“Decentralized R&D and strategic competitiveness: globalised approaches to generation and use of technology in multinational companies”

By Robert D. Pearce

Illustrated by the R&D structure of General Motors Corporation

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Decentralized R&D and strategic competitiveness: globalised approaches to generation and use of technology in multinational companies

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Introduction

The purpose of this report is to analyze the article “Decentralized R&D and strategic competitiveness: globalised approaches to generation and use of technology in multinational companies” by Robert D. Pearce. This paper was written in 1999 and was aimed at analyzing the centrifugal and centripetal forces that drive location of R&D centers in multinational enterprises. This paper has also received over 130 citations by the literature\(^1\). We will first summarize the main findings of this paper which were the results of a survey conducted by D. Pearce.

The second part of this report focuses on the automotive industry and more specifically at General Motors. We will first describe the company’s activities and main characteristics, before focusing on innovation within GM. We will try to gain insights on GM’s R&D activities and try to determine to what extent are these research activities coherent with the results reaped by R. Pearce in 1999.

The automotive industry is one of the world’s biggest investor in R&D and General Motors is one of its key players\(^2\). Therefore, we found that it would be interesting to compare ongoing trends within this sector with the survey results issued by R. Pearce.

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\(^1\) List of citations available on googlescholar: http://scholar.google.be/scholar?hl=en&lr=&cites=4936655648465022708

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Section 1: Article summary

1. Introduction

In the past, foreign R&D centers from Multinational Enterprises (MNEs) use to simply apply the existing products and technology to the foreign environment. The application of existing technologies abroad means both shaping a suited product and adapt its production process.

Nowadays, MNE use their foreign R&D facilities to foster ideas which will shape the future competitiveness of the firm. This development occurs in both the medium and long term. In the medium-term, decentralized R&D centers develop new products which better meet customers’ needs. In the long-term, these foreign R&D centers will create new knowledge which will benefit the firm.

The literature usually cites centrifugal and centripetal forces as two main drivers of R&D location. A main centrifugal force is the need to “adapt products or processes to subsidiaries’ local-market conditions”.

Centripetal forces include:
- The wish to retain the more creative at home.
- Economies of scale: MNEs believed that it would turn out to be cheaper and more efficient to gather scientists and equipment within fewer R&D centers.
- Agglomeration force, which reflects the fact that companies tend to settle their R&D centers close to each other in order to benefit from synergies and research institutions.

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3 Pearce R. (1999), Decentralised R&D and Strategic Competitiveness: Globalised Approaches to Generation and Use of Technology in Multinational Enterprises (MNEs), Research Policy, 28(2-3), 157-78.
- Control and coordination, which was believed to be easier when R&D activities are conducted under one roof. This would also avoid parallel research in different R&D locations.
- Information leakages: companies believed they would face IP protection issues when implementing worldwide network of R&D centers.

The last decades have witnessed an increase in MNEs’ foreign R&D facilities. This cannot be explained by a simplistic centripetal of centrifugal approach, which assumes that the parent unit has full control and authority over foreign subs. A more modern view is that MNEs are building mutually-supportive worldwide knowledge networks, enhancing the strategic competitiveness of firms. The role of the center, or parent, would in that case be to facilitate knowledge exchange and a global coherence rather than controlling.

2. Decentralized R&D in the contemporary MNE

The authors distinguish two different environments in which R&D labs are performing.

The first context is characterized by the fact that R&D activities work along with other functions within the subsidiary in order to develop a particular product which would be brought on to the market by the subsidiary. In order to better address local needs, the R&D laboratory uses company-level knowledge and develops its own manufactured goods.

The second context reflects a more contemporary view, implying that laboratories shape the company’s core knowledge. The way foreign R&D centers
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may achieve such a task is by reaping foreign comparative advantages (technological heritage, scientific competences…) and applying the latter in a company-wide strategic research. This can be done by developing key capabilities and specialize in a specific field which will make the lab essential for the company’s growth. Decentralized R&D labs will specialize in an area of competence reflecting the host-country knowledge legacy, and eventually enhance the enrichment of group-wide technology. The key challenge in managing decentralized R&D centers is to maintain and ensure a global coherence and focus of research.

3. Survey Methodology

In order to gain an insight on the ongoing trends among foreign R&D centers of MNEs, the authors have conducted a survey, using two questionnaires. This survey took place between 1992 and 1994 in the United Kingdom.

