

# **PRIVATE SECTOR R&D: GLOBAL VIEW**

ERASMUS / Interlace-Invent 2007

**Locomotive**

EU SIXTH FRAMEWORK [Regions of Knowledge 2]  
Dissemination of knowledge concerning current R&D  
localisation motives of large regionally important private  
sector organisations  
Project acronym: Locomotive  
Work-package N° 4 Deliverable 7

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## Introduction

The report on the Global View of the outsourcing of R&D is prepared as part of the Locomotive project, a European Commission program, funded by the 6<sup>th</sup> Framework Programme.

The Global Outsourcing of R&D has vast influence on the European Union especially as R&D investments have become a central topic on the European Agenda. As this report underlines, investments in R&D support the global economic growth and is as such beneficial to both the investing countries as well as the receiving countries. However, great care should be taken, on both the national and the industrial side, to ensure that the outsourcing of R&D is done with respect for the special circumstances under which the world is becoming increasingly global. This includes also sensitivity to economic as well cultural factors, of which the best-performing multinational firms bear evidence through their successful outsourcing strategies.

On behalf of the Locomotive project, ERASMUS University in Rotterdam and Interlace-Invent, we would like to thank all who have participated in the preparation of this report.

August 2007

**Dr. Rob van Tulder**

**Fabienne Fortanier**

**Sandra Genee**

**Dr. Jakob H. Rasmussen**

**Sascha Haselmayer**

For further information, please contact:

Interlace-Invent ApS

PO Box 135

DK-1004 Copenhagen K

Denmark

t: +45 3071 1761 (dk)

f. +44(0)20 7900 3295

<http://www.livinglabs-europe.com>

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## Executive Summary

Multinational enterprises (MNEs) play an important role in regional systems of innovation, in the European Union and elsewhere. They are the key investors in research and development, a slowly but steadily growing portion of which is invested outside their home countries. A key managerial challenge for technology-intensive MNEs is therefore to effectively coordinate their innovation activities across borders, both within their own organization and in cooperation with other players including suppliers, buyers, governments and knowledge institutes in a context of 'open innovation'.

The LocoMotive project aims to provide a better understanding of the factors that influence where these MNEs locate their R&D, and how they organize their innovation efforts across borders, in order to help regional, national and European policy makers to better deal with these firms and maximize the benefits that result from their presence. This document is part of the LocoMotive project and documents in detail the R&D strategies of 8 of the largest technology-intensive firms in Europe: Airbus, Siemens, Philips, Nokia, Volkswagen, Motorola, Shell and GlaxoSmithKline.

The internationalization of R&D of these eight firms - and many other similar ones - goes beyond IT and business process operations, and can also include strategic activities, production, delivery of core products and services and sales and marketing. Although one of the key drivers of this trend is the quest for lower costs (engineers and researchers in regions outside Europe and the US are still much cheaper), access to knowledge and a highly educated workforce are equally important. Access to markets (and future markets) is a strong determinant of the growth of R&D towards India and China. The case studies confirm these impressions and highlight the combination of markets and technology as key locational determinants for R&D investment. The action of competitors is particularly relevant for companies that operate in consumer markets with relatively standardized products.

Yet there are also several impediments. Coordination costs and scale economies favour locating R&D in one single (often headquarter) location, rather than abroad. Insufficient tangible (airport, roads) and intangible infrastructure (legal environment) in host locations often make it impossible to locate R&D elsewhere. Factors related to quality and quality control, as well as IPR concerns, are further impediments. Lack of a common language and cultural differences also make internationalization of R&D difficult. The majority of firms in the case studies has opted to manage their international network organization like networks of interconnected centres of excellence and product development. But when policy influence via e.g. government procurement is large a more 'multidomestic' R&D strategy can be observed. Historical path dependencies, such as a strong headquarter or instead relatively autonomous brands within a group, continue to influence the organizational structure of R&D substantially.

From a European (policy) perspective, concerns with respect to R&D are primarily related to the potential relocation of R&D from Europe to other markets. Although examples of this process have been found – they are often prominently cited in the media – it does not appear to be a general trend. There seem to be few 'trade-offs' in locational decisionmaking, although the relatively small R&D base of many firms in developing countries, and the high market growth rate of these emerging markets will imply that future investments in R&D will grow more rapidly elsewhere than in Europe.

## R&D Strategies of Leading Multinationals

Technology firms are today much less vertically integrated, and increasingly use globally dispersed networks of outsourced suppliers and assemblers. This has led to the disintegration of traditional divisions in research, development and innovation. The corporate research lab does no longer exist and much of R&D spending today is in incremental improvements and faster go-to-market of new ideas and innovations.

In a speech at the European Foundation for Quality Management, Gerard Kleisterlee, President and CEO of Royal Philips Electronics made a plea for Europe to increase its competitiveness and to strengthen its knowledge based activities. Even though “Western Europe has frequently been depicted as a somewhat stuffy open-air museum - a region that is in danger of being crushed between the economic power of a flexible, dynamic America on the one hand, and, on the other, Asia with its explosive expansion led by superpowers like China and India” - he believes Europe can improve its competitive position by transforming to a “knowledge economy” specialized in high-end, knowledge-based jobs. (Philips, 2005) “The way in which we organize our economy around knowledge and knowledge-application will be crucial for the future welfare of our society,” and will ultimately determine if Europe will be able to meet the challenges set out by the Lisbon agenda. (Philips, 2005)

The ways in which Europe can improve the conditions for (local/regional) R&D spending is the focus of the Locomotive project. Because of the important role multinationals play in regional systems of innovation, the Locomotive project aims to contribute to more effective policy making by providing a better understanding of the factors that influence the way internationally operating firms organize their R&D.

Recent studies on the locational patterns of R&D around the world delineate the following four ‘global’ trends (see European Commission, 2006; Unctad, 2005; Dearing, 2006; Thursby and Thursby, 2006; OECD (2005); Van Tulder, with Van der Zwart (2006); and the literature contained in Fortanier, Van Tulder, 2006)

### **Trend #1: Large (core) companies prevail in innovation**

The orchestration of Innovation is increasingly in the hands of a limited number of (large) and often multinational companies. Formal R&D investments are at the same time increasingly concentrated in the private sector, which in turn is dominated by a relatively small number of large firms. 700 companies account for about 80% of private R&D and more than half of the total R&D performed within OECD member states (Dearing, 2006). The relative financial contribution of in particular governments has consistently been decreasing since the mid-1980s (OECD, 2005). R&D expenditures remain geographically concentrated in a few countries (and regions) around the world: the ten largest spenders accounted for more than 86% of total R&D in 2002. Two of these countries are emerging economies: China and South-Korea (Unctad, 2005). There is a limited, but noticeable trend that firms in developing countries are a growing source of formal innovation. The share of foreign patent applications from firms located in developing countries jumped from 7% to 17% in the 1991 to 2003 period (ibid).

## **Trend #2: Degree of internationalisation of core firms rises slowly but steadily**

The internationalisation of R&D develops much slower than the internationalisation of sales and assets. But the R&D activities of firms are gradually becoming more international. This process departed from different levels of internationalization and therefore diverges for various home country bases. In the 1994-2002 period, the share of R&D in the affiliates of US MNEs for instance rose from 11% to 13%. For Swedish MNEs (largely as a result of the take-over of core Swedish firms by foreign investors) the figure rose from 22% to 43% (Unctad, 2005). As a result, foreign affiliates are assuming more important roles. Unctad (2005) estimates that between 1993 and 2002 the R&D expenditure of foreign affiliates of MNEs worldwide climbed from around U\$ 30 billion, to U\$ 67 billion (or from 10% to 16% of global business R&D). The rise was more significant for firms in developing countries, than in developed countries. This illustrates the fact that core firms from developing countries are in a big need to complement their weak national systems of innovation by searching for strategic assets in the developed economies.

## **Trend #3: Centralised decentralisation as major challenge**

Core companies are increasingly seeing innovation as a 'network' approach. They involve other core companies in their own network and aim at 'informal' innovation through innovation through networks with local companies and institutes. New techniques used by core companies are venturing and different types of (outsourcing) partnerships. European firms outsource an average of 18% of their R&D investment (EC, 2006). This figure seems lower than in the case of Japan and/or the United States and some of the developing countries. New products and technologies are developed in close consultation with customers and other stakeholders. This process is better known as 'open innovation' (Dearing, 2006). It requires decentralised management structures of a large number of technology agreements with stakeholders in relevant locations. Yet, most commonly, their prime R&D networks remain at home. A considerable number of firms is therefore still relatively conservative in the internationalisation of R&D (almost 40% of a sample of 200 multinationals did not anticipate any change in their worldwide R&D distribution; EU, 2006). The company's home country in many respects continues to be the most attractive place for locating R&D investments.

## **Trend #4: No trade-offs in locational decisions**

Relocation of R&D (i.e. closing down one site in favour of another site in another country) is not a dominant motive (Thursby, 2006). Although most managers expect their global investment in R&D to grow (EC, 2006), the developed or emerging country sites for R&D locations are considered no substitutes for each other. For developed countries, strategic assets (quality of R&D personnel and related infrastructure, as well as level of IP protection and a predictable legal framework for R&D) are important locational factors, whereas for developing countries market growth potential provides a strong incentive for location. However, the lack of regulation (in particular of IP protection) is considered a major risk of investing in developing countries. Cost (and related tax breaks and/or labour costs) do not appear anywhere as a dominant motive for location.



## Understanding the Main Reasons for Globalisation of R&D

The main reasons for the globalisation of R&D can be seen in the firms' attempts to lower rising global costs of R&D and mitigate risks in product development. Also, in certain industries such as high technology, medical devices, textiles and micro electronics shortening product life cycles can be a primary reason for moving R&D abroad. Finally, reasons such as increasing multidisciplinary complexity of technology, requiring large and lateral research teams, as well as the intensifying competition on global markets, have been highlighted as main reasons for the globalisation of R&D.

Figure 1. Global share of R&D 2006

Region	Share of global R&D
US	31.9
Europe	23.2
China	14.8
Japan	12.5
India	4.0
Other	13.6

Source: "Global R&D Report"

The expansion of investments in R&D in countries such as China and India are not isolated events, but should to a large degree be ascribed to changes in government policies and emphasis on the investment and structural conditions for R&D. Also, in order to enhance military strength, direct investments have been a key instrument in the expansion of R&D budgets in e.g. China.

The liberalisation of economies in both China and India has been paramount to attracting private investments and expanding companies in both the domestic and international markets, and policies and regulation encouraging foreign investment and ownership has been a significant driver in the emergence of new businesses. Further, the development of education systems and an emphasis on the availability of a highly-educated workforce in areas such as information technology, engineering and biotechnology, as well as the availability of skilled or semi-skilled workers have been drivers of both the development of India and China.

Finally, foreign multinationals have thus been part in developing the economic systems of India and China by investing in new subsidiaries, joint ventures as well as outsourcing both manufacturing and R&D.

Figure 2. Global R&D spending by private industry 2006

Country	Spending EUR Bn	Average growth over 4yrs
US	167	10.4
Europe	137	5.6
China	1	10.0
Japan	80	5.9
Rest	30	-
Total world	415	

Source: The R&D Scoreboard 2006

Outsourcing goes beyond IT and business process operations, to also include strategic activities, production, delivery of core product and services, and sales and marketing. A recent study by PWC shows that 32% of companies that outsource, actually outsource a varying degree of R&D activities.<sup>1</sup> In the manufacturing industry, the outsourced R&D

processes have until now centred on materials innovations, new innovations, new process innovations, electronic design, component design, software design / development. Some surveys of industry in the US indicate that as much 23% of outsourced R&D also targets basic research, and 47% targets applied research.<sup>2</sup> The results of these surveys further indicate that outsourcing of R&D is not only limited to low-level or trivial research, but also targets high ends of the R&D value chains in major industries. Beyond the outsourcing of research to Asia, South America and other low-cost areas, US and European companies also increasingly outsource R&D across the Atlantic. According to surveys, more than a third of US companies involved with R&D plan to increase the outsourcing of R&D to Europe<sup>3</sup>, and Intel has set up R&D centres in countries such as Brazil, China, Egypt and India to research in platform definition and other new generations of high-tech components and infrastructure.<sup>4</sup>

Figure 3. Distribution of sales of top R&D Leaders from each Industry

Company	Industry	Country	R&D EUR M	EU	N. Ame.	Rest
Intel	Technology hardware & equipment	USA	4,995	21	15	59
Volkswagen	Automobile	Germany	4,667	73	14	13
Matsushita	Leisure goods	Japan	4,645	13	14	72
EADS	Aerospace & defence	Netherlands	2,710	40	26	34
Bayer	Chemicals	Germany	2,160	44	27	30
BT	Fixed line communications	UK	1,212	96	3	0
Royal Bank of Scotland	Banks	UK	548	82	17	1
Lagardere	Media	France	433	73	12	15
Cadence	Software	USA	412	18	48	34
Kirin	Beverages	Japan	237	3	3	95
Ajinomoto	Food producers	Japan	233	10	7	83
Alcan	Industrial metal	Canada	220	47	36	17
Tchibo	Food & drugs retailers	Germany	125	85	8	7
Telenor	Mobile communications	Norway	118	84	0	14
Store Enso	Forestry & paper	Finland	100	72	17	12
Suez	Gas, Water & multiutilities	France	97	79	10	11
Anglo	Mining	UK	38	46	9	44

Source: The R&D Scoreboard 2006

Due to the outsourcing of R&D, many Asian companies that have gained knowledge through R&D partnerships with leading multinationals have managed to move up the value chain within the multinationals' ecosystems. Many of these new players have created similar capability-building processes, and succeeded in creating product platforms, on which they can create their own intellectual property. Currently an estimated 20 to 30% of global clinical trials are outsourced to developing countries.<sup>5</sup> This has persuaded local governments to improve clinical research facilities. In countries such as China and India, the access to high-quality healthcare, although often limited to certain parts of the population, adds to the benefits of R&D outsourcing.

Studies in the implications of outsourcing have questioned whether effects on performance can be directly measured. No general linkages across industries have been found between outsourcing and company performance, however outsourcing has been found to interact with strategy and environmental factors in other ways; strategies such as cost leadership and innovation differentiation can be further leveraged, and some companies, even when operating in stable environments have been found to achieve performance increases via outsourcing (Gilley, 2000).

Figure 4. Overview of Outsourcing Characteristics of Selected Industries

	Automobile	Electronics	Pharmaceuticals & Biotechnology	Aerospace	Software	Telecom equipment	High Technology	Professional services
Examples of leading firms	Ford, VW	Philips, Samsung, Siemens	Eli Lilly, Pfizer, Novartis, Bristol-Meyers, GSK, J&J	Airbus, Boeing	IBM, Microsoft, Yahoo	Ericsson, Alcatel, Lucent, Cisco, 3Com	Intel, Qualcomm	Accenture, Cap Gemini
Drivers of outsourcing	Low-cost manufacturing, access to markets	Access to markets, access to R&D centres.	Outsourcing of non-strategic process, contrac research	Access to business systems, access to engineers	Access to staffing, low-cost of labour, access to talent, purchase of best-in-breed	Market access, purchase of best-in-breed technologies and R&D	Access to talent, access to best-of-breed companies	Access to staffing, low-cost of labour, language skills
Innovation systems	Complex supply chains, with large parts of R&D outsourced to suppliers supplying the whole industry. Integration with other industries such as nanotechnology, design and IT	R&D partnerships, collaboration with universities on basic reserch, R&D centres or outsourcing for applied research.	Long development times, focus on pipelines and screening. R&D outsourced	Combination of inhouse and outhouse design, strategic R&D projects.	Inhouse software development and client-based R&D in programmes. Application and implementation partnerships.	Inhouse R&D, software / developer networks	Inhouse R&D, purchase of complementary technologies	Inhouse R&D, purchase of branded product or companies, businessmodel flexibility to develop new services
Global hotspots	Europe, China, South Africa, Brazil	Taiwan, Korea, China, India, japan	India, China, Brazil	US, Europe, Russia, India	India, China, South America (incl. Mexico), Russia, Eastern Europe	China, India	China, India, Europe, US, Brazil	India, China
Focus of outsourcing	Materials innovations, sub-components, process innovaiton	Electronic & component design, process innovations, new materials	Clinical trials, testing, molecule-processing	Special engineering skills, software design, new engines	Development, maintenance & support	Convergence, software development, imposing standards	Basic research, wireless & broadband technologies, convergence	Business process outsourcing, advanced business services, accounting services

Figure 5. Primary Industries for R&D by Country

US	Europe	China	India	South America	Russia
Nanotechnolgy	Medical Devices	Production technologies	Software	Clinical trials	Aerospace
Biotechnology	Automation	Pharmaceuticals	Pharmaceuticals	Automotive	Software
Network technology	Automotive technologies	Consumer electronics	Business processes		
Microelectronics	Software	Telecommunications	Clinical trials		
	Industrial engineering		Electronic components		
	Microelectronics		Industrial automation		
			Engineering		
			Consumer electronics		
			Automotive		

## **Drivers of Outsourcing**

Some of the main reasons for firms to engage in offshore outsourcing is to support R&D in pre-existing manufacturing or marketing facilities, establish facilities tailored to specific R&D activities or contracting with independent sources of R&D such as universities or private laboratories. Hence, establishing R&D operations in target markets is often intended as a method to overcome barriers such as the speed in addressing problems or opportunities in the local markets; or understanding and adapting to local practices and regulations. Local operations may also be influenced by the quality of available resources, infrastructures and materials, or for purposes such as securing local licenses or permits.

The main perceived value derived from outsourcing or off-shoring R&D often involves basic economic rationales such as to improve R&D cost effectiveness and increasing overall competitiveness. However, also less quantifiable, yet strategically important issues such as the creation of a global R&D infrastructure, increasing overall R&D capabilities and building new markets rank high among the reasons for multinational firms to invest heavily into outsourcing R&D.

Consequently, outsourcing to countries such as China and India maintains its basic attractiveness, as long as there is an abundance in qualified R&D personnel available at competitive prices. The maintenance of R&D centres in these countries also has an additional benefit, as the presence can lower direct costs of research relevant for adapting to local conditions. Thus, building local R&D centres brings with it a strategic investment in advantages of proximity, as the economies of nations such as China and India grow and become important markets. In fact, around the world key public procurement such as defence or healthcare is linked to localising related R&D investments, which has in some cases influenced multinationals localisation of R&D investments.

### **IBM and Outsourcing**

IBM has a long history of outsourcing R&D and doing business abroad. After several waves in which IBM has been expanding and reducing the number of R&D facilities throughout the firm's history, IBM today has limited R&D to eight laboratories worldwide. However, IBM has recently understood that R&D is not necessarily limited to certain research sites, and has consequently found ways of funding high-level R&D by linking it to consultancy projects, and thus charge a premium to its clients. For low-level R&D, IBM employs a more traditional model in the form of a global sourcing strategy, where activities are placed where they are done best and most inexpensively. Consequently, IBM today has more than 50,000 IT employees in India and research in software for health care, insurance as well as software to testing language skills, and is ready for further expansion in India is necessary to maintain a low-cost R&D base.

Multinationals with diverse R&D strategies in terms of geographical presence have been shown to obtain advantages in the ability to develop new technologies, due to a more diverse base of researchers, as well as ease of entry into new markets. This includes also development of new processes that cater for local or regional means and cultures, and products for new and emerging markets.

Figure 6. Drivers of Outsourcing

#### Drivers of Outsourcing

- Low costs
- Access to skills
- Linkage to key hubs
- Access to markets
- Scale of R&D facilities
- Recruitment potential
- Language skills
- Willingness to take on new skills
- Increasing business-model flexibility
- Access to best-of-breed companies
- Access to local networks
- Adoption standardisation
- Avoid regulatory challenges

*Low costs* – One of the key drivers of global outsourcing of R&D is undoubtedly the aim to maximise cost efficiency, by taking on staff in low-income countries with large pools of skilled labour. Despite massive annual pay rises, engineers and researchers in countries in Asia, South America and Eastern Europe are still between 15-40% of the costs of engineers and researchers in the US and Europe. Lowering costs can either enable more competitive bidding, support low-cost strategies, or can be used to staff up to improve time-to-market, slash research times, or engage in new and more rigorous processing of e.g. molecules in the pharmaceutical industry to improve pipelines and overall competitiveness.

*Access to skills / highly educated workforce* – With the vast number of engineers trained in the emerging economies, these markets provide an abundant source of engineers to bridge the gap between supply and demand of skilled labour such as engineers and programmers in the western economies. Despite the ongoing debate on quality, companies such as IBM and Accenture are staffing massive R&D centres in India with part of the countries annual 600,000 engineering graduates. The same tendency can be seen in other outsourcing destinations such as Russia, Ukraine and Hungary, where access to the large and advanced base of researchers, Phd's and engineers within strategic industries, enables western companies to tap into the countries historic knowledge and skill bases in areas such as aerospace, computer programming and mathematics. The challenges, however, are that working cultures might be radically different in different parts of the world. Consequently, IT companies experience the return to more hierarchical management methodologies in countries such as India and China, and challenges with retaining experienced employees in non-managerial positions, making horizontal careers and the development of experienced specialists a challenge.

The flow of hiring does not only go from west to the east. Recently, the recognition in some Chinese companies that the quality of the countries graduates and skill base is still suffering has sparked Chinese companies to set up R&D centres to get access to traditional high level of skills of German engineers. Consequently, the pattern on the world markets for access to skills are not unilateral, but increasingly shows behaviour of synergies and a more Pareto-optimal distribution of skills across national borders.

*Linkage to key hubs* – the geographical placement of R&D centres also relates to the proximity to current or future global hubs, in relation to market access, branding and access to recruitment. Further, the strategic localisation of activities may also be driven by expectations

(or bets) on the likely future hotspots of innovation, or just as importantly, those places with strong linkages to such future hotspots for historical, cultural or economic reasons. Such placements enable R&D centres to build local networks with firms, government and universities in linked low-costs locations, and use the linkages to global hubs to improve market-ties.

*Access to markets / presence in future growth markets* – Despite the improvements in global trade and global access to markets, proximity in national economies are still important for access to national and local markets. Proximity enables international firms to develop increased sensitivity to local customs, culture and understanding through hiring national experts with insights and knowledge of the market conditions. Proximity also enhances the possibilities to build partnerships and networks which can leverage local insights and knowledge, and thus improve the basis for the integration into the local economy.

In economies such as China and India, local presence can be paramount to securing long-term access to markets not just for political and cultural reasons, but also for the purpose of producing at the local cost-base, thus maintaining competitiveness as well as brand awareness in the emerging markets. The Swiss pharmaceuticals company Novartis, is current expanding R&D facilities in China for this reason, despite the recent problems of Pfizer in securing protection against copycats of its Viagra drug. Finally, presence in emerging markets means global firms are gathering important knowledge and experience of the local market conditions, business culture and political landscape for future use as the markets grow. Such market knowledge is of vital importance, as brands and key competitors are emerging. This knowledge can also be obtained at a very high cost, as some US companies have experienced by going very early into China, and by learning the hard – and expensive – way how the Chinese markets work in relation to R&D, partnerships and protection of IPR. An important aspect here is the global firms' ability to assess the local markets on the dimensions of market size, potential future revenue stream, quality of recruits and the competition. Some of these lessons have been learned the hard way by western companies, as the national strategies of e.g. China and Russia are still unclear, or changing, as the countries economies evolve.

*Scale of R&D facilities* - the ability, for the same costs to hire 3 or 4 times as many researchers, or have access to hire from massive pools of candidates such as from the universities of India and China, is in some industries a key driver of the location of outsourced R&D facilities. For IBM this has been a quick way to internationalise R&D, and quickly staff-up on low-cost programmers and engineers. For other industries it has been a strategic move to locate activities in areas with large reserves of knowledge workers to have the ability to quickly grow R&D operations further and to avoid recruitment bottlenecks as seen in Western Europe in certain skill-areas such as engineering and programming resources. For the pharmaceutical industry, it has meant new competitive drivers linked more to quantity, instead of traditional quality, in research. The ability to screen massive numbers of molecules, do 24/7 research, or have access to large populations for clinical trials, means that mundane activities associated with the R&D efforts can be stepped up, with the decisions and core research being lead from facilities in the US or Europe.

In other industries such as engineering, it means that less advanced engineering tasks such as design of circuit boards, application of technologies and testing can be done by cheap engineering resources in R&D centres or through contract-research, focusing US and European engineering capabilities on further development of leading-edge technologies. The ability to create massive R&D facilities, either fully owned, in partnership or through contract research, has also meant the ability to derive economies-of-scale in areas which can be more or less standardised. Scale and speed of R&D based on bulk and size, instead of quality of R&D

departments have gained new meaning as a driver of competitive advantage for R&D companies.

*Recruitment potential* – for companies in software and IT, the access to sheer numbers of engineering graduates is a driver in itself. For IBM, the ability to launch a new R&D centre in India has given the company an opportunity to re-enter a market it left many years ago, and to quickly scale up global capacity to service its clients with low-cost resources for tasks which require massive manpower. These service areas include maintenance, support but also R&D-intensive tasks such as the development of industry-grade software and application integration. For a number of IT companies, the ability to scale up in regions like India is also part of their branding and marketing efforts to show a dedication to stay competitive, have an international focus and offer their customer access to low-costs engineering resources.

However, behind the drive for outsourcing e.g. software development evidence is still lacking about the true costs of such outsourcing of projects. Consequently, IT projects in the shipping industry for companies such as Maersk Sealand have shown that the costs incurred through the need for increased coordination, monitoring, high turnover in Indian companies, quality control, and also quality deficiencies, coupled with annual increasing wage rates of 10% to 20%, can severely influence the total costs of outsourcing. Outsourcing of software services are therefore increasingly seeking other competence centres such as Russia, Ukraine and Hungary, where there are strong software traditions, higher quality, proximity to European countries and in some cases lower wages by comparison with Asia.

Some studies also suggest that the numbers of engineers in India and China are overstated.<sup>6</sup> With the US turning out around 70,000 engineers, India 350,000 and China 600,000, the quality and skills of the engineers are debateable. Despite educational programmes in e.g. India in software development being designed and set up in part by engineers returning from the US, the sheer numbers of graduates and resources allocated to each graduate, questions the attention and level of skills, though without any conclusive evidence. China has been accused of overstating the number of engineers to attract foreign investment, and in some cases upgrade the official position of low-tech workers to skilled workers with industry-specific skills, and inflate educational achievements to boost the number of graduates within hot areas.

*Language skills* – a major driver of the outsourcing of software to India has been the historical high fluency in English, due to the countries' past as a British colony. The outsourcing of business processes, call centre operations as well as more advanced R&D processes, have been eased by the ability to communicate in English, and thus made the country a choice for US and many European firms. For European firms outsourcing to countries such as Russia, Ukraine and Poland has been hindered by low fluency in the main European languages such as German, English and French, and has lead to some European firms selecting India for outsourcing opportunities, despite the proximity and other advantages of the European neighbours. However, countries such as Romania, which have had traditional strong ties to e.g. France, have successfully created a niche market as the place of choice for outsourcing from French companies in software and other industries.

*Willingness to take on new skills / training* – the willingness of the workforce to be retrained in asset-specific skills, such as new languages – even certain accents and limited language areas – or call centre functions and local accounting rules, have lead to countries such as India being able to build companies that focus on functions with direct customer contact in other countries. The low costs of labour means that it may also be relatively inexpensive to train and re-train workers to handle skills that are normally depending on local aspects such as language, knowledge of local rules and regulation etc.



*Increasing business-model flexibility* – the ability to develop parallel organisations with different processes, to quickly expand and contract huge operations, and to conduct inexpensive retraining of staff in completely new fields, provides new opportunities for innovative companies to experiment with alternative business models, or to take risks in new markets, product- or service-lines, with relatively low financial risk. IBM's ability to scale IT engineering through Indian facilities is one example, the significant lowered financial risk of developing new ventures in outsourced locations, such as Skype in Estonia or Google Earth in Bangalore, provide new possibilities for experimentation with new business models, which otherwise would be deemed too costly or too risky.

*Access to best-of-breed companies through joint ventures in new and emerging markets and economies* – in R&D locations such as eastern-Europe, Russia and China, the presence in local market provides access to best-of-breed companies with specialised competences, presence in key markets, or special strategic positions. Yahoo's purchase, come merger, come joint venture with Tao-Bao in China is an example of how US firms, as late comers to recently deregulated markets, can use their early presence to take a first pick at leading companies, even though it comes at a price. Ebay's purchase of Skype, a leader in voice-over-IP communication was an example of a leading European company, originally with the software base developed at R&D facilities in Estonia, coming under US ownership. In some cases, entire Indian companies have been purchased to accelerate recruitment.

*Partnerships with biotechnology companies to boost new product development* – small biotech start-ups in Europe and elsewhere are being targeted by international firms to boost their pipeline, effectively creating outsourced R&D operations, though targeted towards specific aims, through direct and frequent corporate buyouts.

