



# Globalization of R&D: Recent Changes in the Management of Innovation in Transnational Corporations

By Alexander Gerybadze & Guido Reger

---

Discussed with the **3M** case

---

André-Victor Lobe & Olivier Mary

**R&D in Multinationals**

Prof. Michele Cincera



## Table of contents

Introduction.....	4
Part 1: Summary of the Article.....	5
The context.....	5
Methodology and Selected Firms .....	6
Part 2: Critical Assessment of the Paper .....	16
Scientific quality .....	16
Part 3: Case Study – 3M Company .....	19
History of 3M Company .....	19
3M Company Profile.....	20
R&D at 3M Company.....	23
Creating a Corporate Culture for Innovation: .....	24
Research and Patents.....	25
Research centers at 3M:.....	27
Programs for continuous improvement and innovation: .....	28
Part 4: Overall Conclusion .....	30



## Table of figures

Figure 1 : Four generic types of transnational R&D and Innovation.....	12
Figure 2: 3M's six business segments and their proportion of the total sales in 2007.....	22
Figure 3 : 3M's R&D Intensity from 2002 to 2007 .....	23
Figure 4 : 3M's R&D activities location worldwide in 2008.....	28



# Introduction

Since the early 80s, the globalization process has increased considerably, including both basic research and industrial R&D. While in an early phase (60s-70s) corporations aimed at strengthening their position abroad by building up sales, distribution and assembly operations, internationalization was driven by the concern of supporting their foreign activities.

Today, more than ever, there is a broad literature on the internationalization of R&D. Corporation on one hand and public research centers at the other hand have sensed the importance of strategic R&D regarding their international reputation, hence their chance of survival in a fast developing world. It is thus comprehensible that managers among others are obsessed by making the right decisions when it comes to investing on R&D, abroad as well as inland.

Ten years ago however-i.e. almost 2 decades after the start of the globalization process-facts on the matter we now consider and view as normal and anchored in the corporation chairman's mindset were not that obvious. A lot of studies were already conducted but they always covered the material from a macroeconomic and political angle, focusing on the American internationalization processes and neglecting business related aspects and trends in other important players in Europe and Asia. The study and research of Gerybadze and Reger (G&R) was thus motivated by the aim of examining those deficit areas and closing these gaps.

Our paper aims at giving a brief summary of Gerybadze and Reger's statements, discussing them and linking them with a realistic example of a R&D company.

It consists in 4 parts:

1. A summary of the article
2. Critical assessment of the paper
3. A Case Study: 3M
4. Overall conclusion



# Part 1: Summary of the Article

## ***The context***

The study conducted in the article was mainly motivated by the aim of completing the deficit areas that were identified for a large part of existing research on globalization of R&D. Concretely, the authors spotted the following shortfalls:

- A large part of the studies on R&D internationalization consisted of macroeconomic or sectoral surveys and analysis from the viewpoint of political sciences whilst neglecting more specific business-related aspects with concrete implications for CEOs.
- Many studies focused on US-corporations, putting European and Asian firms aside.
- Most researches on the topic were based on outdated paradigm of management and business administration and therefore do not take sufficient account of the flexible, dynamic new organizations and institutional configuration.
- And whenever a survey adopted the new paradigm of multinational enterprises, it did not examine explicitly the issue of R&D.

In their survey, the authors examine R&D globalization on 3 levels:

- a. First, they highlighted the generic socio-economics trends that have impacts on transnational firms and R&D systems in the developed countries in the long run.
- b. Second, they identified, for major technology-intensive firms, changes in their choice of R&D locations and the establishment of competence centers.
- c. Finally, they analyzed at the management level, for the selected corporations, the issue of which new coordination mechanism are increasingly adopted.



## **Methodology and Selected Firms**

Right from the start, the author wanted to give an empirical orientation to their investigation. To do so, they focused on gathering information and insights from the so-called “trend-setting” corporations, i.e. corporations that are big enough (basing on the market capitalization) and R&D intensive enough to lead the others in terms of R&D policy. They proceeded according to the following investigation plan:

- a. The first task consisted in evaluating the core literature, databases and new empirical surveys on this subject.
- b. Secondly, workshops lasting for half a day each were carried out involving research managers, top managers and scientists (so-called Senior External Advisors).
- c. After the workshops, the questions to be addressed by the project were fined down to core questions. A qualified interview guideline was then elaborated and tested out in 20 pilot interviews in order to be re-adapted.
- d. Following to these adjustments, 21 corporations were selected. 120 semi-structured expert interviews were conducted on 3 levels: board member, head of research and project leader.
- e. The output of the interview was compiled into 21 corporate profiles and 6 case studies on innovation projects. A comparative analysis of the profiles and case studies base on an inductive structuring plan was also performed.
- f. The results obtained from the research were submitted to an intensive discussion at 3 workshops, with enterprises delegates and representatives of the Federal Ministry of Education, Science, Research and Technology.

The final empirical sample contains the 21 most R&D intensive transnational firms worldwide. The author made sure the most R&D driving industries were represented: electronics and information technology, machinery and advanced engineering and chemical and pharmaceutical. Together, the selected firms have an above-average R&D intensity of 8.3%. Some of them are very far advanced in the process of R&D internationalization. The authors gave thus for each corporation the extent of globalization. However, they insist on one point:

*“The extent of internationalization cannot be compared with the parameter of the share of R&D performed abroad. The former also considers the extent of worldwide distribution of R&D and innovation activities, the globalization of management and the corporate culture, and the type of transnational coordination and interaction.”*



Further, the authors were able to divide the selected firms into 2 clusters:

- i. A group of high-tech firms with a strong internationalization and a strong presence abroad (more the 50% of R&D is performed abroad) and very R&D intensive (on average greater than 8.5%). These include ABB, Ciba-Geigy, Eisaj, IBM, Hoechst, Philips, Roche and Sandoz
- ii. A second group included enterprises mainly active on the field of medium-to-high tech, sometimes with a division classified as high tech. Their overall R&D intensive fluctuates between 4% and 10%. They are not very advance in the globalization process. These include Hitachi, Sony, Sharp, Melco, etc.

## **1. Tendencies in the 90s**

### **1.1 Transnational Technology Transfer vs Transnational Corporate Learning**

Technology transfer has been influenced by a traditional paradigm, which is characterized by the concept of technology adoption: R&D solutions are generated in one central location and are further distributed in other peripheral locations. This procedure is sometimes called *outward learning*.

In contrast, the new paradigm of multinational innovation is characterized by:

- Stronger market and technology interaction
- Geographical distribution of centers of learning
- Cross-functional learning ( technology transfer between business units)
- *Inward* as well as *outward* learning

With inward learning, R&D is no longer only performed in home countries and exported to guest countries. More and more firms built up R&D activities abroad (mainly in US, Europe and Japan), triggering the creation of knowledge centers at diverse locations worldwide. This gave no choice to lagging-behind-companies but go for “global sourcing” if they wanted to catch up their lag and to benefit from the available advanced research. Firms witnessed a shift from a mono-centric to a polycentric structure of national research and technology systems. With this new trend, firms had to cope with a new problem: the conversion of knowledge into marketable products. As a solution, the corporations engage in “global scanning” of knowledge and established efficient internal mechanisms for the transfer of R&D output.

