a good product. Our insulin pen is one of the most used in the world. Our turnover has increased by 70% because of design. Our packaging gives us greater value and thus raises the price, because we can offer people a better solution to their problem.

The company operates globally, with in-depth knowledge of the healthcare systems of each country in which it is present. Although a large proportion of the company's intellectual property on innovation is still generated in house, Novo has been trying to use open innovation as a complementary strategy to sustain leadership aspirations. Besides cultivating closer ties with academia, research institutions, and external partners, the company has restructured the insulin and medical device area, separating the medical device department, in order to make it more productive and lessen its dependence on decisions made in the insulin area. The stated aim has been to increase the number and quality of new products developed, give inspiration to other areas through open debate, and provide ideas for the next generation device and for line extensions.

Over the years and for various projects, many different ways of being open have been

applied. Organizationally, innovation has recently become a cross-functional activity: different departments are involved in idea generation with the medical device department in order to develop a more systematic investigation of current and potential customers, as the head of the product development department explains:

The strategy is to pursue open innovation, to find external knowledge to support our business and ambitions for the device pipeline, to increase diversity, and to value ideas and solutions through these external challenges and innovation. We believe that the company can increase its speed of development for ideas outside our competence area.

Novo Nordisk also started working with new approaches to innovation as they became aware that they were lagging behind their competitors. As the head of Product Development says:

Novo considers itself innovative in relation to R&D, but when it comes to commercialize ideas, we have mostly been a number 2 or 3, acting as a fast market follower and being very risk adverse. Commercialization of a product happens when our company sees a threat from competitors; frequently we wait and study what the others are doing.

In order to ensure innovation in the next generations of diabetes devices, it has been an ambition at Nova Nordisk to establish a portfolio of early-stage device projects to guarantee device leadership within hemophilia, growth disorder, and inflammation. The

organization is expected to develop competencies by sharing information among departments, preparing and implementing strategies, scouting for new opportunities, generating and receiving new ideas, collecting, coordinating, pushing knowledge in device R&D, and aligning working methods and technologies across device R&D projects. The official mission of the department is constantly to seek candidates for sustainable and radical innovation projects. Medical devices are considered extremely important for supporting the sale of medical drugs, because in recent years insulin has been on par with and competition is attained through the combined sales of drug and medical devices.

We have gathered information on 14 recent projects conducted within the auspices of the device department. The department has a dual focus on concept development and concept realization, but is also involved in network building activities in various projects.

To support the exchange of knowledge and collaboration inside Novo Nordisk, multiple sustaining projects have been conducted. Among them are:

- An innovation portal for employees to facilitate increased sharing of ideas and expertise within Novo Nordisk. The portal has three sections: "Help me!", "Coach me!", and "Challenge me!"
- Idea Storm, which is a platform to collect ideas and best practices, and to generate comments on them.
- Novopedia is a wiki tool, wherein employees can post and exchange information, solutions, and suggestions.

- A blog at [novonordisk.com/career](http://novonordisk.com/career) targets university graduates who are looking for a career in the field.

Table 2 provides an abbreviated presentation of the projects, with a short characterization of the type of open innovation practice employed in each project.

<i><b>Project</b></i>	<i><b>Project description</b></i>	<i><b>Open Innovation approach</b></i>
<b>NovoPen</b>	This injection pen was the first ever developed; it eliminated the embarrassment caused by using traditional injection methods. It provided a simple means of injecting precisely the right dose of insulin, providing improved control of the blood-sugar level, and thus reducing the risk of the patient developing long-term diabetic complications.	User involvement
<b>NovoLet*</b>	The first disposable insulin syringe combined the pen's simplicity with convenience and high-dosage accuracy.	External designer
<b>Innovo</b>	This first combined blood glucose monitor and insulin injection system was unique in that it included a blood glucose monitor through an LCD (liquid crystal display) screen using modern testing technology.	Partnership with company
<b>yyyy pen project</b>	This pen represented the development of a medical PDA device able to inject insulin, monitor blood glucose levels, and record and upload data.	Partnership with several companies
<b>Novotrack</b>	This project concept involved a website, an educational tool, and the realization of a PDA device able to upload data from the yyyy pen about blood glucose level. Users could insert daily comments.	Partnership with several companies
<b>InnoLet</b>	This project was a pen designed for insulin users with poor eyesight or reduced manual dexterity.	Partnership with external supplier
<b>Xxxx project</b>	Development of an injection device with integrated memory, able to record use of and dose of insulin.	External consultant and on-line intermediaries
<b>Diadvisor</b>	This item represents a large-scale explorative project aimed at the development of a prediction-based tool, which uses easily available information to optimize the therapy of both Type I and II diabetes. Novo Nordisk developed the device from knowledge collected in the network partnership.	Partnership with universities, hospitals and companies
<b>Customized graphic design</b>	This web-based interface made it possible for users to design and order their own pen.	User involvement