*Adoption standardisation and of collaborative practices and processes in global supply chains* – for some industries, the option of owning or creating joint ventures with foreign subsidiaries or R&D centres is a conscious strategy to enforce standardisation of supply chain processes. This can be logistics, manufacturing or spare parts design and production firms, or it can be R&D facilities in logistics, such as the RFID centre in Denmark being approached by the US military as well as Wal-Mart for the purpose of directly or indirectly influencing the standardisation of RFID.

*Avoid regulatory challenges* – the prospect of looming trade wars, spiring economic nationalism or tight regulatory regimes on areas such as stem cell research, or environmental concerns, has lead firms to outsource R&D to foreign locations to gain access to areas with less strict regulations on certain issues. Biotechnology R&D facilities are operated in Singapore, or via subsidiaries in India and China, to avoid barriers or political backlash. The strategy, however, is not only limited to western companies, as Japanese car-manufacturers successfully deployed this strategy in the 1990's, and set up R&D facilities, joint ventures, as well as manufacturing facilities, to avoid the consequences of US punitive taxes on imports from Japan. Consequently, the outsourcing of R&D, as well as manufacturing, is also a pattern of the increasingly interconnected global economy, which makes traditional instruments to control and enforcement of national trade policies more complex to implement and predict.

## **Barriers to Outsourcing**

Despite the many drivers for outsourcing, several factors linked to the integration of economic systems, the emergence of economic hotspots on the global stage, and the new political and economic landscape become barriers for the successful outsourcing of R&D across international economies.



Figure 7. Barriers to Outsourcing

Barriers of Outsourcing

Infrastructures  
Quality control  
Control of processes  
Protection of IPR  
Commercial hold-out  
Partisan or inefficient judicial systems  
Lack of international standards  
Language  
Work Culture  
Economic nationalism  
Impact on branding  
Safety concerns  
Ethical concerns

*Infrastructures* – significant challenges to outsourcing are the physical as well as intangible infrastructures of the developing economies. In the case of physical infrastructures, these are often transportation and access via airports, hotels, broadband access, phone lines, electricity, advanced facilities such as laboratories and other high tech installations. Intangible infrastructures can be anything from the time to incorporate a company, quality of legal services, quality, availability and reliability of services such as electricians, masons and other craftsmen, or ability to manage cross-border financial or IP flows. The investments required to take many of the emerging economies to western level are massive, and may be beyond the initial economic leap forward, as trade surpluses need to be reinvested in developing tangible and intangible infrastructures instead of being used to fuel the primary production of goods and services for foreign companies.

*Quality control / loss of control of processes* – major challenges persist in maintaining the quality of outsourced R&D, and control how services are delivered within an organisation and to its external partners. Challenges can relate to skills, culture or communication, and can be found in the inability to scale the firms control and support systems fast enough, as well the inability to conduct proper training, or the lack of sufficiently skilled candidates for the tasks ahead.

Consequently, firms are faced with new challenges to adjust or re-design quality control procedures and business processes to fit the requirements of the foreign subsidiaries. In the case of widespread local supplier networks, contract research or outsourced processes to local second- or third-tier companies, the results of the standard quality control systems can become highly unreliable, and more rigorous testing needs to be implemented. There are cases with Chinese suppliers misunderstanding the European CE mark on consumer products tied to single products, mistaking them for overall approval of the supplier, thus putting these quality marks on products without adhering to safety regulations, or producing low quality batches and still supplying them with the same marks of quality.

Other cases involve counterfeiting or parallel production of drugs of inferior quality, such as malaria medicine, for local markets, which end up on global markets with severe consequences for users as well as the brand owners. Sufficient quality control can also be hindered by lack of implementation of global standards in the local R&D systems, insufficient education, or cultural or other unwillingness to perform according to company procedures. Such conditions require an increased use of monitoring and control or, as many software

development companies have done, redesigning work procedures for the foreign R&D centres to tailor them to specific work cultures or specific outsourcing destinations.

*Control of proprietary knowledge / protection of IPR* - the joining of the WTO has meant that new and more rigorous IPR protection regimes are required to be imposed in countries such as China and India. Originally, countries had a transition period of 10 years to impose new regulatory frameworks, and ensure the proper protection was put in place. The reality however is that new regulations have only been introduced at the end of the grace period, and taking significant time to implement, not just in the legal codes, but also in the practicalities of the judicial systems as well as in the business culture. Although the protection of IPR can be serious barrier to attract foreign R&D to developing countries, implementing proper protection systems require fundamental changes in the make-up of the countries' political, cultural and industrial systems, which in turn delay their implementation.

Another challenge to foreign investment into R&D are the conflicts related to access to the producers in areas such as drugs and cures for major diseases in emerging countries. South-American and African countries have contemplated forced licensing of patents and IPR of drugs owned by foreign companies to treat pandemics such AIDS, in an effort to lower prices of such drugs and increase access to therapy. This has stoked an outrage in the pharmaceutical industry threatening to undermine the industry's willingness to continue investing in research into cures for diseases associated with the developing world, as well as to reduce the amount of foreign investment into R&D in the same countries. Fears stem from the expected reduction in revenues and hence in thereby the justification of research budgets as well as potential loss of control of R&D results from operations in the developed world.

For the US and EU there are challenges in industries linked to military R&D such as aerospace, software and microelectronics. Outsourcing of R&D can result in industrial espionage or the transfer of technology for military use to potential future adversaries. Such considerations have been linked to e.g. networking equipment, development of chipsets and other high technology research, and show that there is a political reality beyond the economic rationales for the outsourcing of R&D. The problems of unsanctioned technology transfer have created outrage in areas such as high speed trains, telecommunications equipment and industrial engineering, with military-owned Chinese companies such as Huawei climbing fast up the value chain through a combination of joint ventures, after which telecommunications equipment from Cisco has been effectively copied and resold at discount prices to the world markets.<sup>7</sup> Similar cases can be found with Siemens know-how on magnetic levitation trains possibly being copied to the benefit of Chinese manufacturers; the copying of technologies for developing concrete factories from FLS Schmidt industries; and Indian pharmaceutical firms copying process technologies from Lundbeck.

In 2006, China repealed Pfizer's patent on Viagra, a market which has already been undermined by Chinese producers of the drug, working without repercussions in China. There are many potential leaks across the research pipeline, which makes outsourcing of R&D in strategic areas potentially hazardous to firms' knowledge base. Some US lawmakers have already started warning companies about outsourcing R&D to China, in the case of military tensions with the US

*Commercial hold-out, due to improper management of collaborative or third-party relationships* – many western companies have experienced that joint ventures in local markets resulted in painful break-ups, and the company's brands, production facility, market access or work force being taken hostage by local partners.

*Partisan or inefficient judicial systems* – the challenges of emerging economies also relate to the ability to build efficient intangible infrastructures such as banking, government, regulatory authority, as well as efficient and reliable judicial systems. For foreign companies to invest in local markets and be willing to do R&D and develop new products, they must have reasonable assurance that their investments and as well the agreements that govern relationships will be protected by fair and impartial legal systems. Recent cases from Russia and China show that this is not always the case.

The problems of BP in the Sakhalin-2 project have been difficult to challenge, since the allegations are complex and link to legal areas that are ambiguous, arcane and politically biased, such as the Russian tax system or environmental regulations. Similarly, challenges are found in China where manufacturers are known for producing extra copies, outside of contract, for the local markets from the same assembly lines, or sometimes building identical copies of the same factories. Some of these products end up being exported as pirated copies, with the Chinese government doing little to stem the supply. For India, the challenges can be the ability to wait for a court ruling on commercial cases, which can be delayed and take up to ten years even for the first steps in the judicial system.

*Lack of international standards* – As international players establish R&D centres in emerging economies, it is often overlooked that many of the costs advantages come with clear deficiencies in the intangible infrastructures as well as lack of knowledge of internationalisation best-practices and know-how. There exist vast variations in the application of international standards for research and manufacturing across the developing economies. To address these issues, India has recently amended the schedule Y of the Drugs and Cosmetics Rules of India, to clarify the environment for clinical research. In China, the government has imposed regular monitoring of clinical trials to ensure good clinical practice and compliance with international standards in research centres. The low costs advantages cannot in the long term sustain challenges to the quality of activities and output from China and other Asian developing economies, and consequently, avoiding further scandals in research results and exports are paramount to keeping the overhead of managing security and quality in the R&D centres down, to compete with economies such as India. Furthermore, the requirements of international standards make it difficult for firms in the emerging economies to move up the value chain, and hence can pose limits to the scale and scope of activities, which can be outsourced, from international firms.

*Language* – insufficient language training, the unwillingness to acquire new language skills and the resistance to introducing new languages in both emerging as well as developed economies, can work as barriers to harvesting the countries' status as preferred locations for outsourcing. For China, the Chinese language poses a challenge to western-style contracts, and the insistence on global standards for communication, often in English, requires the Chinese to invest in training of its workforce, which works as a disadvantage vis-à-vis neighbouring India. For countries such as Poland and Ukraine, the tradition for speaking Russian as preferred second language, has meant that programmers, engineers and other professionals have challenges communicating with R&D teams in their western parent organisations, and have in some instances lead companies to choose the longer journey to India for new R&D centres or outsourcing of other functions. The challenges of language are, however, not limited to emerging economies. The unwillingness of France to adopt English, has lead to challenges regarding the placement of R&D facilities by European and US companies, and in some cases created parallel cultures or isolated research communities in major research hubs near Paris and Nice / Cote d'Azur.

*Work culture* – inclusion in the world economy also means the adoption of new customs for work culture and the ability to understand and implement the processes of western firms in traditional societies. In India, several western firms have experimented with western-style management, but have had to adjust to more traditional and hierarchical management to accommodate for the local work cultures.

Other clashes of culture in the software development industry have been the willingness of Indian programmers to hand over their code for testing by other programmers, which is normally associated with a strong sense of ownership. In China, local managers are often paid equal to their western counterparts, despite the lower-level of compensation for their, based on the managers' ability to navigate the local business culture, speak the language and behave as is expected in the local context. Finally, factors such as gender specific issues, religion, corruption, and nepotism are also challenges to merging work cultures across international supply chains, and are posing challenges to harvesting expected synergies from the global outsourcing of R&D.

*Economic nationalism* – despite the increasing integration of global markets and global supply chains, the economies of emerging countries such as China and Russia, still serve as drivers of global political influence as well as tools supported underlying nationalist emotions. The speeches of Chinese leaders concurrently underline the ambition of China to become an economic superpower, and preferably by the emergence of domination by Chinese firms. The original joint ventures imposed on foreign firms entering the Chinese markets enforced majority ownership of Chinese firms in any joint ventures, and many sectors are still protected from majority foreign ownership for reasons of national as well as economic security. Recent moves to hinder Chinese take-overs of US oil firms, Dubai services-firms to run US harbours, Scandinavian firms protection from foreign ownership by placing ownership in special foundations, all underline that economic nationalism, in one form or the other, is not only the act of emerging economies, but just as widespread in the political and economic landscape of developed nations as well.

*Impact on branding* – brands such as BMW have had problems with brand identity after production of cars, parts, as well as R&D, in developing countries become more and more widespread. The traditional brands based on national identity as marks of quality and exclusivity are under pressure when taking advantage of low costs and access to talent in other countries.

Multinationals such as Apple have successfully created a proactive brand awareness by labelling all their products as 'Designed in California, Assembled in China' to communicate their use of outsourcing almost as an enabling, and value-adding factor (possibly using smart outsourcing in production to enable more investment in design innovation).

*Safety concerns* – recent problems with counterfeited Procter and Gamble products coming out of China containing dangerous chemicals, have underlined the problems of safety concerns, due to lack of controls in the new global manufacturing chains. Scandals in stem cell research in Korea, also underline the fierce competition and new challenges to traditional control systems of scientific results. Increased pressure is placed on traditional safe guarding mechanisms such as clinical trials (already 20-30% of global clinical trials according to some sources<sup>8</sup>) that are conducted under developing countries legal regimes, or in areas with different traditions for control. Traditional brands can come under pressure if factors outside of their control create scandals in consumer safety, due to outsourcing of activities and subsequent loss of control.

India has recently made amendments to the Drugs and Cosmetics Act, governing clinical trials, and China has improved monitoring of research centres to ensure compliance with the

Good Clinical Practices standards. The problem is also present in other industries, such as automotive. Recently, Toyota, with a global network of producers and suppliers to spark growth has experienced declining quality, with the resulting deterioration of brand value. However, attempts to comply with international standards are undermining some of the competitive advantages the emerging economies enjoy, and the motivation to zealously pursue the control regime can be under pressure from other forces. In addition, the recent scandals over corruption in the high levels of Chinese governmental levels on food safety show that the basic control mechanisms can be seriously flawed.

*Ethical concerns* – in the rush to lower costs, western companies have run into ethical concerns about the practices of their suppliers in many areas such as child labour, labour laws, workers' rights, use of toxic substances, pollution as well the clash of religious, political or cultural values, which spill over to the economic sphere.

The outsourcing of jobs to emerging economies is still a hot issue in western politics, debated on many levels such as the erosion of the western manufacturing base; the replacement of blue and white collar-workers whilst top management retain their positions (such as IBM top-management was accused of when they publicised their intention of opening R&D facilities in Bangalore, India); and the loss of knowledge advantages through the transfer of intangible capital to foreign R&D subsidiaries and third party firms.

In the pharmaceutical industry, part of the attraction of outsourcing is access to more lax regulatory regimes, clinical trials, and R&D, which exploit the work and skills of the emerging population while passing little IPR value to the country, and often pricing the end-products out of range for the countries' populations. In the recent debates over CO<sub>2</sub> emissions, China, alongside other developing nations, has begun presenting the case that the emerging economies should be exempt from reductions. One core argument is that the developed world has already had its industrialisation, whilst the developing world is only beginning to develop the same living standards. Secondly, it is argued, that much of the emissions are caused by the production for developed countries.

In the areas of wage-cuts, the unions of the western European countries have, often successfully, argued that the employment of cheap eastern-European, Chinese, Indian or Philippine labour is unethical due to the poor working conditions, poor workers' rights for those nationalities, and the unethical aspect of differentiating wages for the same work done, based purely on nationality.

## **Consequences for Domestic Facilities**

For the domestic facilities of the multinationals, there is some evidence that outsourcing or off-shoring of R&D has led to a reduction of staff, as well as a reduction of funding in existing facilities. However, as the many case studies from leading firms have shown, this cannot be said to be generic, but is instead likely related more to the R&D profile of the multinational in question. There is evidence that the capital-intensive and mature industries of Europe suffer more heavily from the outsourcing of R&D from Europe than the high-technology companies of the US, which to a large degree see expansion into China and India as a driver for growth and new markets, than as an alternative to domestic R&D. In addition, there is evidence that for many US companies, the cost-savings in outsourcing R&D to offshore facilities are re-invested in e.g. basic or strategic research to drive further advantages in R&D.

The current wave of outsourcing from the US and Europe to China and India has been driven by industries such as pharmaceuticals, software and electronics. But beside the emphasis on outsourcing of R&D to China and India, an increasing number of multinationals now also look

to smaller Asian as well as South- or Latin-American economies, especially Brazil and Mexico, for placing R&D facilities within the same industries. The question is thus whether China and India have provided special circumstances for attracting these industries, or whether these industries are the easiest industries to outsource in terms of costs as well as practicalities. Further, the concentration of investments in two main economies is also considered by some multinationals to be a risk worth mitigating to avoid over-dependencies. In all, questions could be raised as to the continuing trends in consolidation and motives for R&D investments after the intensive investment period into primarily China and India.

Some of the lessons learned by multinationals in off-shoring R&D relate to dealing with internal operations, as well as external issues such as policies, legislation, red tape and cultural differences. As one of the main reasons to outsource R&D is the access to lower cost-bases, many firms have been surprised by the total costs of the off-shoring operation when taking into account training, establishment costs and recruitment, lost efficiency and quality issues. Recent studies have shown that only about one-third of US multinationals have so far generated a profit from the operations in China. Also, due to special features of the job markets in e.g. China and India, it can be difficult for companies to deal with the high turnover of employees, and related lack of competence building, experience and track record, as well as the high rate of growth in wages for qualified candidates. Hence, many firms have learned to standardise processes and start with scaled-down operations focusing on e.g. product and process research. However, for multinationals that do manage to create efficiently running subsidiaries, the profits can be very attractive, also taking into account the smaller, yet fast growing markets the Asian economies (excluding Japan and South Korea).

For some firms, it has been critical not to see their off-shoring facilities as isolated entities, but to maintain a high degree of interaction between domestic and offshore R&D teams to enable cross-pollination to lower barriers in communication as well as ease cultural differences. Japan serves as a special case since the country's 2002 emergence from the 1992 recession. With the world highest R&D spending of 3.2% of GDP, Japan is currently refocusing its R&D strategies on increased efficiency in R&D spending, flexibility in allocating public R&D funds, to emphasise non-manufacturing R&D, focus on supporting R&D in start-ups, and strengthen international linkages. However, when looking at the global picture, Japan is the least internationally involved country in the developed world, when it comes to outsourcing of R&D, except in the automotive sector.

The big pharmaceuticals are seeing their business models change from being research-driven to being market-driven, in the sense that boardrooms are increasingly populated with economists, lawyers and accountants rather than doctors and engineers.

After a steady decline in the number of drugs researched for tropical disease, the number of drugs in development of the ailments of the third world are now picking up again with a global pipeline of more than 60 drugs in the making. However, with Brazil's recent threats against major drug makers for compulsory licensing of anti-viral drugs against HIV, leading pharmaceuticals might again pull out of research directed at third world and developing countries.

An increasing number of pharmaceutical firms outsource large parts of their R&D budgets to external researchers and firms, opening up the global market for innovative firms and talented scientists to approach the outsourcing budgets for the leading firms in the biotechnology industry, disregarding their location geographically.

The leading multinationals in the pharmaceutical industry, traditionally re-investing a high percentage of sales into R&D, have built networks of research centres that enable them to tap into resource bases across the globe. Many firms that are headquartered in Europe or the



US, can do basic and advanced research in US and Europe, as well as outsource their clinical trials to, for example, Asia benefiting from the low-cost workforce in more standardized R&D processes. This not only reduces R&D costs, but also serves to cut cycle-times for new products to boost productivity and may also reduce regulatory approval in key growth markets.

## **Building Global Networks**

For multinational companies involved in major R&D activities, the ability to build global networks of R&D for the purpose of product development carries many advantages in the possibility to leverage the capabilities of different regions to build efficient R&D supply chains. Consequently, a more open model of R&D is emerging, where companies see good ideas not only emerging from the inside, but also coming from the outside, through advanced R&D networks, which tap into many markets and many diverse talent pools.

The outsourcing of R&D in some cases leads to decreasing R&D in the companies' home markets. Surveys have shown that over one third of companies in the US outsourcing to Asia plan to decrease R&D in their home countries by over 10%.<sup>9</sup> In the US, the outsourcing of manufacturing has led to fears that this will at one point have an impact on the R&D capabilities of the nation. It is argued, that an eroding manufacturing base may impact the prospects of US engineers, leading to a decline in the uptake on universities, compared to nations such as India, China and Japan.<sup>10</sup> Despite an average annual rise of 3% in R&D spending in the US<sup>11</sup>, R&D in the US manufacturing industry have declined by an estimated 10% since the late 1990's, whilst the expenditure on R&D outsourcing has increased by 15% a year in the same period (with the number of firms outsourcing R&D growing by 7% annually).<sup>12</sup> Behind these numbers, there may also lie an indication that global R&D is increasing, even though the global R&D landscape is changing. There are, however, very diverging results in this area, as many companies end up merely extending their R&D operations with increasing specialisation of R&D functions based on capabilities, improved time to market, 24/7 research, local market access or specialisation along certain technology lines.

Studies in the automotive industry show that the R&D ratio, R&D spending over sales, is closely linked to global sourcing, meaning that vertical integration of new product development across countries tends to increase R&D costs (D'Aveni 1994).

Studies of supplier integration on product innovation in an outsourcing context have shown these effects to be negative (Koufteros 2005), due to the outsourcing of product development to sub-suppliers, leading to less investments in R&D, primarily due to parallel and overarching ambitions to cut costs at the same time, thereby depleting R&D budgets and other overheads.

There are indications, which are also supported by research (e.g. Ettlie 2006), that the ability to successfully manage R&D outsourcing, like other technology partnerships, becomes a competence in itself for firms to harness the advantages of global R&D networks. To take advantage of lowering transaction costs, enhancing flexibility and reducing impact on the environment, firms need to build capabilities to manage these relationships, also in turbulent market conditions. These capabilities include organising process-coordination and integration, learning, reconfiguration of competence profile vis-à-vis environmental issues, and the ability to renew competences.

Despite the current dominance of countries such as India and China, outsourcing has also been popular to other countries such as Japan, Taiwan, Israel and Singapore. IBM has been outsourcing development to Western Europe since the end of World War II. Texas

Instruments opened R&D facilities in chips and chipsets in Japan in the 1990s to get access to Japanese engineering talent, and to get closer to the market. Singapore has with less strict rules on stem-cell research become a leading area for outsourcing R&D in biotechnology, and consequently developed into an international hub for research in this area.

## Europe

Europe's industrial base needs updating, and a large part of the capital-intensive industries have reached the end of their innovation cycle. In addition, as also outlined in the Lisbon agenda, Europe invests too little in R&D. However, with a mature industrial base, increasing spending in R&D can be difficult. Comparing the top 10 R&D spenders worldwide, the European situation, especially vis-à-vis the US becomes clear.

Figure 8. Top R&D spending worldwide

Company	Country	R&D EUR M	Change % Yr	% of sales
Ford Motor	USA	7,767	8.0	4.5
Pfizer	USA	7,223	-3.0	14.5
General Motors	USA	6,503	3.0	3.5
DaimlerChrysler	Germany	6,468	0.0	3.8
Microsoft	USA	6,392	6.0	14.9
Toyota Motor	Japan	6,210	11.0	4.1
Johnson & Johnson	USA	6,127	21.0	12.5
Siemens	Germany	5,903	2.0	6.8
Samsung	South			
Electronics	Korea	5,282	12.0	6.8
GlaxoSmithKline	UK	5,220	10.0	14.5

Source: The R&D Scoreboard 2006

Figure 9. Top R&D spending in Europe

Company	Country	R&D EUR M	Change % Yr	% of Sales
DaimlerChrysler	Germany	6,468	0.0	3.8
Siemens	Germany	5,903	2.0	6.8
GlaxoSmithKline	UK	5,227	10.0	14.5
Novartis	Switzerland	4,705	15.0	15.0
Volkswagen	Germany	4,667	-2.0	4.3
Sanofi-Aventis	France	4,630	2.0	14.8
Nokia	Finland	4,555	4.0	11.6
Roche	Switzerland	4,202	12.0	16.1
BMW	Germany	3,567	11.0	6.7
Robert Bosch	Germany	3,355	1.0	7.0
AstraZeneca	UK	3,280	-11.0	14.1
Ericsson	Sweden	3,127	16.0	16.9
EADS	Netherlands	2,710	2.0	6.9
Philips	Netherlands	2,677	-8.0	7.7
Renault	France	2,593	15.0	5.6
Peugout	France	2,463	2.0	3.8
BAE Systems	UK	2,415	31.0	13.2
Alcatel	France	2,052	15.0	13.6
Finmeccanica	Italy	2,000	20.0	15.6

Source: The R&D Scoreboard 2006



One of the major obstacles to increasing R&D spending in Europe, as opposed to American firms, is the expected return-on-investment shifting from incremental to more radical innovation for European firms. As an example, Lafarge, the French construction group, currently spends only 1% of its annual USD 15Bn revenue on R&D in new materials.

European universities are extending their efforts in developing joint R&D projects and corporate venturing projects together with firms. National R&D funding programmes have been set up in many European countries to promote such joint research activities, based on co-funding models, where all partners cover part of the costs.

Corporate responsiveness to such measures varies widely, and no generic assumption can be made about multinationals' practices. As an example, whilst IBM globally utilises such insourcing and joint venture practices in collaboration with universities extensively, Hewlett-Packard, a key competitor, places more emphasis on collaboration with SMEs as R&D partners – a practice not adopted by IBM. Further, such partnering practices are often linked to historic headquarter or division sites and may not be easily constructed in new locations.

Yet, European (and national) R&D policy and the increase in public co-financing budgets have triggered a review of such joint venturing opportunities between multinationals and public research institutions.

Figure 10. R&D spending of European companies per industry sector

Company	Country	Industry	R&D EUR M	Change % Yr	% of Sales
DaimlerChrysler	Germany	Automobile	6,468	3.0	3.5
Siemens	Germany	Electronics	5,903	2.0	6.8
GlaxoSmithKline	UK	Pharma & Biotechnology	5,227	10.0	14.5
Nokia	Finland	Technology hardware	4,555	4.0	11.6
EADS	Netherlands	Aerospace & defence	2,710	13.5	4.6
Philips	Netherlands	Leisure goods	2,677	-8.0	7.7
Bayer	Germany	Chemicals	2,160	-22.0	6.9
Volvo	Sweden	Industrial engineering	1,288	18.0	4.4
SAP	Germany	Software	1,247	7.0	12.8
BT	UK	Fixed line telecom	1,212	39.0	3.7
Nestle	Switzerland	Food producers	1,105	6.0	1.6
TOTAL	France	Oil & gas producers	773	6.0	0.6
L'Oreal	France	Personal goods	568	-2.0	3.4
Royal Bank of Scotland	UK	Banks	548	9.0	1.3
AREVA	France	Electricity	467	1.0	4.0
Lagardere	France	Media	433	18.0	2.9
Henkel	Germany	Household goods	372	19.0	2.7
Saint-Gobain	France	Construction	350	0.0	0.9
Vodafone	UK	Mobile telecom	343	-6.0	0.6
Anglo American	UK	Mining	268	47.0	2.2
Carl Zeiss	Germany	Health care equipment & services	263	10.0	10.4
ThyssenKrupp	Germany	Industrial metals	213	-3.0	0.4
Amadeus	Spain	Travel & leisure	208	19.0	7.6
JM Voith	Germany	General industrial	205	20.0	5.0
Royal & Sun Alliance	UK	Nonlife insurance	203	4.3	1.9
Deutsche Post	Germany	Industrial transportation	200	-40.0	0.4
Tesco	UK	Food & drugs retailers	192	35.0	0.3
RWE	Germany	Gas, Water, Utilities	145	-1.0	0.3
BAT	UK	Tobacco	110	-1.0	0.7
Store Enso	Finland	Forestry & paper	93	7.0	0.7
Deutsche Borse	Germany	Financial	82	-14.0	4.0
Old Mutual	UK	Life insurance	67	300.0	0.3
Co. Generale de Geophysique	France	Oil equipment	45	17.0	4.5
GUS	UK	Retailers	37	47.0	0.3

Source: The R&D Scoreboard 2006

## India

India is still one of the main drivers for outsourcing of the software industry. Microsoft, with 400 researchers in Redmond, and another 300 in offices around the world, is currently investing heavily in India, setting up R&D and technical support facilities for more than EUR 1.3Bn in Bangalore. Intel also has a large R&D lab in India with more than 1,500 engineers, as well as similar sized R&D facilities in Israel, Russia and China. Cisco with its more than 16,000 engineers has been setting up R&D centres in India with an investment value of more than USD 1.1Bn in Bangalore. However, although firms such as Nortel and Cisco have outsourced R&D work to Indian subsidiaries, this is primarily in the upgrading of old products, and not in R&D of new product lines.

Figure 11. Top Private R&D Spenders India

Company	R&D EUR M	Change % Yr	% of Sales
Ranbaxy Laboratories	64	21.0	9.2
Tata Motors	62	29.0	2.0
Dr Reddy's Laboratories	30	26.0	12.5

India is attempting to transcend beyond the notion of cheap labour and outsourced call centres or back office functions. Currently, one of the fears of the US is that major parts of the country's R&D base, and thus its ability to innovate, is being outsourced to Indian engineers. Although companies such as IBM and Texas Instruments have placed research facilities in India, American firms often downplay the role and level of R&D done in Indian firms, or subsidiaries of international firms.

India has the technical skills as well as access to capital, for the country to develop an innovation-driven industry. Yet, it has been argued that the country lacks adequate business models for how to leverage the potential of Indian R&D to the global scale.

More than 130,000 IT professionals now work in the Indian IT cluster of Bangalore, with the largest Indian IT-services firms such as Wipro, Infosys and Tata forming part of a large cluster for professional services. Infosys has a EUR 120M R&D business, primarily in outsourcing of IT, back-office and call-centres. However, the industry is hoping to increasingly also take on high-value innovation and R&D activities to expand the scope of the outsourcing business.

The outsourcing from Europe to India also goes the other way. Infosys has opened a centre in Brno in the Czech Republic focusing on IT. The Eastern European countries often offer teams that are more controllable and culturally close to the European markets.