The first questionnaire was aimed at foreign production subs based in the UK, which were asked about their role in the “group’s strategic operations” and the technology creation and implementation. The second questionnaire was sent to foreign R&D labs based in the UK which were asked about their role in supporting the “group’s technological and commercial progress”. The authors wished to proof that a trend exists towards increased centrifugal factors at the expense of centripetal ones. Two hypotheses were made while conducting this survey. The first one is that research labs operating in production subs have more potential for new product development. The second hypothesis is that foreign labs have evolved from a state of dependency to an interconnected network of knowledge. Foreign labs can specialize in a field as well as gain
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knowledge about local needs and taste. Hence, they become more involved in the production process at a group-wide level and collaborate with production subsidiaries in order to bring these products on to the market. The authors also assume that the location choices of key R&D labs are driven by country-specific knowledge heritage.

On the other hand, centripetal forces have weakened, because the need to organize and control, can be fed by enhanced communication technology, along with more efficient managerial practices. IT has also decreased the relevance of R&D economies of scale because decentralized research labs may overcome distance by improved communication practices.

R&D Labs in Subs
The survey conducted by the authors asked questions in order to define seven variables which are as follows:

- OWNLAB: is defined as: “R&D carried out by their own laboratory”. Therefore, this variable indicates the presence of in-house R&D in foreign subsidiaries.

For subsidiaries which had a R&D center in-house, four extra variable have been added to determine the role of the R&D center within the subsidiary:

- ESTPROD/UK: is defined as the degree to which the sub produces goods that belong to the group’s product range for the UK market.
- ESTPROD/EUR: is defined as the degree to which the sub has a role in providing the European supply network with parts of already established products. This variable therefore will be used by the authors as a sign of integration.
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- COMPART: is defined as the extent to which the sub “plays a role in the MNE group’s European supply network by producing and exporting component parts for assembly elsewhere.

- DEVELPROD: is defined as the extent to which the sub “develops, produces and markets for the UK and/or European (or wider) markets, new products additional to the MNE group’s existing range”.

4. Survey Results

The first aim of the survey was to compare the dependent variable “OWNLAB as a source of technology” with independent variables illustrating subsidiary roles. The results of this survey are provided on the table here below.

Regression with evaluation of OWNLAB as a source of technology as a dependent variable

<table>
<thead>
<tr>
<th>Variable</th>
<th>USA</th>
<th>Japan</th>
<th>Europe</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>2.2615 * (2.67)</td>
<td>0.7880 (1.14)</td>
<td>-0.1055 (-0.34)</td>
<td>0.9335 * * (2.61)</td>
</tr>
<tr>
<td>Food</td>
<td>-0.2734 (-1.41)</td>
<td>-0.1303 (-0.87)</td>
<td>0.0313 (0.41)</td>
<td></td>
</tr>
<tr>
<td>Automobiles</td>
<td>-1.8791 * * (-2.03)</td>
<td>-0.1679 (-0.54)</td>
<td>-0.0541 (-0.95)</td>
<td>-0.2591 (-0.82)</td>
</tr>
<tr>
<td>Aerospace</td>
<td>-0.9643 * * (-2.12)</td>
<td>-0.2760 (-1.35)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronics and electrical appliances</td>
<td>-0.3020 (-1.05)</td>
<td>0.0264 (0.36)</td>
<td>0.0611 (0.38)</td>
<td>0.0246 (0.38)</td>
</tr>
<tr>
<td>Mechatronics engineering</td>
<td>-2.8833 * (-2.25)</td>
<td>-0.0359 (-0.55)</td>
<td>0.0474 (0.78)</td>
<td>-0.0264 (-0.61)</td>
</tr>
<tr>
<td>Instruments</td>
<td>-0.2522 (-1.60)</td>
<td>0.0018 (0.57)</td>
<td>0.1318 (1.23)</td>
<td>0.0270 (0.47)</td>
</tr>
<tr>
<td>Chemicals</td>
<td>-0.4999 (-1.67)</td>
<td>0.0077 (0.64)</td>
<td>0.2433 (1.80)</td>
<td>0.0868 (0.93)</td>
</tr>
<tr>
<td>Pharmaceuticals</td>
<td>-0.1744 (-1.62)</td>
<td>0.0930 (0.84)</td>
<td>0.0788 (1.42)</td>
<td>0.0591 (0.91)</td>
</tr>
<tr>
<td>Metals</td>
<td>-0.2125 * (1.79)</td>
<td>0.0059 (0.08)</td>
<td>-0.0239 (-0.35)</td>
<td>-0.0025 (-0.15)</td>
</tr>
<tr>
<td>USA</td>
<td>-0.0811 * (2.02)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>-0.0811 * (2.02)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ESTPROD/UK</td>
<td>-0.0856 (-0.64)</td>
<td>0.0323 (0.21)</td>
<td>0.1740 (1.29)</td>
<td>-0.0609 (-0.60)</td>
</tr>
<tr>
<td>ESTPROD/EUR</td>
<td>0.0798 (0.39)</td>
<td>0.1072 (0.67)</td>
<td>0.2722 * * (2.09)</td>
<td>0.1020 * * (2.12)</td>
</tr>
<tr>
<td>COMPART</td>
<td>0.2011 (1.29)</td>
<td>-0.2118 (-1.07)</td>
<td>-0.1693 (-0.70)</td>
<td>-0.0596 (-0.59)</td>
</tr>
<tr>
<td>DEVELPROD</td>
<td>0.5432 * * * (4.27)</td>
<td>0.4357 * * * (2.95)</td>
<td>0.5122 * * * (5.18)</td>
<td>0.4799 * * * (6.70)</td>
</tr>
<tr>
<td>R^2</td>
<td>0.3987</td>
<td>0.2302</td>
<td>0.6496</td>
<td>0.3279</td>
</tr>
<tr>
<td>F</td>
<td>2.45 *</td>
<td>1.26</td>
<td>4.89 * *</td>
<td>5.14 * *</td>
</tr>
<tr>
<td>n</td>
<td>92</td>
<td>64</td>
<td>41</td>
<td>174</td>
</tr>
</tbody>
</table>