### **1.2 New Modes of Lateral Organization**

R&D globalization is a time- and money-consuming process and thus exposing the corporations to serious coordination problems: In order to enhance their absorptive capacity, an increasing number of large transnational corporations build on cooperative modes and networks. Through these strategic alliances (consortia), leading technology multinationals have found a way that allow rapid and flexible networking of institutionally and regionally dissipated centers of knowledge. However, aligning the interests of the strategic partners to the firm’s own strategy and corporate culture is no trivial matter, even in the age of global information and communication systems.



Consequently, the awareness of these coordination problems have led back to more globally centralized restructuring in eminent multinationals as Ford, General Motors or Hoechst.

### **1.3 Organizational and Fiscal Consolidation**

Even large multinational enterprises are confronted with strong financial restrictions and have difficulty in keeping pace with the R&D race in order to avoid lags vis-à-vis competition. Organizational associated with fiscal consolidation are solutions that allow corporations to surpass the barrier of R&D financeability. However, fiscal consolidation has some consequences: a stronger application-oriented R&D performance and a limitation (hence deterioration) of basic R&D which led to a much stronger division structure inside each corporation.

### **1.4 Changing Relationship between Basic Research, Development and Innovation**

Traditionally, there has been an institutional separation of basic R&D, applied research, development, production and application. Since firms are now more and more thinking in terms of integrated process chains of innovation, basic research is also consider as a cornerstone in these process chains. Therefore it needs to be organized with a strong interaction to production and marketing. These trends are giving rise to decisive alterations in the management within firms (e.g. multidisciplinary projects, coordination of multinationals, etc.) as well as between independent corporations (e.g. joint ventures). In a nutshell, transnational firms are no longer simply optimizing production in search for low-cost locations, but also trying to create knowledge , searching for options at the leading competence centers of the world and converting these as fast as possible into successful businesses.

## **2. Findings and Analysis**

### **2.1 Driving Forces for Locating R&D and Competence Centers Abroad**

The authors analyzed the globalization process from 3 different angles:

- The traditional view of internationalization of R&D and Research laboratories within a firm.
- The internationalization of cross-functional business processes such as product generation processes, new venture management, etc.
- The internationalization of competence centers

The investigations showed that internationalization strategies for R&D are different from those for cross-functional business processes or from those for competence centers. In their strategy, multinational corporations pursue the following diagram:

- First, they define the basic decision-making unit, for which a coherent strategy and clear responsibilities are outlined
- Second, they define the center(s) of gravity for this unit at a global scale; it typically comes down to the location where critical knowledge and key resources are located



Furthermore, globalization strategies adopted by firm also depends on their country-of-origin, which leads to the following cluster:

- R&D driven global players from small industrialized European countries. For these firms, R&D basis is clearly limited from the outset, so that they participate actively in foreign research pools (e.g. Philips/NL, Roche/CH, etc.)
- Corporations in large developed European countries (typically the UK, Germany, and France) with a predominant technology base in their countries (e.g. Siemens, AG Metall, Daimler-Benz, etc..). Chemical and pharmaceutical firms are the only exception to the rule. Hoechst for example, has attained a high proportion of R&D conducted abroad.
- R&D Internationalization in Japan has not reached a far advanced phase. Big players as Sony, Hitachi or Mitsubishi all still have values below 10% for their proportion of foreign R&D. Only Eisaj is an exception with 50%.
- US firms are not representative enough to draw significant conclusions. However, IBM is an example of a highly internationalized corporation regarding R&D. UTC on the other hand is strongly centered on its country of origin.

### **2.1.1 New factors Driving R&D and Innovation Location**

The author's survey shows that there is a clear tendency for internationalization on 3 levels: R&D function, process and Competence Centers. The following motives for ongoing internationalization were spotted:

- *Acquiring impulses innovation processes and learning in lead markets and adaptation to sophisticated customer requirements by locating in the most dynamic and forward-driving markets.*
- *R&D is located close to the point of sale, where cash flow is generated and where new products concepts can be tested according to a "probe and learn process"*
- *Locations where regulatory conditions and licensing procedures are advantageous and where standardization agreements are decided. Specific regulatory environment stimulates innovations and subsequently provide enterprises that have been active in these regulatory niches with international competitive advantage*
- *For some sophisticated products, close linkages between R&D, advanced manufacturing and an efficient supplier network are decisive. Integrating high-quality production and simultaneous engineering on the spot with local R&D capacities is necessary in order to secure advantages of cost, performance and flexibility*
- *Research intensive firms (e.g. genetic engineering, integrated circuit design, etc.) emphasize the access to unique resources and leading research results and talents in particular centers of excellence with a high international reputation*



The drivers of R&D internationalization do not thus merely relate to exploiting the cost advantages of globally distributed R&D units, but emphasize more the value-added effects of international learning process along the whole chain (from research to sales and services relationship). Toshiba for example assigns 40% of corporate value-added to the generation of knowledge.

Further, globalization of R&D happens to be relatively far advanced in those sectors and product segments where there is a high degree of knowledge generation (chemical/pharmaceutical industry, information technology industry) and of country-specific differentiation. In contrast, industries in which research, product and process development as well as manufacturing are relatively easily decomposable (i.e. automotive and aerospace industries) tend to lag behind.

### **2.1.2 Focusing on Competence Centers**

The investigations reveal that the more specialized the area of competence that a corporation longs to acquire and the more important its links with complex knowledge (e.g. research, product competence, user competence) the fewer high performance centers tend to arise worldwide. Firms distinguish between:

- Leading-edge or pre-eminent locations; only one or two centers in the world classified as such
- Advanced locations (typically the major market and research systems in the industrialized countries)
- Less developed locations; i.e. less sophisticated and non-dynamic markets and research

The globalization process in the mid 90s is accompanied by an even more consistent concentration. Firms tend to emphasize on a few leading centers of research, advanced manufacturing and lead-market. While choosing the location for their R&D, they focus on those places where the best conditions for R&D and product development are united. The key criteria for this choice are:

- *Which location has the most advanced status of development and the best reputation in a certain field worldwide?*
- *Where do R&D requires strong inducements from highly sophisticated lead markets and customers requirements and where can these activities receive sustainable impulses for further lead performance?*
- *Where do manufacturing plants and business units generate the cash flow for leading edge research?*
- *Where is it possible to exert influence on regulatory regimes and dominant designs by participating in research consortia and standardization networks, consequently gaining early advantages in the worldwide innovation competition?*
- *Where does the competition stimulate the search for successful new business and sustainable innovation?*



The selection and evaluation of these “top locations” are some times carried out at a smaller level, like the Strategic Business Unit (e.g. the pharmaceuticals for the treatment of the central nervous system) or even at the level of the technology (e.g. flat panel displays). The quality of research itself is no longer sufficient; competence centers have to be internationally well-reputed to be eligible as “top location”. Enterprises are not always able to assess the performance quality of each center. Having a good international reputation allows more global visibility. Consequently, internationally reputed research centers or universities are those that can afford huge advertising campaigns or benefit from the alumni networks.