Some western companies now hire entire R&D teams in India to manage R&D of projects that the companies do not want to allocate their own in-house engineers to, or as temporary R&D teams. In the Western Telecommunications industry, it is not uncommon to hire teams of over 300 engineers in Indian firms. Recently, SAP has expanded with more than 3,000 engineers in India, and the expansion of SAP's R&D is now entirely focused on off-shoring to especially India, and also to some extent China.

The WTO has improved poor countries access to patented medicines, and countries such as Brazil and India with expertise in producing cheap generic medicine will be able to exploit the new possibilities for combating diseases such as AIDS, malaria and tuberculosis.

Despite the fears by American and European companies that generic drug-makers in e.g. India will start exporting drugs at low prices to the American markets, Indian drug-makers are

increasingly looking at expansion into the regulated markets through innovations as well as through generic drugs.

The underlying patterns for the outsourcing of software to India relates to business practices dating back more than 20 years, and are partly ascribed to the massive influx of Indian engineers to the US software and information technology industry. This created strong ties between India and the US and has allowed US-trained Indian engineers to return to India to start companies and change the conditions for education of future generations of Indian software engineers. In addition, this evolution concurred with IBM leaving India due to certain changes in the political context and outlook of the Indian governments, which left a vacuum in the Indian markets for information technology, allowing Indian companies to flourish.

More than 30% of Fortune 500 companies today have R&D activities in India, a number that is expected to increase in the future.<sup>13</sup> Current estimates of the number of foreign companies with R&D functions in India are more than 400, with more than 23,000 workers according to 2006 numbers.<sup>14</sup> Only 0.5% of global chemistry research is carried out in India, and 1% of clinical trials.<sup>15</sup>

The integration with the local R&D systems can however be limited. Over 50% of foreign R&D facilities in India have no local contacts, while under 40% have R&D relationships such as contract research or the likes.<sup>16</sup> Much of the research results achieved in India are commercialised by the foreign companies outside of India, which has the consequences for knowledge and value generated in India only to a limited degree benefit the Indian economy beyond the workplaces created by the R&D industry and the upgrading of the workforce in terms of knowledge, skills and experience. Consequently, there are ideas to place the knowledge generated in Indian R&D facilities into the public domain after a certain period of time, under patent protection or otherwise. Other models also considered include licensing and royalties, which could be reinvested in the higher education systems of India, or an increasing use of public-private partnerships between R&D facilities and the public laboratories for purposes of joint development and joint knowledge creation.

Companies in India are also outsourcing R&D, however currently most outsourcing takes place within India. One such company is Bharat Earth Movers Ltd, which currently has a network of 350 vendors supplying components and hardware, planned to increase by 10% a year.<sup>17</sup> Hindustan Aeronautics is likewise focusing its strategy on outsourcing R&D in production of components and sub-assemblies, but will do so to small local technology centres on a local campus, thus not looking into the global markets for R&D.<sup>18</sup>

The western pharmaceutical industry is sceptical of the pharmaceutical sector in India, despite India being a huge market for medicines and drugs. This is in part due to widely spread copying and production of generic medicines, and the fear that they would further risk losing valuable knowledge to Indian rivals by investing in R&D in India.

AstraZeneca has invested in R&D facilities in Bangalore, specialising in Tuberculosis, and GlaxoSmithKline has initiated joint development projects with companies such as Ranbaxy<sup>19</sup>. However, despite investments in such R&D centres, India does still not figure as a major research hub for AstraZeneca and GlaxoSmithKline.

Biocon have signed R&D partnership agreements with Bristol-Meyers for outsourcing of R&D to India related to services for discovery and early drug development. NPIL have entered into agreement with Eli Lilly to conduct clinical trials globally and to do marketing in certain regions for pre-clinical drugs.<sup>20</sup>

The Indian software industry has been aided by the return of Indian nationals trained at US universities and working in the US pharmaceutical and software industries. India is also

developing a position as an R&D hub for electronics hardware. Companies such as Agilent Technology are developing state-of-art-technology for the global test and measurement industry.<sup>21</sup> Wipro employ more than 10,000 engineers for production engineering services in areas such as telecom, computing, storage, consumer electronics and industrial automation, which also features testing and R&D for leading western companies.<sup>22</sup> Consequently, as the Indian companies builds there research based, knowledge and skills, they are increasingly interesting into entering into partnerships in development projects, instead of just doing contract-research and work as outsourcing centres for US, European or Japanese companies.

## China

The growth of the Chinese economy in combination with the increase of foreign direct investments into China, has lead to an increase in foreign R&D. Currently, an growing number of large foreign companies are investing in R&D in China. Recent studies have shown that foreign multinationals prefer to invest cautiously and use experience and knowledge from historic operations and networks. Also, multinationals prefer non-equity-based R&D co-operative agreements to equity-based R&D joint ventures.

Chinese R&D has grown to 1.34% of GDP, and China might soon become the second biggest spender on R&D, after only the US, especially in industries such as electronics, telecommunications, biotechnology and aerospace. Similar growth figures are found in the number of researchers, which currently surpasses 1 million, making China number second worldwide only to the US.

Figure 12. Top Private R&D Spenders China

Company	R&D EUR M	Change % Yr	% of Sales
Petro China	231	9.0	0.6
China Petroleum & Chemical	162	48.0	0.3
ZTE	141	-13.0	9.1
Semiconductor manufacturing	46	1.0	6.7
CNOOC	29	50.0	0.6

Currently, Philips is the company with largest number of inventions and patent filings originating from China, yet the total number amounts to less than 1% of Philips overall patent filings. Other large companies taking out patents from Chinese R&D are IBM, Microsoft, Mitsubishi, Siemens and Pfizer.

After the disbanding of the Warsaw pact, R&D spending in China was divided equally by industry and government, with academia only covering around 10% of total R&D spending. However, after 1998 there has an increased percentage of R&D being done by industry. Over the last years, China has seen a tremendous growth in R&D spending of more than 17% on average, compared to the rise in spending in Japan, US and Europe of 4-5% annually. Currently, China's spending equals Japan's spending in 2006, if this is calculated on a PPP basis. However, a large part of this rise in spending is due to the outsourcing of R&D to China, by foreign multinationals.

China is currently the main target for outsourcing of R&D especially in life science, physics, engineering, materials science and theoretical physics, but also challenging India as the number one country for outsourcing in software development. However, Chinese companies have also started making foreign investments in the US and Europe. The recent purchase of IBM's laptop division by Lenovo, and TCL's purchase of Thompson's television division, are

examples of Chinese companies acquiring western assets. In addition, the recent shortages of highly-skilled engineers and researchers have spurred Chinese companies to open R&D facilities in Germany, to get access to the highly-qualified engineering and R&D competences of the German industries and educational systems.

In the process of expanding abroad, Chinese companies face challenges to their strategies and traditional *modus operandi*. Hence, Chinese companies are forced to develop their brands, and their technological and institutional capabilities to compete in the more transparent Western and Japanese markets. Further, Chinese companies in foreign markets cannot rely on their government networks, experience and special access to information that they enjoy in the Chinese markets.

To meet the increased demand for contract research from global pharmaceutical companies in China, joint contract research organisations are now appearing as joint-ventures between leading Chinese joint research companies, and will be able support contract research in areas such as synthesis of new pharmaceuticals, development, tests, lead optimisation, *in vitro* and *in vivo* research.<sup>23</sup>

China has until now been the country of choice for manufacturing, where India has been seen as the place to conduct R&D<sup>24</sup>. However, China is evolving together with India to also become the country of choice for the outsourcing of R&D, according to some sources even overtaking India's role as the most attractive global destination for outsourcing<sup>25</sup>. The Nortel R&D Centre in Guangzhou is currently carrying out research in breakthrough wireless technologies such as SIP-based video calls and HSDPA for cross-network roaming.<sup>26</sup>

Microsoft has used its research labs in China to get access to research into special technologies such as speech recognition, as well as getting access to low-cost programming resources.

## USA

Spending on R&D in defence is still a major contributor to the American overall investments. However, civilian and commercial technologies are taking over as key drivers to innovations in defence.

US companies are increasingly supporting R&D in their subsidiaries in Western Europe and Asia. In particular, China has grown to become the chosen country for US investments in R&D, topping both India and Western Europe. This is especially due to the ambition of creating a low-cost R&D base in China. Although the number of US deals on outsourcing is increasing, the number of smaller deals with European and Latin American subsidiaries and outsourcing ventures are increasing also. The US is to a large degree building a network of partnering countries, which are expected to be the primary focus for future investments in R&D, and will thus affect R&D investment patterns in the future, not only from the US, but also investments from the partnering countries to the US. Some drivers, which have been highlighted in this process are the increasing availability of talent, the lowering of costs of doing business and the development of the domestic economic conditions of the partner country.

Growing attention is placed by US companies on defending their patents and intellectual property positions, as these are being seen as a valuable asset and source of income of R&D activities. Companies such as Qualcomm and ARM focus on licensing technologies and know-how to the telecommunications industry and with market shares of 80% and 70% in the

chipsets and communication protocols for mobile phones, have become virtual R&D companies for many large handset and device manufacturers.

Figure 13. International Patents 2006 based on registered first country of filing

Country	No. Patents
Japan	350,000
US	169,100
Europe	103,000
China	48,000
Russia	21,200
Brazil	4,280
India	900

Besides specific industry sectors, such as electronics where Japanese companies issue very specific patents, US companies are among the most patenting in the world, especially when it comes to software patents. However, enforcing the patents, especially outside US, has become difficult, as the ongoing bilateral negotiations between the US and other key economies, especially China, illustrate.

#### Conexant

Conexant, a US company specialised in broadband digital communications, was founded 1999 as a spin-off of Rockwell Semiconductor System - part of NASA's lunar program. From originally having a 100% US team of engineers, today 50% of the engineers are located in Asian R&D facilities. The American engineers are the innovators, whereas the Asian engineers take care of implementation. However, the division of labour is expected to have a negative impact on the US teams of engineers in the long run, as the Asian part not only takes on an increasing part of the value chain and also become increasingly innovative, possibly challenging the US status as sole innovators.

*Source: The New American April 2006, Vol 22, Issue 8*

Looking at the Chinese-American trade, China is already fastest growing export market for the US economy. However, as the devalued Yuan makes labour inexpensive in China, forces in congress are currently contemplating several initiatives to curb Chinese continuous efforts to sustain the huge trade surplus, including declaring the low Yuan an illegal subsidy, thus empowering American firms to seek compensatory tariffs. The question is, whether the weak Yuan reflects a bilateral trade imbalance, or whether the situation reflects changing supply patterns, with more goods passing through China, than former major exporters such as South Korea and Taiwan.

## Case Studies

The following chapter presents a selection of case studies of European firms and their global R&D strategies. The firms included in the case studies have been select on the basis of their representation of European strategic industries, their global focus and their importance on the global scene within their respective industries.

Figure 14. Firms included in the case studies

Case	Firm
1	Airbus
2	Siemens
3	Philips
4	Nokia
5	Volkswagen
6	Motorola
7	GlaxoSmithKline
8	Shell

The case studies aim to understand the trends of European firms in relation to the global outsourcing of R&D, and to obtain an understanding of the R&D strategies employed by each company. The extent to which some of these trends are perceived or real is often difficult to establish. Most of the times the proof for these trends is based on questionnaires and the expected investment patterns as voiced by the managers of these firms (EC, 2006; Thursby, 2006; Dearing, 2006). The actual (implemented) strategies of firms can diverge from these expectations. Another problem is often the lack of unifying framework (often based on relatively superficial questions that are multi-interpretable). The Locomotive framework tries to solve this problem. In this section, the three dimensions of that framework will be applied to score the case studies.

Locational determinants refer to the motives for R&D investment in certain regions. For each case study, quotes that describe the main developments of the way R&D is organised internationally are grouped under one of the six broad groups of determinants or motivating forces (Cf. Fortanier, Van Tulder, 2006):

Factor	Description
1	Market or demand-side factors abroad, which may make it necessary or advantageous to adapt products (and/or processes) to local market characteristics.
2	Technology or supply-side factors that make it necessary to access a wider range of scientific and technological skills and knowledge than is available in the home markets
3	Competitor factors - refers to the need to closely monitor and learn from the technological developments and strategies of competitors.
4	Arguing for decentralising R&D activities are political factors, including 'host country' factors like friendly regulatory legislation.
5	Environmental factors such as surroundings, which can stimulate innovation and attract staff
6	Finally, other factors like path dependencies or mergers and acquisitions also can be an important determinant of R&D locations.



Political factors, even if they are not explicitly mentioned, also play a prominent role in the locational decisions of Airbus (such as the location of R&D facilities next to production sites in China). Companies that operate on even stronger government procurement' markets like Siemens (in particular its infrastructure and public services activities), have strong political motives for local R&D investment as well. Increasingly, large government procurement contracts demand localisation of R&D facilities as part of the contribution to the national economic development.

Volkswagen needs to cooperate with governments to implement new infrastructures for new technologies such as biomass and fuel cells. On the other hand, the action of competitors is particularly relevant for companies that operate primarily in consumer markets with relatively standardised products (Philips, Nokia, Motorola). The location of R&D facilities near consumer markets, not only gives these companies a 'window' on local customer preferences – and thus facilitates adaptation' – but gives them also an opportunity to experience the local market dynamism' that in different countries that could lead to different innovation strategies (for instance in linking R&D activities and product design to marketing).

## Methodology

The present document aims to provide more specific information on the R&D activities of a selected group of large multinationals, in order to provide a more global view' to the 'regional portraits' that will be made of R&D activities in eight selected regions as well as to provide background information for interviews with R&D managers and roundtable discussions with stakeholders.

The case firms were selected on the following criteria:

Figure 15. Criteria for the choice of case studies

Criterion	Description
1	Leading firm in the European system of innovation (i.e. with a large number of R&D employees, sizable R&D investment and a large number of patents located in Europe)
2	Present in at least two of the eight regions that are represented in the LocoMotive research project (i.e. with some spread already of their R&D activities across Europe)
3	Substantial sales and production around the world (i.e. with sales and production abroad that is larger than sales and production in the home market)
4	Headquarters spread over a number of countries (i.e. limited overlap in the home base of these companies)

The description of the R&D activities of these firms has been compiled from publicly available information, annual reports, research articles, consultant reports, European as well as global statistics databases. The data collection has been guided by the categories and variables that comprise the three research themes (location motives; organizational structure; regional embeddedness). Quotes were selected if they provided descriptions of the conditions under which particular phenomena were found. In combination, these quotes therefore form a portrait of the company's perception of why R&D facilities are located where they are, how their activities linked to other parts of the firm and in what ways their R&D activities are embedded in local institutions and business environments. But the case studies also confront the perceptions with the realised strategies by looking at the actual spread of facilities over

countries. The case studies thus document how firms move from 'global views' to sometimes perhaps remarkably local realisations'.

The case descriptions are not all-inclusive. The picture is only complete to the extent that it has been communicated by the company, so the conditions under which the information is produced must be kept in mind. For example, China is a hot topic, so there are several communications that particularly concern the transition from manufacturing-only to locating R&D in China, and the reasons why. This may over-emphasise the importance of the related locational factors and linkages - just because no quotes were available on the reasons for locating R&D activities in other regions. The resulting bias seems rather limited, since this study has been designed to be part of a larger, multi-method study, evidence presented in this report can be corroborated with data from other sources.

# Airbus

Airbus, headquartered in Toulouse, France, develops and produces a range of 14 aircrafts. In 2006 they became a European Aeronautic Defence and Space (EADS) company. “The four national entities which had previously formed the Airbus consortium transferred their Airbus-related assets to the new company and became shareholders in Airbus” , thereby merging Airbus France, Airbus Deutschland and Airbus Espana into one company. Besides the aircraft manufacturer Airbus, the EADS Group also includes helicopter supplier Eurocopter and the joint venture MBDA, the international leader in missile systems.

Figure 16. The global network of Airbus R&D centres



After Boeing begun to outsource an increase part of the work to suppliers in Russia, China and Japan, Airbus are increasingly investigation forming joint ventures with non-European engineering companies. However, until now the global R&D networks of Airbus have been mainly domestic European with two R&D centres outside of Europe in Moscow, Russia and Wichita, USA.

Airbus activities consist of operations, programmes and core functions, and are located across 160 international locations. This includes 16 main development and manufacturing sites in France, Germany, the U.K., and Spain with final assembly taking place in Toulouse and Hamburg. Following a major reorganisation in 2004, these European sites were formed into a range of Centres of Excellence (CoE) in the design and building of the aircrafts. Each Centre has its own responsibilities and chain of decision-making, while maintaining close links with other core functions.

“In operations there are six CoEs based around expertise in key production areas -- wing at Filton and Broughton, UK; forward and aft fuselage at Nordenham, Varel, Bremen and Hamburg in Germany; nose and centre fuselage at Toulouse, Saint Nazaire, Nantes and Méaulte in France; vertical tailplane in Stade, Germany; pylon and nacelle at Saint Eloi, France; horizontal tailplane and A380 sections at Getafe, Illescas and Puerto Real in Spain.”<sup>7</sup> Besides the CoEs in operations, the cabin and customisation CoE in programmes is responsible for

driving all design and production activities and a CoE Electricity has also been set up to provide electrical products across the company.<sup>7</sup>

In the selected region Midi-Pyrénées, France, Airbus has located its headquarters. Specific R&D activities that take place in Toulouse include those from teams of four centres of excellence involved in the design, manufacture and integration of pylons and nacelles, nose and centre fuselage, cabin and cargo customization and aircraft electrics.<sup>27</sup> The A380 is assembled at a site named Jean-Luc Lagardere, extending “over 50 hectares and comprises a logistics area (receipt of supplies, sections, etc.), the final assembly line (10 hectares), aircraft external testing facilities, a static test building and weighing hall.”<sup>28</sup> Besides the A380, Toulouse also hosts the sites of the final assembly of the A300/A310, A330/A340 families, as well as the A320.

## **Market and demand-side factors**

The market or demand-side factors that have induced Airbus to internationalise certain R&D activities include demand for local product and process support and proximity to customer markets and third parties who are affected by its innovations. Airbus should be considered a European firm, with corporate headquarters in France. Investments in product and process adaptation across Europe should not be seen as a factor for internationalising R&D; home country should be interpreted as being Europe rather than just France. R&D mostly takes place at the previously mentioned Centres of Excellence, which means that the firm is strongly embedded in European markets and institutions.

However, Airbus has a global customer base and does have “centres spread across all its customers’ main areas of operations”<sup>29</sup>. Subsidiaries like Airbus Middle East have been created for marketing activities and customer services like training and technical support<sup>30</sup>. Other subsidiaries, such as those in Japan and Russia, have been created to gain a better understanding of markets in developing products processes and services. In Japan “the objective is to provide Airbus with a better understanding of and access to the Japanese market”<sup>31</sup>, and in Russia “Airbus opened its regional office in Moscow to provide on site support in dealing with the Russian government, aviation authority, industry, airlines and media on development and implementation of the whole range of Airbus cooperation with Russia”<sup>32</sup> Airbus has also assembled teams of experts to support their customers with the entry into service of their A380 aircraft, as well as placing specialist teams at third party locations who are affected by their innovations - i.e. airports.<sup>33</sup>

## **Technology and supply-side factors**

The technology or supply-side factors that have induced Airbus to internationalise certain R&D activities include the presence of sophisticated suppliers, partners and skilled labour. On an industry level Airbus’ current R&D strategy is to substantially increase cooperation with the Russian and Chinese aviation industries<sup>34</sup> “In 2005, Airbus decided to extend its ties with the Chinese civil aviation and as such signed several agreements with China for increased cooperation. Two contracts signed with China Aviation Industry Corporation I and II (AVIC I and II) were followed in December by an agreement to study the feasibility of an industrial partnership to set up an A320 Family plant”<sup>35</sup>. In Russia activities have been implemented for the “facilitation and development of future cooperation with Russian aviation industry”<sup>36</sup>

Although cooperation on an industry-level and in certification fields has influenced locational choices, the availability of sophisticated suppliers and partners has played a larger role in the internationalisation of R&D activities. Airbus has implemented “a programme of expansion which is seeing new suppliers emerging in areas where Airbus itself is growing, such as Russia

and China: putting Airbus suppliers where the sales are.”<sup>37</sup> Airbus’ Chinese programme is “committed to increasing procurement and R&D” to reach a value of \$ U.S. 120 million dollars by 2010 (in 2007 the target is \$ 60 million), and is also offering the Chinese aviation industry participation in up to five percent of the proposed A350 programme<sup>38</sup> In Russia, “Airbus intends to offer Russian companies contracts with a value of US\$ 110 million per annum. As such, in August 2005, Airbus and Irkut, the Russian scientific production corporation, signed a preliminary agreement on Russian participation in A350 development and future Airbus aircraft programmes.”<sup>39</sup> In the U.S., there have been a series of multi-million-dollar A380 contracts that have been awarded to manufacturers. One example of suppliers influencing the location of development activities in this way is the contract that has recently been signed with Eaton. Over the next 20 years certain Airbus R&D activities will take place at Eaton’s California, Michigan and Mississippi aerospace units. “Eaton is a fine example of why Airbus travels the world to find the very best suppliers for every component of its aircraft,” says Allan McArtor, Chairman of Airbus North America”<sup>40</sup>

Since a large part of innovation takes place at a supplier level, the previous motives concern capacity to improve linkages with the local innovation environment. However, availability of skilled labour has also been a deciding factor in creating or expanding R&D activities at Airbus subsidiaries outside of Europe. “Airbus enjoyed growing success and increasingly appreciated the advantages of a culturally diverse workforce, looking far beyond its 16 engineering and manufacturing facilities in Europe to capitalise on the potential offered by a more global talent pool.”<sup>41</sup> In China, “Airbus plans to establish an engineering centre in China and recruit 200 Chinese engineers by 2008”, whereas in Russia. Airbus’ regional office has been carrying out numerous research and technology projects from as far back as 1995.<sup>42</sup>

“ECAR, the Airbus and Kaskol Group’s joint-venture engineering centre, has operated in Moscow since spring 2003, and currently employs 120 Russian engineers”<sup>43</sup> Another example is Airbus’ engineering and design facility in Wichita, Kansas, which was selected because “the talent pool of aerospace and aviation experts here in this city is among the richest in the world [and] by reason of time zones, this office allows nearly 24-hour development work on the A380, in concert with Airbus engineering headquarters in Europe.”<sup>44</sup>

## Environment

The third type of motivating forces that could be identified are environmental factors such as surroundings, which can stimulate innovation and attract staff. Although the only example actually refers to skilled labour as the locational determinant, this factor is cited as a benefit in connection with establishing the first research facility in the U.S. The specific location of a historical industrial neighbourhood in Wichita was chosen because of its surroundings: “The environment offers the Airbus team an environment more akin to a college campus rather than a typical aircraft factory”<sup>28</sup>

Finally, historical developments and mergers and acquisitions have been a very important determinant of Airbus R&D locations across Europe. The determination of the locations of the company’s centres of excellence in France, Germany, Spain and the UK can be traced back as far as 1970: “Airbus (...) started life as a French-German consortium in 1970. Later it was joined by CASA of Spain and British Aerospace”<sup>45</sup>

New R&D facilities in Europe are located in the region where it complements R&D activities already carried out there. For example, the new fuel systems test facility at the Airbus site in Filton, UK has been located there because “design and supply of fuel systems is a key responsibility of Airbus in the UK”<sup>46</sup>

## Organizational Structure

Local R&D units are specialized competence centres that have been diversified according to technological expertise in key production areas. “Each site produces a complete section of the aircraft, which is then transported to the Airbus final assembly lines in Toulouse or Hamburg. This unique industrial concept based on Centres of Excellence has proved to be extremely efficient. Airbus’ industrial network has been expanded to include a satellite design office in North America, a joint venture engineering centre in Russia and further engineering centre in the People’s Republic of China.”<sup>47</sup>

Research activities also take place at local partner and supplier sites, for example: “In the early stages of the programme, our priority was developing and proving the many ground-breaking technologies that have gone into Goodrich products on the A380.”<sup>48</sup>

Domestic R&D in Toulouse includes teams of four centres of excellence, but they do not have a particular hierarchical function over the series of 16 centres across Europe. “Each CoE is responsible for specific parts of the aircraft and has its own chain of decision-making and command”<sup>49</sup> Only final assembly is centrally coordinated in Toulouse and Hamburg.<sup>50</sup>

Development of the A380 has not been coordinated by home country R&D divisions but by a cross-national team located across different Airbus sites: “These teams have responsibility for delivering aircraft components or systems, meeting quality and performance targets, on schedule and within budget. The Aircraft Component Management Teams are located in Toulouse (France), Getafe (Spain), Hamburg and Bremen (Germany) and Filton (UK), close to the Airbus design offices in these countries. They report to a central programme team headed by Charles Champion.”<sup>51</sup>

The Centres of excellence are linked to each other to form a range of competence centres that have their own responsibility for the part of the aircraft they are producing. The Programmes (e.g. the A380 programme) they participate in drive design and production activities across the individual units. There is frequent contact between units participating in the same development programme, for example: “the development programme brought together engineering teams from Airbus’ long-range and A380 programmes, pylon specialists from France, wing designers in the UK and Germany and the A380 Iron Bird systems test rig team.”<sup>52</sup> Lateral ties with other R&D can therefore be characterised as a network organisation: “The system reinforces trans-national ties - for example, around 160 design engineers in Wichita, USA, may be part of Airbus North America but they are also part of the wing Centre of Excellence working directly with Filton and Broughton in the UK.”<sup>53</sup> To facilitate frequent contact and information sharing between R&D units a common working platform has been created - Airbus Concurrent Engineering (ACE). This is being employed in the development of the A380 throughout the entire life-cycle of an aircraft. It can also be used to co-ordinate activities with Airbus suppliers and enables quicker response to late customer modifications<sup>54</sup>

There are strong ties between the centres of excellence and other functional areas: “CoEs maintain close links with core functions such as procurement, human resources, engineering, quality and customer services to develop and manage skills, manage policies and ensure that Airbus employees share knowledge and ideas with colleagues in other CoEs”<sup>55</sup> CoEs also work closely with the assembly line in Toulouse to ensure customer needs are met.

Programmes bring together employees from different R&D and production units and other functional areas; integrating engineering, industrial, financial and marketing activities. “Drawing on the lessons learned from previous aircraft development programmes, Airbus has created a new A380 team structure involving true transnational and cross-functional working,

with co-located teams in Hamburg, Filton, Toulouse, Getafe and Bremen.”<sup>56</sup> This new way of working has been considered a key element in the successful design of the new aircraft.<sup>57</sup>

The Airbus centres of excellence function as local R&D and production units, which are interconnected to each other through programmes that are coordinated by a trans-national team. This forms a “network of multifunctional teams, which include all the skills such as engineering, manufacturing and procurement that are necessary to deliver complete aircraft section”<sup>42</sup>

“Airbus structured itself around three main elements: Activities in Programmes are based on the overall view of aircraft production: setting the pace of deliveries and taking the lead role in both development and series production. This includes managing the final assembly lines and the centre of excellence for cabin and cargo customisation. Within Operations, seven further centres of excellence are responsible for the on time, on cost and on quality delivery of fully equipped and tested aircraft sections to the final assembly lines: forward and aft fuselage; nose and centre fuselage; wing; pylon and nacelle; horizontal tailplane and A380 section 19/19.1 and belly fairing; vertical tailplane; and electrics. Each has its own responsibilities to maximise production flexibility, with overall co-ordination through a central team, which is responsible for their performance and improvement. All of these teams receive operational support from the Core Functions of engineering, procurement, quality, human resources, customer affairs, customer services, information systems, legal, government relations and communications, and finance and controlling. The Core Functions manage Airbus policies and guidelines as well as developing and managing skills, competencies and best practice in their specific disciplines. Close links between Programmes, Operations and the Core Functions ensure that Airbus employees maintain and develop their technical and professional skills and continue to share knowledge, ideas and experience right across the company.”<sup>58</sup>

## **Linkages between MNE R&D and the region**

By describing the type of interactions between Airbus and regional actors, this last section will give an overview of how Airbus investments in R&D contribute to regional innovation and growth.