Source: Pearce R. (1999), Decentralised R&D and Strategic Competitiveness: Globalised Approaches to Generation and Use of Technology in Multinational Enterprises (MNEs), Research Policy, 28(2-3), 157-78.

This table clearly shows that product development (which is illustrated by the DEVELPROD variable) plays an increasing role in overseas subsidiaries. The
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degree to which companies will set up laboratories in foreign subsidiaries is
increasingly to develop new products.

Besides, in European subsidiaries, labs provide technology by “playing a
role in the MNE group’s European supply network by specializing in the
production of and export of part of the established product range”.

The second step of the survey was only aimed at production subsidiaries
which had research laboratories. The latter were asked several questions based
on four indicators:

- ESTPRODADAPT: defined as the “adaptation of existing products
and/or processes to make them suitable to our markets and conditions

- NEWPRODDEVEL: defined as to what extent does the sub “play a role
in the development of new products for our distinctive markets”.

- GROUPADVICE: defined as to what extent does the sub “advises on
adaptation and/or development to other producing subs of our MNE
group.

- BASRAD: defined as to what extent does the sub “carries out basic
research, which is not correlated to current products, and which is part
of a wider MNE-group-level research program.

The table below presents the outcome of the second aspect of survey concerning
the role of laboratories within foreign subsidiaries.
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This table proofs that, on average, labs in foreign subs mostly focus on the development of new products, rather than applying existing technology to local markets. However, the gap between these two variables (NEWPRODDEVEL and ESTPRODADAPT) is lower than expected. His means that labs based in foreign subs continue to apply existing group-wide technologies on to the local market needs.

The way to conciliate the two tables presented here below is to claim that foreign R&D centers are primary focusing on new product development, but that once these centers have reached this stage, they are also asked to adapt existing technologies to local constraints.

Technological advice on established products or new inventions appears to be carried on primary by "ESTPROD" or "DEVELPROD" subs rather than by "GROUP ADVICE".