<b>NovoConcept</b>	This project enhanced the evidence-based management of diabetes, development of best practice guidelines, and a measurement device. It provided improved clinical studies with a Diabetes Electronic Management System (DEMS). The alliance produced a continued medical education program and worldwide training of health care professionals. The NovoLet project is an offspring*.	Alliance and collaboration with users and non-profit organizations.
<b>Care system</b>	This call center and Internet-based service was used by patients (64% of contacts), pharmacists (18%), physicians (12%), and others (6%) for referrals, basic information, training, product problems, literature request, and medical inquiries.	User involvement
<b>Changediabetes now.com</b>	This Internet tool facilitates and improves dialogue with external stakeholders.	User involvement
<b>Oxford project</b>	The Oxford Health Alliance (OxHA) was founded by Novo Nordisk and the Oxford University and is dedicated to the prevention and reduction of the global impact of chronic diseases.	Network with universities, NGOs and others
<b>DAWN project</b>	The Diabetes Attitudes, Wishes, and Needs (DAWN) program is an international partnership effort for improving diabetes care by focusing on the patient's behavioral and psychosocial barriers to effective diabetes management.	Partnership with universities, doctors, patients and NGOs

Table 2: An overview of the 14 innovation projects. The last four in the table are network and knowledge-generating projects that have the potential to later inspire device development, as the NovoConcept project has already done with the NovoLet device.

## NETWORK ASPECTS IN THE INNOVATION PROJECTS.

Based on the identified open innovation characteristics (Table 1) and quotes from top managers, our analysis of the Novo Nordisk projects (see Table 3) indicates that the overall organizational structure and systems support external collaboration. And when internal and external collaboration is required and implemented, it usually works well. The project manager for the customized graphic design project never did look for external collaboration. The incentive and performance system in Novo Nordisk has never been modified to support open innovation explicitly, and managers regard external

collaboration as an integrated part of project managers' duties. This may explain why many projects begin with an internal focus. Although open innovation approaches are sometimes championed by senior management, they must be adopted by the project managers. In several instances, these approaches seem to have been driven by necessity rather than as a deliberate strategy, as one project manager explains:

The open innovation strategy was decided when I realized that we do not know everything about patient management. We recognized the necessity to get help from someone who sits in a clinic and manages the patients, and in different parts of the world to obtain a global view. As a company, we decided to ask our sales companies in different countries to conduct an interview with the doctors to understand what they needed.

It seems that a Not-Invented-Here syndrome prevails and has, in some instances, blocked increased collaboration with outsiders and even with other units within the company. The employees in the device and innovation unit consider themselves among the best designers and engineers in the industry and have often been reluctant to network with outside actors whom they do not consider to have similar high levels of competency. One example is the Innolet project, which was first considered to be a purely internal project, but after this approach was unsuccessful, an external search and partnerships were considered. Thus, in several projects, the approach originally began with a relatively closed approach to innovation, and when that did not produce the desired results, more and more open innovation approaches were added to the project.