They manage thus to conserve their leading position while research institute drop further down the list in the assessments of international manager.

### **2.1.3 Globalization vs Concentration of Core Competencies in the Home Countries**

Despite the overall globalization trends, there is an underlying feeling of chauvinism:

“Core technologies associated with strong prospects of market success and high differentiation from competitors and with a generic application potential for many of the corporation’s products are consequently kept close to the home market base, most often in research centers close to headquarters.” However, perceptible re-thinking is already under way: the dynamics of changes more and more depend on the firm’s global technology strategy and on the size and resource base of the company’s home country.

Corporations with a strong research and market basis in their home country prefer to perform only scanning and exploration function in foreign units (i.e. USA, Japan, and Germany except for chemical firms).

In contrast, firms with less developed research and market basis in their home country have taken the role of precursors in globalization (e.g. Sweden, The Netherlands). In this last case, when the center of gravity for R&D does not coincide with the firm’s headquarters, the latter is reduced to a legal or financial entity.

A prerequisite for a firm however to derive lasting benefits from its R&D activities is its absorptive capacity, which depends on the concentration of knowledge on one spot, with local unit receiving sufficient support from headquarters in terms of resources and decision-making competence.

Moreover, internal conflicts have broken out for world product competence and recognition as international center of competence. Consequently, the firm division that are successful in these fights are those which

- Have very high research know-how
- if possible, have a very strong product that stimulates R&D
- have profit centers that generates their own cash flow
- whose manager occupies a strong hierarchic position within the firm



## **2.2 A New Framework for analyzing R&D Globalization within Multinational Firms**

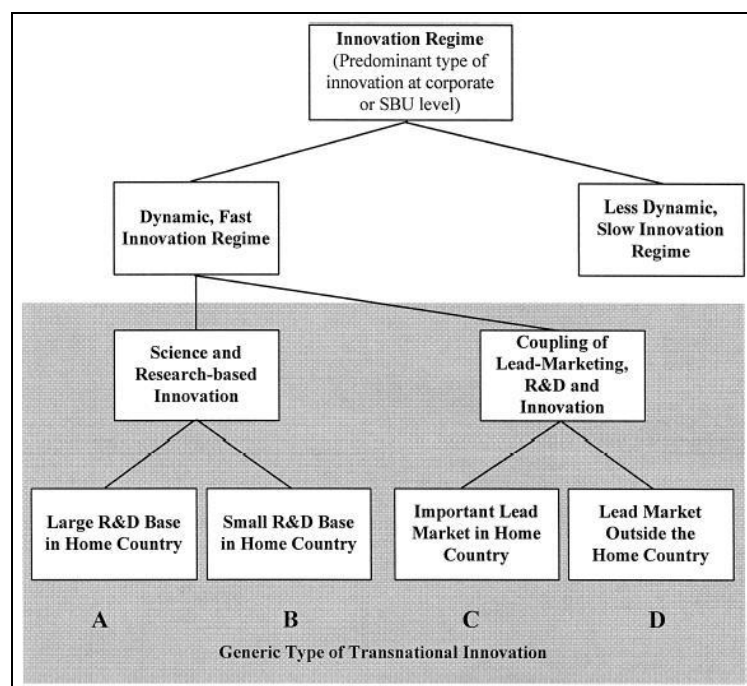
The author's investigations have shown that globalization of R&D does not necessarily lead to greater decentralization of ownership and control. In order to benefit from the best center of competences, corporations tend to concentrate ownership and control of their most critical resources in only one country or in a small number of internationally reputed centers. The following analyses outline the predominant patterns of globalization.

### **2.2.1 Four Generic Types of Transnational R&D and Innovation**

The authors have found it useful to distinguish between:

- Dynamic, fast innovation regimes, characterized by high R&D intensities, fast innovation cycles and a relatively strong importance of breakthrough innovation
- Less dynamic, slow innovations regimes with less dynamic business, low R&D intensities and slow innovation cycles

Most companies in the sample are to be classified in one of the categories. For those that have diverse products with different features, the authors concentrated their analysis on the more dynamic, innovation-intensive business units. For a long time, dynamic business segments were considered as science-based. Nevertheless, surveys have shown that a large share of innovation is generated through demand articulation. Demand patterns are driving investment behavior which in turn influences the selection of new technology. Innovations in the fields of consumer electronic or medicine are at least dependent of the interaction of lead markets and science-based innovation. Since these two components require different strategies, the authors have found it suitable to subdivide them in 2 distinct clusters.



**Figure 1 : Four generic types of transnational R&D and Innovation**



### **2.2.2 Types of companies and their Dominant Patterns of Transnational Innovation**

- **Type A:** is characteristic for large firms with a pre-eminent R&D infrastructure at home. A typical example are advancements in human genome research, where the US, based on funding by the National Institute of Health, has attained a world leadership position. U.S. pharmaceutical and health corporations would have little incentives to offshore their R&D.
- **Type B:** firms from a (small or large) country with less developed R&D infrastructures. Typical examples are transnational corporations in Switzerland, Sweden, The Netherlands (small countries) or Germany and Japan (large countries with less developed infrastructure).
- **Type C:** companies from large countries with a highly developed lead-market and a strong R&D base at home. This is the case for LCD innovations in firms as Sharp, Hitachi or Canon but also for the mechanical engineering in Germany. It implies the setting up of one or two dominant R&D and Innovation centers in the home countries and the effective linkage of R&D and products units.
- **Type D:** is characteristic for firms based in small countries or large countries with lead market deficiencies. European firms active in semiconductors for example perform a significant part of R&D and Innovation abroad (i.e. in Japan or the U.S.). Very few companies in the sample however have demonstrated a strong track record with D-type R&D activities.

### **2.2.3 Effective Coordination Mechanisms Dependant on the Type of Transnational Innovation**

In many cases, R&D locations lead to conflicts and coordination problems. Management thus tends to compromise by allowing for multiple centers with overlapping responsibilities. From their side, the authors want to sketch out an organizational architecture and the most appropriate coordination mechanism for each transnational innovation pattern.

- **Type A:** the locus for value creation is always kept close to the corporate headquarters. In the case of science-based innovation, a leading edge research center with strong ties to the corporate center and centralized decision-making is often sufficient. Continuous innovation is enhanced through a research-type corporate culture. Corporate technology Platforms and R&D Committees are centered in the home country and support the effectiveness of the R&D program.
- **Type B:** since leading research is located abroad, corporations often have to organize R&D as a network of several R&D laboratories at different locations in the world. This requires an effective global team management; team members with different cultural as well as educational backgrounds have to be socialized and integrated. This



can partly be reached through an effective and coherent corporate R&D and technology strategy and culture.

- **Type C:** as in type A, the locus for value creation is also kept close to the headquarters. In this case, innovations require stronger cross functional integration and a more stringent system focus across the value chain, but within one dominant country. The establishment of cross-functional teams and of internal quasi-markets and contracting between units or functions poses no serious problem.
- **Type D:** since the lead market and critical assets are located abroad, the establishment of cross-functional teams and contracting between units pose a great problem. The corporation has to establish an effective business unit or a new division in the foreign lead-market. The prime factor for success is that the corporation's top manager in the headquarters understands the dynamics of the business and are willing to and capable of mobilize enough critical resources to respond to the customer's needs.