Subsidiaries were rarely able to explain the work done in their labs to the extent which was expected by the authors. This could reflect the evolutionary

### Roles of R&D laboratories of MNE subsidiaries in the UK, by industry and home country

<table>
<thead>
<tr>
<th>Laboratory roles (average response*)</th>
<th>ESTPROD ADAPT</th>
<th>NEWPROD DEVEL</th>
<th>GROUP ADVICE</th>
<th>BASRAD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>By industry</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food</td>
<td>2.71</td>
<td>3.00</td>
<td>2.57</td>
<td>1.57</td>
</tr>
<tr>
<td>Automobiles</td>
<td>2.86</td>
<td>3.00</td>
<td>1.86</td>
<td>1.43</td>
</tr>
<tr>
<td>Electronics and electrical appliances</td>
<td>2.59</td>
<td>2.73</td>
<td>1.89</td>
<td>1.54</td>
</tr>
<tr>
<td>Mechanical engineering</td>
<td>2.60</td>
<td>3.00</td>
<td>1.87</td>
<td>1.40</td>
</tr>
<tr>
<td>Instruments</td>
<td>2.20</td>
<td>3.17</td>
<td>1.80</td>
<td>1.90</td>
</tr>
<tr>
<td>Industrial and agricultural chemicals</td>
<td>2.81</td>
<td>2.81</td>
<td>2.38</td>
<td>1.86</td>
</tr>
<tr>
<td>Pharmaceuticals and consumer chemicals</td>
<td>2.38</td>
<td>2.50</td>
<td>1.75</td>
<td>2.38</td>
</tr>
<tr>
<td>Other manufacturing</td>
<td>2.54</td>
<td>2.82</td>
<td>1.73</td>
<td>1.45</td>
</tr>
<tr>
<td>Total</td>
<td>2.62</td>
<td>2.84</td>
<td>2.00</td>
<td>1.64</td>
</tr>
<tr>
<td><strong>By home country</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USA</td>
<td>2.52</td>
<td>2.90</td>
<td>2.19</td>
<td>1.76</td>
</tr>
<tr>
<td>Japan</td>
<td>2.78</td>
<td>2.93</td>
<td>1.74</td>
<td>1.54</td>
</tr>
<tr>
<td>Europe</td>
<td>2.59</td>
<td>2.63</td>
<td>1.96</td>
<td>1.56</td>
</tr>
<tr>
<td>Total</td>
<td>2.62</td>
<td>2.84</td>
<td>2.00</td>
<td>1.64</td>
</tr>
</tbody>
</table>

Source: Pearce R. (1999), *Decentralised R&D and Strategic Competitiveness: Globalised Approaches to Generation and Use of Technology in Multinational Enterprises (MNEs)*, Research Policy, 28(2-3), 157-78.
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process in the MNE groups’ technology programs and the increasing complexity of operations.

Whenever the laboratory role is defined as “GROUP ADVICE”, this lab could be tempted to provide more information to the sub in which the lab is incorporated. If this is the case, the network of production subsidiaries could suffer from a lack of information which would result in an overall lower efficiency. To avoid this situation, some UK-base labs operate independently from production subsidiaries in order to support the full network in an equal and neutral way.

Another striking fact of this survey is that the more traditional adaptation role of existing products is rarely predominant.

5. Types of work done in MNE laboratories

The authors assumed that decentralized labs of MNEs could support their group’s hunt of strategic competitiveness in different degrees of commitment to different types of scientific work.

Therefore, the authors asked MNE’s to assess the relative importance in their operations of six different types of scientific investigation or technological support.

The 6 different types and function of laboratories are:

1. “Basic research”
   - is the predominant (or only) function of 18.9% of responding labs
   - is absent from the activity of 47.9% of responding labs

These results could either reflect the high reluctance of MNEs to decentralize basic research or that MNEs acquire some pure scientific
results from independent research institutions (like universities). Collaboration with host-country institutions may be an important role of overseas labs.

2. “Applied research aimed at creating a possible commercially applicable concept from basic research results available in the group”
   - is the predominant (or only) function of 35.4% of responding labs
   - is the secondary function of 43.8% of responding labs

   These centers follow a specifically defined commercial objective which could end with a new product concept. It involves defining the essential service that will be given to the customers and should put all scientific knowledge needed to produce it together. But it does not set out details of the ultimate commercial format.

3. “Development work aimed at helping to create a commercial product for particular market(s) from new ideas resulting from our own lab’s applied research”
   - predominant (or only) function of 48.0% of responding labs
   - secondary function of 35.4% of responding labs
   - absent in 16.6% of responding labs

   In this setting, the lab develops its own knowledge by working with other relevant functions to define the commercial format of the product concept.