In only the two projects in conjoint partnership was it decided to try to modify the existing (closed) business model, toward one in which the involved companies could share results and intellectual property rights. Two attempts at modifying the existing business model, however, by trying to commercialize the intellectual property rights from the yyyy project and the Innovo project were not successful, for different reasons. After successful concept development and test production and sales, it was decided that the Innovo pen was not generating high enough revenues, and was taken off the market – even in the face of positive consumer reactions. These outcomes seem to have made Novo Nordisk managers more closely evaluate its device development. Did they really need to consider alternative business models in the future, they asked themselves. They could have tried to explore this matter in greater depth, but so far they have not done so.

Being risk adverse also blocks the path to increased network collaboration. The device development unit succeeded in applying a model of narrowcasting in the xxxx project involving an external company, but did not succeed in the broadcasting model because Novo Nordisk was afraid that the intermediaries, which were collaborating with its main competitor on similar projects, could disclose critical information or propose similar solutions to other companies.

Novo Nordisk's large number of relationships with universities, nurses, doctors and hospitals are nurtured because they are believed to be less risky in terms of spillovers; universities, for example, are seen as sources of ideas and places where problems can be solved cheaply. For this reason, the company is also financing a considerable number of

PhDs. These interactions are conducted within more explorative projects that could later be turned into products or services.

The possibility of connecting the development projects to an external innovation community is considered key to the managers in the device division. But this approach is still untested in practice, partly because of the Not-Invented-Here syndrome, requiring employees to refuse ideas developed outside their own department, but also partly due, according to the managers, to some large uncertainties that have yet to be resolved. The development unit has reached the conclusion that it is necessary to develop some type of guideline to help its members decide in which part of the process and with which modality it is desirable to involve external partners and networks even further. Novo Nordisk is now willing to use knowledge brokers, but not willing to receive ideas from inventors and entrepreneurs, because the device units is unsure how to deal with the IPs and the potential problems it may cause.

#### **KNOWLEDGE ASPECTS IN THE INNOVATION PROJECTS.**

Internal and external knowledge exchange is officially supported and the use and integration of knowledge from external partners and consultants has been successful in most projects. The existing norms and value systems – especially the outspoken messages from top-management – also support the use of external knowledge. As indicated in Table 3, the various processes and systems, such as web-based tools and databases, which support the use of external knowledge has been used.



The utilization of knowledge exchange in innovation processes within Novo Nordisk becomes somewhat restricted, however, by the dominant idea that openness should initially be reserved for low-profile projects. This is reflected in the fact that systematic technology scouting and technology mapping has been used in only a few projects. The external search for technologies and solutions usually begins – and then only reluctantly – when a project is unsuccessful but the project manager is required to come up with some results.

There seem to be two ways of using external consultants and external collaboration in Novo Nordisk's device development. One is simply to outsource the project or the part of the project on which they would like the consultants to work, which would merely yield them a finished product, with no learning acquired and limited knowledge transferred. A second way is to employ an external consultant with the necessary competences, and work with this person or company for a limited time. In the Xxxx project, Novo Nordisk has clearly adopted a jump-in approach (Clark et al. 2000), with the aim of creating a sense of urgency, excitement, and new energy to promote change (Chesbrough 2007). The hiring of external consultants with experience in open innovation approaches has improved the processes in some instances.

The dissemination of knowledge from one project to another can be difficult, as employees highlighted in their interviews. There is no specific methodology or approach to integrate what has been learned during a project, and it becomes frustrating for

employees when a new project with similar characteristics is started and the external consultant is not available.

Managers periodically examine capabilities, processes, metrics, organizational structures, and the deployment of resources. The "Innovation portal" is an internal database with some potential as an internal knowledge-sharing portal, but it has not been fully exploited. The structured innovation model that had been used in Novo Nordisk for years seems, in some instances, to work against an open innovation approach by prescribing certain approaches that focus on internal rather than external knowledge utilization. This confirms observations in other companies (Grönlund et al. 2010).

Novo Nordisk has a long tradition of collaboration with doctors, nurses and patients, mainly in clinical projects and trials. Suggestions and comments from patients and medical staff are used primarily to provide feedback on completed projects, and input from the marketing department is rarely used in the innovation processes. The innovation unit has recently been more involved in the explorative projects, however, in which Novo Nordisk collaborates with outsiders. The Oxford project and the DAWN project, for example, provide useful inputs to the next generation device development projects. That type of project also serves the double purpose of demonstrating Corporate Social Responsibility as participating in a broader debate.