Airbus engages in much contact with suppliers when developing a new aircraft, including risk-sharing and co-development of new technologies. “The A380 gave Airbus the opportunity to develop a new way of working with its existing and new suppliers and industrial partners by allowing them to be much more closely involved in the development and long-term future of the programme”<sup>59</sup> Approximately 120 suppliers and industrial partners within Europe, the USA, Japan and China have been contracted for developing the A380. Examples of such collaborations include cooperation between Hamburg’s A380 fuselage structural assembly team and JAFO Technologie<sup>60</sup>; integrated design teams between Airbus and Rolls-Royce<sup>61</sup>, as well as SAAB of Sweden and Finavitec of Finland<sup>62</sup>; and a partnership between the engineering design teams from supplier EADS Military Aircraft and Airbus’ plant in Filton.<sup>63</sup> Linkages are facilitated through a software tool that streamlines communication and collaboration, enabling suppliers to manage their performance, exchange information on products and better anticipate opportunities. “The Airbus Supply portal is designed to increase the scope and efficiency of Airbus’ collaboration with its suppliers”<sup>64</sup>

Besides suppliers the company also has contacts with customers “to anticipate future demands and creates innovative products”<sup>65</sup> These interactions range from working with a group of representatives from key potential customers in the pre-development phase<sup>66</sup> to customizing final products to consumer needs. A software tool called Airbus customisable



cabin/cargo configurator (A3C) has also been implemented to manage communication flows. “Customers are able to work alongside Airbus to define the best possible cabin layout for their aircraft. A3C also enables engineers to address certification issues and assess technical feasibility at the earliest possible stage”<sup>67</sup> Another way to interact with customers is through the Airbus mock-up centres in Toulouse and Hamburg that both show “customers what is possible with the most modern and advanced aircraft in the world”<sup>68</sup>. While the Felix Kracht mock-up centre in Toulouse acts mostly as a sales and marketing showcase to 1800 customers a year, “the A380 design mock-up centre in Hamburg (...) is a proving ground for engineers and developers to test different concepts for the A380, with suppliers transforming designs into mock-ups at the centre”<sup>51</sup>

But it’s not only customers and suppliers that are involved in the development. “Airbus listens to aviation authorities, to pilots, to environmental experts, to the communities around its sites and to suppliers and industrial partners.”<sup>49</sup> The third parties affected by Airbus innovations are closely involved in the development process, to provide information concerning issues like safety, airport and government regulations<sup>69</sup> “Airbus designed the A380 in collaboration with some 60 major airports, ensuring airport compatibility and a smooth entry into service”<sup>70</sup>

There are numerous examples of linkages between Airbus, universities and research institutes. Cooperation with universities include exchange programmes for South African students resulting from the partnership with South Africa's Department of Science & Technology<sup>71</sup>; student placements from universities affiliated with the Partnership of a European Group of Aeronautics and Space Universities (PEGASUS)<sup>72</sup>; and joint projects between Airbus and students, researchers and engineers from the four high-tech engineering schools in Nantes. Together with these schools, Airbus established the TECHNO’CAMPUS. “The location was selected, because of the high scientific level of public research close to two Airbus production plants. TECHNO’CAMPUS is actively supported by the French state, the region of “Pays de la Loire and the city of Nantes”<sup>73</sup>

Airbus also cooperates with the German Aerospace Center (DLR), thereby becoming part of the European Research Area, ONERA. “Airbus is looking to increase its access to groundbreaking technologies and to optimise its use of research resources. The new relationship with DLR and ONERA is important to Airbus as these organisations possess proven scientific and technological capacities.”<sup>74</sup> Other collaborations with research institutes include joint aeronautics research and technology projects with Polish applied research group Technology Partners<sup>75</sup>; a Research and Technology Framework Agreement with the Cooperative Research Centre for Advanced Composite Structures Limited (CRC-ACS) in Melbourne<sup>76</sup>; and a cooperative study with Japan's R&D Institute of Metal and Composites for Future Industries (RIMCOF). “Our joint efforts between Japan and Europe with cutting-edge technologies from both sides would greatly contribute to the advancement of future commercial aircraft technologies.”<sup>77</sup>

Airbus is linked to the region through its employees, encouraging them “to develop their individual talents and experience and to be proud of their roots.”<sup>78</sup> The company stimulates diversity and believes the mix of expertise, experience, and culture is invaluable in the innovation process. Knowledge is transferred to employees through training. For example, a new training centre has been set up to train technical staff from the Hamburg plant. “The A318, A319 and A321 assembly line in Hamburg is in close proximity to the new training centre, which will give trainees a practical insight, and contribute to the overall quality of the courses.”<sup>79</sup> For employees (as well as customers) Airbus also has three major training centres in Toulouse, Miami and Beijing. “A more extensive network of training centres exists through



Airbus' co-operation with training specialist CAE, making Airbus-standard courses available even more widely around the world"<sup>80</sup>

There are several linkages with the EU and cooperative projects that stimulate innovation on a European level. Airbus has instigated the PAMELA (Process for Advanced Management of End of Life of Aircraft) project to research aircraft recycling. "With partners, SITA, EADS CCR, Sogerma Services and the Préfecture des Hautes-Pyrénées, Airbus will now set up a special centre at Tarbes Airport (South West of France) where procedures for decommissioning and recycling aircraft in safe and environmentally responsible conditions will be trialed out". The European Commission has selected this Airbus project to be part of the LIFE programme (l'Instrument Financier de l'Environnement) "which means that Airbus will disseminate the environmental knowledge and practices it has gained to other industrial sectors, allowing them to benefit from its valuable experience in implementing this innovative EMS"<sup>81</sup> In addition, Airbus is collaborating with seven major European aerospace manufacturers (Airbus SAS, Dassault Aviation, Eurocopter SAS, Liebherr-Aerospace Lindenberg GmbH, Rolls-Royce plc, Safran and Thales) in the Clean Sky Joint Technology Initiative (JTI) - "the largest research project ever set up jointly with the European Commission"<sup>82</sup> The initiative will investigate the possibilities of reducing environmental impacts of aircraft components and operations. "This research project will be a flagship for Europe, enabling the industry to network with universities, research centres, SMEs, which work together to minimise environmental impact in the future."<sup>66</sup>

Finally, the technology programme Aircraft Wing with Advanced Technology Operation (AWIATOR) involves collaboration between Airbus engineering firms in France, Germany and the United Kingdom, European aeronautical research institutes, and more than twenty industrial partners in Europe and Israel. Airbus is contributing 60 per cent of the 80 million Euro budget and will contribute to programme management in jointly developing and validating the sophisticated technologies under investigation. "Airbus is committed to maintaining its leadership in technology and to do so, we continue to invest in research that is of direct benefit to our core business, said Airbus Chief Operating Officer Gustav Humbert. We rely on an international research network of partners from centres of excellence all over Europe and around the world."<sup>83</sup>

With revenues of EUR87Bn, operations in 190 countries, and 80% and 60% of sales from outside of Germany, Siemens is not only a leading European company it is also one of the largest multinationals worldwide. Siemens does R&D in low-costs medical devices in China, and in increasing number of product lines such as transportation will be designed and developed in countries such as China and India in the future.

Figure 17. The global network of Siemens R&D centres



Headquartered in Berlin and Munich, Siemens enjoys a strong technological position as one of the world's largest electrical engineering and electronics companies.<sup>84</sup> "Innovation has always been one of the most important elements in Siemens' business strategy,"<sup>85</sup> and development is geared to establish a new technology, de-facto standard or indispensable feature on the market. Siemens has the goal to become a trendsetter rather than a "first mover" or "fast follower". Aligning this innovation strategy with its business strategy "involves achieving technological leadership, global presence and a comprehensive portfolio of patents that will enable the company to help define the major trends regarding products, systems and services, and to offer its customers important added value."<sup>86</sup>

Siemens spends EUR 5.1 Bn on R&D every year.<sup>87</sup> In 2005, R&D expenditures amounted to EUR 5.2 Bn, or 6.8 percent of the company's turnover<sup>88</sup> - "more than the amount spent annually on research by the European Union."<sup>89</sup> Siemens R&D expenditures ranked 7<sup>th</sup> in a study of the 1,000 companies with the highest R&D expenditures, carried out by business consultants Booz Allen Hamilton (BAH) in 2005.<sup>6</sup> Within its own industry - global electrical engineering and electronics - Siemens has the highest R&D expenditures.

The percentage of people employed in Research and Development reflects the percentage of expenditures mentioned in the previous paragraph. "Siemens now employs more than 47,000

researchers and developers worldwide. This figure represents more than 10% of all the company's employees."<sup>90</sup> R&D takes place at a 150 sites, located in 38 countries<sup>91</sup>.

"Corporate Technology has a leading role to play within Siemens' R&D operations. It acts as an international network of competencies and a worldwide partner for innovations for the Siemens Groups and Regional Companies."<sup>92</sup> Corporate Research takes place at sites in Germany (Munich, Erlangen, Berlin), the USA (Princeton, Berkeley), Great Britain (Hampshire), China (Beijing, Shanghai), India (Bangalore), and Russia (Moscow, St. Petersburg)<sup>93</sup>; and employs a total of 2400 employees.<sup>94</sup> Besides carrying out long term Corporate Technology also has a coordinative role to exploit the synergy potential between R&D activities.<sup>95</sup> This also includes patent management throughout the entire company. To this end it employs "its Corporate Intellectual Property and Functions Division to perform key tasks such as ensuring that the company's R&D successes are safeguarded from competitors."<sup>96</sup> Located in 18 locations worldwide, this division manages Siemens patent portfolio at a strategic level.<sup>12</sup>

To remain competitive, Siemens places a lot of emphasis on patent generation. Following the Patent Initiative launched in 1995 the company initially focused on increasing the number of patent registrations for new inventions, whereas now it focuses on the value of patents - judged by the value placed upon it in cross-licensing agreements, among other things<sup>97</sup> "Siemens currently possesses some 40,000 patents and patent groups - and the portfolio is renewed every five to six years. That translates into approximately 7,000 new inventions registered each year."<sup>14</sup>

The selected location of Munich is the home to Siemens' headquarters. "Nearly half of all Siemens Divisions, many Group headquarters and a large number of R&D activities are located in the city. About 35,000 employees work at over 30 Munich facilities."<sup>98</sup> The other selected location of Siemens Prague focuses on the business areas of Automation and Control, Information and Communications, Power, Medical, and Transportation. "Siemens currently has more than 15,000 employees in the Czech Republic, making it the largest electrical engineering company and one of the most important employers in the country."<sup>99</sup>

## Locational Determinants

"The year 2004 saw a further expansion in Corporate Technology's international presence, with new sites being established in India and Russia. Corporate Technology's objective is to enlarge its existing network of research institutes, get closer to the customer through local R&D know-how, provide better on-site support for the Business Units, expand cooperation with universities and research facilities, and seek out high achievers to join Siemens' ranks"<sup>100</sup>

The market or demand-side factor that motivated Siemens to internationalise certain R&D activities is to be close to its main customer markets. "The reasons for this are simple. A company must have active research and development teams in the biggest growth markets and the countries where innovation is most dynamic, so that it can quickly respond to regional requirements by coming up with new solutions."<sup>101</sup> Specifically the R&D Divisions within Siemens' regional organizations in China, India, Japan, and Russia provide local product development support to the Business Units, and track technology developments within their respective markets<sup>102</sup>.

Although these R&D activities are located in growing markets to meet customer requirements, other factors generally play a large role in the location of R&D activities as well: "Siemens focuses on its core expertise and builds up additional capacities in places where we can establish the necessary proximity to customers, find qualified employees and operate at competitive costs."<sup>103</sup>

“China and Eastern Europe are not just important markets. They are also an excellent source of qualified employees. The human factor is and remains critical for companies, and excellent, highly motivated employees are the key to success.”<sup>104</sup> Diversity is considered a very valuable asset in this respect: “Siemens President and CEO Dr. Heinrich v. Pierer pointed out the importance of today's team spirit and cultural cooperation when he said, ‘Siemens has millions of customers and over 400,000 employees from all over the world. This is why we promote diversity on all levels.’”<sup>105</sup>

Siemens locates R&D activities where there is presence of skilled labour. “A key role in this regard is played by Siemens’ close contacts with top universities all over the world, which include the approximately 1,000 cooperative research projects Siemens launches every year with universities and research institutes”<sup>106</sup> This provides Siemens with insights into academic research, but most importantly allows them to establish contact with researchers “who are potential future employees”.<sup>26</sup> “Siemens is always on the lookout for highly qualified young people. It currently employs more than 103,000 college graduates with degrees in the natural sciences, IT or engineering - and each year more than 10,000 fresh college graduates are hired.”<sup>26</sup> The ability to safeguard and attract a skilled workforce is considered to be a key success factor for Siemens divisions, and thus for its location. For example, the percentage of highly qualified employees at the Siemens plant in Berlin “has reached 80 percent of the plant’s 1,000 person workforce; ten years ago, that figure was around 65 percent. This too is helping to safeguard the future of Germany as an innovative business location.”<sup>26</sup>

China is however one of the most important locations where Siemens has situated itself to be able to recruit skilled employees: “Compared to Germany, China today already has twice the number of people working in research – some 900,000 – and produces ten times the number of university graduates in core engineering disciplines. Industry forecasts are unanimous in predicting that China, by 2010, will be the foremost manufacturer of electronic components among the world’s newly industrialized countries, and will likely have a share of around 14 percent in the world market – greater, even, than Western Europe. This not only explains why many new rivals are emerging in China, it also underscores that any company wishing to compete effectively in the international marketplace has to operate in China”<sup>107</sup>

Locations of certain R&D units are chosen to be able to learn from target competitors or industrial partners. To do so, Siemens primarily uses venture capital to invest in start-up companies “These start-up companies also give rise to valuable cooperative projects in high-tech areas, and these in turn generate innovations in Siemens Groups”<sup>108</sup> Furthermore Siemens recognizes the increasing importance of monitoring competitors in managing its patent portfolio. “We not only have to be active in all markets, but we also have to protect them. Competitors are analyzed and gaps in the patent portfolio are closed.”<sup>109</sup> However, no specific mention is made of this being an important factor in choosing its R&D locations.

The final motivating factor that is mentioned are political factors. To be able to stay globally competitive Siemens believes that local presence of R&D can be a prerequisite because “many countries give priority to domestic bidders or companies that will execute the contract in-country.”<sup>110</sup> Another related reason is the objective to be perceived as a global citizen: “If you just sell your products in a country, then you are a guest; if you produce them locally, then you are welcomed as a friend. But you are regarded as a citizen only if you carry out your R&D there too.”<sup>111</sup>

## Organizational Structure

Siemens is comprised of six business areas, namely Information and Communications, Automation and Control, Power, Medical, Transportation, and Lighting “Operating in these

areas, we have a number of different Groups, each one an entrepreneurial unit responsible at the global level for its own development, manufacturing and sales activities”<sup>112</sup> Local R&D takes place in the technology divisions of the regional companies, of which there were 64 operating as “entrepreneurs at the national level” in 2002.<sup>32</sup> “These organizations provide local product development support to the Business Units, maintain contacts with universities, and track technology developments within these markets.”<sup>113</sup> Strong research activity takes place at these R&D units, considering approximately 95% of Siemens' R&D budget goes to the Siemens Groups and Regions for product, system and production development.<sup>114</sup>

Corporate Research takes place at Siemens' Corporate Technology Department, primarily located in Munich, Erlangen, and Berlin.<sup>115</sup> Within Corporate Technology, R&D activities are organized in five Technology Divisions that are focused on more than forty core technologies. Through these R&D activities, Corporate Technology makes its own contribution to Siemens' innovations.<sup>116</sup> “Experts in each core technology area are gathered in their respective centers of competence, which function as internal technology companies and offer their services to the company's Business Units.”<sup>117</sup>

On an international level, Corporate Technology coordinates the R&D activities that take place in Siemens' regional organizations in Germany, USA, Great Britain, China, India, Japan, and Russia; acting as “an international network of competencies and a worldwide partner for innovations for the Siemens Groups and Regional Companies.”<sup>38</sup> Corporate Technology in charge of centralized units as well, such as the as Information Research Center and its virtual library, “which ensure that vital knowledge doesn't get lost and that it remains available to the greatest number of people at the same time”<sup>118</sup>; as well as the Corporate Intellectual Property and Functions Division, which performs key tasks like patent protection and support in regulation across the company<sup>119</sup>

There is strong emphasis on creating synergy between the local R&D units that are part of Siemens' Regional Organization to cut development costs and to reduce problems on the customers' end.<sup>120</sup> This means that the local teams of the Groups are pulled together. “Increasingly, we must present ourselves as ONE company instead of each Group acting as an individual competitor.”<sup>121</sup> There is therefore frequent contact between local R&D units, as well as between Corporate Technology divisions and the Siemens Groups.

Tools to promote contact between R&D units include “benchmarking and best practice sharing, active patent management throughout the entire company, and the joint development of multiple-impact technologies or platform strategies.”<sup>122</sup> Furthermore, Groups also promote idea workshops for experts across the company, and innovation managers from all of the Siemens Groups exchange experiences in the Community of Practice Innovation Management<sup>123</sup>. On a company wide level Siemens has also created the Innovation working group, where Chief Technology Officers, R&D heads from the Groups, and representatives from the regions discuss current innovation issues<sup>44</sup>, as well as the top+ Innovation program which focuses on further increasing the efficiency and effectiveness of R&D activities.<sup>124</sup> The latter program is mandatory for all groups, and has been implemented to create synergy and to promote frequent contact, development of cross-product technology platforms, and best-practice sharing between R&D units.<sup>125</sup> Finally, any Group can include all the patents from other Groups in any cross-licensing agreement with external partners, “which once again shows how synergy effects are being exploited at Siemens”<sup>126</sup>

Within the different Groups, local R&D units support regional organizations that are responsible for their own development, manufacturing and sales activities. It is apparent that there must therefore be frequent contact with local functional areas, however contact

between R&D and other functional areas is promoted throughout the entire firm: “trendsetters must closely align their R&D activities with their business strategy”<sup>127</sup>

At a corporate level, all corporate technology units are supported by the Strategic Marketing and Strategic Planning Divisions “which systematically investigate and evaluate commercial and technological trends, in order to ensure that Corporate Technology is tuned in to the most important technologies worldwide at the earliest possible stage”<sup>128</sup> Also “part of Corporate Technology are the Corporate Functions Standardization and Regulation; Information Research Center; and Environmental Affairs & Technical Safety”

## **Linkages between MNE R&D and the region**

By describing the type of interactions between Siemens and regional actors, this last section will give an overview of how Siemens investments in R&D contribute to regional innovation and growth. Siemens is dedicated to contributing to society through their technologies and innovation, as well as “delivering benefits through education, training, knowledge transfer, and partnerships with schools and universities in many of the world’s countries; and benefits through citizenship activities in the social and cultural spheres.”<sup>129</sup> On the other hand, Siemens has a lot to benefit itself from contacts with local firms and other organizations: “when it comes to developing innovations, we can rely on a global knowledge network, hundreds of cooperative projects with universities, our own R&D laboratories all around the world, multicultural innovation teams, and the extensive involvement of various departments, customers and suppliers”<sup>130</sup>

Within R&D, Siemens collaborates with local firms to be able to manage the range and complexity of new technologies, to maintain its global presence<sup>131</sup>, and most importantly to gain knowledge to develop new innovations. “We will need to identify best practices in a more targeted way and use the information we gain as a systematic aid. Here, the most important thing is timely inclusion of our local companies in innovation activities.”<sup>132</sup>

There is extensive involvement with local companies, ranging from start-ups to customers and suppliers.<sup>133</sup> Besides maintaining contacts through customer service “to develop products that meet constantly changing customer requirement”<sup>134</sup>, there are “thousands of account managers” that act as an interface between Siemens’ developers and customers. Products are optimized to these needs by engineers, IT specialists, designers, and psychologists in usability labs in Munich, Princeton and Beijing.<sup>57</sup> Siemens also involves customers directly into the development process. “One prominent case in point is our collaboration with the U.S. Postal Service (USPS) on the development of the Postal Automated Redirection System (PARS)”;<sup>135</sup> another example is the collaboration with Daimler Chrysler to develop cordless phones for technical support at their Sindelfingen plant in Germany.<sup>135</sup> In addition to co-development with customers, “Siemens Corporate Technology also participated in over 100 cooperation projects with more than 300 European companies and institutions, primarily in the fields of information and communication technologies, materials, production and manufacturing technologies, and energy and transport technologies.”<sup>136</sup>

To be able to respond to regional requirements, Siemens’ support of start-up companies should not be underestimated. “To date, Siemens Venture Capital has invested around 700 million euros in more than 100 companies and 30 venture capital funds, primarily in the U.S., Europe and Israel, but also increasingly in China and India. These start-up companies also give rise to valuable cooperative projects in high-tech areas, and these in turn generate innovations in Siemens Groups”<sup>137</sup> Besides providing capital, Siemens also provides complementary technologies, knowledge to bring innovations to market, and builds



prototypes of product innovations. It does this through divisions like the Siemens technology accelerator in Germany and the Siemens Technology-To-Business Center in US.<sup>138</sup>

In addition to exchanging technical knowledge, Siemens also wants “to highlight the influence of high technology on culture and its significance as a force for innovation in art.” It does this by advancing projects and artists through the Siemens Arts Program, with the aim of building “bridges between culture, industry, and society to encourage the transfer of ideas.”<sup>139</sup>

“In 2005, Siemens launched over 1,000 collaborative projects with universities and research establishments worldwide. In general, both parties profit from such relationships. Siemens employs a variety of models, from supporting students, all the way up to strategic alliances to expand its global cooperation network.”<sup>140</sup> For example, the Technology Divisions of Corporate Technology in Germany are closely linked to two independent research institutions: Siemens Corporate Research in Princeton, New Jersey, U.S.A., and Roke Manor Research in Hampshire, England.<sup>141</sup> However, “the most common form of cooperation is that of a bilateral relationship between Siemens and individual university scientists.”<sup>63</sup> Other forms of collaboration include technology transfer, part-time lectureships, the Siemens Ambassador University Program and the Center for Knowledge Interchange (CKI) model.

“A total of 33 universities and three institutes of technology are part of the Ambassador Program. Each is assigned its very own “ambassador” from senior company management. It is their responsibility to initiate and promote as many strategic forms of cooperation as possible.”<sup>142</sup> The closest relationship with a University is created through a Center of Knowledge Interchange: “The CKIs are especially important, since they provide us with direct access to innovation (...) Each CKI has its own administrative office that acts as an interface between the industrial and the academic worlds. It’s here that representatives from the Siemens Groups regularly meet with people from universities.”<sup>63</sup> “In addition, almost 250 theses and doctorates were conducted at Corporate Technology. These also represent a valuable source of top-class new recruits for positions in engineering and science.”<sup>143</sup>

For Siemens these collaborations are beneficial as it provides “insight into all the latest results from the worlds of pure and applied research as well as establishing contacts to the researchers concerned, who are potential future employees. At the same time, it means the company can dovetail its own R&D activities with those of university departments working in areas in which Siemens lacks expertise.”<sup>65</sup> For Universities benefits include the “opportunity to explore unconventional avenues of research”; “support for students who are writing dissertations and doctoral theses”; “technical know-how required to advance pure research projects at a university”; and “personal discussions with professors and students, the awarding of research contracts, and the funding of part-time lectureships”<sup>65</sup>. “Such lectureships represent a sensible addition to their teaching profile on the applied side, whereas they give [Siemens] the opportunity to train students as potential employees by providing them with specific practical content.”<sup>65</sup> Another example of how Siemens greatly benefits from global networking activities with universities is the best practice database, which stores cases from internal and external sources.<sup>144</sup>

“At present, research cooperation at Siemens has a distinctly German flavor. In view of this, Prof. Klaus Wucherer, a member of the Corporate Executive Committee of Siemens AG, plans to increase the number of international contacts. ‘We still need much more cooperation with outstanding universities around the globe,’ he said at a university conference in July, 2006. At the same time, he also emphasized that this did not mean that the company would be reducing its commitment in Germany.”<sup>65</sup> In expanding its university network, Siemens aims to increase the number of CKIs from 4 to 12, especially focusing on China, India and the U.S.<sup>64</sup>.

“Siemens has almost 50,000 people working in R&D in 30 different countries. This is how we bring our technology know-how to other countries and build local competency.”<sup>145</sup> Siemens transfers knowledge and skills to employees through education programs, making “every effort to attract qualified and motivated people to work for us, and to retain and support them”<sup>66</sup> “For employees today, lifelong learning is an everyday part of their professional life. Today’s rapidly changing work environment is a constant call to extend their knowledge and skills. Siemens feels it is responsible for creating the requisite opportunities for employees to build new competencies.”<sup>66</sup>

This sense of responsibility is not just limited to Siemens’ own employees: “Given that the development of knowledge and skills has to begin before people join our company, we maintain close ties with schools, colleges and universities and with their governing bodies.”<sup>66</sup> Ties to universities were already described in the previous section, and provide “an important recruiting ground for new employees. Of the 461,000 people Siemens employs full-time worldwide, 34 percent have an academic qualification (26 percent in engineering, natural sciences or IT)”<sup>146</sup> However, Siemens’ also provides its own vocational training programs, which plays an important role in securing a well-qualified workforce in the regions it operates in. In Germany they are “the number one provider of vocational programs, with 8,600 youngsters currently training at around 60 Siemens locations”<sup>147</sup> “The company has continued to overfulfill its obligations in the vocational training sector in Germany by putting more people through programs than it actually needs for its own workforce”<sup>68</sup> What’s more, Siemens also partners with schools to “encourage a mutual transfer of knowledge and information to promote the development of high educational standards”, shaping curricula to advance education in maths sciences and technology, and supporting a wide range of projects that encourage interest in new technology among youngsters.<sup>68</sup>

Siemens maintains dialogue with interest groups about the influence the company and its innovations have on the development of the economy and on people’s quality of life. “Siemens takes a proactive approach to communication on these and other issues – in part through the Siemens Forums in Berlin, Erlangen, Munich, Vienna and Zurich.”<sup>68</sup> Other examples include regular lectures for political leaders, employees of NGOs and university students in the Netherlands, an annual competition for science journalists in South Africa, and membership of the Club de Excelencia en Sostenibilidad, a business organization that seeks to promote excellence in sustainability, to provide a forum for dialogue with stakeholders, and to create a benchmarking platform. <sup>68</sup> “At the European level, the European Commission is extremely active in promoting a climate of open dialogue that brings together companies, management and labor, environmental and consumer organizations, environmental and socially aware investor groups, and other nongovernmental organizations (NGOs). We take part in this dialogue and seek to promote a grounded and realistic discussion by presenting concrete examples drawn from within the company.”<sup>68</sup>



# Philips

More than 122,000 employees in 60 countries, and design still primarily done in the Netherlands while low-value manufacturing has been outsourced to Asia. However, 25% of the R&D budgets are spend outside of Europe and an increasing part of R&D also goes to China where Philips now has 15 research centres.

Headquartered in the Netherlands, Philips is a global leader in the interlocking domains of healthcare, lifestyle and technology<sup>148</sup>. Technology is the driving force of Philips' Healthcare and Lifestyle products, and it is "the continuing Philips tradition of innovation" that allows Philips to provide solutions that realize the full potential of fast-evolving digital technologies.<sup>149</sup> In 2005, R&D expenditures amounted to 2,534 million euro<sup>150</sup>, but it is Philips' 80,000 registered patents that truly "illustrate the innovative nature of the company"<sup>151</sup> Another source refers to more than 130,000 patent (total R&D) and design rights<sup>152</sup>, while yet another refers to more than 115,000 patent rights.<sup>153</sup>

Figure 18. The global network of Philips R&D centres



Philips' activities are organized in five product divisions - Semiconductors; Lighting; Consumer Electronics; Medical Systems; Domestic Appliances and Personal Care; and Other Activities<sup>154</sup> – "each of which is responsible for the management of its businesses worldwide".<sup>155</sup> "At the end of December 2005, the total number of employees of the Philips Group was 159,226", of which 13% was employed in R&D<sup>7</sup> Of this number, approximately 16,000 employees were active in R&D activities in the product divisions; "predominantly engaged in product development and development of production methods."<sup>7</sup>

The remainder of employees is active in Corporate Technologies.<sup>7</sup> Reporting directly to Philips' Board of Management, this is the corporate body that "controls and coordinates" the international research activities of Philips.<sup>156</sup> "With approximately 4800 highly skilled employees at some 20 locations worldwide, Corporate Technologies comprises organizations dedicated to research, intellectual property and standards, system integration services, emerging activities, and technology, competence and innovation management."<sup>157</sup>

With an annual research budget of EUR 30.4 billion in 2005 ("slightly less than 1% of Philips' annual sales"<sup>158</sup>), Philips Research is the organization responsible for creating innovations for the product divisions: "With laboratories in three regions (Europe, East Asia, North America) and staffed by around 1,800 people, Philips Research creates innovations in the areas of Healthcare, Lifestyle and Technology."<sup>159</sup> "Philips Research Europe has its main laboratory on the High Tech Campus in Eindhoven (Netherlands) and in Aachen (Germany). Sectors in Hamburg (Germany), Redhill (UK) and a department in Bangalore (India) are closely aligned with co-located units of Philips Medical Systems, Philips Applied Technologies and the Philips Innovation Campus, respectively."<sup>160</sup> Philips Research East Asia is located in Shanghai<sup>161</sup>, and Philips Research North America is located in Briarcliff Manor, NY.<sup>162</sup>

Design activities take place at a separate organization, that has activities spread in 12 locations around the world and employs 450 people.<sup>163</sup> "Originating as a Corporate Design Department within Philips Electronics, we have naturally evolved into a dynamic design studio. As part of Philips we also have a strong link with the Philips Group and its technological knowledge but also offer design services - especially in the strategic area - to other clients."<sup>164</sup>

## Locational Determinants

The market or demand-side factors that have induced Philips to internationalise certain R&D activities include the need to support local business units as well as the need to understand the demands of the customers they serve.<sup>165</sup> This is actually the starting point for innovation, as Philips is "convinced that the combination of innovation and market focus is the key to profitable growth."<sup>166</sup>

Philips Research units have been internationalised to support local Philips organizations in selected geographies, such as Asia Pacific, where there are "high growth opportunities." For example "Philips Research East Asia was established in 2000 in Shanghai, serving Philips' rapidly growing business in the East Asia region."<sup>167</sup> Proximity to customers is also an important factor in investing in innovation in this region, because Philips does not just want to serve the Chinese market itself, it also wants to "want to make China a global competence center for economy- to mid-range medical systems, using China as an export base to other developing and emerging markets in Asia and beyond."<sup>168</sup> Furthermore, "Philips Research continuously strives for its mission by leveraging capabilities and international presence to influence regional standards and markets"<sup>169</sup>

On the other hand, Philips Design units act as the "bridge between technology and people"<sup>170</sup> to ensure that innovations are adapted according to customer needs: "We constantly stress the need for relevance, context and genuine appeal, based on expressed user preferences."<sup>171</sup> "Technology alone cannot successfully deliver solutions that take into account all the complexity that the new relationship between people and objects will entail: cultural, personal, ethical diversity and so forth."<sup>172</sup> At a corporate level, Philips Design focuses research on understanding the needs of its main customers groups in the U.S., Europe and China, to "help Philips to create meaningful innovations"<sup>172</sup> Design facilities have therefore

been internationalised to gain “insight into emerging local trends and developments, some of which can have significant consequences far beyond their region”<sup>173</sup>

While demand-side factors were portrayed as people-focused in terms of customers, Philips is also people-focused on the supply side; “that’s why we employ so many experts in human sciences. That’s why we carry out design research projects, often in conjunction with external institutes and partners.”<sup>174</sup> This refers to the second type of motivating forces, which are technology or supply-side factors that have induced Philips to internationalise certain R&D activities. They include the presence of skilled labour, universities and sophisticated suppliers, as well as the proximity of centers of innovation. The decision to locate R&D facilities in China has been influenced by all these determinants.