### **3. Conclusion**

One thing is for certain: R&D globalization is a fast evolving process. Although many corporate functions and activities have become geographically dispersed, coordination and control of R&D and innovation is increasingly kept within one center of opportunity. Manager are now concerned with the following questions:

- Where are the major driver and the center for value creation for innovation process?
- How are critical resources dispersed over geographical locations and how can we best control the most critical assets?

Furthermore, the observed changes and the proposed concepts of the authors also affect innovation policy, which has overemphasized supply-side R&D capabilities in the past. National policy should prevent simple "Me too-strategies", and has to emphasize sustainable national leadership positions, based on R&D capabilities, dynamic national firms, effective clusters of business activity as well as on dynamic lead markets.

Finally, the authors suggest more theoretical as well as empirical research on the globalization process of R&D and Innovation. Additional research should address the following topics:

- Understand transnational R&D and innovation in a period of stronger consolidation and tight budgetary as well as managerial restraints.
- Emphasize more solid empirical research and validation; particularly more cumulative, empirically grounded research and a further refinement of suitable methods



- More research at the level of Strategic Business Units and at the project level within transnational corporations is needed; too many empirical investigations are still characterized by corporate-level generalizations
- A more detailed analysis of world product responsibilities resp. global technology responsibilities within transnational corporations at locations outside the home country would be very useful. Where do multinationals establish effective centers abroad which drive innovation and new business with strong corporation implications?
- More research should address the ownership and control issues for intellectual capital within multinationals. Where and why do firms concentrate ownership of the most valuable intellectual? How does this concentration of intellectual capital affect corporate responsiveness, i.e. the ability of a firm to control a line of opportunity for future business, as opposed to the mere exploitation of the line of authority for today's business?

## Part 2: Critical Assessment of the Paper

In this session of the report, we will try to assess the contribution and the scientific quality of G&R's paper. We will also outline our criticisms and own analysis on the paper by comparing G&R's models and concepts to other findings from investigations conducted by several scholars on the R&D globalization phenomenon.

### **Scientific quality**

To assess the scientific quality of the paper, we will use the following criteria:

- Has the paper been published?
- If published, what is the (international) reputation of the journal
- Number of citations of the paper
- Number of citations of the author's
- Has the paper been presented at conferences or seminars?

Our investigations show that G&R's paper is a high quality scientific paper and has contributed to a better understanding of R&D and Innovation globalization patterns: the paper has been published in eminent journals such as the Journal of International Management (1999) or the Journal of World Business (1999). Furthermore, it has been cited more than 170 times (On Google Scholar) since its release in papers written by scholars all over the world. It also has been used for conferences and seminars (e.g. it was used for the case study of Taiwan in the framework of National Innovation).

### **1. The link with the HBA and HBE concepts**

Several papers on the R&D globalization phenomenon have been written during the last decades. Among them, investigations conducted by Patel and Vega (*Patterns of Internationalization of Corporate Technology, 1999*). In their paper, they addressed the issue of evaluating whether advantage is created home or abroad. In that framework they outlined 2 main concepts: HBA and HBE.

#### **1.1 HBA**

They described HBA as follow: spotting and expending complementary knowledge to their existing basis or add new knowledge fully created abroad. Moreover, they focus on high technology sector. They investigations show that firms whose countries-of-origin are strong on a particular technological field will adopt a HBA-behavior. Focusing on the technological advancements in the home country, we can thus-very carefully-compare the HBA model to the TYPE A (science and Research based and large share of critical assets in home country) or TYPE C (lead market&innovation and large share of critical assets in home country) of Reger and Gerybarze's paper.

However there is a huge difference between R&G concepts and P&M's: basing on the results of their investigation, the latter suggest that firms operating on a certain research-intensive technological field prefer HBA whenever both host and home country are highly competitive on that field. This is clearly not the point of view of



R&G who claim that corporations will keep their innovation home if their home country has got a competitive advantage in the field they are operating on and thus can provide them with the critical resources. No major R&D activity will be performed abroad.

We more agree with G&R's analysis, since it takes into account a greater scope of imaginable factors, i.e. the influence of chauvinism in the internationalization, the distinction between science-based innovation on one hand and the coupling of lead-marketing, R&D and Innovation on the other hand, the cost-benefit couple while off shoring, etc. Moreover, G&R do not ignore the less technologically advanced countries as HBA does. Therefore, we find it a more accurate analysis.

## 1.2 HBE

HBE can be described as the international exploitation, by a given corporation, of the knowledge it has developed through the production process. Again, some similarities with G&R could lay on TYPE C the lead-marketing part of research-intensive industries: R&D is mainly conducted home, where the market can stimulate innovation and exploited in host countries; some very small development can be conducted in foreign countries in order to adapt the research output to the local customers needs. Nevertheless, major R&D and Innovation activities are kept home, close to the headquarters. This counts also for TYPE A.

## 2. Market-based and Technology-based concept

Many scholars often outlined R&D globalization patterns as being composed by two factors: market driven industries on one hand and technology driven industries on the other hand.

One interesting example is the article of von Zedtwitz and Gassmann (*Market versus technology drive in R&D: Four different Patterns of Managing Research and Development*) where the authors describe 4 archetypes of R&D globalization:

- National treasure: R&D is kept home, apparently because all critical resources are available on the spot
- Technology driven: Research is conducted abroad, while the product is developed at home. The reason of the split is the domestic scarceness of one or many critical resources
- Market driven: internationalized development ( to adapt the product to the local customer's needs) and home-made research
- Global R&D: both science-based research and development are conducted abroad

There are a lot of similarities with G&R conclusions: "national treasure" can be compared to TYPE A or TYPE C of our paper while "Global R&D" will have more to do with TYPE B or even TYPE D: not only science-based research can require the internationalization of both research and development; if the home market does not stimulate innovation enough, firms would prefer to conduct research and development in those foreign markets that encourage innovation.



Moreover, in the case of technology driven research, R&D can be kept in the home country if critical resources are available.

Once again, it seems to us that G&R offer a better model since the 4 archetypes neglect the characteristics of either the home country or the host country in terms of technological advancements or the R&D stimulating power of the markets. They tried to include these factors in their paper *New Concepts and Trends in International R&D Organization (1999)* but this time they neglected the R&D and industry specificities.



## Part 3: Case Study – 3M Company

### *History of 3M Company<sup>1</sup>*

3M was founded in 1902 at the Lake Superior town of Two Harbors, Minnesota. Five businessmen set out to mine a mineral deposit for grinding-wheel abrasives. But the deposits proved to be of little value, and the new Minnesota Mining and Manufacturing Co. quickly moved to nearby Duluth to focus on sandpaper products.

Years of struggle ensued until the company could master quality production and a supply chain. New investors were attracted to 3M, such as Lucius Ordway, who moved the company to St. Paul in 1910. Early technical and marketing innovations began to produce successes and, in 1916, the company paid its first dividend of 6 cents a share.



The world's first waterproof sandpaper, which reduced airborne dusts during automobile manufacturing, was developed in the early 1920s.