## **TECHNOLOGY ASPECTS IN THE INNOVATION PROJECTS.**

Technology transfers represent special challenges and require specific skills and processes (Bianchi, Chiesa, and Frattini 2011), but they also necessitate a general acceptance of the importance of exchange of technology. There is a basic difference between the network projects and the device development projects: The network projects do not focus on technology or the transfer of specific technologies, but on explorative knowledge generation. Members of the device development unit, on the other hand, are knowledgeable about the methods and processes needed for technology transfer and have been successful when deciding to engage in technology transfer. A Novo Nordisk project manager answers the question: Why are things still produced in-house, rather than being bought in the market or with more open-innovation approaches?

Once Novo acquires the technology and the knowledge, we prefer to develop and create the object ourselves rather than in the market, because we prefer to have the control, and because we think that what is produced outside it is not good enough. If you create a bad product, others may think that you are destroying your reputation of being a creator of good products.

The medical industry traditionally places a great deal of attention to intellectual property rights, as evidenced in everyday thinking and behavior in the industry. The device unit is presently not connecting the management of IP to the underlying technology life cycle. Novo Nordisk is using the same level of protection for products in the market, products that have not yet been produced and products that are declining or already dismissed from production. Intellectual properties are considered a tool to sustain and protect innovation

in the company. IPs are considered a valuable strategic resource, in need of strong protection because of the investments behind them. IPs are therefore strongly controlled by Novo Nordisk. Patents are perceived as a barrier to entry into the market. In our interviews with managers at all levels, concerns about the role of IPs were introduced into the discussion in one way or another. The head of the product development department, for example, raised these concerns in an interview:

A question that the company would like to know the answer for is: If we acquire something from outsiders, should we pay an upfront fee or should we pay based on a license agreement? And if we are working with co-developers, how do we actually share IP rights? Maybe we can have an agreement in which we have the rights within our core business area, and then do we have to leave the rest to the partner? These are things that we're considering right now. We're also considering the confidentiality. When Novo Nordisk is approached or is approaching external partners, how much information do we want to receive and disclose in a confidential way or not in a confidential way? By the end of this year, a task force is supposed to come up with some answers to these questions. Moreover, we have the NIH [Not-Invented-Here] syndrome. Instead of NHI, Novo Nordisk is hoping it should one day become "proudly invented somewhere else".

An unsolved question for the development unit in Novo Nordisk is related to the modality of acquisition of external knowledge: how, when, and how much information should be received. Some attempts at outsourcing internal competencies have been tried. The unit

sold some old patents to other companies outside the diabetes and hemophilia area. Moreover, for some products that were realized but dismissed (related to the glucose area) the patents have been put on the market for licensing. In this way, Novo Nordisk gains some experience and builds knowledge of technology transfers as a managerial competence (Sieg, Wallin, and Von Krogh 2010).

The department considers intermediate markets are inefficient because it is difficult for them to evaluate the information and the potential value of goods is difficult to predict and calculate. Innovations are sometimes left idle on the shelf, therefore. From the point of view of managers in the innovation device unit, another problem with the intermediate market is the definition of the time after which ideas can be sold; the innovation unit is afraid to sell a patent that could turn out to be a winning idea in a decade. For these reasons, the unit is unwilling to create a secondary market for innovation.