Besides becoming a vital supplier base, “China has an enormous and low-cost labor pool, excellent higher education, rapidly expanding R&D and an impressive inflow of foreign investment.”<sup>175</sup> Philips has 15 R&D centers in China, and employs 900 people. “In the spirit of Open Innovation, we cooperate closely with Chinese universities, research centers and companies”<sup>28</sup>, because to Philips “China is not just a workshop, or a marketplace – it’s also a center of innovation for new products and services with global application.”<sup>28</sup>

“Competition forces us to invest where the conditions are the most favorable.”<sup>176</sup> However, rather than relocating all R&D activities to China because of skilled labour at low costs, Philips still spends 75% of its R&D budget in Western Europe.<sup>28</sup> Nonetheless, “the lack of progress on business location factors is particularly worrying”<sup>29</sup>, which is why Philips is committed to increase the competitiveness of Europe as an R&D location. With this in mind, they initiated the High Tech Campus, where they share their “facilities with scores of other companies, from established names such as IBM, SUN Microelectronics, Atos Origin and ASML to promising start-ups”<sup>28</sup> In doing so, they created a prime example of how “Open Innovation” clustering in Europe can contribute to create the right investment climate in the Netherlands: “Dutch companies will be more inclined to maintain activities here, while foreign firms will be glad to come here too.”<sup>29</sup> “There are currently some 4,000 people working at the Campus – but this number is expected to rise to 7,000 or 8,000 by 2008 (...) It is the heart of the Eindhoven region where 40% of all R&D activities in the Netherlands takes place (...) Here, experienced researchers suddenly feel rejuvenated, revitalized by so much innovative energy. This is the very kind of élan that Europe needs.”<sup>28</sup>

Proximity to centers of innovation and universities is also a determinant for locating facilities in other regions across Europe: “Cambridge offers a good example of a cluster of excellence with a tremendous capacity to create value. On the European continent, one example among many others of an ever more successful cluster is the cross-border triangle formed by Leuven in Belgium, Eindhoven in The Netherlands and Aachen in Germany.”<sup>28</sup> Besides Research facilities in Eindhoven and Aachen, Philips has also located a facility in the IMEC (Inter-University Micro Electronics Center) in Leuven.

Besides proximity to universities, the availability of sophisticated suppliers is another determinant of where R&D facilities are located, because there is “an emerging shift from competing industries to competing networks. Best-in-class companies are those who successfully integrate their suppliers in both innovation and business fulfilment”<sup>177</sup> While in mature markets Philips is consolidating sourcing, their focus on “local for local solutions” in emerging markets means they are focused on developing their supply base in Eastern Europe and countries such as India, China, Brazil and Mexico.<sup>178</sup>

This locational determinant refers to the need to learn from technological developments and strategies of competitors, and the possibility of strategic alliances. “Strategic alliances are an important part of business at Philips. They enable us to bring new products to the market

that we would not have been able to develop on our own. Philips combines with a number of leading global companies to build advanced products and services”<sup>179</sup>

For example, Philips approached Rivers Run Red - the leading development agency for Second Life in Europe – because of their “considerable experience and expertise in designing and implementing within this emerging medium”<sup>180</sup>; and they are able to build a strong position in healthcare IT through the partnership with Epic Systems, “which has afforded Philips a prominent position in PACS.”<sup>181</sup> In China, the “joint venture with local Chinese company Neusoft (...) is a cornerstone of this strategy.”<sup>182</sup> Together, they will develop and produce medical equipment for developing and emerging economies. Other joint ventures and participations include: LG Philips LCD (32.9%); LG Philips Displays (50.0%); Taiwan Semiconductor Manufacturing Co. Ltd. (16.4%); FEI Company (25.0%); InterTrust Technologies Corporation (49.5%); Philips Medical Capital (USA, Europe) (40.0%); TPV Technology Limited (15.0%)<sup>183</sup>

The final motivating factor for the location of certain R&D activities is historical development. Although Philips is a global firm, it remains strongly rooted in the Netherlands and in Europe in general. “Of course there is a special bond between companies with Dutch roots like Philips and Dutch society and the Dutch economy.”<sup>184</sup> However, the bond between Philips and the Netherlands is not only being developed by a continuation of the past, “we have and will retain a presence in the Netherlands with advanced industrial activities, such as our lighting factory in Roosendaal (...) that also brings with it high-value employment.”<sup>37</sup> Another example of “new economic activity in the Netherlands” is the previously mentioned High Tech Campus in Eindhoven.

## Organizational Structure

There are local R&D units in more than 25 countries, which are part of the operating divisions. They are “predominantly engaged in product development and development of production methods”<sup>185</sup>

In addition, Corporate R&D has been fragmented into several organizations, each of which also has dispersed units across the globe. For example, Philips Research has laboratories that are closely aligned with co-located operating divisions. “Roughly two-thirds of the corporate research work is geared to the activities of the Product Divisions of Philips, with contractual agreements about programs and costs. The remainder is research of a more exploratory nature.”<sup>186</sup>

“The international research activities of Royal Philips Electronics are controlled and coordinated from a corporate body, which is called Philips Corporate Research. This body, which reports directly to Philips’ Board of Management, is responsible for research that is organized in three regions: Europe, East Asia and North America.”<sup>187</sup> “Corporate Technologies supports Philips’ operating divisions in turning innovations into advanced products. It stimulates the exploitation of technology synergies across the operating divisions through its shared labs and competencies”<sup>41</sup>

Corporate Technology is comprised of organizations dedicated to research, intellectual property and standards, system integration services, emerging activities, and technology, competence and innovation management.<sup>188</sup> Each organization in turn has its own sites and employees across the globe that supports local R&D divisions and business units:

- “Philips Research supports Philips’ operating divisions with innovations, inventions and long-range vision, and employs some 2,100 technology experts around the globe.”
- “Intellectual property and standards is responsible for managing Philips’ intellectual property on a group-wide basis, employing around 400 people.”
- “Philips Applied Technologies helps its customers to transform initial ideas into competitive products and costefficient manufacturing solutions by integrating new and existing technologies. Some 1,200 highly skilled professionals work at eight sites across Europe, Asia and the USA. TASS (Technical Application Software Services) develops embedded software on demand with a workforce of some 250 people.”
- “In order to speed up the process of transforming R&D projects into new business opportunities for Philips, Corporate Technologies operates the Technology Incubator, in which dedicated investments in promising value propositions are made. Philips Software, which has been transferred to Philips Semiconductors as of January 1, 2006 develops and markets software solutions for mobile multimedia. Together, the Technology Incubator and Philips Software employ around 400 people.”
- “The Office of the Chief Technology Officer (CTO) supports technology management, competence management and innovation effectiveness across Philips. It provides assistance for cross-divisional programs such as digital rights and security management and automotive technology management, and strengthens R&D competencies by offering a company-wide R&D core curriculum. The CTO Office also promotes innovation effectiveness by facilitating a joint, market-driven approach by the functions involved, principally R&D, marketing and supply management.”<sup>189</sup>

There is a large degree of contact between R&D units from different operating divisions and corporate technology organizations as well as between R&D units that belong to the same group or organization.

Although historically Philips was a very fragmented organization with little cooperation between different units, “making “One Philips” the foundation of the way we work enables us to share solutions more effectively throughout the company, to reduce the number of suppliers, and to deploy shared service centers for support functions.”<sup>190</sup> These shared service centers include the corporate technology organizations mentioned in the previous section as well as Philips Design, among others. Examples of ties between different R&D units that are referred to are that “Semiconductors is working with Research on the bio-chip, and Lighting is providing clean air and drinking water with ultraviolet technology”, and “Medical Systems, Design and Lighting have worked together on the development of the Ambient Experience concept”<sup>191</sup>

As has been mentioned in the previous paragraphs, there are strong ties between R&D activities and the other functional areas at the Philips product divisions, as they have either been integrated or have been established with the goal of supporting other business functions. For example, Philips research generates innovative concepts in close cooperation with the Philips Product Divisions, “based on multi-disciplinary strength”<sup>192</sup>

## **Type of Organisational Structure**

At local R&D units there is strong research activity, and ties between R&D units and other functional areas are also strong. Although Corporate Technology does coordinate R&D activities, it has a supportive function rather than a hierarchical position over the R&D activities in the product divisions. Besides supporting the operating divisions, corporate

technology is also responsible for generating innovations and inventions, supporting Philips' businesses with long-range vision and feeding their innovation pipeline.<sup>193</sup>

## **Linkages between MNE R&D and the region**

In recent years, Philips has strengthened their knowledge-based activities with a strategy of open innovation, clusters of excellence and public-private partnerships in R&D.<sup>194</sup> “Open innovation means getting rid of the ‘Not Invented Here’ syndrome, embracing co-operation in research with other companies as well as universities.”<sup>197</sup> “Our philosophy of ‘open innovation’ also implies a commitment to alliances as a means of leveraging our innovative capabilities”<sup>195</sup>

However, Philips has always been closely linked to the regions they operate in. “At the height of its industrial production, Philips was Europe’s largest ‘native’ consumer electronics business. Factories and offices were completely integrated in many local communities, part of the fabric of society.”<sup>196</sup>

## **Contracts and informal ties with local firms**

On the one hand Philips acquires knowledge from “local organizations to identify the needs of our target market. On the other hand, Philips also transfers knowledge to their partners, as well as educating the local “market on the ways our solutions can help”<sup>197</sup> For example in China, they “cooperate closely with Chinese universities, research centers and companies, transferring knowledge to them.”<sup>198</sup> “What really sets us apart is our willingness and capacity to adapt, our eagerness to learn from our local partners and our emphasis on mutual respect as the basis for a long-term, win-win partnership.”<sup>199</sup>

For Philips the nature of knowledge acquisition ranges from one-time collaborations to joint ventures, strategic alliances and acquisitions. In the case of most of these collaborations, Philips is able to gain knowledge with regards to local markets or draw on unique expertise in a specific technological field, enabling them to bring new products to the market they would not have been able to develop on our own.”<sup>199</sup> In addition to linkages with strategic partners, Philips also builds “partnerships with key customers and suppliers, both in the business-to-business and business-to consumer areas”<sup>200</sup>

Suppliers are involved early on in the innovation process, with the goal of building long-term business relationships, where they “share both the risks and rewards”<sup>201</sup> “We work with a limited and clearly classified set of suppliers in both business-to-business and business-to-consumer markets. Our formalized relationship management enables us to embed sustainable joint value creation through strong relationships with strategic suppliers.”<sup>202</sup> Specifically, this enables “‘designing in’ standard solutions” that meet customer expectations and reduce the overall total lifetime costs of products, thus maximising value.<sup>203</sup> The company also has directly contacts customers to ensure that products meet their expectations. “Consumer feedback is an intrinsic part of our product creation process and is a crucial part of building relevant value propositions for both our consumers and business-to-business customers.”<sup>204</sup> Consumer insights are gained through ‘Meet and greet’ sessions, in-home visits, and consumer test centers. “Domestic Appliances and Personal Care (DAP) has five consumer test centers around the world, in Drachten and Hoogeveen, the Netherlands; Klagenfurt, Austria; Snoqualmie, USA; and Singapore. Consumer Electronics (CE) conducts Consumer Experience Testing during the development phase in Experience Centers in Singapore, Hong Kong and Brugge, Belgium. Product validation testing OEM (Original Equipment Manufacturer) customers are strongly involved in the specification design for innovations in Lighting and Semiconductors.”<sup>205</sup> Philips also transfers knowledge to customers through



education: "Medical Systems division's educational offerings include an Online Learning Center; customized clinical user training focused on diagnostic and treatment; and specialized service training for biomedical engineers and other specialists"; "Lighting Application Centers around the world provide hands-on opportunities for industry professionals to explore the fundamentals of lighting, real world lighting applications and the use of new lighting technologies; and "Consumer Electronics has created the Philips Online Academy, an e-learning environment using online interactive multimedia courses, for its retailers."<sup>57</sup>

Philips Design also collaborates with several companies to be able meet customer needs, and to create "dynamic and refreshing products that cross traditional boundaries."<sup>205</sup> "Sustainable meaningful solutions cannot be created by one industry in isolation but only through sharing competence and creativity, and by involving people from the early stages of research onwards."<sup>58</sup> Examples include collaboration with Alessi for the design of kitchen appliances, collaboration with Italian furniture designers Cappellini to integrate Philips technologies in traditional furniture, and a collaboration with Olivetti to find ways in which technology could enhance the communication flow between colleagues, clients and headquarters.<sup>58</sup> In 1999 Philips Design also collaborated with Nike to develop wearable electronics, because "a technology company alone is not sufficient to deal with the complexity of new products types of this nature and, also for branding issues, needs to join forces with companies leading in the markets in which Wearable Electronics can be applied."<sup>206</sup>

## **Contracts and informal ties with research institutes**

As has been previously mentioned, Philips Open Innovation strategy involves actively pursuing cooperation with universities in the innovation process.<sup>207</sup> Among the Philips organizations, Philips Research is perhaps the most closely linked with universities. "Philips Research has embarked on its Open Innovation strategy of cooperation with universities, research institutes and other companies."<sup>208</sup> For example, Philips Research Europe "is cooperating with business partners, universities and other knowledge institutions in Europe like the Embedded Systems Institute, the Holst Center, the Center for Molecular Medicine, Fraunhofer institutes and a variety of renowned universities in an Open Innovation setting."<sup>209</sup> Philips Research East Asia partners with "the academic and R&D communities in East Asia"<sup>210</sup> "for standards, competencies, talents, and start-ups."<sup>211</sup>

At Philips Research East Asia - as well as at the 15 R&D centers in China - Philips' "efforts help to increase China's knowledge-economy."<sup>212</sup> "In the spirit of Open Innovation, we cooperate closely with Chinese universities, research centers and companies, transferring knowledge to them."<sup>65</sup> Ties between Philips and Chinese universities are strong. For example in 2005, "Zhejiang University (China), the Technical University of Eindhoven (the Netherlands) and Philips Research (with laboratories all over the world) have joined forces in three disciplines: Physics, Electrical Engineering and Biomedical Engineering."<sup>213</sup> "This agreement is intended to foster a new culture of technical excellence through the creation of a 'brain bridge' between eastern and western universities, and to support China's efforts to produce the top-flight homegrown scientists and engineers needed to sustain its growing economy."<sup>214</sup> In addition, Philips is exchanging knowledge with China on the issue of intellectual property, through courses given by Philips IP professionals from the US and Europe at the universities of Renmin, Tsinghua and Fudan, through exchange of IP experts, by inviting a number of Chinese professors to visit various IP institutes in Europe,<sup>67</sup> and through the IP-academies that have set up at three Chinese universities<sup>215</sup>

Philips also actively participates in joint research programs such as the Eurekaprograms like Medea in micro-electronics and ITEA in software-intensive systems.<sup>67</sup> Especially Healthcare

Systems Architecture - a research group of Philips Research - contributes to externally funded projects, such as the Virtual Laboratory for E-Science (2004-2005), Freeband B@Home (2004-2008), Smart Surroundings (2004-2009), IST MyHeart (2004-2006), and TRUST4All (2003-2005), among many others.<sup>216</sup>

Philips transfers knowledge to its employees because “develop people” is one of the company values.<sup>217</sup> Accordingly, they are “further developing our people competencies, e.g. through career development programs that reflect our commitment to diversity and inclusion, and accelerating the development of our top talent.”<sup>218</sup>

### **Other contractual and informal ties with the local region**

There are several other types of linkages between Philips and local organizations in emerging markets. Philips South Africa has set up a program called Project SOAR –Supply Opportunities and Achieve Results, which provides goods and services and works “directly on educating the children through a variety of activities, including educational trips and events.”<sup>219</sup> In India, cooperation between local organizations has created the innovative service provided by project DISHA. Philips cooperates with the hospital, public authorities and some NGOs, to provide a mobile teleclinic with multi-diagnostic capabilities and a satellite link to a hospital, which tours poor remote areas of India.<sup>71</sup>

Philips also cooperates with Chinese authorities in their efforts “to define, implement and promote a solid system of Intellectual Property Rights in China.”<sup>220</sup> With regards to China, Philips also provided knowledge to the Dutch government and Dutch society, considering their perspective as a global multinational which is larger in the USA, and is becoming larger in China, than it is and is able to be in the Netherlands where it is headquartered.<sup>74</sup> They did this “together with a number of other large companies, via what was known as the “business location matrix”: a series of recommendations to government on how to increase the competitiveness of the Netherlands as a business location.”<sup>221</sup> “As Philips, we agreed and still agree with most of the Lisbon proposals: less red tape, more flexible markets, bigger efforts in R&D, more cooperation between business and universities, take away barriers within the internal market”<sup>222</sup>



Headquartered in Finland, Nokia is a leader in the mobile communications industry. The company is comprised of four business groups - Mobile Phones, Multimedia, Enterprise Solutions, and Networks - that are supported by divisions like customer and market operations and technology platforms.<sup>223</sup> “As of December 31, 2005, we had R&D centres in 11 countries and employed 20,882 people in research and development, representing approximately 36% of Nokia’s total workforce. R&D expenses totalled EUR 3 825 million in 2005, representing 11.2% of Nokia’s net sales in 2005, compared to 12.9% of net sales in 2004.”<sup>224</sup>

Figure 19. The global network of Nokia R&D centres



Corporate Research takes place at the Nokia Research Center, responsible for carrying out Nokia’s longer-term research and acting as “a link between basic industry research and product development - as well as responding to the product development needs of Nokia’s business groups”<sup>225</sup> Nokia’s corporate research unit operates from laboratories in six countries and “employs nearly 1,100 staff, with one in five employees holding a PhD (...) Our success is shown by the fact that Nokia Research Center generates half of the essential patents of the company.”<sup>3</sup> In 2005 311 were patents granted in 2005 in 268 patent families.<sup>226</sup>

The selected location of Nokia Research Center (NRC) Budapest was established in 1998. As well as a new corporate R&D unit, Nokia Telecommunications also established a R&D unit that would concentrate on the development of Nokia’s Mobile Switching software and applications. A significant expansion followed to meet the target of “employing approximately 300 software systems and telecommunications specialists by 1999.”<sup>227</sup> The locational motivation for selecting Budapest for this site is because “Hungary is a country that provides high-quality education in computer science and technology.”<sup>4</sup>

## Locational Determinants

Since Nokia's business strategy is customer focus and consumer understanding in all areas of day-to-day business<sup>228</sup>, it is not surprising that Nokia has located R&D subsidiaries close to all major customer markets in the world. Lifestyle and sociological trends are monitored by specialist consumer and market research teams to shape the design, engineering and manufacture of future products according to customer needs across the globe<sup>229</sup>. In addition, "to increase its depth of consumer understanding, earlier this year Nokia brought together all of its 250 designers, psychologists, researchers, anthropologists and technology specialists into a single team. The newly named Nokia Design organization is now responsible for the entire design process – from strategy and conceptualization to product development – for the company's complete portfolio of devices. The team takes its inspiration from many different cultures, with its members based around the globe in cities such as Helsinki, Copenhagen, Los Angeles, Tokyo, Beijing and at Nokia's UK headquarters near London."<sup>230</sup>

"China and India increasingly driving demand and design preferences"<sup>231</sup> Nokia has been committed to strengthen its market position in these regions, and continues to invest in expanding R&D activities. In India, Nokia has located three Research and Development facilities to support local manufacturing and to local customer demands. "The end-to-end operations strengthen Nokia's complete solution offering and uniquely position it to work with Indian operators to reduce time to market for both network equipment and terminals and achieve the Government's target of 200 million mobile subscribers by 2008."<sup>232</sup> Engaging skilled labour for local product support was a locational motive when Nokia opened a R&D facility in Mumbai: "Primarily focused on providing software support and technical expertise in CDMA technology, the new R&D facility will leverage Nokia's existing global CDMA competences to build a team of local talent specialising on the CDMA protocol."<sup>233</sup>

In China, Nokia has made a "long-term commitment to be the preferred partner"<sup>234</sup>, which also involved a significant expansion of its R&D facilities. This included the launch of a Nokia Postdoctoral Program, the creation of a unit to promote open standards and technology localization, the establishment of a CDMA R&D facility in Beijing,<sup>235</sup> and a major research and development center in Hangzhou.<sup>236</sup> Meeting customer needs has been a motive for locating R&D in China for a long time. Nokia started investing in making China an integral part of the manufacturing product development chain in the 1990s<sup>14</sup>. In 2001, "Nokia's investment in China had surpassed USD 1.7 billion. Nokia has established over twenty offices, eight joint ventures and one R&D center, with over 5,500 employees in China"<sup>237</sup> By 2004, Nokia had five R&D units in China employing more than 600 people, and sustained many collaborative relationships with China's research community. Product adaptation remains a reason to stay: "This cooperation will boost technology innovation and localization, enabling us to strengthen our R&D in key areas and respond to Chinese customer needs."<sup>238</sup>

To gain a better understanding of customer needs, Nokia also partners with local companies such as Shanghai Alliance. "Shanghai Alliance has rich experience in the IT industry and a deep understanding of the China market and customer needs. We strongly believe that the cooperation between Nokia and Shanghai Alliance will secure the future success of the company."<sup>239</sup>

The technology or supply-side factors that have induced Nokia to internationalise certain R&D activities include the presence of skilled labour and universities and the proximity of centers of innovation.

In 1998, Nokia's first phase of internationalising R&D for mobiles phones saw the opening of a research and development centre in the U.K. at a site where the skilled workforce was a major asset to the company. The Southwood Product Creation Centre includes "a global state-of-the-art mobile phone testing facility, a global Product Design Centre, university liaison, global environmental work and regional security operations"<sup>240</sup>. At that point Nokia already had R&D operations in four locations and a base station production plant in the U.K. Today access to skilled labour and proximity to universities remained an important locational determinant since "Nokia's R&D centers are located adjacent to leading technical universities in 12 countries."<sup>241</sup> Even in China Nokia choose to locate itself in Hangzhou to be able recruit well-educated personnel. "The presence of Zhejiang University, a focus on software capabilities and high-level education, as well as good transportation and communications infrastructure were pivotal in Nokia's choice of Hangzhou"<sup>242</sup>

In the U.S., the proximity of Massachusetts Institute of Technology's Computer Science and Artificial Intelligence Laboratory (CSAIL) motivated the opening of a joint research facility in Cambridge, MA, USA<sup>243</sup>. Besides cooperation with Stanford University, the local innovation environment provided by Silicon Valley was also motivated the establishment of a Nokia Research Center in Palo Alto: "In our search for future disruptive technologies, Silicon Valley provides a unique blend of Internet companies, entrepreneurs and academic institutions offering a distinct environment to foster open innovation and collaboration."

The following locations of R&D units were chosen to learn from target competitors or industrial partners. For Nokia, the nature of knowledge acquisition ranges from one-time collaborations to joint ventures and acquisitions.

The Hangzhou R&D center is an example of collaboration with local partners influencing Nokia's locational decision. The center was established to carry out R&D activities together with a local Chinese partner, and "builds on Nokia's long experience of cooperation in technology development with Chinese partners and universities"<sup>244</sup> Investment in strategic R&D collaborations is a motive for Nokia to invest in certain locations. For example, Avaya and Nokia are collaborating to invest in R&D resources "to realise the enterprise fixed mobile convergence market".<sup>245</sup>

Other examples of R&D activities being established by joint ventures includes a new company formed by a joint venture between ICL and Nokia. The company supports Nokia Information Management's e-business development in Finland. "Nokia chose ICL as its partner because of the company's impressive track record in the e-business area. The arrangement also ensures that in addition to our own growing resources, we have the best expertise in the field at our service."<sup>246</sup> Another example is the company Meridea Financial Software, which has been established by Accenture, Nokia, and Sampo. "The new company, which combines the expertise of the founders in the fields of mobility, banking and finance, produces and markets software for mobile and online financial services."<sup>247</sup> To gain a competitive edge Nokia also gains knowledge by acquiring competitors. For example the acquisition of Intellisync Corporation will "position Nokia to deliver the industry's most complete offering for the development, deployment and management of mobility in the enterprise. The transaction is also planned to enhance Nokia's ability to respond to customer needs in this fast growing market"<sup>248</sup>

## Organizational Structure

The following section will describe the intra-firm functional, hierarchical, and lateral linkages that characterise the way Nokia has organized their international R&D activities.

Local R&D primarily involves the development of products within the internationally dispersed business groups Mobile phones, Networks, Multimedia, and Enterprise solutions. “The majority of Nokia’s R&D work is product development conducted within the business groups.”<sup>249</sup>

“New Business development teams across Nokia collect and evaluate submitted new business ideas”<sup>250</sup> which are incubated in the business unit that best fits the scope of the idea. Ideas are not just collected from within Nokia; they are also collected from external sources. Corporate venturing then involves providing the resources to develop the idea to a profitable business.<sup>251</sup>

Besides the product focused R&D that is conducted at the business groups, research also takes place within the Technology Platforms group and the Nokia Research Center.<sup>252</sup> Both entities centrally coordinate R&D activities, and operate from sites in several countries.

Technology Platforms is a horizontal R&D division that focuses on multiradio technologies, including software platforms, chipset platforms, and intellectual property rights among others. “Technology Platforms also works with leading external developers, suppliers and partners.”<sup>30</sup> Research from technology platforms is integrated with the business product groups. The management and compatibility of technologies is centrally coordinated by Technology Platforms. “We support Nokia’s overall technology management and development by delivering leading technologies and well-defined platforms to Nokia’s business groups as well as to external customers.”<sup>253</sup>

On the other hand, the Nokia Research Center is the corporate research division that coordinates research cooperation and standardization. It focuses on strategic and long-term research<sup>254</sup>, looking beyond current products, platforms and standards<sup>255</sup> to strengthen Nokia’s core competencies.<sup>256</sup> It is not attached to a specific product development business unit,<sup>257</sup> but rather “acts as a link between basic industry research and product development” by carrying out longer term research and responding to the product development needs of the business groups.<sup>258</sup> It does this from 10 sites in Finland, Germany, Hungary, China, Japan, and USA<sup>259</sup>.

It is apparent from the previous sections that lateral ties within Technology Platforms and Nokia Research center are strong. Because Nokia does not directly refer to linkages between the R&D units within the business groups, it is not clear if these units also have a lot of contact. It rather seems that they are only linked to corporate research and supported by Technology Platforms. “Nokia researchers support the product development units to master key technologies and their evolution”<sup>260</sup>

The product development business units are part of the business groups and therefore strongly tied to other functional areas. Nokia Research center and Technology platforms both deliver technologies to Nokia’s business groups; however it is the local product development units that integrate new technologies into the business group, taking into account the specific needs of their customers<sup>261</sup> The Nokia Research Center and Technology platforms therefore perform more of a supportive role to Nokia product development units, and are not directly linked to manufacturing or marketing. “New business cases are created around technologies under development in Nokia Research Center. In most cases, this is done by Nokia’s business units, which fund the majority of research projects at Nokia Research Center.” Projects without a clear business case are already incubated in the research center’s incubation unit and eventually transferred to the Nokia Ventures Organization.<sup>262</sup>

Local R&D is primarily involved with market driven R&D. At these R&D units product development according to the (local) market needs take place, and they have been integrated with other functional areas. Corporate research acts as a strong centre that directs coordinates dispersed research units, and explores disruptive technologies and long term research objectives. In its coordination role it is supported by Technology Platforms, responsible for coordinating cooperation between units as one of the three horizontal groups that were introduced to make the company more efficient.