A second major milestone occurred in 1925 when Richard G. Drew, a young lab assistant, invented masking tape – an innovative step toward diversification and the first of many Scotch® Pressure-Sensitive Tapes.

In the following years, technical progress – resulted in Scotch® Cellophane Tape for box sealing and soon hundreds of practical uses were discovered.

In the early 1940s, 3M was diverted into defense materials for World War II, which was followed by new ventures, such as Scotchlite™ Reflective Sheeting for highway markings, magnetic sound recording tape, filament adhesive tape and the start of 3M's involvement in the graphic arts field with offset printing plates.

In the 1950s, 3M introduced the Thermo-Fax™ copying process, Scotchgard™ Fabric Protector, videotape, Scotch-Brite™ Cleaning Pads and several new electro-mechanical products.

Dry-silver microfilm was introduced in the 1960s, along with photographic products, carbonless papers, overhead projection systems, and a rapidly growing health care business of medical and dental products.



Markets further expanded in the 1970s and 1980s into pharmaceuticals, radiology and energy control.

In 1980, 3M introduced Post-it® Notes, which created a whole new category in the marketplace and changed people's communication and organization behaviour forever.

In the 1990s, sales reached the \$15 billion mark. 3M continued to develop an array of innovative products, including immune response modifier pharmaceuticals; brightness enhancement films for electronic displays; and flexible circuits used in inkjet printers, cell phones and other electronic devices.

---

<sup>1</sup> <http://solutions.3m.com/> History



In 2004, sales topped \$20 billion for the first time, with innovative new products contributing significantly to growth. Recent innovations include Post-it® Super Sticky Notes, Scotch® Transparent Duct Tape, optical films for LCD televisions and a new family of Scotch-Brite® Cleaning Products that give consumers the right scrubbing power for a host of cleaning jobs.

For a detailed historical view of 3M Company, we advice you to read the 3M Story: “A Century of Innovation, the 3M Story”<sup>2</sup>

## 3M Company Profile

3M is a diversified technology company with a global presence in the following businesses: industrial and transportation, health care, display and graphics, consumer and office, safety, security and protection services, and electro and communications. 3M is among the leading manufacturers of products for many of the markets it serves. Most 3M products involve expertise in product development, manufacturing and marketing, and are subject to competition from products manufactured and sold by other technologically oriented companies. At December 31, 2007, the Company employed 76,239 people, with 34,138 employed in the United States and 42,101 employed internationally, i.e. 55% of the total staff.<sup>3</sup> Moreover, 63% of total sales are made internationally (total sales reach \$24.462 billion in 2007).

---

The most famous 3M's brands, which also are market leaders, are the following: Nexcare™, Post-it®, Scotch®, Scotch-Brite®, and Scotchgard™.<sup>4</sup>



---

The following companies are the major competitors of 3M Company:<sup>5</sup>

- Bayer AG (R&D intensity of 8%: 2578 \$ / 32,385 m\$<sup>6</sup>)
- Kimberly-Clark Corporation (R&D intensity of 1.5%: 276.8 m\$ / 18,266 m\$<sup>7</sup>)

---

According to a recent company profile made by Datamonitor.com, in December 2007, the Swot analysis of the company is presented as follow:

The strengths and weaknesses concern the internal environment of 3M Company, whereas the opportunities and threats are linked with the external environment of the company. This swot analysis is presented in order to assess the overall situation of 3M Company.

---

<sup>2</sup> <http://multimedia.mmm.com/mws/mediawebserver.dyn?6666660Zjcf6lVs6EVs666IMhCOrrrQ->

<sup>3</sup> <http://www.3M.com/> 3M Company, 2007 Annual Report

<sup>4</sup> <http://solutions.3m.com/> 3M Brands

<sup>5</sup> <http://www.datamonitor.com> 3M Company, 10 September 2007 and 24 December 2007

<sup>6</sup> <http://www.annualreport2007.bayer.com/>

<sup>7</sup> <http://www.kimberly-clark.com/> KC 2007 Annual Report (according to us, the R&D expenses seem underestimated)



### **Strengths**

- Strong research and development capability
- Diversified business portfolio
- Strong financial performances
- Strong return on average assets and investments

### **Weaknesses**

- Poor inventory management
- Increasing cost of healthcare segment

### **Opportunities**

- Growing demand for LCDs
- Rising healthcare spending in the US
- Global expansion

### **Threats**

- Growth in private labels
- Exchange rate fluctuations
- Slowdown in the US and Eurozone<sup>8</sup>

---

3M Company has a strong business portfolio divided into six business segments:<sup>9</sup>

#### **Consumer and office business**

- Sponges, scouring pads, high-performance cloths, consumer and office tapes, repositionable notes, carpet and fabric protectors, construction and home improvement products, home care products, protective material products and consumer health care products.

#### **Display and graphic business**

- Optical films and lens solutions for electronic displays, touch screens and touch monitors, reflective sheeting for transportation safety and commercial graphics systems.

#### **Electro and communication business**

- Packaging and interconnection devices, insulating and splicing solutions for the electronics, telecommunications, electrical industries, and visual systems.

#### **Health care business**

- Medical and surgical supplies, skin health and infection prevention products, pharmaceuticals (sold in December 2006 and January 2007), drug delivery systems, dental and orthodontic products, health information systems and microbiology products.

#### **Industrial and transportation business**

- Tapes, coated and nonwoven abrasives, adhesives, specialty materials, filtration products, closures for disposable diapers, automotive components, abrasion-resistant films, structural adhesives and paint finishing and detailing products.

---

<sup>8</sup> [www.datamonitor.com/](http://www.datamonitor.com/) 3M Company

<sup>9</sup> <http://solutions.3m.com/> 3M Businesses



### Safety, security and protection services business

- Personal protection products, safety and security products, energy control products, commercial cleaning and protection products, floor matting, roofing granules for asphalt shingles, and Track and Trace products, such as supply chain execution software solutions.

3M's six business segments bring together common or related 3M technologies, enhancing the development of innovative products and services and providing for efficient sharing of business resources. These segments have worldwide responsibility for virtually all 3M product lines. Certain small businesses and lab-sponsored products, as well as various corporate assets and expenses, are not allocated to the business segments.<sup>10</sup>

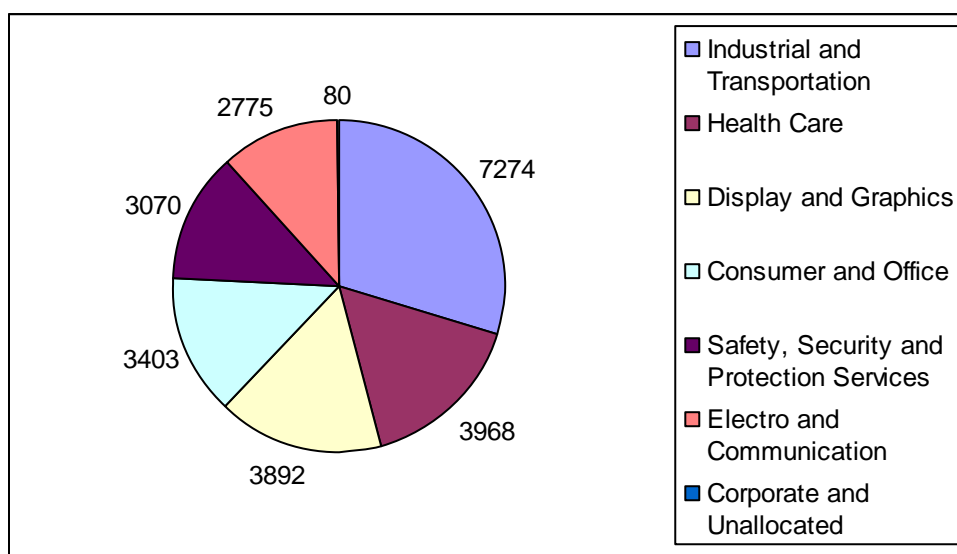


Figure 2: 3M's six business segments and their proportion of the total sales in 2007