4. “Development work aimed at helping to create a commercial product for particular market(s) from new ideas resulting from applied research carried out in other laboratories in the MNE group”.
   - predominant (or only) function of 32.0% of responding labs
   - absent in 29.8% of responding labs
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In this setting, research and ideas from other laboratories belonging to the MNE are used in order to develop a product which suits local needs.

5. “work to adapt current products for particular markets”
   - predominant (or only) function of 17.0% of responding labs
   - absent in 38.3% of responding labs

6. “work to adapt current production processes to particular conditions”
   - predominant (or only) function of 6.4% of responding labs
   - absent in 53.2% of responding labs

6. Influences on laboratory development

To gain insights on the drivers of decentralization of R&D labs in MNE, MNEs were asked to evaluate the relevance of drivers:

MNEs were asked to evaluation four influences on either their establishment or on their recent growth or development.

The four factors can be separated in two groups of similar factors:

- the two first factors relate to the way such labs may be integral elements in the repositioning of technology and creativity
- The two others reflect on the hypothesis that says that overseas R&D labs that are positioned in global strategies are influenced by the supply-side of the region

The strongest of the four influences confirms that a key response contemporary market pressures could be to react to localized tastes and conditions.
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The second strongest of the four factors is “to make effective use of strong UK technological capability in areas of science particularly relevant to our industry”. It is rated as major influence by 56.6% and irrelevant for 19.6%.

The previous type of host-country capability could be positioned into pre-competitive research programs or they could be positioned to support technologically ambitious product development efforts. In different segments of the world the evaluation was different.

The fourth factor was defined as ‘to make effective use of the general strong UK technological and research infrastructure’, covering the possession of a widespread availability of high-quality research institutions and a well-educated scientific labor force. Because the availability of reliable input is necessary for all types of laboratory work it is widely relevant. But it seems that it often only has a minor influence.

The survey also had an alternative set of questions for those MNEs without labs. Those companies were asked if certain factors had contributed to the choice not to have an in-house facility.

The three centripetal forces found were:

- the economies of scale,
- communication and coordination, and
- the sensitivity of technology
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The most strongly supported reason for not having an in-house R&D unit was that “We can obtain adequate adaptation/development advice from other labs of our MNE group”

7. Conclusions

The paper addressed issues relating to the positioning of decentralized R&D units in contemporary MNEs.

In their pursuit of competitiveness the roles and motivations of overseas labs now reflect particularly strategic needs of these companies.

MNEs both need to address medium-term development of strongly evolutionary new generations of products and long-term generation of the core technology to enhance strategic competitiveness.

Two key developments emerge as crucial in redefining the position of overseas R&D in contemporary MNE. There are 2 new centrifugal forces:

- new roles played by decentralized labs putting emphasis on product development by ensuring that available technology is applied as commercially as effective as possible, and provide overseas labs with positions in centrally-coordinated global programs of basic or applied research to reinforce or revitalize the MNE’s core technology.
- Helping to pull more of MNEs’ R&D into decentralized locations. Strong and distinctive technological competences emerge therefore in an increasingly wide range of countries

4 Source: Pearce R. (1999), Decentralised R&D and Strategic Competitiveness: Globalised Approaches to Generation and Use of Technology in Multinational Enterprises (MNEs), Research Policy, 28(2-3), 157-78.
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The authors claim that the main challenge in managing a network of R&D labs is to create an environment within which each entity supports the other. Meanwhile, there must be a tradeoff between connecting and focusing research and providing a creative environment to foster innovative ideas.
Section 2: the case of General Motors

1. Overview of the company

General Motors Corporation is the largest vehicle manufacturer in the world. It is active in the development, production and marketing vehicles as well as in finance and insurance operations. The latter are car related and provide a range of fiscal services including financing mortgage services, service contracts and insurance coverage\(^5\).

General Motors Company was founded in 1908 by incorporating the Buick Motor (founded in 1903), it then acquired Old Motor Works and acquired Cadillac automobile within a year. Old Motor Works was founded in 1897, which makes it the oldest unit of General Motors.

Headquarters are located in Detroit, Michigan and operates in North America, Europe, Latin America, Africa, Mid-East and Asia Pacific in over 55 countries.

More than 55500 patents have been granted to GM worldwide and are listed on the espacenet website.

During its history General Motors acquired a lot of companies including Vauxhall Motors and Hughes Aircraft company. It also stepped into numerous joined ventures with Toyota Motors, Isuzu motors, Shanghai Automotive Industry, etc. GM established a lot of subsidiaries over 55 countries for example in Argentina, Australia, Egypt and Japan.