## **Linkages between MNE R&D and the region**

Nokia's research vision for the coming years is to "extend the innovation pool"<sup>263</sup> to a wider community. "Collaboration is a key ingredient in Nokia's growth strategy. We work with other companies, research institutions, authorities, and industry organizations to further the competitiveness of our company and the strength of our industry as a whole."<sup>264</sup>

Nokia collaborates with several firms to maintain global contacts and to monitor and influence technological developments.<sup>42</sup> "We are also working with leading companies in other industries to bring to the market advanced specialized technology and applications,"<sup>265</sup> such as fixed IP network security, mobile corporate e-mail and extended corporate telephone systems to mobile devices.<sup>266</sup> Another example includes the collaboration between Nokia and Carl Zeiss optics that resulted in the integration of Carl Zeiss optics into camera phones.<sup>267</sup>

To acquire knowledge about specific markets, Nokia has entered into several joint ventures over time, including in China. "Regional joint ventures have proven to be an effective way to combine Nokia's global technology leadership with strong local partners to accomplish faster and higher market penetration in new and emerging markets."<sup>268</sup> Knowledge about the market is also acquired directly from the consumer, for example at the Nokia Experience Centers. Apart from showcasing their products, these centers allow Nokia "to learn more about consumer needs and wants, which will help Nokia with the creation of future consumer-focused products."<sup>269</sup>

"Nokia recognizes that innovation does not only happen within Nokia"<sup>270</sup> and therefore seeks contact with external sources that have ideas that fit into the Nokia vision.<sup>271</sup> This is primarily done by the Nokia Ventures Organization and other venturing teams. One of these teams is "involved in capturing market innovations through various means, including the joint development of new ventures or partnerships." To facilitate start-up, Nokia provides knowledge and expertise to entrepreneurs, thereby benefiting from getting early exposure to innovative ideas. Another team is responsible for developing and operationalizing strategic new business ideas from inside and outside the company. Besides knowledge, capital is also provided by teams like Nokia Venture Partners and Nokia Growth Partners. The former is a venture capital firm that invests exclusively in mobile and IP-related start-up businesses and technologies on a global level, while the latter is a global mid- to late-stage venture capital fund that invests in mobile technology companies that are already experiencing industry adoption by large companies.<sup>272</sup> Venturing at Nokia extends Nokia's innovation network and creates linkages for developing new businesses.

Besides venturing, Nokia remains up to date on the latest technological developments by keeping its "soft signal antenna" up through participation in standardization bodies as well as "continual external networking with business communities, customers, product users, and a range of other stakeholders"<sup>273</sup> Nokia is represented in many standardization bodies and large international cooperation projects in which Nokia sees specific interest and

opportunity.<sup>274</sup> Examples of standardization bodies Nokia is involved in include the Multiband OFDM alliance to support Multiband OFDM UWB technology<sup>275</sup>, and the Open Mobile Alliance (OMA) Interoperability Programme to provide the market with interoperable products. In these bodies Nokia is involved in activities such as driving standards and innovation, providing services like testing, and creating specifications<sup>276</sup> Besides standard bodies, Nokia also participates in international research projects and industry forums. A Nokia Research Center representative currently chairs the Wireless World Research Forum<sup>277</sup> and Nokia has also joined forces with Marconi through their Italian consortium Securcomm, to provide the Italian police with secure and reliable communications services.<sup>278</sup> Research projects at an EU level are discussed in the section “Other contractual and informal ties with the local region.”

Collaboration on new business ideas is also achieved through a network of research centers and academics.<sup>279</sup> There are numerous examples such research projects. Besides the fact that “Nokia's R&D centers are located adjacent to leading technical universities in 12 countries.”<sup>280</sup>, “Nokia works with approximately 100 universities globally.”<sup>281</sup> “Research collaboration with the industry and academic institutions has been a key element of Nokia Research Center's success. From the beginning, Nokia Research Center has participated in the work of various industry fori and in several research programs run by national or international agencies, such as the Tekes of Finland and the European Union Framework Programs.”<sup>282</sup> Nokia also participated in The UWB (Ultra-WideBand) Program that was partially funded by the Finnish National Technology Development Institution (TEKES)<sup>283</sup>; cooperates with the Zhejiang University in China; and is planning to provide knowledge transfer in Symbian technology to 10 Chinese universities through training, seminars and coursework.<sup>284</sup>

However, Nokia mostly refers to cooperation with U.S. universities in their communications, especially with Standford University and the Massachusetts Institute of Technology (MIT). Nokia is to pursue joint research with Stanford University, as well as providing new project-oriented courses on mobile computing and services.” Given their close proximity, researchers from Nokia and Stanford will work together using the Stanford campus community as an experimental testing ground for new technologies and services developed by Nokia Research Center.”<sup>285</sup> There are even stronger links between Nokia and MIT including many research collaboration projects<sup>286</sup>and the establishment of a joint research center<sup>287</sup>

Nokia is linked to the region through its employees, encouraging them to develop their own ideas using tools such as the Annual Venture Challenge idea campaign<sup>288</sup> Nokia also exchanges knowledge with external sources of labour. Interaction with (independent) developers is achieved through Forum Nokia, a global developer program that connects over 2 million developers “to the tools, technical information, support, and distribution channels they can use to build and market applications around the globe.”<sup>289</sup> “The total global revenue earned by third party developers from mobile Java applications running on device platforms from Nokia would be EUR 340 million in 2005 alone.”<sup>290</sup>

Nokia believes their employees are their most valuable asset in attracting skilled labour: “Nokia's corporate research unit employs nearly 1,100 staff, with one in five employees holding a PhD. The best, most knowledgeable people attract others like them and our diverse teams bring together both newcomers and distinguished experts”<sup>291</sup> Further studies are therefore actively encouraged, and “many internal processes, such as internal job rotation, promote personal development and the transfer of competencies”<sup>292</sup>



## **Other contractual and informal ties with the local region**

There are several linkages with the EU and cooperative projects that stimulate innovation on a European level. For example, in the European 6th Framework Program Nokia leads the MobiLife research program on user driven communications solutions for the future. “The MobiLife consortium consists of 22 partners in 9 countries, 5 application owners and SMEs, 3 operators, 8 manufacturers and 6 academic partners.”<sup>293</sup> Nokia also participates in three EU-ITEA projects with the goal of enabling the construction of open configurable middleware for consumer devices. “All three of these projects are examples of open innovation involving Nokia Research Center, Philips Research (Project coordinators), Fagor, IKERLAN, academia, and research institutes.”<sup>294</sup> Another example of cooperative research project on a European level includes a collaborative project of Ericsson, Helsinki University of Technology, Nethawk, Nokia, Secgo, TeliaSonera Finland, University of Helsinki and VTT (MERCoNe)<sup>295</sup> and Nokia also contributes to the development of a market for more environmentally friendly products through a cooperative pilot project with the European Commission. “Nokia contributes to this cooperation with its background in environmental work experience based on product life-cycle thinking.”<sup>296</sup>

# Volkswagen

Headquartered in Wolfsburg, Germany, and with 44 production facilities spread across eleven countries in Europe, and another seven countries in America, Asia and Africa, Volkswagen is “one of the world’s leading automobile manufacturers and the largest carmaker in Europe.” In total the Volkswagen Group owns 8 strong brands ; which are “divided into two brand groups. Under the leadership of the Group, the Audi and Volkswagen brands are responsible for the performance of their respective brand group worldwide” “The Audi brand group is made up of the Audi, SEAT and Lamborghini brands. The Volkswagen brand group includes the Volkswagen Passenger Cars, Škoda, Bentley and Bugatti brands. Each brand has its own character, and operates autonomously on the market. (...)The Commercial Vehicles brand is responsible for the Group's commercial vehicle products”

Figure 20. The global network of Volkswagen R&D centres



Following a corporate restructuring effort that started in 2001 , “the Group’s decision to form two brand groups in the Automotive Division was driven by the desire to tap synergy effects in the development sector, for example, by using our platform and module strategy, as well as in purchasing and logistics” The brands are united under Volkswagen AG, which is the parent company of the group. Therefore, “in its function as parent company, Volkswagen AG holds interests in AUDI AG, SEAT S.A., Škoda Auto A.S., Volkswagen Financial Services AG and numerous other companies in Germany and abroad.” However, each individual brand or company conducts business at their own responsibility with “considerable leeway to develop their own strategies” , albeit under the general leadership of the Group: “Each brand in the Volkswagen Group is managed by a senior brand manager. The Group targets and requirements are aid down by Volkswagen AG or the Group Board of Management. The



companies of the Volkswagen Group are managed separately by their respective management.”

Besides developing vehicles and engines for the Group in its function as a parent company, Volkswagen AG also produces and sells vehicles under the Volkswagen Brand Group and the Commercial Vehicles brand.<sup>297</sup> Within the Audi brand group, “the Audi brand is the technology leader,”<sup>298</sup> and “the Financial Service Division’s portfolio of services ranges from dealer and customer financing and leasing, through banking and insurance activities, down to vehicle rentals and the fleet management business”<sup>10</sup>

Although there are group-wide platform and module strategies that aim to unite the development activities of the two brand groups, publicly available information on group wide research and development is scarce. Considering the fragmentation between the brand groups, this is to be expected. To illustrate, specific details on R&D centres that fall under in the Audi brand group can only be obtained from the Audi website. For example, the Aluminium and Lightweight Design Centre in Germany which developed the Audi Space Frame for the Audi A8 and the Lamborghini Gallardo<sup>299</sup> is not mentioned in any communications on the Volkswagen Group website. “Clear lines have been drawn between brand functions and Group functions, meaning that responsibilities have been unequivocally defined.”<sup>10</sup> To create a complete picture of R&D activities of the Volkswagen group, it would therefore be necessary to investigate each brand separately. However, given this case-study’s group-wide focus, the profile will be based on descriptions obtained from the group-website.

Departments such as the Future Research function and the electronic research department fall under Group Research at Volkswagen AG. “Volkswagen’s research and development is the driver for innovation within the group. In 2005, around 10,000 employees in Wolfsburg initiate new solutions and concepts to ensure the technical advantage of our company,”<sup>10</sup> total R&D costs amounted to €2.0 billion, and 1,340 patents were granted of which 1,024 were in Germany and 316 abroad.<sup>10</sup> “In fiscal year 2005, research and development activities focused primarily on improving functionality, quality, safety standards and the environmental compatibility of Group products. In the case of all new models, advances that we achieved during the development process were systematically implemented in the product”<sup>10</sup>

## **Market or demand-side factors**

The market or demand-side factors that have induced Volkswagen to internationalise certain R&D activities include the need to close to the main customer markets they serve. This is actually included in their Group Values and Group Guidelines, which state that they give their customers’ interests priority, and their “internal standards consistently reflect our customers’ needs, expectations and wishes.”<sup>300</sup> In line with these guidelines, one of their strategic goals is to increase their presence to move from being a European exporter to establishing a worldwide integrated network.<sup>301</sup>

Global presence is necessary to learn about local trends and preferences as well as being able to appropriately integrate innovations into new models to reflect technological advances or customer demand. “This is because customer preferences vary enormously in our markets across the globe. Individuality is prized everywhere, and the characteristics of different regions must be taken into account in order to succeed in the local market.”<sup>302</sup> “It was with a view to zoning in more closely on this regional influence that, for instance, an interdisciplinary team of engineers, sales people, marketing experts and designers was sent to the USA.”<sup>15</sup> The motivation behind establishing the “Moonraker” project in the USA was to employ “scouting

activities” to capture the demands of American consumers, which were translated into technological terms and transferred to the development departments.

The Moonraker project is only one of the examples of the cross functional teams that are established before work starts on the development of new models, and in 2004 Volkswagen dedicated an entire section within Group Research to analyse trends and draw up scenarios.<sup>303</sup> This is especially significant with respect to China, which will be “the world’s largest car market”, and requires the “development of cars to be targeted to tastes and prices of growing Asian markets.”<sup>304</sup> To defend its current position in China, the Volkswagen Group’s activities are therefore being redirected to focus on “the development of a product range that takes greater account of the dynamically growing needs and expectations of Chinese customers.”<sup>305</sup>

## **Technology or supply-side factors**

The necessity to access a wider range of scientific and technological skills and knowledge than is available in the home markets also influences the location of R&D activities. In this respect, the technology or supply-side factors that make have motivated Volkswagen to internationalise R&D activities include proximity to sophisticated suppliers, universities and links with clusters of SMEs and knowledge hubs related to the region.

Proximity to key suppliers is increasingly important especially in Europe, as “supplier integration continues to be a key factor in our procurement strategy.” Workshops were recently held with suppliers to work together on technical development areas, among others.<sup>306</sup> “Germany and its West European neighbors continue to be the main sources of procurement for the Volkswagen Group, primarily owing to their technical expertise and geographical proximity to our production locations and extended supplier base.”<sup>307</sup> Volkswagen’s presence also stimulates the development of clusters of suppliers, for instance at SEAT’s research and development centre in Martorell, Spain: “Over the past few years, the activities of SEAT have also been instrumental in promoting the development of the area around the Martorell plant. Some 15 companies have now relocated to the industrial estate established by SEAT for its suppliers, creating a total of around 3,000 new jobs”<sup>308</sup>

“Nonetheless, in addition to traditional markets, emerging countries such as China, India and Russia are increasingly attractive for us as supply sources.”<sup>309</sup> In Russia Volkswagen has decided to build a new production plant in the city of Kaluga. Some 70 sites had been examined but “taking everything into consideration, the Kaluga location offered the best framework for the investment.” In addition to allowing Volkswagen to substantially increase their share of the rapidly-growing Russian automotive market, the Kaluga location was specifically attractive because it “is well known for research and industry and is the seat of the regional administration.”<sup>310</sup>

In the USA, proximity to Stanford University and a knowledge hub were key factors for the location of Volkswagen Group’s Electronics Research Laboratory (ERL) in Palo Alto, California, (in the middle of Silicon Valley) in 1998. The employees at this location operate as “trend scouts”, and “their early recognition of technology, research and initial development leads to innovative new ideas with which Volkswagen Group products can gain a competitive advantage.”<sup>311</sup> Volkswagen also pursues joint projects with Stanford University, “using the unique chance to work with one of the most renowned universities and prove what is currently technically possible”<sup>24</sup>

## Competitor factors

The Electronics Research Laboratory (ERL) in Palo Alto also allows Volkswagen to target specific firms in the centre of innovation to collaborate with. “The ERL is the Volkswagen Group's central research centre in the USA. In the heart of Silicon Valley, it is able to work directly with globally leading high-tech and start-up companies. The close working relationship between the ERL and these partners facilitates the design and development of innovative features and applications, which are then applied to test vehicles of the Volkswagen Group brands for further analysis.”<sup>312</sup> This illustrates the third type of locational determinant, which refers to locations of R&D units being chosen to learn from target competitors or industrial partners.

For example, the Electronics Research Laboratory has collaborated with the graphics card manufacturer nVidia and Google to develop a new navigation system that uses data from Google Earth to generate 3-dimensional images of the route.<sup>25</sup> Volkswagen has also collaborated with DaimlerChrysler to develop “a mini-van to meet the specific needs of our American customers,”<sup>313</sup> and in China, joint ventures are a way to reinforce the strategic orientation of activities, as they allow Volkswagen to achieve cost-effective production and the ability to meet the legal requirements governing in-country manufacture under local management.<sup>314</sup> For example, in 2005, two joint venture companies were established in China - Volkswagen FAW Engine (Dalian) Company Ltd. and Shanghai Volkswagen Powertrain Company Ltd. - but joint ventures have been important in China as far back as 1984, when Volkswagen AG and Shanghai Automotive Industrial Corporation signed a joint-venture contract with a duration of 25 years<sup>315</sup> “The Development Center of SVW consists of a Research & Development Center and a Proving Ground,”<sup>28</sup> which will remain to be important since in 2002 the contract was extended by another 20 years. Other joint ventures in China include one with the FAW Group, established in 1990, which was also extended by 25 more years in 2003.<sup>316</sup>

## Political Factors

Cooperation with local governments is one of the political factors that motivated Volkswagen to set up R&D facilities in the third German state Hesse and the States of Brandenburg and Lower Saxony. Volkswagen is collaborating with these states on the development, production and introduction of synthetic BtL (biomass to liquid) fuels. “Developing the scientific foundations for a new technology such as the production of BtL fuels by one German state requires early and close co-operation with the commercial sectors involved and with other state governments. Research plans need to be coordinated, for example, as does the acquisition of EU financing.” “One of the driving forces behind this agreement was the stipulation contained in the Kyoto Protocol of 1997 that Germany reduce its CO<sub>2</sub> emissions by 21% by the year 2010, another is the fact that the European Union expects its member states to increase the share of bio fuels used to 5.75% of overall fuel consumption by 2010.(...) For the states party to it, the agreement is also significant from a broader research and eco-political perspective, since the scheme holds the promise of generating added value and securing jobs, most notably for the agricultural community.”<sup>317</sup>

At an investor conference in 2006, Dr. Suixin Zhang, Executive Vice President of the Volkswagen Group China, mentions how the changing Regulatory Framework in China might affect the attractiveness of China as a location. In line with new national strategy “To build country of innovation”, the Chinese government is focusing on Chinese dominated innovation and aims to decline the country's reliance on foreign technology to 30%

(currently: 60%). The supporting policies and measures will aid Chinese brands to gain market share, which will put pressure on foreign companies.<sup>318</sup>

The final motivating factor for the location of certain R&D activities is historical development. The image of the brands that make up the Volkswagen group are strongly tied to their country of origin, where development of new models still takes place, for example Bentley in England, Lamborghini in Italy and SEAT in Spain. Another example is Bugatti where “the production of the Veyron 16.4 began on historical ground. This is the site where Ettore Bugatti once created four-wheeled legends”<sup>319</sup>

## **Local R&D**

The headquarters Wolfsburg, Germany are home to the Group Research site, including Volkswagen Commercial Vehicles and Volkswagen technical development. The remaining Volkswagen brand group technical development sites are located in California, Mexico, Brasil, China, Japan, and South Africa, and also include the Bentley, Bugatti, and Skoda sites in England France and Germany respectively. The local R&D site in California Volkswagen is a specialized competence centre in Electronics Research. “Their early recognition of technology, research and initial development leads to innovative new ideas with which Volkswagen Group products can gain a competitive advantage”<sup>320</sup> The Audi brand group technical development sites are located in Germany, Spain (SEAT) and Italy (Lamborghini).<sup>321</sup>

Each individual brand conducts their business at their own responsibility<sup>322</sup>, which has resulted in R&D being strongly centralized in the original home countries of the brands that make up the Volkswagen Group. This implies that at the R&D sites across the different brands strong research must take place, and the geographically dispersed units maintain technological capabilities in the same or similar fields of technology. Only the Volkswagen brand has dispersed R&D activities at local production sites, primarily aimed at facilitating the transfer of technology from the parent to local manufacturing, as well as to learn about local trends.

## **Vertical ties with home country R&D**

Coordination of research activities is achieved by using platform and module strategies, which is stimulated by Group Research, located at headquarters in Germany. Group Research employs some 8,361 people for Volkswagen Technical development, 736 people for Volkswagen Commercial Vehicles Technical Development, and 542 people for other Group research functions such as Future Research, which supports Volkswagen brands with innovations, and long-term vision.<sup>35</sup>

There is no evidence that decisions concerning R&D activities of the other brands are centralized at Group Research, it rather seems as if local R&D sites are primarily linked to each individual brand, and perform their own research. This research is however supported by the Group platforms and modules, and ultimately communicated to the research functions of the other brands (rather than directed) by Group Research. “At Volkswagen, knowledge management aims at making available knowledge at any place and at any time and subsequently passing on innovative local solutions to the entire Group.”<sup>323</sup>

## **Lateral ties with other R&D**

Contacts between R&D units are promoted through software solutions such as the “Expert finder” - the electronic Volkswagen Yellow Pages<sup>324</sup>; the “Expert room” - a virtual network of technical experts<sup>325</sup>; and common Knowledge bases - e.g. a central database that allows users to access information from any development site.<sup>326</sup> “Finding the right contact person and

enabling people to find you as an expert are the two essential aspects of a pioneering knowledge offensive at the Volkswagen Group,”<sup>327</sup> and “teams improve and intensify their collaboration in the knowledge networks.”<sup>328</sup> “These knowledge networks are a new form of global cooperation in the group. In this manner, experts in the group can learn from one another and based on existing experience, can now take important decisions quicker and more securely”<sup>41</sup> Additionally, using a centralized system, allows Volkswagen “to keep track of innovations based on customer requirements and new technological solutions. In this way, we are able to match innovations with individual models, thereby increasing their competitive edge. 2005 also saw the introduction of product workshops, events where employees from all parts of the company involved in the product development process come together.”<sup>329</sup>

## **Lateral ties with other functional areas**

Volkswagen has reorganized activities into two brand groups, the Volkswagen and the Audi brand group, “to tap synergy effects in the development sector (...) as well as in purchasing and logistics.”<sup>330</sup> Even though the board of management has agreed to make changes in the process organization including an increase in cross-divisional cooperation<sup>43</sup>, there still seems to be little cooperation between R&D units from one brand and functional areas from another. This is also because “the brands and companies each define their individual policies and thus focus on different aspects in their activities.”<sup>331</sup>

So while R&D activities may be closely linked to functional departments within an individual brand or company, there are few ties with functional areas from other brands. However, following the unification of production standards by joining employees from the individual brands and plants, Volkswagen is now planning “to develop new production technology across the Group by implementing a uniform system known as “scouting”. By adopting this approach, which is closely linked to the research and development scouting process, we can ensure that scientific innovations are used early on in the production process”<sup>332</sup>, thus strengthening the ties between R&D and functional areas across the company.

## **Type of Organisational Structure**

Local R&D is primarily linked to the individual brands that make up the Volkswagen Group. Since these brands operate independently, and strong research activity takes place at their respective R&D sites. However, there is little cooperation between R&D units across different brands; knowledge sharing is only achieved through Group Research. In this respect Group Research has a coordinative role; however ties with local R&D units are not formal in the sense that Group Research controls the type of activities they engage in. It rather acts as a centre that facilitates knowledge sharing between R&D units (through platforms, module strategies, portals etc.) and explores long term research objectives for the entire Group.

The fragmentation between the different brand groups and the resulting structure of R&D activities is changing however, as Volkswagen aims to “develop from a European exporter to a worldwide integrated network of human resources, know-how, complex products and services (...) by 2010”<sup>333</sup>

## **Linkages between MNE R&D and the region**

By describing the type of interactions between the Volkswagen Group and regional actors, this last section will give an overview of how Volkswagen investments in R&D contribute to regional innovation and growth. These ties are used for knowledge acquisition or knowledge

transfer, and “the ability to manage knowledge and incorporate it in future products and services is an essential factor in the success of our company. Our aim is to furnish relevant, contemporary knowledge for decisions-making. The following questions come to mind: How can knowledge become accessible to all? How can knowledge and experience of individuals be obtained? How can knowledge be augmented?”<sup>334</sup>

“In the global working world, quick, flexible implementation of business processes and the provision of information and applications is decisive for success.”<sup>335</sup> Knowledge sharing with regional actors is therefore facilitated through internet portals, namely the B2E employee portal, the B2B supplier portal and the B2C customer portal, which respectively provide information, communication services, processes and IT-systems for local employees, optimisation of business processes for suppliers, and better and new services for consumers.<sup>48</sup>

## **Contracts and informal ties with local firms**

Volkswagen acquires knowledge from local customers to reduce the risk that they “will not accept these products”<sup>336</sup> through a scouting process whereby information is gathered directly from customers. They also acquire knowledge from local firms such as suppliers or venture partners. In creating these (and manufacturing) linkages, they transfer knowledge, therefore having “an important part to play not only as an employer but also in terms of infrastructure and regional development(...) - a responsibility we live up to worldwide by offering above-average working conditions and compensation, contributing to local structural development and ensuring the Group-wide transfer of modern processes and technologies”<sup>337</sup> Volkswagen further contributes to certain regions by creating “a framework for further entrepreneurial activities around those locations. Opening up the regions to new industries in the long term will result in their sustained strengthening.”<sup>338</sup>

Volkswagen collaborates with specific local firms because of their unique expertise. For example the Braunschweig-based solar energy and heating specialists Solvis collaborated with Volkswagen to create the first solar filling station in lower Saxony, which started “operation on the grounds of the Volkswagen Technology Center in Isenbüttel near Gifhorn.”<sup>339</sup> In addition, Volkswagen maintains links with local firms for the purpose of advancing certain standards, such as with other European manufacturers to develop universal standardization of Car-to-X communication.<sup>52</sup>

As supplier integration continues to be a key factor in their procurement strategy, Volkswagen has been also been exchanging knowledge with suppliers. “For this reason, the first ever supplier workshop meeting was held in the year under review; over a number of days, selected suppliers worked together with staff from our procurement and technical development areas with a view to optimizing costs”<sup>52</sup> Besides acquiring knowledge from local suppliers, price advantages also play a role: “In the wake of the eastward expansion of the EU, we have also increased procurement activities in Eastern Europe and are already enjoying additional price and locational advantages. North America also plays an important role in our procurement activities.”

In China, to become a “Focus Supplier” cost advantages are required to be “at least 20% compared to Europe”<sup>340</sup> However, Volkswagen will contribute to the development of the regions they source from through the relationship between their Chinese joint venture partners and their supplier networks. Volkswagen sees an opportunity to achieve a platform strategy by establishing a Common Sourcing Process for their Chinese Joint Venture partners (SVW, FAW-VW & VW AG), thereby “enhancing competition, generating economies of scale



& scope due to high volume, and increasing volume and depth of local content,”<sup>53</sup> among others.