Sources: [www.3m.com/](http://www.3m.com/) 3M Company, 2007 Annual Report

About the distribution at 3M Company, we can see that 3M products are sold through numerous distribution channels, including directly to users and through numerous wholesalers, retailers, jobbers, distributors and dealers in a wide variety of trades in many countries around the world.

3M's general offices, corporate research laboratories, and certain division laboratories are located in St. Paul, Minnesota. In the United States, 3M has nine sales offices in eight states and operates 74 manufacturing facilities in 27 states. Internationally, 3M has 148 sales offices. The Company operates 93 manufacturing and converting facilities in 32 countries outside the United States.<sup>11</sup>

<sup>10</sup> <http://www.3m.com/> 3M Company, 2007 Annual Report

<sup>11</sup> <http://www.3m.com/> 3M Company, 2007 Annual Report



## R&D at 3M Company

The main challenges of 3M Company are:<sup>12</sup>

- high diversity of products and services (over 50,000 different products)
- highly decentralized organization
- different customer needs in local markets

The company will try to tackle those challenges and therefore keep a leading position as an innovative company by developing customized product in local markets and transferring know-how across business units and markets.

3M Company has a strong focus on research and development (R&D) and has consistently invested in it for the past few years. The company's R&D expenditure as a percentage of sales accounted for 5.6% in 2007. The company's R&D capabilities, with its strong knowledge and understanding of technologies such as adhesives, materials science, light management, micro replication and non-woven materials, has resulted in production of several innovative products such as 3M Paint Replacement Film, Post-it, and Scotch-Brite. Further, through global manufacturing facilities and R&D centers, the company has substantially reduced cycle time, from innovation to commercialization, to two and a half years from a period of four years. The company's strong R&D capability provides it with a competitive advantage and helps it to innovate and launch new products.<sup>13</sup>

Here is the R&D intensity (R&D expenditure as a percentage of sales) of 3M Company during the last five years. Unfortunately, the R&D intensity for each of the six business segments is not available nor on the 3M's website or in 3M's annual report. We assume that the R&D intensity of 3M Company is an average of the six business segments and does not really reflect the reality of each business separately.

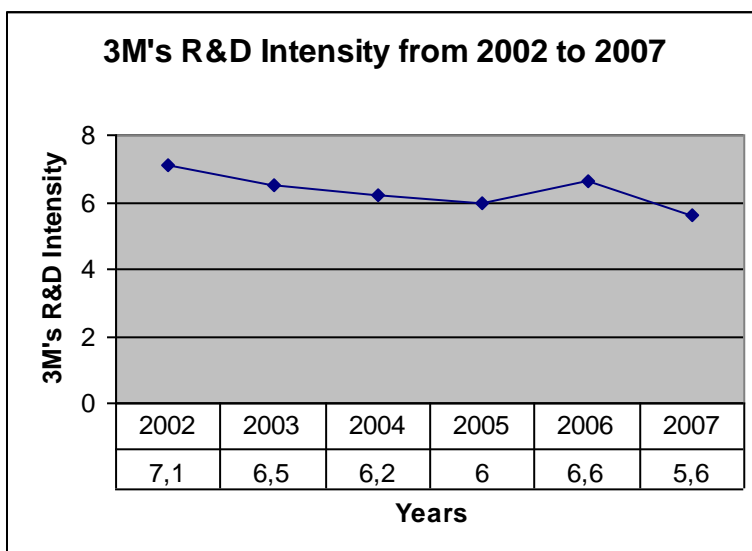


Figure 3 : 3M's R&D Intensity from 2002 to 2007

Sources: [www.mmm.com/](http://www.mmm.com/) 3M 2007 Annual Report

<sup>12</sup> [http://www.esb-research.org/STR\\_Gesprache\\_Ohmayer.pdf](http://www.esb-research.org/STR_Gesprache_Ohmayer.pdf)

<sup>13</sup> <http://www.datamonitor.com> 3M Company, 10 September 2007 and 24 December 2007



The graph shows that the R&D intensity is on average of 6.33 during the last five years. However there is a decline of one percentage point in 2007 when compared to 2006, due to the divestment of the R&D-intensive Pharmaceuticals business.<sup>14</sup>

### **Creating a Corporate Culture for Innovation:**

3M has a number of programs geared to support and grow innovation among its researchers.<sup>15</sup> These include:

**The 15% option:** Many employees can spend up to 15% of their workweek on projects of their own choice that might benefit the company. They often don't have to inform their manager of the project or even justify it.

**Seed capital:** If researchers create a new technology or idea, they can request seed capital from their business unit managers to develop it further. If that funding is denied, they can take it to any other 3M business unit. Failing even that, they can request a corporate Genesis Grant for independent R&D awards of up to \$100,000; about a dozen of these are granted each year.

**Dual career path:** Researchers can choose to follow a technical career path or a management career path, with equal advancement opportunities. This option is offered successfully by a number of technology firms, allowing researchers to more fully develop their technical professional interests without being penalized financially for not going into management.

**Rewards and recognition:** 3M sponsors 12 global and four US-based award programs to honour individuals who make significant contributions to the company. Each business and staff unit, department, and area also has ways of recognizing and rewarding people. These include:

- **The Carlton Society** honours employees for outstanding career scientific achievements, their contributions to new technologies or products, and high standards of originality, dedication, and integrity.
- **Circle of Technical Excellence & Innovation Awards** recognize employees who have made exceptional contributions to 3M's technical capabilities.
- **Pyramid of Excellence Awards** recognize the top performing administrative employees for their exceptional achievements.
- **Quality Achievement Awards** recognize employees for individual and team outstanding quality improvement efforts.

---

<sup>14</sup> <http://www.mmm.com/> 3M 2007 Annual report

<sup>15</sup> « 3M – Where Innovation Rules » Studt, Tim, R&D Magazine, Apr. 2003, Vol. 45 Issue 4, p20  
<http://www.rdmag.com>



## Research and Patents

As mentioned previously, research and product development constitutes an important part of 3M's activities and has been a major driver of 3M's sales growth. Research, development and related expenses totalled \$1.368 billion in 2007, \$1.522 billion in 2006 and \$1.274 billion in 2005. Research and development, covering basic scientific research and the application of scientific advances in the development of new and improved products and their uses, totalled \$788 million in 2007, compared to \$943 million in 2006, decreasing due to the \$95 million for purchased in-process research and development and also due to the pharmaceuticals business divestiture as said earlier.