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Nowadays, GM manufactures the following brands: Buick, Cadillac, Chevrolet, GMC, GM, Daewoo, Holden, Hummer, Opel, Pontiac, Saab, Saturn and Vauxhall.

GM manufactures compact cars, mid sized cars, large sized vehicles, luxury vehicles, sports utility vehicles, crossover utility vehicles, small and medium pickup trucks, full size pickup trucks, passenger vans, cargo vans, chassis cabs, and utility vehicles.

It had a turnover of 207 billion during the fiscal year 2006 and over 280,000 employees worldwide.

The annual fiscal revenue has increased by 6.5% between 2005 and 2006. In 2006 the company recorded an operating profit of nearly 10,000 million while books showed an operating loss in 2005.

**SWOT analysis**

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strong brand portfolio</td>
<td>Declining market share</td>
</tr>
<tr>
<td>Growing business in Asia Pacific and Latin America region</td>
<td>Overdependence on North America</td>
</tr>
<tr>
<td>Large scale operations</td>
<td>Unfunded pension and other post retirement benefits</td>
</tr>
<tr>
<td></td>
<td>Weak profitability</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increasing demand for hybrid electric vehicles</td>
<td>Declining demand for light vehicles in US</td>
</tr>
<tr>
<td>Opportunities in China and India New models</td>
<td>Rising raw material prices</td>
</tr>
<tr>
<td></td>
<td>EU regulations</td>
</tr>
</tbody>
</table>

Datamonitor, “General Motors Corporation”, Company profil, February 2008
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2. Overview of R&D Activities in GM’s Laboratories

General Motors was the third R&D investor in 2006 with a total amount invested of $bn 6.6. Out of the 6 biggest worldwide investors in R&D, four of them were within the automotive sector. The overall R&D intensity of the latter accounted for 4.1% in 2006 whereas the same indicator showed a 3.2% R&D expenditures/sales in the case of GM.

During the last three decades, the automotive sector has changed tremendously. During the 70ies, American companies faced little competition and cars were highly standardized, which enabled car manufacturers to reap economies of scale. Nowadays, competition is fierce and margins low. Besides, customers can chose between panels of car accessories which has forced car manufacturers to create a production system highly modular.

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Decentralized R&D and strategic competitiveness: globalised approaches to generation and use of technology in multinational companies

In terms of R&D, General Motors (GM), as well as other U.S. car manufacturers, had to innovate in order for the company to remain profitable. GM created a knowledge network between its several R&D centers, Universities, key suppliers and automotive alliance partners.

In the 1970ies, GM’s R&D centers’ primary focus was on safety improvement and computerization of production processes. During the 90ies, due to increased competition, the R&D activities were to reduce costs and improve the quality of vehicles.

At the beginning of the 21st century, competition was so intense that GM had to remake their entire R&D structure. Therefore, they decided to create:

- 7 science laboratories, focusing on developing new technical competency
- Innovation programs = application of technology on business side. For instance, in order to connect knowledge at different stages of the company, researchers were transferred to the purchasing department in order for them to broaden their perspective and gain better insights on market constraints
- Technology intelligence = technology and potential business impact
- Exploratory projects = aimed at business innovation, consuming 30% of resources. These projects enabled researchers to innovate in the way GM was doing business.
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GM also focused on communication within the company’s R&D centers and business units, as the key actor in the company’s success. Besides, strong connections with universities were made in order for GM to permanently find ways to increase their level of knowledge.

Nowadays, General Motors has 7 R&D labs in twelve countries; each specialized in a specific field. The GM network of R&D centers has its HQ in Warren, Michigan. The main “research activities include improving environmental performance of GM’s vehicles, diversifying energy sources, and providing gasoline-saving solutions around the world like active fuel management, variable valve timing and six-speed transmissions, developing advanced diesel engines, fuel cell and hybrid vehicles, electronics and controls and researching new materials”\(^9\).

GM’s R&D labs and their area of focus are listed here below:

- Chemical & Environmental Sciences Lab
- Electrical & Controls Integration Lab

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- India Science Lab, specialized in modeling and chemistry
- Materials & Processes Lab
- Manufacturing Systems Research Lab
- Powertrain Systems Research Lab
- Vehicle Development Research Lab

These science labs can be spotted in the map here below.