## **Contracts and informal ties with research institutes**

Volkswagen cooperates with research institutes and universities for the development of several new technologies. They collaborated closely with the Paul Scherrer Institute to develop the Bora HY.POWER, which is driven by a hydrogen PSI fuel cell and an electric engine.<sup>341</sup> “The new technology platform has been developed by Volkswagen's research unit in co-operation with our project and technology partner - the PSI in Switzerland working closely together with the Federal Technical University of Zurich (ETH) and the German FEV Motortechnik GmbH in Aachen.”<sup>342</sup> Other examples include the Volkswagen research department in California, which collaborated with Stanford University to create an autonomous automobile. “Many aspects of the autonomous automobiles will eventually be used in other, more conventional driver assistance systems. ‘In this joint project, we are using the unique chance to work with one of the most renowned universities and prove what is currently technically possible,’ emphasises Dr. Carlo Rummel, head of the ERL in Palo Alto.”<sup>343</sup> Another type of linkage has been created with the Westfälische Wilhelms-Universität in Münster, where Volkswagen established a unique professorship for Applied Material Sciences for Energy Storage and Energy Conversion, the only professorship of its kind anywhere in Europe. “For Volkswagen AG, advances in the area of energy storage are one of the keys to further advancing drive technology. The deal sealed today lays the foundation stone for a very promising collaboration between industry and university-based research,” said Prof Jürgen Lehold, head of Volkswagen Group Research.”<sup>344</sup>

In China, “Volkswagen AG and the car producing joint venture Shanghai Volkswagen (SVW) are to develop a vehicle with a combined electric motor and petrol engine. The market launch of the hybrid vehicle is set to coincide with the 2008 Olympic Games in Beijing. Development will run parallel in Wolfsburg and Shanghai.”<sup>345</sup> Volkswagen has enhanced these efforts by setting up a joint research project with the Tongji University in Shanghai for developing a fuel cell vehicle. Winfried Vahland, CEO and President of the Volkswagen Group China emphasised: “With the development of a hybrid vehicle in China, Volkswagen is supporting the efforts of the Chinese government to foster alternative technologies with the objective of conserving natural resources.”<sup>58</sup> Another effort that Volkswagen is supporting in China is improving road safety standards, for which the group has taken a number of measures. “These include an accident research project funded by the Group at Tongji University, Shanghai; the “Volkswagen Experience” training course for drivers; and the use of ESP in vehicles for the Chinese Market.” The accident research project with Tongji University employs a “multi-disciplinary team of specialists from the areas of vehicle development, medicine and psychology. Volkswagen has sent members of its German accident research team to China specifically for this project” with one of the objectives to “find out how to optimise European safety technology for use in China.”<sup>346</sup>

Volkswagen also transfers knowledge to the region by establishing vocational training schemes such as the training of automotive technicians at the VW Argentina plant, where a 183 people have already qualified as automotive technicians. This has resulted from agreements between the company and technical schools in Córdoba and Pacheco<sup>347</sup> “Vocational training for young people is on the agenda at all our plants and training measures are adapted to local requirements by the respective companies.”<sup>348</sup> Volkswagen also has its own university, which “serves as a center of competence and culture at Volkswagen AG and addresses the upper echelons of Job Families and management elites.”<sup>349</sup> “The AutoUni is its

own internationally recognised Institution for postgraduate education with a scientific profile,” which for now only “focuses on the Volkswagen World. In a second step, it will open up to suppliers and partners. In a third step, opening up to the public is planned.”<sup>350</sup>

Besides training for upper management through the AutoUni, “Volkswagen Coaching GmbH provides tailor-made vocational training, continuing professional development and executive development programmes for Volkswagen, as well as offering its services on the open market. In 2004, at its bases in Wolfsburg, Hanover, Brunswick, Kassel, Emden, Salzgitter, Zwickau, Chemnitz and Dresden the company held approximately 4,100 training events for some 36,000 participants”<sup>351</sup> “In addition to an extensive range of technology and quality seminars and team training, we offer staff development programs tailored for individual target groups such as supervisors, planners and developers.” One of these programs is the ForMotion program, which has “a view to boosting employee know-how, generating new knowledge and communicating this across the Group.”<sup>352</sup> “At Volkswagen, the employees create knowledge for the company with their experience. This knowledge in its entirety is the ‘intellectual capital’ of a company. The knowledge resource is not consumed by its application, rather it proliferates. Managing knowledge means handling this resource with awareness and promoting its application in the company specifically.”<sup>353</sup>

Volkswagen specifically supports employees in acquiring IT skills, making a “decisive contribution to enhance the performance of our employees and to improve the competitiveness of our Group as globalisation intensifies.”<sup>354</sup> They are “convinced that tomorrow’s world of work at Volkswagen requires a minimum level of IT skills at every workplace, in every country”<sup>355</sup>, and are “assuming responsibility for the regions in which the Group facilities are located.”<sup>356</sup>

In assuming responsibility for regions throughout the structural change in the automotive industry,<sup>357</sup> “our employment research has shown that regions characterised by a high degree of ‘cluster formation’ also present strong increases in employment. We implement this finding with our AutoVision concept. The concept aims to reduce unemployment at Volkswagen Group locations and to create a framework for further entrepreneurial activities around those locations. Opening up the regions to new industries in the long term will result in their sustained strengthening.”<sup>358</sup> The “Spreading Our Wings” project in Poznan, Poland is an example of how Volkswagen is “driving forward the development of a region that is set to become an automotive centre of competence (...) In parallel with the expansion of the plant into an advanced automobile production facility, the second stage of the process - transforming the employees into multiskilled operatives who can lead a team with initiative and take responsibility - began in the autumn of 2004.” “The third stage will comprise of function-oriented measures designed to boost competitiveness, enhance quality and create jobs.”<sup>71</sup>

## **Other contractual and informal ties with the local region**

The example of the activities taking place at the VW Poznan plant demonstrates another type of linkage with the region. “As in the past, in these activities too, VW Poznan can count on support from the surrounding region. Consequently, growing together with the region and giving something back as a good corporate neighbour is all part of plant policy. The outcome is that, like VW in Wolfsburg, VW Poznan has triggered a process of social development that opens up great opportunities for the region and for the plant itself – not least by consistently involving local suppliers in the value-added chain.” Volkswagen also collaborated with local authorities, environmental groups, local people, companies and the media.<sup>71</sup>



“Ever since it was founded in 1999, Wolfsburg AG (WOB AG), a public-private partnership between the Volkswagen Group and the City of Wolfsburg, has been responsible for implementing the AutoVision programme. The objective is to reinforce the regional economy in a sustainable way and to create new employment prospects.” The partnership focuses on supplier relocation, support for business start-ups, the expansion of the service sector, and the development of “business clusters” combining expertise from the fields of mobility, leisure, tourism and health. “This mainly means using new ideas to create and maintain jobs. By the end of 2004, some 8,000 new jobs had been created in Wolfsburg, reducing unemployment in the city to 8.2 percent” Other links with governmental bodies to advance development of the local region include investments in regions designated by the Commission of the European Communities as qualifying for special support. “Through our investments in these disadvantaged regions and the transfer of know-how, we are contributing to their economic development. Among the measures supported by the European Regional Development Fund (ERDF) and various national programmes are our projects in Portugal, Spain, Germany’s new federal states and four new EU member countries (Poland, Czech Republic, Slovak Republic and Hungary). In addition, our Group companies are also engaged in the educational sector, as well as in research and development work in a wide range of projects that are subsidised by the EU.”<sup>359</sup> Volkswagen also contributes to the development of the Brazilian state of Pará, where “Volkswagen is cooperating with the Brazilian research and development programme ‘Poverty and Environment in Amazonia’ (POEMA) and creating new jobs in a region with structural problems”<sup>360</sup>

Furthermore, they also maintain ties through alliances and partnerships. This includes the Alliance of Synthetic Fuels in Europe (ASFE), comprised of DaimlerChrysler, Renault, Sasol Chevron, Royal Dutch Shell and the Volkswagen group. “The objectives of ASFE are to promote synthetic fuels and support a range of activities in the field of sustainable mobility including research, projects demonstrating the benefits of synthetic fuels including vehicle trials, cooperation with governments and promotion of public awareness.”<sup>361</sup> Volkswagen has also joined the Clean Energy Partnership- an international association of Aral/BP, BMW, Berliner Verkehrsbetriebe (BVG), DaimlerChrysler, Ford, GM/Opel, Hydro, Linde, TOTAL, and Vattenfall Europe <sup>362</sup>- and the Car-2-Car Communication Consortium - comprised of Audi, BMW Group, DaimlerChrysler, Fiat, Renault and Volkswagen<sup>363</sup>

Finally, Volkswagen promotes contact with its customers through autoshows across the globe, for example in New York, Lisbon, Geneva, Madrid, Düsseldorf, Los Angeles, Sydney and Tokyo, where in 2005 the “Volkswagen brand presented the prototype of the EcoRacer”<sup>364</sup> Volkswagen even has its own “theme world” Autostadt. Located in Wolfsburg, Germany, this is where they bring “its brands and all their facets to life for more than two million visitors and delegates per year. The Autostadt is the ideal platform for dialogue with various social groups, for developing relations with local residents and for enhancing the acceptance of the Group among the public, potential future employees and business partners.”<sup>77</sup>

# Motorola

Motorola is a global communications company “known for innovation and leadership in wireless and broadband communications.”<sup>365</sup> Following reorganization in 2005, “the Company was organized into four main business groups, focused on mobile devices, government and enterprise, networks and the connected home (...) In addition, the Company's key support functions, including supply-chain operations, information technology, finance, human resources, legal, strategy and business development, marketing, quality and technology have been architected centrally and distributed throughout the Company”<sup>366</sup>

Figure 21. The global network of Motorola R&D centres



“Throughout history, Motorola has relied, and continues to rely, primarily on its research and development (R&D) programs for the development of new products, and on its production engineering capabilities for the improvement of existing products”<sup>2</sup>; allowing its four operating segments to remain competitive in industries with constant changes in technology.<sup>2</sup> Corporate technology consists of 5 R&D divisions; Motorola Labs, Motorola Software, Technology Solutions R&D, Innovation Acceleration and Standards.<sup>367</sup>

“R&D expenditures relating to new product development or product improvement were approximately \$3.7 billion in 2005, compared to \$3.4 billion in 2004 and \$3.0 billion in 2003. (...) Approximately 25,000 professional employees were engaged in such research activities during 2005.”<sup>2</sup> In 2004, 572 patents were granted in the U.S., adding to a total of 8,416 patents owned in the U.S. and 12,885 in foreign countries.<sup>368</sup> Another source states they “have over 21,300 patents and counting”.<sup>369</sup>

Global headquarters are in Schaumburg, Illinois, but Motorola Technology’s innovation centres are spread all over the world, in order “to have a global footprint.”<sup>370</sup> These R&D

centres support the operating business segments. In addition, the Networks business segment and the Connected Home Solutions segment also have number of R&D facilities in the U.S.<sup>371</sup>

## Market or demand-side factors

The *market* or *demand-side* factors that have induced Motorola to internationalise certain R&D activities include the need to support local business units as well as the need to understand the demands of the customers they serve, in order “to develop technological solutions specific to each region’s needs.”<sup>372</sup>

This especially applies to the Asian regions that Motorola is active in. For example, The Taiwan Technology Center in Taipei, the second R&D center in Taiwan, has been established to provide a “vital link to the overall development of Motorola’s Connected Home solutions which are tailored to customer needs in the region”<sup>373</sup> The Advanced Communications Laboratory at the Motorola Asia Pacific Customer Solutions Centre (CSC) in Penang, Malaysia has been “designed to serve as a critical Asia Pacific system support backbone with strong software development and application integration capabilities to meet the future needs of Motorola’s customers across the region.”<sup>374</sup>

Motorola has established 18 R&D facilities in China to date, in order to be close to key customers.<sup>375</sup> The Hunan Innovation Center, for example, “demonstrates Motorola’s commitment to driving global and local innovation through strong investment in innovation activities. With the advantage of local access, the new center will help operators adopt advanced technologies, seize time-to-market advantages and increase customer revenue, thus enabling them to benefit from the rapid development of China’s telecommunications”<sup>376</sup> “With the establishment of the new Hangzhou R&D center, Motorola is taking another step towards addressing the specific needs of operators in the China market”<sup>377</sup>

In addition to supporting the Networks operating segment to develop, test and launch product offerings for their customers, the Hangzhou R&D center also contributes to the development of “local talent while driving network innovation and the growth of China’s wireless communications industry.”<sup>13</sup> This reflects that besides internationalising R&D activities to adapt products to regional needs, it also allows Motorola to work “with some of the best scientists and engineers in the world”<sup>378</sup>

## Technology or supply-side factors

Access to skilled labour is included in the second type of motivating forces to internationalise R&D activities. These are *technology* or *supply-side factors*, which make it necessary to access a wider range of scientific and technological skills and knowledge than is available in the home markets. “Motorola wants to be close to customers, university partners, and the best talent pools worldwide.”<sup>379</sup> For example in China, the Broadband Wireless China Research Center “will bring deep technical expertise to Motorola business teams in China and will drive research partnerships with customers and universities in China.”<sup>380</sup> “The opening of the center is a further testament of Motorola’s China strategy: to develop China as a production and R&D base”<sup>16</sup>

“The company has also identified India as a technology development (R&D) base, a fact that is reflected in its scope and scale of operations in India”<sup>381</sup> Especially in India the establishment of R&D facilities is motivated by access to local talent pools: “With access to India’s proven best-in-class scientific and engineering talent and the ability to collaborate with world-class universities and institutes, Motorola believes India is the ideal market for applied research and software development.”<sup>382</sup> “We were among the first telecom companies to realize India’s

software potential and invest in establishing a development center here”<sup>383</sup> Opening its first R&D facility in Bangalore in 1991,<sup>384</sup> the company “today has the largest, most versatile and fastest growing R&D presence in the country among all telecom MNCs.”<sup>385</sup>

In 2005, Motorola’s R&D investment in India added up to US\$85 million in technology and R&D. With plans to grow this investment by 10-20% per year<sup>386</sup>, Motorola is rapidly expanding its R&D presence in the country. “Between April and July 2005 it launched Motorola Labs, expanded the presence of its Global Software Group to Hyderabad and launched new facilities for its Core Network Division (CND) and Embedded Communications Computing (ECC) businesses. All of this represents very high-end cutting edge software development and R&D work.”<sup>387</sup> “The investment reflects Motorola’s commitment to India and its confidence in the software talent available in India.”<sup>388</sup>

## **Competitor factors**

This locational determinant refers to the need to closely monitor the technological developments and strategies of competitors. The locations of R&D units are chosen to learn from target competitors or industrial partner. “We currently partner with industry leaders to meet customer product and service requirements and to develop innovative advances in design and technology. Some of our partnerships allow us to supplement internal manufacturing capacity and share the cost of developing next-generation technologies. Other partnerships allow us to offer more services and features to our customers”<sup>389</sup> The nature of knowledge acquisition ranges from one-time collaborations to joint ventures and acquisitions.

Motorola’s “success is dependent, in part, upon our ability to form successful strategic alliances” For example, the Crolles2 Alliance with ST and Philips, means “three of the semiconductor industry’s most innovative suppliers are working together to develop the leading-edge technology platforms.”<sup>390</sup> The alliance has been formed to pool their respective research and development strengths; sharing costs and accelerating the development and availability of advanced technology.<sup>26</sup> Another example is the acquisition of an R&D center from BenQ, which makes Denmark “one of its R&D and development hubs in the region.” “This transaction provides Motorola with another highly skilled R&D team and high-tech facility with a proven product track record, the team will support Motorola’s development of innovative new mobile devices that increase our ability to deliver breakthrough products and experiences that integrate the technologies of both Motorola and our strategic partners”<sup>391</sup>

To gain a competitive edge Motorola also gains knowledge by acquiring competitors. For example, Motorola “has acquired next-generation cable network technology assets from Broadband Innovations, Inc.”, which strengthens Motorola’s solutions with patented innovations. “Many of Broadband Innovations’ employees will join the Motorola Connected Home Solutions business, and will continue to be based in San Diego.”<sup>392</sup>

## **Local R&D**

Two of the four operating business segments have their own R&D facilities, but they primarily rely on Motorola’s R&D programs for the development of new products<sup>393</sup> These R&D programs are organized under one of the five divisions of corporate Technology. Each division has its own R&D units located across the globe, where strong research activity takes place: “locally-driven innovation has enabled Motorola to take a leadership role in the industry.”<sup>394</sup>

## Vertical ties with home country R&D

R&D at the headquarters in Schaumburg, Illinois, U.S.A. does not have a particular hierarchical function over other R&D Centres. Corporate R&D activities are centrally architected under Motorola Technology, which consists of the divisions Motorola Labs, Motorola Software, Technology Solutions R&D, Innovation Acceleration and Standards. With 25,000 engineers and scientists<sup>395</sup> distributed across the company, these divisions support the operating business segment units located across the world.

Although all these divisions are grouped under Corporate Technology, there is limited central coordination. Each division consists of a set of interconnected specialized competence centers or teams that support the Motorola business segments:

- Product development is concentrated at Motorola Labs, which are organized “into discrete Centers of Excellence in key research areas”<sup>396</sup> “In Motorola Labs’ 14 centers around the world some of the brightest minds in their fields to work collaboratively on applied research crucial to the advancement of Motorola’s businesses.”<sup>397</sup>
- “The Motorola Software organization devotes more than 6,000 engineers in 18 design centers worldwide”, “to support and enhance Motorola’s Seamless Mobility reality by providing custom software products, component system solutions and platforms for Motorola business units and their customers.”<sup>398</sup>
- Technology Solutions R&D consists of the R&D teams that are located across Motorola, “pushing innovation and leadership in our four major market businesses: carrier, home, enterprise, and government”; to creating a competitive advantage for the business segments through technology.<sup>399</sup>
- Innovation Acceleration initiatives consist of research teams that identify “promising developmental projects, and then to manage their growth.”<sup>400</sup> “Our goal is to commercialize technologies so that they may graduate to product groups in Motorola’s businesses.”<sup>33</sup> One of these teams is the Motorola the Early Stage Accelerator (ESA). Created to be “the prime commercialization engine for the company, “ESA’s focus is to incubate ideas that are disruptive and/or cross business units”<sup>36</sup>
- Standards teams develop and execute Motorola’s strategies in leading industry standards “Dozens of Motorola managers are actively involved in leading industry standardization efforts. These managers volunteer their time and the experience they have gained in the management of technology to help industry groups advance and promote standards. They hold positions as chairs of technical committees as well as positions on the board of the organizations developing standards.”<sup>401</sup>

## Lateral ties with other R&D

Lateral ties between the units or teams within an R&D Decision are strong, and knowledge is also shared with other R&D divisions. For example, the Early Stage Accelerator, “a multi-disciplinary team of business and technology professionals, is leading cross-business knowledge sharing and investment”<sup>402</sup>, and “Motorola Labs is aligned to deliver solutions in eight crucial technology areas. Each has a specific role in delivering the vision of Seamless Mobility. It is a fluid model that allows for knowledge sharing among the dedicated centers.”

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## **Lateral ties with other functional areas**

There are strong contacts between the R&D units and other functional areas, as the R&D units provide support to the business segments. For example, “the work of Motorola Labs is strongly aligned with the company’s business units and their growth targets”, “Motorola Software Group provides key research and development of production-level software to support product development for Motorola businesses” , and the “Early Stage Accelerator (...) works across businesses to identify and accelerate commercialization of technologies and innovations into marketable products.”<sup>404</sup> In turn, “technical data and product application ideas are exchanged among Motorola's business segments on a regular basis”<sup>405</sup>

## **Type of Organisational Structure**

At local R&D units there is strong research activity, and ties between R&D units and other functional areas are also strong. Corporate Technology acts as a weak center with little central coordination of activities at the R&D divisions. Instead, the R&D divisions function as a network of interconnected specialized competence centers and teams, with strong communication and information flows between them. “Our organization is based on a fluid, functional model”<sup>406</sup>, and it’s this “global research network and locally-driven innovation has enabled Motorola to take a leadership role in the industry.”<sup>407</sup>

## **Linkages between MNE R&D and the region**

By describing the type of interactions between Philips and regional actors, this last section will give an overview of how Motorola investments in R&D contribute to regional innovation and growth. “Around the globe, we are working to make a positive impact and address the needs and concerns of our stakeholders - employees, customers, investors and the community at large (...) each local Motorola facility is able to identify deserving organizations to assist, based on locally-relevant issues and the needs of individual communities.”<sup>408</sup>

## **Contracts and informal ties with local firms**

Motorola contributes to regional innovation by stimulating the local environment through collaborations with firms. In the Hangzhou development zone “Motorola’s new R&D center will help to further drive talent and innovation in the region and beyond. The center will focus on improving the capabilities of enterprise platforms and mobile applications, providing a venue for Motorola to work with operators, service providers, content providers and end-users on wireless application innovation and development, thus driving innovation across the entire value chain”<sup>409</sup> But knowledge is not only transferred to local partners, the co-development of new technologies makes “the most of Motorola’s ability to work with the entire industry, including operators, service providers, application developers and end users.”<sup>410</sup>

Motorola maintains close links with users: “We build long-term relationships with our customers and partners based on trust and integrity. We work closely with customers to develop and test new products and to ensure satisfaction.”<sup>411</sup> In addition, there are a series of Motorola initiatives “designed to demonstrate mobile communications technologies to the end user and to assist customers when choosing technologies appropriate to their subscriber needs” One of them is the EMEA Motorola Innovation Centre in its facility in Swindon, UK, which “signifies our commitment to working closely with our customers and partners to bring new communication solutions to the market to enhance consumer experience.”<sup>412</sup> Another way Motorola has communicates with customers is at conferences like



MOTOINNOVATION, where customers from the Asia Pacific region and beyond were able to have a first-hand look at many of its leading edge technologies<sup>413</sup>

There is also extensive involvement with suppliers, which is included under Motorola's "third-party arrangements for the design or manufacture of certain products, parts and components."<sup>414</sup> Especially the Mobile Devices Segment and Government & Enterprise Mobility Solutions Segment utilize electronics manufacturing suppliers ("EMS") and original design-manufacturers ("ODM") "to enhance our ability to lower our costs and deliver products that meet consumer demands in the rapidly-changing primarily in Asia" <sup>415</sup> Knowledge exchange is important in these relationships. For example, "the Wireless Broadband China Research Center plans to work with Chinese partners to achieve their goals together, and at the same time to prepare Motorola for the exciting future brought by wireless broadband technologies"<sup>416</sup>, and a licensing agreement has been formed with Mitsui that will allow Motorola to implement Mitsui's commercial foil into its own products. "The licensing agreement with Mitsui adds a new dimension to Motorola's ability to transform laboratory innovations to world class solutions for use in converged mobile devices." <sup>417</sup>

Besides contacts with local firms, Motorola is also linked to more than 40 standards bodies. "Motorola will maintain and expand its participation and leadership in formulating the industry-wide standards that facilitate new innovations."<sup>418</sup> "Standards teams develop and execute Motorola's strategies in leading industry standards" and "managers volunteer their time and the experience they have gained in the management of technology to help industry groups advance and promote standards." <sup>419</sup> "Working within global standards bodies, Motorola has helped to define new markets. (...) We have also helped existing customers adapt to new standardized technologies."<sup>420</sup> Specific examples of how Motorola is driving industry standards can be obtained from the previous reference.

## **Contracts and informal ties with research institutes**

There are numerous examples of linkages between Motorola, schools, universities and research institutes. Cooperation with research institutes includes the establishment of a joint "Things-To-Things Research Center" in Seoul with Electronics and Telecommunications Research Institute (ETRI) as part of an effort by the Korean Institute of Information Technology Assessment (IITA). <sup>421</sup> Located in a region that is considered "one of the world's most advanced hubs of high-tech and microelectronic research", the Crolles2 Alliance facility also cooperates with many research institutes. "The Alliance will benefit from an outstanding pool of competence in the region through close cooperation with leading engineering schools and labs, including CEA-LETI, IMEC, France Telecom R&D and other cutting-edge centers in France, Belgium and the USA." Spill-over effects are multidirectional, and affect all players located in the region.<sup>422</sup>

Furthermore, R&D facilities are located close to universities to enable collaboration. This has already been explored in the section supply-side factors, especially in emerging economies like India and China this has a large impact on the local innovation environment. For example in India, access to local knowledge and "the ability to collaborate with world-class universities and institutes"<sup>423</sup> is given as the most important determinant, and in China "Motorola China has a long history of cooperating with local Chinese research institutes and universities in R&D projects. Through developing local partnerships, Motorola has gained deeper understanding of the China market as well as shared the latest telecommunications technologies with our partners. To date, Motorola China has over 30 technology cooperation projects with more than 20 Chinese partners."<sup>424</sup>



Linkages with universities and schools go beyond establishing joint research projects benefit Motorola directly. Motorola also transfers knowledge to the region by supporting “educational institutions and programs that inspire students - especially women and minorities - to embrace science, technology, engineering and math and give them the tools to become the next generation of innovators.”<sup>425</sup> One of the Motorola projects that aims to inspire students is the Building Bridges and Futures project in the United States, which engages high school students in analytical research of Motorola’s new products.<sup>61</sup> “Motorola gets valuable consumer insights while giving students an incredible learning experience and exciting them about business and technology.”<sup>61</sup> Another example is the Ulwazi E-Learning initiative in South Africa, which aims to develop educational opportunities among five schools in the Pretoria area. “The project, the result of a partnership between Motorola, Inc., South Africa’s Department of Education and Communication, and Omega Digital Technologies, endeavours to address teacher shortages in underserved areas.”<sup>426</sup> In general, “Motorola supports systemic and continuous improvements in schools at all grade levels, concentrating on mathematics, science, and engineering, especially for under-represented groups. We fund best-in-class organizations around the world that inspire and target innovation generation.”

“Motorola University is globally recognized as a leader in corporate education. This provides prospective clients with the assurance of consistent, high-quality services.”<sup>427</sup> Motorola is the globally recognized creator of Six Sigma and offers clients the option to partner with Motorola University for Six Sigma implementation. For the client, this ensures that services are based upon first-hand experience, continuous improvement of the methodology and awarding Six Sigma certification.<sup>63</sup>

Motorola is linked to the region through its employees, and they “embrace and value diverse individuals, opinions, cultures and abilities”<sup>428</sup>. “Motorola embeds diversity into our business practices,”<sup>64</sup> in multiple ways. For example the Global Diversity Office, besides providing resources and tools for embedding diversity into business practices, is also responsible for Motorola’s five Diversity Business Councils.<sup>429</sup> “Led by senior executives and emerging leaders, the councils provide opportunities for employees to connect, develop professionally, advance Motorola products and extend a helping hand to their communities”

To develop employees, knowledge is also transferred by offering “training opportunities that meet both business and personal development needs.”<sup>64</sup> Motorola acquires knowledge from employees by fostering “an open-door policy and encourage clear, constant two-way communication through employee surveys, face-to-face meetings, question-and-answer forums and our company intranet”<sup>64</sup> Motorola also “encourages R&D employees to pursue innovative technologies and ideas”<sup>430</sup>, for example through a symposium such as the annual Technology show of Motorola China. “Researchers and engineers from Motorola and our partners come to show how their innovative technologies can improve our products, user experiences and our life,” said Ruey Bin Kao, president of Motorola (China) Electronics Ltd. “And the best technologies and the best innovators will be awarded for their achievements.”<sup>431</sup>

## **Other contractual and informal ties with the local region**

There are also several linkages between Motorola and local governmental and non-governmental organizations. These linkages range from support from local governments to “relationships with local, national and international non-profit organizations to extend resources to communities in need.”<sup>432</sup>

Collaborations with local governments have contributed to developing regions to become innovation hubs. In China, this applies to the new R&D centers in Hangzhou and in Hunan.

“With the close participation and support from the Hangzhou government, Motorola’s new global R&D center will further help transform Hangzhou into a global telecommunications development and innovation hub.”<sup>433</sup> In building the Hunan Innovation Center, “Motorola had strong support from the Hunan government”, which “hopes to take the lead in hosting mobility enterprises and advanced telecommunications applications and services. Motorola Hunan Innovation Center will help Hunan to build experience that will be valuable for the whole country.”<sup>434</sup> In France, the Crolles2 Alliance facility benefits from the fact that “the Grenoble area already was one of the world’s most advanced hubs of high-tech and microelectronic research - thanks to more than two decades of consistent policy by the French central and local authorities’ to encourage public-private partnerships in the sector.”<sup>435</sup> On another level, Motorola has partnered with the local government of Chicago to transfer knowledge about the benefits of technology through a Technology Innovation Week. The City of Chicago is “proud to partner with Motorola to build awareness among our schools, companies and the community – celebrating Chicago’s spirit of innovation.”<sup>436</sup>

On a national level, Motorola also maintains links with governments, actively engaging in the public policy dialogue of countries and communities where they do business “We maintain ongoing dialogue with legislators, regulators and others involved with policy leadership. We also engage policy-makers and regulators through our membership in trade, advocacy and business organizations.”<sup>437</sup> “With 320 facilities in 72 countries and more than 50 percent of our revenues generated outside the United States, Motorola supports policies that promote trade and foster growth in emerging markets,”<sup>73</sup> as well as supporting “an increase in the U.S. president’s fiscal year 2007 budget request for research, development, acquisition and operation in the Homeland Security appropriations bill.”<sup>73</sup> “In the United States, political campaign contributions are one way Motorola advances our views on public policy. Where permissible by state and local law, we support, on a bipartisan basis, candidates and elected officials who share Motorola’s public policy views.”<sup>73</sup>

Motorola is also linked to non-profit organizations, because they “recognize the power of strategic partnerships and nurture them in the many communities in which we live and work. (...) We also know the impact of arts and cultural programs on the fabric of communities.”<sup>438</sup> “In 2005, Motorola worked with leading non-governmental organizations and advocacy groups on issues of mutual interest and concern, including supply chain responsibility, community engagement, education, conservation of natural resources and wildlife protection.”<sup>439</sup> Motorola engages with these organizations directly in meetings, conferences and forums, as well as indirectly through the Global eSustainability Initiative. For example, Motorola is a founding member of the FuTURE Mobile Communication Forum; “an open and international, non-governmental and non-profitable telecommunication organization”<sup>440</sup> Examples of collaborating with a non-profit organization to support educational needs include Project Hope in China and Junior Achievement in China, Hungary, Ireland, Russia, the United Arab Emirates (INJAZ) and the United States (Arizona, Florida, Illinois, Massachusetts and Texas) “Project Hope improves teaching conditions and promotes the development of education in China” and in “Junior Achievement Motorola volunteers teach students from ages five to 17 about financial market activities, and high school students how to set up and run a business.”<sup>75</sup>

To advance environmental needs of the communities they operate in - besides supporting NGOs - Motorola also contributes with its own ECOMOTO program. “Through our ECOMOTO program, we explore innovative ways to measure and improve the environmental characteristics of Motorola products. (...) Our research also has provided product and material test methods that are driving restriction of hazardous substances test standards for the global electronics industry.”<sup>75</sup>

Employing more than 108,000 in 130 countries and territories worldwide, Royal Dutch Shell, with headquarters in the Netherlands, is one of the world's leading energy firms focusing mainly on the extraction of oil and gas. The vision of Shell is to “engage efficiently, responsibly and profitably in oil, oil products, gas, chemicals and other selected businesses and to participate in the search for and development of other sources of energy to meet evolving customer needs and the world's growing demand for energy”<sup>441</sup>.