The Company's products are sold around the world under various trademarks that are important to the Company. The Company also owns, or holds licenses to use, numerous U.S. and foreign patents. The Company's research and development activities generate a steady stream of inventions that are covered by new patents. Patents applicable to specific products extend for varying periods according to the date of patent application filing or patent grant and the legal term of patents in the various countries where patent protection is obtained. The actual protection afforded by a patent, which can vary from country to country, depends upon the type of patent, the scope of its coverage and the availability of legal remedies in the country.

The Company believes that its patents provide an important competitive advantage in many of its businesses. In general, no single patent or group of related patents is in itself essential to the Company as a whole or to any of the Company's business segments.

More than most any other company, 3M is known for its long and successful history of innovation. It's at the core of their continuing success. Innovation is embedded into 3M's corporate culture and consciousness. It's an essential part of their corporate motto: "Leading Through Innovation."<sup>16</sup>

However, innovation is not an easily maintained corporate characteristic. It's often easy for large corporations, even 3M, to fall into an easier operating mode of incremental improvements, rather than to keep a constant stream of new innovations or "breakthrough" products.

The former chief executive officer of Research and Development at 3M Company, Jay Ihlenfeld, was responsible for 7,000 technical employees within 3M global organisation. According to him, there are three elements of 3M's current R&D strategy:<sup>17</sup>

- Investing in technical capabilities where the customers are, and that is increasingly outside of the US.
- Continuing to nurture 3M's entrepreneurship.
- Keeping pace with external sources of technology.

---

<sup>16</sup> <http://solutions.3m.com/> A Century of Innovation The 3M Story

<sup>17</sup> « 3M – Where Innovation Rules » Studt, Tim, R&D Magazine, Apr. 2003, Vol. 45 Issue 4, p20  
<http://www.rdmag.com>



**Jay Ihlenfeld**

The previous points suggest that 3M's businesses are both market driven and science-based. Furthermore, 3M's R&D chief executive officer acknowledges the fact that for the market driven businesses, the critical resources are to be found abroad. All these elements put together, we can easily conclude that some business segments correspond to TYPE D (i.e. market driven businesses as the Consumer and Office Business), TYPE A (i.e. Health Care Business), or TYPE B (i.e. Display and Graphic Business in Japan) of G&R's paper.

3M continues to invest heavily in its Asian facilities and capabilities. In 2002, it began relocating its R&D and manufacturing capabilities for high-end optical components from Austin, Texas, to Singapore, establishing an Optoelectronics Center of Excellence at its manufacturing facility there. In the past, 3M had concentrated its electronics R&D on hard disk drives, semiconductor packaging, and display technologies. With the move, a new R&D focus for optical and telecommunications markets has surfaced for the company. We can see that 3M is following the trends of the market and the technology as well.

About the localization of the research, Ihlenfeld sees building technical capabilities outside of the US for focusing on the development of local products as the most important structural change to 3M's R&D organization in the near future. "We need to direct R&D growth to where our business growth is expected to be," he says. 3M already has more than 500 researchers in Japan and 65 in China. It has had a continuing presence in China since 1984. The Chinese market is expected to be an exceptional growth platform for 3M, according to Ihlenfeld: "about 85% of 3M's existing products already fit into the Chinese marketplace".

One can notice that 3M Company does not hesitate to adapt its R&D strategy to the trends of the market: the company switches from one TYPE to the other whenever it is needed in order to follow the most innovative path; even if it means that R&D must be brought abroad.



## Research centers at 3M:

3M spends more than a billion dollars a year on R&D. About 20% of this budget supports its 32 technology centers.

The most important technology centers are located in Minnesota, Japan, and Shanghai. The approximately 1000 researchers that work in each of these centers are commissioned to identify and develop new technology bases that could take from five to 10 years to develop into marketable products. The research center in Minnesota defines the corporate R&D strategy, provides along with Japan and Shanghai the basic research development and finally coordinates and develops R&D activities across R&D locations. The other R&D locations are affiliated to business units and are spread all over the five continents. They provide regional product development with close customer interaction.

A key aspect of 3M's innovation growth has always been and continues to be that new products often come about as a result of a combination of technologies from different areas. This also can include a combination of manufacturing capabilities as well.

The technologies covered in these centers includes: Corporate Analytical, Corporate Process, Display Materials, Electronics and Inorganics, Engineering Systems, Film & Light Management, Interface Materials, Microreplication, Nonwovens, Organic Materials, Optoelectronics, Software, Electronic, and Mechanical Systems.

Each division has its own research capabilities as well. In 2002, Chairman of the Board and CEO James McNerney, reorganized its 40 business units into seven businesses: Health Care, Industrial, Consumer and Office, Display and Graphics, Electro and Communications, Transportation, and Safety, Security, and Protection Services. In 2008, it is only six business segments that compose the 3M Company.

Some hypothesis can be formulated for the location of the main research centers:

- St. Paul, Minnesota (USA): where the company's headquarter is located; critical resources for health care and industrial & transportation businesses are also available on the spot (i.e. qualified researchers, cash flow, etc)
- Loughborough, England: the company has consolidated its European pharmaceutical manufacturing operations at one site.<sup>18</sup> It is obvious that the R&D activities which are involved in the entire production process are intense in that part of the European continent.
- Shanghai, China: the third biggest R&D center of 3M Company has been implanted in Caohejing new technology park in 2005 because of the presence of 111 multinational regional headquarters and 158 R&D centers of different companies. The company hopes there so to benefit from the important spillovers and the innovation stimulating demand.<sup>19</sup>

---

<sup>18</sup> <http://www.pharmaceutical-industry.info/> 3M Health Care Ltd

<sup>19</sup> <http://english.peopledaily.com.cn> "3M sets up its third largest R&D center in Shanghai"