	Novoconcept *	Care system	Changediabetesnow.com	Oxford project	DAWN project		Customized design	yyy pen project	Novotrack		Innovo	Novopen	Novolet*	Innolet	Xxxx project	Diadvisor
<b>NETWORK</b>																
Organization structure and systems support external collaboration.	x	x	x	x	x		x	x	x		x	x	x	x	x	X
Reward and performance systems support open innovation.															x	
Collaboration worked among units and actors.	x	x	x	x	x			x	x		x	x	x	x	x	X
Project designed and established a new business model.								x			x					
<b>KNOWLEDGE FLOW</b>																
Organization and project supported exchange and integration of knowledge and had needed absorptive capacity.	x	x	x	x	x		x	x	x		x	x	x	x	x	X
The project norms and culture supported the use of external knowledge.	x	x	x	x	x			x	x		x	x	x	x	x	X
The project applied technology scouting, watching, and mapping	x											x			x	X
The project used a system or processes for knowledge transfer.	x	x	x	x	x			x	x		x	x	x	x	x	x
<b>TECHNOLOGY</b>																
Mechanisms and processes for transfer of technology, R&D, IPs, or licenses exist and are known to the project.			x	x	x			x	x		x	x	x	x	x	X
The project uses these transfer mechanisms.			x	x	x			x	x		x	x	x	x	x	X
Project successfully employed technology transfer.								x	x		x	x	x	x	x	X
<b>OUTCOME</b>																
Technical success											x	x	x	x	x	X
Commercial success											x	x	x	x	x	X
Network/CSR success	x	x	x	x	x				x		x				x	X

Table 3: Open innovation aspects in the projects. Projects are ordered after their main type of outcomes. The first five projects are network projects. The next three are unsuccessful device projects and the last six are successful ones.

## **OUTCOMES**

The outcomes are separated into three types of successes: Technical, commercial, and network/CSR successes. *Technical success* means that a device or other type of solution was produced. *Commercial success* refers to a product or service that was brought to the market, made a profit, and remained on the market for at least three years.

*Network/Corporate Social Responsibility (CSR) success* means that the project is an investment in network building; these network projects are often part of CSR activities as well. CSR and network building is producing a stream of knowledge that may later spur new projects, services, and products. CSR aspects are valued highly in Novo Nordisk, which was among the first companies worldwide to apply a "triple bottom-line" approach to measure economic, ecological, and social outcomes.

Participants regard the five projects aimed at network building as successful. These projects have managed to get existing and new external partners involved in various activities, and a few of the projects have already informed the initiation of new service and product innovation.

Three of the device projects have not been commercial successful. The Novotrack and yyy pen projects are closely interrelated and are of interest because of their originality and radical innovation – unlike all of the other device development projects. They were designed to apply an open innovation approach that included a redesigned business model, deliberate scanning for external knowledge and technologies, external partnerships, and user involvement. The collaboration between external partners and Novo Nordisk was considered excellent in the Novotrack project. Both projects were eventually stopped by top management, however, as they constantly faced technical issues that made it impossible to get the original concept to work. The Customized design project was based on a clever idea, but remained relatively closed in its approaches, and remained a departmental project while the design tool was being developed. As the design tool proved to generate some interest from customers, but was poorly integrated into the production and costly to operate, management decided to discontinue the project and terminate its services. We can only speculate if the project might have been able to produce a success if it had been better linked internally and externally (Akrich et al. 2002a), but the original idea seems promising: to deliver devices designed by consumers themselves.

The six successful device projects did apply most of the open innovation features, but only one project included the redesign of the business model that included profit sharing with external partners. Of the six successful projects, a deliberate technology search was undertaken in three of them. Internally the Xxxx project is considered to be the only one that has actually produced a new radical innovation; the others are considered more



incremental, but not less successful. Novoconcept was an explorative effort with external partners, which helped Novo Nordisk to produce the commercially successful insulin injection device called Novolet. Taken together, these two projects have been successful on all three criteria.

## **CONCLUSIONS:**

The analysis and our plotting of the application of different open innovation approaches shows that there are indeed many ways to apply the open innovation approach, each of which could lead to successful outcomes. Different interpretations and different practices coexist in the same company. Open innovation has become a widespread management technology, based on a concept that is difficult to question: that it is possible to learn from others, and to learn from collaboration. The concept has grown over time, to include ever more examples of methods and approaches that can support open innovation as a deliberate management approach. The analysis of these 14 Novo Nordisk projects shows that open innovation is a management technology that can be applied in a highly flexible manner. It is indeed bendable, and can take many forms. Our analysis also shows that the most radical product development project did indeed apply many of the approaches identified within open innovation; other projects in which the same approaches were used, however, turned out to be less successful.