To accomplish these aims Shell is involved in searching & recovering of oils and natural gas, refining and selling of oil and oil-based products, alternative energy, trading and shipping, as well as global consulting services to the petrochemical and processing industries.<sup>442</sup>

Under the motto of “more upstream and profitable downstream”<sup>443</sup> Shell's strategy focuses on delivery, growth and strengthening Shell's strong portfolio of upstream activities. Consequently, over 80% of capital spending will be allocated to upstream activities, covering both conventional and unconventional hydrocarbon projects. Also, as part of the program, emphasis is put on CO<sub>2</sub> management including sequestration and energy efficiency, although it is difficult to determine the investment in real terms in these sustainable technologies.

Technology and innovation remains central to the group's strategy, involving both development and application of technology as well as innovation in financial and project management skills. Some leading projects of Shell includes the Athabasca oil sands project, Pearl gas to liquids in Qatar, Groningen gas field in the Netherlands, Bonga deepwater project in Nigeria, Na Kika in the Gulf of Mexico, Nanhai petrochemical complex and the Sakhalin II in Russia.<sup>444</sup>

Figure 22. The global network of Shell R&D centres



R&D spending of Shell in 2006 was EUR 741M or EUR 1040M including field tests and involvement of third party technology is included, out of annual revenue of EUR 276Bn or approximately 0.27% of revenue allocated for R&D. The R&D spending in 2005 was EUR 483M out of annual revenue of 265Bn, an increase of 53% between 2005 and 2006.

Technology and R&D are central to Shell's global strategy: "Meeting the world's growing energy needs in an environmentally responsible manner is a tremendous challenge. Technology is essential to answering that challenge."<sup>445</sup> The results of R&D can furthermore be seen in some of the examples in the following chapters underlining the impact on parameters such as costs, production and accessibility of oil and gas reservoirs based on innovations in detection, extraction and refining technologies. Consequently, R&D is prioritised as the one of the four critical functions identified in the company to require specialised directors after the recent restructuring efforts; "I am convinced that technology is key to delivering our business strategy and the complex projects of the future. In 2006 we appointed a Chief Technology Officer to head our technology drive with seven Chief Scientists and thousands of technical staff at our worldwide technology centres, including our new one in Bangalore, India." – Jeroen van der Veer, CEO<sup>446</sup>

The activities of Shell are organised into upstream; exploration & production, gas & power, downstream; oil products, chemicals and other industry segments; renewables, shipping, trading & shell global solutions. <sup>447</sup> R&D however, are organised into distinct areas aimed to "produce energy and petrochemicals sustainably and economically"<sup>448</sup>

These R&D areas are exploring, developing & producing, difficult hydrocarbons, gas commercialisation, refining and supply and new energy sources. Breakthrough innovations often come from innovations in other fields than direct oil & gas technology related research areas such as 3D imaging, catalysts, or chemistry. This realisation demands a broad portfolio of R&D skills in Shell's extended R&D organisation, and is also supported by the availability of experts in diverse fields among senior R&D researchers in Shell. Consequently, the specific Shell R&D projects are linked according to scope and scale of the business lines, and have thus geographical, thematic as well as organisational dependencies.

One of the central issues of R&D in the extraction and energy industry is the strategic importance of costs, efficiency and other basic strategic drivers, which takes many years to develop and maintain competitive. One example is the gas to liquids technology of Shell: "Scientific advances provide only part of the answer to our challenge. Tomorrow's increasingly complex energy projects – often in frontier locations like ultra-deep water or the Arctic – will oblige us to apply new technologies at an unprecedented scale. To do so often requires long-term commitment and many billions of dollars of investment. Our proprietary Gas to Liquids (GTL) technology, for example, took 25 years to develop. It offers new ways of delivering natural gas as clean-burning, efficiency-boosting liquid transport fuel and other products to consumers around the world."<sup>449</sup>

Consequently, although radical changes in technologies can happen, and are often part of a long-term perspective to main a lead in costs of exploration, return on capital or other fundamental KPIs often develop incrementally in the long view, requiring Shell to have a long-term view on R&D.

Large part of R&D is linked to collaborative projects and joint ventures with other partners or foreign oil companies. In China, for example Shell has formed a large scale partnership with CNOOC, and in other parts of the world such Australia, Europe, US and Russia projects are done on a joint-venture basis with varying degree of Shell ownership in the ventures.

Shell has established research centres across the world with primary R&D centres in the US and Netherlands and other technology centres in India, Canada, Germany, Belgium, Qatar, Norway, Singapore and the UK.<sup>450</sup> Research themes involve areas such as Liquid Natural gas (LNG), Catalysts, Seismic Imaging, Smart Wells, Deep water drilling, tight gas, CT Fuel, Coal Gasification. Shell is also active in the alternative energy sector including wind and solar energy, biofuels, hydrogen, coal-to-liquids and oil shale.<sup>451</sup> The new possibilities of outsourcing R&D to Asia is also on the agenda at Shell, including the new research centre in Bangalore: “Shell Technology India was established in Bangalore in 2006. Its staff could eventually grow to more than 1,000 people”<sup>452</sup>

In addition, in in-house R&D, Shell has developed partnerships with a number of universities in the US, UK, China, Norway, Russia and the Netherlands. These university partnerships are expanded with competitions, innovation contests and other activities involving also the student core in innovation, R&D and for recruitment purposes.

Technologies such as LNG, smart wells and snake drilling has been pivotal to the success Shell is enjoying as one of the leading companies in the LNG market, with Shell being part of projects involving more than 40% of the world's LNG.<sup>453</sup> Smart Field technologies combine several technologies including digital information to enable engineering to remotely change extraction methods to optimise the extraction of oil and gas from complex fields, a technology which increases the average amount of oil and gas recovered by 10% and 5% respectively.<sup>454</sup> Other technologies such as snake wells and new extraction technologies have helped to lower the costs of exploration and extraction to sustain Shell's competitive position through R&D.

To enable researchers and engineers to work together on optimising exploration, extraction and research, 12 virtual R&D centres have been set up to allow geologists and engineers to collaborate at different locations with 3D images of underground reservoirs using advanced imaging techniques.

## Locational Determinants

As a natural consequence of the extraction of gas, oil and other energy sources from the environment, geography, proximity and local determinants has traditionally been very important to the place of activities, and thus indirectly R&D activities. A number of projects underline the importance of location in R&D related to activities, some examples are:

- The R&D project related to oil shale in Colorado is linked to the rock in the Green River Basin, which potentially could convert into kerogen using a heating technique developed by Shell called in situ conversion, potentially yielding large amounts of high-quality liquid hydro-carbons, estimated by the US government to be equal to one trillion barrels.<sup>455</sup>
- In China, Shell has formed a 50:50 joint venture with CNOOC for developing a new petrochemical plant in Nanhai, one of China's primary oil fields in Daya Bay in Guangdong with a high degree of recycling of waste and water thus combining both technologies in extraction with the emphasis on R&D into new technologies in recycling and sustainability,
- In Norway, Shell is part of a joint project with Norway's Statoil to develop one of the world's biggest operations to capture carbon dioxide in the Draugen oil field offshore Norway, and using R&D from this venture to recover more oil from the existing oilfields in the region.

- In the North Sea, Shell has deployed its first offshore wind farm 10 kilometres off the Dutch Coast with a capacity of 108 megawatts in a joint venture with electric company Nuon, to developing alternative energy technologies for Northern European countries focusing on increased reliance on sustainable sources of energy with lower CO2 emissions.

Consequently, examining the global map for Shell R&D centres, nearly all R&D centres are located near existing or future energy sources of energy markets, except in the Netherlands although there are fields in the North Sea as well as experimental in alternative energy projects nearby. However, a number of factors might change the future outlook for the locational determinants of R&D in the context of the energy industry.

With the rise of alternative energy sources, the future might be less dependent on the availability of natural resources such as oil and gas in special geographical areas. Instead, more widely available sources of energy such as sunlight, wind, nuclear, nanotech and waves makes the localisation of energy extraction sites in broad terms less dependent on specific geographic characteristics, and might also be less dependent on the proximity of researchers and engineers on location or within short distance. This in turn allows for R&D to be placed independently of resource extraction sites, and consequently, other factors might influence the placement of R&D centres in the future having more to do with intangibles, costs or proximity to headquarters or talent.

The rise of new markets such as China, India and Russia with growing energy demands and growing economies might result in an increased emphasis on the political aspects of the outplacement of R&D for political reasons or reasons of market access. In this aspect the placement of R&D can be seen to evolve along the lines of supply networks, such as being anchored in China for purposes of catering to Chinese energy needs, even though extraction sites feeding the energy networks are found outside of China, such as in Africa, Polynesia or the Middle-East. Similar, Russia's growing position as an energy super-power, puts pressure on Shell to develop strategies which makes the company able to manage its relationships with the state-controlled oil companies on right issues and access to exploration.

Safety-issues and security concerns are currently becoming a more urgent point on the agenda, and might have the effect that R&D centres are prioritised in centres with stability to be able to attract the right talent; "The security situation in Nigeria – which has shut in significant production in the Delta region – remains a serious concern and we do not know when production will resume."<sup>456</sup>

Consequently, the rising violence in certain oil-rich countries in Africa and the Middle-east might result in R&D centres not being prioritised along the geographical lines of business, emphasis the rise of soft factors such as quality-of-life in the quest to attract top talent in R&D.

Another issue, for the energy sector is the environmental discourse, which can be a double-edged sword for the competitiveness of the large MNEs. Shell felt this the hardest with the Brent Spar in the North Sea, and subsequent Ken Sora-Wima incident in Nigeria.<sup>457</sup> This has forced Shell to develop a clean energy or environmental technologies business line, and to allocate considerable resources to R&D into sustainable / alternative energy, as well social responsibility programs; "In the drive to slow the build-up of greenhouse gases, Shell is pursuing cost-effective ways of capturing carbon dioxide from large sources such as power plants and storing it safely underground. Shell's commitment to renewable energy is plain to see in projects like our first offshore wind farm and our involvement in biofuels."<sup>458</sup>



However, other emerging players in the global energy industry might not play by the same rules, leaving Shell in a dilemma between the pressure from the Western markets to maintain a responsible corporate profile, and the competitive pressures of Eastern energy companies with less domestic pressures to focus on environmental issues.

Finally, the energy industry is constantly under pressure from political events and developments, and requires the players such as Shell to accommodate local requirements for gaining access to energy resource; “In Sakhalin, we cleared the way forward by agreeing to partner with Gazprom on what is the world’s largest integrated oil and gas project under construction.”<sup>459</sup>

The further quote, explaining the terms for this ‘way forward’ where; “In December 2006, the partners in Sakhalin Energy, of which Shell owns 55%, signed a protocol to sell half of their shares to Gazprom, clearing the way for possible expansion, as well as further exploration opportunities around Sakhalin Island. The partners also reached agreement with the Russian government on the project’s amended budget.”<sup>460</sup>

The requirements can both have influence on the structure of local relationships and on the decision on where to place R&D facilities to accommodate local markets and national political requirements.

## **Organisational Structure**

Shell has a complex organisational structure comprised of four types of company. The parent companies are Royal Dutch Petroleum Company N.V of the Netherlands, and Shell Transport and Trading Company plc of the UK, which owns the shares of the group holding companies with 60% and 40% respectively. The group holding companies Shell Petroleum N.V. of the Netherlands and The Shell

Petroleum Company Ltd hold shares in the services companies and operating companies of the group. The service companies provide advice and services for the operating companies, but are not responsible for operations. The operation companies numbering more than 200 companies in over 100 countries with varying ownership by Shell are responsible for the actual operations are usually joint-ventures with local contractors, public or private companies from the industry covering a wide range of activities including exploration, extraction, marketing and sales.<sup>461</sup>

The many-sided R&D activities in Shell are organised along the lines of the corporate structure of the Shell group. Historically Shell has been organised in a matrix-structure based on a geographically-oriented principle. As opposed to other oil & gas companies, Shell has not been through large restructuring in the 1980’s, but managed to achieve efficiency through organisational flexibility and the large degree of freedom enjoyed by the matrix organisation. The operation companies bought services from the services companies and reported to the central management, but otherwise knowledge sharing, R&D and services were done through the services companies on the basis of the requirements for services by the country-based operations companies.

However, in the end of the 1990’s Shell financial performance indicated that Shell lagged behind companies such as BP, which had gone from bureaucratic government owned companies to a more lean and innovative profile through wide-reaching restructuring programs. Consequently, Shell went through re-organisation efforts which completed in the beginning of 2000, and led to an organisation along the now established business-lines.<sup>462</sup> In this process it was acknowledged by Shell that the different business lines required different logics regarding knowledge transfer technologies and services, and doing this within different



business within a country or region, did not provide for critical mass. Exploration, for example, requires new technologies and knowledge sharing, whereas downstream are more focusing on methodologies for rationalisation and efficiency.

Today, Shell has a decentralized structure, divided into business organisations, which reports to the Committee of Managing Directors. R&D in Shell is organised under a business director for research and technical services, who is part of the business committee heading each business organisation. The business organisations ensure the focus on the business-lines, and are thus also staking the directions for R&D based on the long-term requirement of each business line for technology and innovations. The operation companies are still focused and countries, but the larger units have been split up according to business lines to ensure that focus is directed towards the global natural partners within the same business line, within the Shell group, in relation to access to R&D resources.

## **Linkages Between MNE R&D and the Region**

The organisation of operation companies focusing on special countries and regions, ensures that each operation companies can be set up in a number of different configurations that serve the necessities of the local markets. In Qatar, this has lead to Shell investing in an R&D centre alongside the oil & gas exploration and extraction operations, in exchange for access to the resources, but also to extract knowledge from the local conditions, which can be of benefit to other operations in the middle-east and elsewhere; “Shell, as a committed technology partner of Qatar and global leader in technological development and innovation in the oil and gas industry, is bringing a world-class technology programme to Qatar, a move which has been facilitated by the development of Qatar's Science & Technology Park. The Centre will be part of Shell's global research and technology organisation and will commence operation in early 2006. The activities of the Centre will initially focus on Upstream and Gas to Liquids (GTL) technologies; technical services; and a related training centre.”<sup>463</sup>

As parts of R&D in the exploration, extraction and distribution of oil & gas is still linked to the knowledge of local conditions and markets, local presence means that knowledge can be transferred from one region or market to the other. For example Shell has experienced that knowledge gained on subsurface geology in the Gulf of Mexico and offshore West Africa could be shared across the two regions leading to discovery of new resources. The linkages to the region also extends into other areas such as developing new refinery technology in one place, and using this in other places or local understanding of markets and cultures.<sup>464</sup> “In many of these pioneering projects, Shell works with partners – governments, universities, research institutes and other companies. We know from experience that good ideas often bear fruit through collaboration with organisations whose strengths differ from our own. In turn, our partners benefit from our technology and our ability to apply it on a large scale.”<sup>465</sup>

The efforts in Qatar to develop gas-to-liquid fuels (GTL) as part of the Pearl GTL project, is mirrored by a joint venture in Canada with logen that produces a similar fuel based on straw. In Germany, Shell has established a partnership with CHOREN Industries for the purpose of developing biofuel based on woodchips, similar to the GTL fuel. In this way Shell is exploiting the local knowledge and resources, and adding extraction, manufacturing, distribution, refinement or other knowledge to the particular partnership needed to come full circle. The location in Germany has the added benefit that it is also the location of Shell collaboration with Volkswagen Audi-brand for using GTL-diesel for fuel in the Le Mans races. By leveraging its knowledge globally, Shell can enjoy the benefit of distributed knowledge resources, and focusing this within one business-line such as biofuels / renewables as well as developing future downstream opportunities for the extraction industry in e.g. Qatar.<sup>466</sup>

Through the joint-venture model, Shell obtains access to markets and to mitigate the risk and investments associated with exploration as well as R&D related to developing new means of developing energy sources. Some examples are:

- In Germany, Shell is taking advantage of the government subsidies to solar panels, by partnering with AVANCIS GmbH for developing thin-film panels, thus ensuring a lucrative local market for early-adaptation of technologies.<sup>467</sup>
- In Nigeria, Shell is involved in e.g. partnerships at the Bonny Island with a 27.5% minority stake. However, although the field has the potential to become as big as Qatar, the security situation means that little R&D is expected to be placed in the local region.<sup>468</sup>
- In Canada, Shell holds 60% stake in a joint venture to develop extract oil from oil sands, and to develop new technology and methodologies for this purpose. The potential in oil sands makes Canada the second largest potential source of oil after Saudi Arabia according to estimates, and already now supplying 10% of Canada's oil needs.<sup>469</sup>

## **Contracts and Informal Ties with Research Institutes**

Shell employs a wide network of university related research and research contracts with leading universities worldwide with specialisations in the key industrial areas and R&D areas related to Shell's activities. Selected partnerships in R&D activities are the following:<sup>470</sup>

- Colorado School of Mines, Golden, Colorado, USA
- Imperial College, London, UK
- Institute of Coal Chemistry, Taiyuan, China
- MIT, Cambridge, Massachusetts, USA
- NTNU-SINTEF, Trondheim, Norway
- Qinetiq, Farnborough, UK
- Russian Academy of Sciences, Moscow, Russia
- St. Petersburg State University, St. Petersburg, Russia
- Tsinghua University, Beijing, China
- TU Delft/TNO, Delft, the Netherlands
- University of Texas, Austin, Texas, USA

In the area of developing new skills, professional services and for purposes of knowledge sharing, Shell has set up programs with four universities to develop curriculum and complement expertise:

- Cranfield School of Management
- Delft University of Technology
- University of Texas at Austin/McCombs School of Business
- Queensland University of Technology.

## GlaxoSmithKline

GlaxoSmithKline (GSK) is a research-based pharmaceutical company with headquarters in London, UK. The company employs over 100,000 staff worldwide, of which 15,000 are working with discovering new medicines, and is one of the world's leading pharmaceutical companies with an estimated seven percent of the world market for pharmaceutical products. The mission of GSK is expressed as "to improve the quality of human life by enabling people to do more, feel better and live longer".<sup>471</sup> Consequently, the company is strongly promoting a profile of responsibility and is active in a number of areas for both medicines and vaccines for the World Health Organisation's three priority areas, HIV/AIDS, tuberculosis and malaria. GSK is also promoting other areas such as corporate equality, as has among other factors over 33% women in managerial positions. The company employs over 40,000 sales people, and sells products in more than 160 countries. It has 24 major and minor research sites in 11 countries and 82 manufacturing sites in 37 countries worldwide. For 2006 and forward, the four key strategic objectives are cancer, diabetes, malaria and further the development of a strong business culture.<sup>472</sup>

The primary areas of GSK are medicines for the six areas of asthma, virus control, infections, mental health, diabetes and digestive conditions, as well as cancer treatment. In addition, the company is a world leader in over-the-counter market in areas such as dental products, smoking control products and nutritional healthcare drinks. GSK supplies one quarter of the world's vaccines, supports over 2,000 new products and line extension launches annually, and has over 1,400 branded products, including 10 of the world's 60 top-branded products such as Augmentin, Imigran/Imitrex, Avandia, Lamictal, Seretide/Advair, Seroxat/Paxil, Coreg, Flixotide, Wellbutrin and Zofran.<sup>473</sup> Turnover in 2006 was EUR 37Bn with investments in R&D of EUR5.5Bn.<sup>474</sup>

### Organisational Structure

GSK is an English public limited company, with headquarters in English and operational headquarters in the Philadelphia, USA. The company was incorporated in 1999, and acquired the two companies Glaxo Wellcome plc and SmithKline Beecham plc by way of a scheme of arrangement for the merger of the two companies.<sup>475</sup>

The top-management is organised with one chief operating officer, and a corporate executive team comprised of eight non-executive officers. The operations are divided into market related activities; Consumer Healthcare, Pharmaceuticals Japan, Pharmaceuticals US, Pharmaceuticals Europe, Pharmaceuticals International, Global Manufacturing and Supply, supporting functions including human resources, information technology and corporate communications & community, and Research & Development.<sup>476</sup>

Figure 23. The global network of GSK R&D centres



## The Organisation of R&D Activities

The R&D strategy of GSK is summed up as: “We aim to create the best product pipeline in the industry for the benefit of society. This includes developing a focused strategy to support the pipeline and manage the full life cycle of compounds from launch as prescription medicines through to potentially becoming over-the-counter products. We measure R&D productivity by the number and level of innovation of the products it creates, and by the ability to address unmet patient needs.”<sup>477</sup> Currently, GSK has 154 projects in clinical development, 31 major products in phase III development or registration, and 94 chemical entities and 23 vaccines in clinical development.<sup>478</sup>

R&D is organised in two research organisations; Centres of Excellence for Drug Discovery (CEDD) and Medicine Development Centres (MDC).<sup>479</sup> The CEDDs are organised as small, multidisciplinary entrepreneurial groups focusing on research and development projects. Consequently, the CEDDs have faster decision-making processes, in order to shorten R&D cycles and lower costs. CEDDs have been created for the research areas of biopharmaceuticals, cardiovascular & urogenital diseases, metabolic & viral diseases, microbial, cancer, musculoskeletal & proliferative diseases, neurology & gastrointestinal diseases, psychiatry, respiratory & inflammation, and external drug discovery, the latter CEDD focused on GSK’s Alternative Discovery Initiatives (ADI), used for handling external R&D.<sup>480</sup>

The MDCs are matrix-based teams responsible for global development opportunities for research & development done by the CEDDs, and support this process with registration, safety programs, pricing and formal negotiations and procedures. The MDCs are linked to the GSK’s Global Commercial Strategy Team; “which ensure regional marketing needs are fully integrated into development plans at an early stage, in order to deliver differentiated products of value.”<sup>481</sup> In addition, the MDCs are linked to the Worldwide Development

organisation, focused on the aspects of global development. In sum, based on this structure, all the major components of the drug development process are integrated in one organisational structure, with its own management and necessary activities areas covered.

GSK estimates that it takes on average upwards of 10-15 years and costs more than EUR 750M to discover and develop a new drug.<sup>482</sup> Consequently, as the pharmaceutical industry is characterised by these long and complex development cycles, with significant risks and high development costs, GSK have developed a number of strategies for maintaining a strong product pipeline for its worldwide markets and ensure business development through the ADI program. Some of these strategies are in-licensing, co-marketing and co-promotion, in which GSK in exchange for access to promising products, provides access to their expertise in R&D, regulatory management and marketing, as well as global market access through GSK's distribution and marketing networks; "Developing new medicines and vaccines is an expensive and risky business. We need to ensure that we have a strong pipeline of new products that will enable us to carry out our mission to improve the quality of human life. One of the ways that we do this is by in-licensing, co-marketing and co-promoting new products with other businesses. This helps to ensure that our business can grow and complements our existing products with new ones that offer new or more effective treatments for disease."<sup>483</sup> Currently in-licensing agreements in 2007 include arrangements with companies such as Genmab, HGS, Gilead/Myogen, Akros/Japan Tobacco, ChemoCentryx, EPIX, Kissei, Pharmacopeia and Sirna.<sup>484</sup>

GSK also offers other means of collaboration with external parties in the areas of research and new products. These models include research collaborations, out-licensing arrangements, academic liaisons, and alternative discovery initiatives. In total, GSK has established over 50 compound alliances, which is now over 40% of the development pipeline. In addition, GSK has entered into a number of technology and academic alliances.<sup>485</sup> One such example is the new partnerships with Hammersmith Hospital in London; "In 2007, GSK's new clinical imaging centre at Hammersmith hospital in London will be fully operational. We have invested £46 million in the Centre. It is an exciting collaboration with Imperial College and evidence of our continuing commitment to experimental medicine. Research will focus on cancer, stroke, neurological diseases such as Parkinson's and multiple sclerosis, and psychiatric diseases.", Moncef Slaoui, Chairman of R&D<sup>486</sup>

Under the ADI programme, the external collaboration activities are organised under the Centre of Excellence for External Drug Discovery (CEEDD), to ensure that these collaborations have one management structure catering to their special needs, as well as securing the advantages of the CEDD and MDC structures for the partnerships: "Combine the revolutionary CEDDs with the MDCs — and GlaxoSmithKline emerges as a leader in product development and commercialization. Every step of the way, your product will be championed by these teams. We are global where it is critical, but small enough to ensure speed and attention to your product or technology."<sup>487</sup>

## **Locational Determinants**

GSK is increasingly aware of having to seek talent for its R&D and external partnerships worldwide. This is the reasoning behind the emphasis on business culture and diversity in the workforce in the company. In addition, the company is also aware of the need to globalise R&D to get access to global talent pools; "We need to work with the world's best talent and globalise the R&D function. Having established a centre in Croatia in 2006, our next step will be to open a new research centre in China. We expect to announce further details on this during 2007," Moncef Slaoui, Chairman of R&D<sup>488</sup> Other pharmaceutical companies are

already taking advantage of the markets in China and India, whereas GSK seems more reluctant to enter the markets and outsourcing R&D to research centres or local companies.

Another area of location determinants is the area of clinical trials for new drugs and vaccines. The placement of clinical trials does not have to be located in proximity of the R&D facilities, but can in effect be carried out anywhere in the world where there is sufficient infrastructure to manage and monitor clinical trials. Consequently, the prospects of lowering costs by doing clinical trials in countries such as India and China, carries interesting prospects for outsourcing of this area of R&D while simultaneously reaping potential political benefits of investing in the countries as a lever for improved market access. In Europe, pharmaceutical companies are in effect able to do R&D in one country, clinical trials in another country and get approval and IPR in a third country. However, the area clinical trials in third countries carry certain connotations that must be observed. Doing clinical trials in poor countries can by some be observed as taking advantage of the world's poor population for medical experiments and risks, and must as such be handled carefully. Secondly, the increasing awareness of evidence-based medicine and differences in DNA profiles and medicine response across the world's major populations, carries the risk that clinical test results from one part of the world might not be completely transferable to the world market. Consequently, GSK cannot be indifferent as to where clinical trials are conducted and where the drugs or vaccines are sold and used. This becomes increasingly important with drugs and vaccines being developed for certain parts of the world such as Malaria medicine.

Lifestyle-related diseases such as diabetes create new markets in the world's emerging economics. Consequently, a country like China is now seeing a boom in diabetes and diabetes-related diseases following the rising income of the population. These and other factors might call for GSK to place R&D facilities in the growing markets partly for obtaining access to the growing population for purposes of research and testing, and also for ensuring that R&D facilities are present in a country where these diseases suddenly gets priority, which might be mirrored in the priorities of universities, R&D labs and government spending, thus creating a talent pool of graduates and more experienced researchers.

Convenience and other-the-counter products are fast-growing markets in the developed countries. Consequently, products such as teeth-whitening, products to quit smoking, as well as treatments for non-life threatening but inconvenient conditions such as the flu are becoming an increasingly interesting market. "2006 saw our Consumer Healthcare business unlock its growth potential across the portfolios. Consumer Healthcare sales were £3.1 billion, a 6 per cent increase over 2005. We are driving growth through greater innovation and more effective marketing strategies on strong brands.", John Clarke, President, Consumer Healthcare<sup>489</sup>

The emergence of products in these fields often relate to local demands and local culture, which signifies local presence to pick up on trends or to spot opportunities for commercialisation of new or existing products. These products can be carried through either from the CEDDs, the MDC, or through the sales organisation, which has local market contact, if sufficient feedback loops exist in GSK. A third alternative is an increased emphasis on innovation models such as open innovation or user-driven innovation that also carries proximity as a central component; "We are looking for innovation wherever we can find it, inside or outside the company – something we call Open Innovation. We have also increased alignment between R&D and our global brand teams so we understand consumers' needs better and can deliver more innovative products that meet those needs.", Ken James, head of R&D for Consumer Healthcare.<sup>490</sup>

Part of the R&D, which entails administration of drugs or vaccines, also carries requirements related to the location aspects. Regimes and processes for administering drugs that work in countries in the development world might not work in countries in the third world, for various reasons, which either require the innovation of new technologies of administration or development and enforcement of existing and new processes. Consequently, GSK has embarked on Positive Action community investment programmes, which play a part in developing or maintaining adequate structures for distribution, administration or monitoring of e.g. vaccine regimes in countries with inadequate healthcare systems in areas such as HIV/AIDS, malaria and tuberculosis. The programs covered a total investment of EUR483M in 2006 and run in more than 100 countries. In addition, there are special programs for diseases such as lymphatic filariasis. The programs also involve education in sanitation and hygiene, in countries such as Mexico, Nicaragua, Peru, Uganda, Zambia, Tajikistan, Bolivia, Bangladesh and Nairobi and are offered in collaboration with humanitarian organisations such as Save the Children.<sup>491</sup>

For major projects such as tackling malaria, GSK also invests in broader research collaborations with global networks of R&D organisations, universities and other pharmaceutical firms that are closer to the markets or specialising in certain areas of the R&D path. The networks and collaborations are funded either directly by GSK through special programmes, or by public-private partnerships such as the Medicines for Malaria venture.<sup>492</sup> In addition, GSK has granted voluntary licenses to eight drug-manufacturing companies in sub-Saharan Africa for the production of Anti-Viral Drugs (ARV) against HIV/AIDS.<sup>493</sup>



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## Appendix: Notes

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