![Map of GM Labs and Science Offices](image)


Along with science labs (GM Labs), General Motors owns five science offices. The latter are located in countries of interest and are aimed at identifying and engaging local institutions which could collaborate with GM’s researchers.

General Motors also collaborated with universities on several specific topics. GM chooses the university that is considered as a leader in a technological field and builds a long-term partnership in terms of R&D. The list of universities and sectorial specialization is available on appendix 1.
General Conclusion

Through this report, we have tempted to sum up the article “Decentralized R&D and strategic competitiveness: globalised approaches to generation and use of technology in multinational companies” from Pearce, with the ongoing trends in R&D laboratories of multinational enterprises. The article has identified the centripetal and centrifugal forces which drive the location of laboratories. Besides, the main types of R&D labs were identified and the authors also pointed out how important it is for MNE’s to ensure the global coherence of their knowledge network.

In order to better assess the accuracy of this article, we have focused on the automotive sector and General Motors. This has enabled us to understand the ongoing trends in the car industry and the needs for MNE’s to adapt their R&D network structure. While a few decades ago, the main challenge was to reap economies of scale (centripetal force), GM is currently building a worldwide network of R&D laboratories and science offices. This is the result of centrifugal forces identifies by Pearce, which has led GM to acquire knowledge from all parts of the world, in order to remain sustainable and innovative.

The main challenge for GM is surely to ensure a good coordination between its R&D laboratories, universities and business partners. This is currently being done by having each R&D lab specializing in a given field and connecting all these sources of knowledge in a global innovation web.
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List of References


4. Pearce R. (1999), Decentralised R&D and Strategic Competitiveness: Globalised Approaches to Generation and Use of Technology in Multinational Enterprises (MNEs), Research Policy, 28(2-3), 157-78.


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Appendixes

<table>
<thead>
<tr>
<th>University Initiated</th>
<th>Technology Area</th>
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<tbody>
<tr>
<td>University of Michigan</td>
<td>Engine Systems Research</td>
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<tr>
<td></td>
<td>Advanced Vehicle Manufacturing</td>
</tr>
<tr>
<td></td>
<td>Smart Materials &amp; Structures</td>
</tr>
<tr>
<td>Carnegie Mellon University</td>
<td>Information Technology</td>
</tr>
<tr>
<td>Stanford University</td>
<td>Work Systems</td>
</tr>
<tr>
<td>Indian Institute of Science Bangalore</td>
<td>Lightweight Materials</td>
</tr>
<tr>
<td>Indian Institute of Technology KGP</td>
<td>Electronics, Controls and Software</td>
</tr>
<tr>
<td>Brown University</td>
<td>Materials Modeling</td>
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<tr>
<td>RWTH-Aachen</td>
<td>Advanced Engines</td>
</tr>
<tr>
<td>University of Wisconsin-Madison</td>
<td>Engine Combustion</td>
</tr>
<tr>
<td>M.I.T.</td>
<td>Materials Manufacturing Systems Analysis</td>
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S.n., “Research and Development” General Motors Corp.  

Table 3: The top five global companies in the automobiles & parts sector (GI250)

<table>
<thead>
<tr>
<th>Company</th>
<th>Nationality</th>
<th>R&amp;D Investment (£ million, 2008)</th>
<th>R&amp;D as a percentage of sales (%) 2008</th>
<th>Operating profit as a percentage of sales (%) 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ford Motor</td>
<td>USA</td>
<td>3,679</td>
<td>4.5</td>
<td>-3.9</td>
</tr>
<tr>
<td>DaimlerChrysler</td>
<td>Germany</td>
<td>3,526</td>
<td>3.4</td>
<td>3.3</td>
</tr>
<tr>
<td>Toyota Motor</td>
<td>Japan</td>
<td>3,485</td>
<td>3.9</td>
<td>10.3</td>
</tr>
<tr>
<td>General Motors</td>
<td>USA</td>
<td>3,372</td>
<td>3.2</td>
<td>4.5</td>
</tr>
<tr>
<td>Volkswagen</td>
<td>Germany</td>
<td>2,857</td>
<td>4</td>
<td>2.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>40,961</strong></td>
<td><strong>4.1</strong></td>
<td><strong>4.1</strong></td>
</tr>
</tbody>
</table>

4 The 2007 R&D Scoreboard