In the cases presented here, however, the application of the open innovation approach has been a challenge to established ways of thinking and doing things that are deeply rooted in the company culture and the industry – things that are not easily changed. This may

reduce the potential benefits of trying to employ an open innovation approach. We do not claim statistical significance from the present analysis, but it seems that the much-talked-about redesign of business models within open innovation is not easily achieved in practice. It challenges deeply rooted norms, processes, and structures.

By employing our analysis, we found that:

- Local interpretations in projects and by project managers bend and transform the application of open innovation.
- It is possible to attain success without applying all the open innovation approaches presented within open innovation.
- The culture, norms, and existing processes are guiding the application of open innovation approaches.
- The development of new business models requires company-wide recognition and support.
- Open innovation approaches require not only external collaboration, but also internal openness and mutual trust among departments.
- Open innovation may be seen as a last resort when the internal processes do not produce the expected outcomes.

The lesson for managers and companies is that the organizational culture, values, and incentive systems should clearly support the open innovation approach from the beginning of the project. Otherwise, the R&D projects can incur costly time and energy

expenditures on fruitless internal processes, before the incumbents realize that they should be considering external sources of knowledge and technology. Management involves the allocation of attention among many different issues (Bentzen et. al., 2010), and incentive systems can stimulate certain preferences. Managers in Novo Nordisk have indicated that the open innovation approach is a possible way, but have not adjusted the reward system to support it. The one clearly failed project here (customized design) supports prior observations that it is critical for people involved in the project not only to speak about the project but also to gain the needed involvement of others. Finally, the application of open innovation is no guarantee for success, as the Novotrack and yyyy pen projects have demonstrated.

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## APPENDIX A.

Table A1: Detailed characteristics of open innovation grouped into three sub-domains from the literature review.

<i>Themes</i>	<i>Characteristics</i>	<i>Examples</i>	<i>References</i>
<b>Open innovation defined as:</b>	<p>Flows in inbound and outbound innovations.</p> <p>Boundaries become semi-permeable membrane.</p> <p>Industry penetration (from pioneers to established companies), now involved both high- and low-tech industries, large enterprises and SMEs, production and service companies, changes in the processes (from stage gate to probe and learn).</p>	<p>"Competitive advantage often comes from inbound open innovation, which is the practice of leveraging the discoveries of others. Companies need not and indeed should not rely exclusively on their own R&amp;D. In addition, outbound open innovation suggests that rather than relying entirely upon internal paths to market, companies can look for external organizations with business models that are better suited to commercialize a given technology" (Chesbrough, 2007, p. xxx).</p>	<p>Dahlander and Gann (2010); Lichtenthaler (2010b); Bianchi et al. (2010); Chiaroni et al. (2009); Chesbrough (2007); Gassmann, Enkel and Chesbrough (2010); Chiaroni et al. (2010); Badawy (2010); Bower and Christensen (1996); West and Gallagher (2006) Ronnberg and Frishammor (2010); Enkel et al. (2009)</p>
<b>Networks:</b>	<p>Increase search breadth and search depth.</p> <p>Establish organizational roles for the implementation of open innovation strategies.</p> <p>Manage the interface for networking with external and internal networks.</p> <p>Implement new use of rewarding systems.</p> <p>Incorporate collaborative strategy.</p> <p>Help to provide information on possible coordination, brokering transactions, acting as mediators, helping in providing final advice, founding and supports for innovation outcomes.</p>	<ul style="list-style-type: none"> <li>• University laboratories</li> <li>• Suppliers</li> <li>• Customers</li> <li>• Competitors</li> <li>• Consultants</li> <li>• Public research</li> <li>• Organizations</li> <li>• Venture capital</li> <li>• Startups</li> <li>• Intermediaries</li> <li>• Intragroup cooperation</li> <li>• Separate R&amp;D centers</li> <li>• Collective centers</li> <li>• Knowledge agency function</li> <li>• Intermediary firms</li> <li>• Bridges</li> <li>• Brokers</li> <li>• Information intermediaries</li> <li>• Superstructure organizations</li> <li>• Online communities</li> <li>• User involvement</li> <li>• Communities of practice</li> <li>• Learning organization</li> <li>• Virtual corporations</li> <li>• Network companies</li> <li>• Learning organization</li> </ul>	<p>Chesbrough (2003 and 2007); BargeGil (2010); Chiaroni et al. (2009 and 2010); Praest Knudsen and Bøtker Mortensen (2010); Howells (2006); Lichtenthaler (2009); Di Gangi and Wasko (2009); Von Hippel, (1988) Hagedoorn (2002); Stam (2009); Johannessen and Olsen (2010); Fichter (2009); Pisano (2006); Albors et al. (2008); Enkel et al. (2009); Howells (2006); Niedergassel and Leker (2010); West and Gallagher (2006)</p>