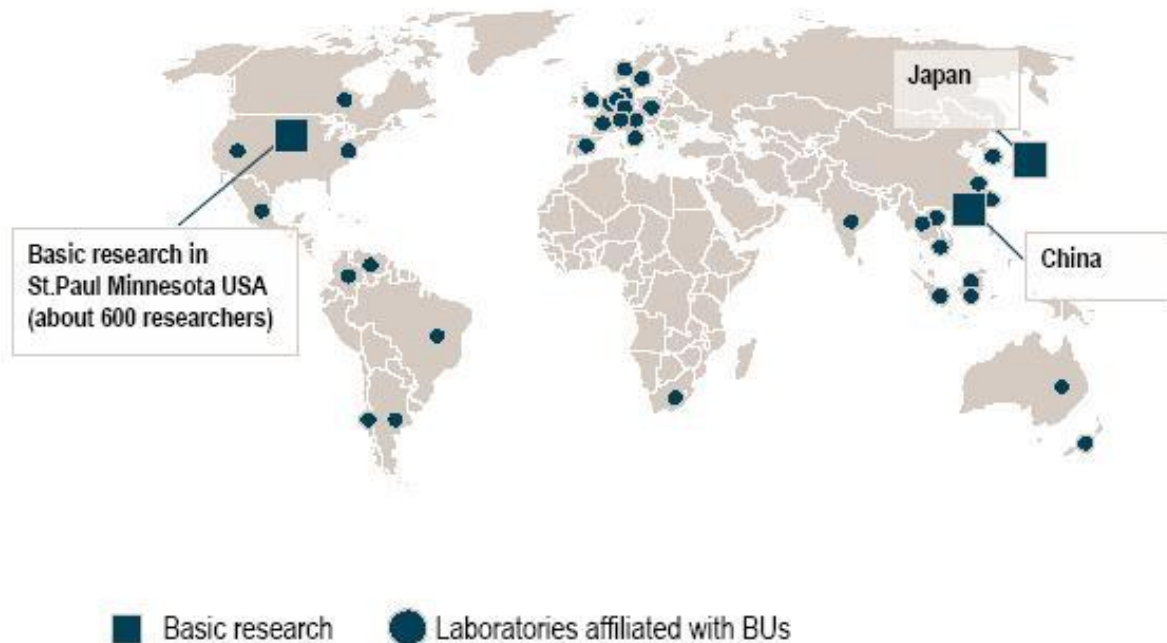


Figure 4 : 3M's R&D activities location worldwide in 2008<sup>20</sup>

### Programs for continuous improvement and innovation:

Here is an overview of the different programs for continuous improvement and innovation, found in an article called "3M – Where Innovation Rules"<sup>21</sup>, in which the chief executive of the R&D at 3M explains the innovation at 3M Company.

3M has made several initiatives over the past several years that exemplify their push for constant improvement. One of them, their Six Sigma Initiative, is just that, a process for constant improvement. Introduced formally to the company in February 2001, Six Sigma<sup>22</sup> has created a common language and measurement mechanism to reduce variation and deliver consistent results across the company.

Technically, Six Sigma is a measure of the standard deviation or error rate. It was initially used as a quality and manufacturing tool, but is now used by 3M in a much broader aspect to increase productivity and delivery times. 3M's Design for Six Sigma (DFSS) process, for example, helps researchers engage customer information in the initial stages of a design discussion. "DFSS tools allow us to be more closely connected to the market and give us a much higher probability of success in our new product designs," says Ihlenfeld.

<sup>20</sup> [http://www.esb-research.org/STR\\_Gesprache\\_Ohmayer.pdf](http://www.esb-research.org/STR_Gesprache_Ohmayer.pdf)

<sup>21</sup> « 3M – Where Innovation Rules » Studt, Tim, R&D Magazine, Apr. 2003, Vol. 45 Issue 4, p20 <http://www.rdmag.com>

<sup>22</sup> For further details about the Six Sigma program, see <http://www.isixsigma.com/>



Another initiative undertaken by 3M is 3M Acceleration. In this initiative, each R&D program is evaluated for the potential impact it has from the overall corporate viewpoint. The top programs, which represent the most critical market needs, are then fully supported by the company and closely tracked to ensure that they are executed quickly and successfully. The overall result of this initiative is to generate greater returns on 3M R&D investments and related expense investments.

Another tool is termed 2X / 3X. "In this program, we set high standards or goals for idea selection," says Ihlenfeld. 2X means that we set objectives for two times the number of new products that were introduced in the past. 3X sets a business objective of three times as many "winning" products as there were in the past.

Setting objectives is easy, whereas obtaining acceptable results to those objectives is the real measure of the organization. And the 3M team appears ready to provide the means for obtaining those results. "We're not about to change the basic culture of innovation at 3M," says Ihlenfeld. "There is a lot of culture in 3M, but we're going to introduce more systematic, more productive tools that will allow our researchers to be more successful." All of the tools combined, the 15% rule, 3M Acceleration, DFSS, 2X / 3X, eProductivity, Sourcing Effectiveness, and Indirect- Cost Control, all work together as enabling mechanisms for successful innovation.

3M is dedicated to innovation and its "3R's." While 3M used to stand for Minnesota Mining and Manufacturing (it no longer does, 3M is the official name of the organization) those three "R's" stand for risk, reward, and responsibility. The company is dedicated to taking risks, has numerous reward programs, and has an infrastructure that defines its responsibility. The current 3M looks a lot like the old 3M and a lot different. It looks poised to succeed.



## Part 4: Overall Conclusion

Today, more than ever, there is a broad literature on the internationalization of R&D. Corporation on one hand and public research centers at the other hand have sensed the importance of strategic R&D regarding their international reputation, hence their chance of survival in a fast developing world. It is thus comprehensible that managers among others are obsessed by making the right decisions when it comes to investing on R&D, abroad as well as inland.

We have noticed that Gerybadze and Reger's paper has contributed a lot to a better understanding of the R&D and innovation globalization process in the beginning of the 2000's. We were able to confront the statements of the two scholars with the reality by examining R&D activities at 3M Company. We can conclude that the concepts proposed by G&R are valid and realistic. Moreover - especially for a complex corporation as 3M Company – these patterns are really useful for the management of global R&D and innovation, since the authors took into account more parameters than others have done before (i.e. chauvinism, R&D intensity in the market driven technologies, and diverging SBU's R&D and innovation strategies).

We only regret one thing: the authors could have provided the literature with more information and details on the impact of fiscal consolidation on R&D activities.



## References

### Documents

*Background report. Internationalization of R&D: trends, issues and implications for S&T policies. A review of the literature. Forum on the internationalization of R&D, Egmont Palace, Brussels, Belgium, March 2005.*

*The Drivers of Foreign Direct Investments into Research and Development: an Empirical Investigation. Case Company: Nokia. By Vesa Renfors and Radoslav Todorov. (SBS, ULB, March 2008)*

*Deconstructing FDI flows in R&D and an examination of Toshiba's R&D activities. By Yang Jin Woo and Tan Kee Yeh. (SBS, ULB, March 2008)*

*The globalization of R&D: results of a survey of foreign-affiliated R&D laboratories in the US. Case company: Novartis. By Amani Kaite and Romeo Sharra. (SBS, ULB, March 2008)*

*An analysis of location vs. home base advantages illustrated by the example of Roche Holding AG. By Alexander Moens and France Joris. (SBS, ULB, March 2008)*

*Market versus technology drive in R&D internationalization: four different patterns of managing research and development as related to Pfizer Inc. By Aaron Sapelak and Luis Ojeda Ricalde. (SBS, ULB, March 2008)*

*New concepts and trends in International R&D Organization, illustrated by the example of Nestlé. By Legros Christopher and Herman Yannicumar. (SBS, ULB, March 2008)*

### Websites

<http://www.3m.com>

<http://www.kimberly-clark.com>

<http://solutions.3m.com>

<http://www.rdmag.com>

<http://www.lesechos.fr>

<http://www.pharmaceutical-industry.info>

[http://www.esb-research.org/STR\\_Gesprache\\_Ohmayer.pdf](http://www.esb-research.org/STR_Gesprache_Ohmayer.pdf)

<http://english.peopledaily.com.cn>

<http://multimedia.mmm.com>

<http://www.isixsigma.com>

<http://www.datamonitor.com>

<http://www.uspto.gov>

<http://www.annualreport2007.bayer.com>