		<ul style="list-style-type: none"> <li>• Virtual corporations</li> <li>• Search engines</li> <li>• Peer to peer</li> <li>• Wikis</li> <li>• Crowdsourcing</li> <li>• Second life</li> </ul>	
<b>Knowledge flows</b>	<p>Consider the various knowledge processes and knowledge flows in the internal use of external knowledge. Explore exploitation retention of knowledge. Identify innovation-relevant knowledge. Institute integration mechanisms. Institute governance mechanisms. Firms check the external technology and knowledge to import it. Look for external organizations that are suited to commercialize a given technology. Employ knowledge capabilities (inventive, absorptive, transformative, connective and innovative, desorptive capacity).</p> <p>Employ knowledge management system (support the diffusion, sharing internal and external transfer knowledge).</p>	<ul style="list-style-type: none"> <li>• Inbound knowledge</li> <li>• Outbound knowledge</li> <li>• Absorptive capacity</li> <li>• Gatekeeping</li> <li>• Technology watch</li> <li>• Road mapping</li> <li>• IP protection</li> <li>• Innovation champions</li> <li>• Identification of innovation-relevant knowledge (personal, disciplinary, technical, market based, geographical)</li> <li>• Cooperation (positive climate, shared values, mutual respect for expertise, establishment of joint social practice)</li> <li>• Establish rules- and roles-routines for integrating knowledge from outside.</li> <li>• Problem solving and decision making</li> <li>• Not-Invented-Here syndrome</li> </ul>	<p>West and Gallagher (2006); Lakhani and Panetta (2007); Huizingh (2010); Chiaroni, Chiesa, Frattini, (2010); Wallin and von Krogh (2010); Spithoven et al. (2010); Cohen (1990); Chiaroni (2009 and 2010); Lichtenthaler (2008a); Kyläheiko et al. (2010); Van De Vrande et al. (2009).</p>
<b>Technologies and market for technologies</b>	<p>Firms must choose from licensing, sourcing, receiving, or not receiving monetary rewards and the level of protection to apply, whether or not to commercialize products left on the shelf, entering new markets, affirming the technology as</p>	<ul style="list-style-type: none"> <li>• In licensing</li> <li>• Out licensing</li> <li>• Equity investments, acquisition contracts, research founding</li> <li>• Purchase of services</li> <li>• Licensing out</li> <li>• Spin in</li> <li>• Spin off</li> <li>• Formal and informal relationships</li> <li>• Joint venture</li> </ul>	<p>Dahlander (2010); Chesbrough (2003); Bianchi et al. 2010); Lichtenthaler (2008b; 2009; 2010a and 2010b) Murray (2004); Laursen (2006) Chesbrough (2003) Bower and Christensen (1996); Arora and Gambardella (1990); Gambardella, Giuri, and Luzzi (2007); Gambardella</p>

	standards.	<ul style="list-style-type: none"> <li>• Non equity alliances</li> <li>• Acquiring</li> <li>• Sourcing selling</li> <li>• Revealing</li> </ul>	(2005) Doganova and Eyquem-Renault (2009); Hurmelinna et al. (2007) Fosfuri (2006.
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Table A1: Characteristics of open innovation, grouped into three sub-domains