Employment and Sustainability in the EU Manufacturing Sector: Foundries and Mechanical Engineering

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EMPLOYMENT AND SUSTAINABILITY IN THE EU MANUFACTURING SECTOR: FOUNDRIES AND MECHANICAL ENGINEERING

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FOREWORD

This is one of three field research studies designed to measure the employment and competitiveness impact of *existing* environment policies in order to help design *future* policies. The research described here is focused on iron foundries and mechanical engineering[1].

There is a dilemna in deciding at what level to measure socio-economic impacts (in this case employment and competitiveness). Individual case studies have the advantage of providing specific data in a way which enables conclusions to be drawn about the impact on a particular enterprise, but generally leave open the question of whether the results are applicable to the sector as a whole. Research which analyses data statistically, e.g. in desk studies or models, can draw sectoral conclusions but leaves open the question of whether they apply to a particular enterprise. In both cases, it may be difficult to explain the causes of the impacts discovered.

In this research, the environmental and economic performance of a number of enterprises in one part of the EU have been compared with a similar number in another. The objective of the comparison was to establish whether differences in environmental policy regimes were associated with different economic performances, and hence to offer explanations for those differences. While there were practical difficulties in obtaining the same balance of data in both countries, the insights offer some explanations while making clear the importance of recognising differences in local circumstances and cultures when framing policy responses.

Jørn Pedersen
March 1998

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[1] The other two research studies are:

- "Effects on Employment, Skills, Productivity and Competitiveness of Environmental Regulation in Food Processing (Dairy and Meat Processing) across the EU (Northern Ireland and Republic of Ireland; Germany, East and West; Italy, North and South)", *David Hitchens, Esmond Birnie & Angela McGowan, Department of Economics, The Queen's University of Belfast; Ursula Triebswetter, IFO Institute for Economic Research, Munich; Alberto Cottica, Eco & Eco, Bologna.* To be published by Edward Elgar in association with the European Foundation

- "Local Sustainability and Competitiveness: The Case of the Ceramic Tile Industry", report by *François Lévêque & Peter Börkey, CERNA, Paris; Margherita Russo, Università degli Studi di Modena, Italy; Francisco Mas & Emilio Cubel, Impiva, Valencia,* European Foundation working paper (forthcoming)

PREFACE

This report describes the overall results of a project on *The Impact of Environmental Pressures on Employment in Small-Medium Sized Enterprises: Foundries and Automotive Parts Suppliers*. The project was funded by the European Foundation for the Improvement of Living and Working Conditions, a European Union institution based in the Republic of Ireland. The work covered enterprises operating in the West Midlands region of the UK and the Basque Country of Spain. The work was carried out by the Science Policy Research Unit (SPRU) at the University of Sussex, UK, and IKEI of San Sebastián, Spain. There are four companion reports describing the detailed findings. These are:

- Gaynor Hartnell. *The UK Foundry Industry*. Report to the European Foundation. November 1995.
- Gaynor Hartnell. *The UK Automotive Components Industry*. Report to the European Foundation. November 1995.
- IKEI. *The Basque Foundry Industry*. November 1995.
- IKEI. *The Basque Automotive Components Industry.* November 1995.

The interview notes from each company appear as an appendix to these reports, although all commercially sensitive material which would enable the companies to be identified has been removed.

EXECUTIVE SUMMARY

Objectives

1. The objectives of this project were:

- to identify the sustainability policies and specific environmental measures, including supply chain pressures, which are having an impact on SMEs in the foundries and automotive parts sectors;
- to describe the techniques being adopted or considered by firms which will promote sustainable development;
- to analyse the direct employment consequences, in terms of both the level and quality of employment;
- to examine the employment implications of any significant changes in the pattern of purchases of goods and services; and
- to examine the consequences of different regulatory regimes, levels of compliance, productivity, skills, external pressures and other relevant factors.

Methodology

2. The study is based on case studies of two sectors - foundries and automotive components - in two EU regions - the West Midlands in the UK and the Basque Country in Spain. The sectors each play an important role in the local economies. Information was collected through interviews with production managers at ten sites for each the four sector/region studies. Additional interviews were conducted with regulators, government agencies and trade associations.

3. The interviews covered: environmental pressures; environmental management and performance; quality management; links to customers; employment structure and training; and employment impacts of environmental pressure. Quantitative data referring to production, sales, costs, resource use, waste disposal and emissions was also collected.

Environmental Pressures

4. Regulatory pressures are more significant than customer or community pressures in both sectors. Foundries are under the greater pressure, reflecting the nature of the activities undertaken. Regulatory pressures are also greater in the UK. Customer pressures are greater in the case of automotive components although, ironically, environmental impacts are generally lower. This reflects the concerns and influence of the automotive assembly companies. Pressures from local communities were found not to be significant, although some foundries in the West Midlands had modified their activities as a result of local pressure.

Environmental Pressures in the UK and Spain

	Foundries		Auto Components	
	UK	**Spain**	**UK**	**Spain**
Regulatory	High	Absent	Medium	Medium
Customer pressure	Absent	Absent	Medium	Low
Community pressure	Generally medium - high in some cases	Generally absent - sometimes modest	Generally low	Absent

The Employment Impacts of Environmental Activity

5. The employment implications of environmental pressures were found not to be significant when compared to the employment effects of ongoing technical change and changes related to the state of the economy. Employment implications were negligible in the automotive components sector and small but discernible in foundries. Those plants which close as a result of environmental pressure are likely to have been less competitive than those which survive. Any negative employment impacts are balanced by significant improvements in living and working conditions in the region concerned.

6. The impact of installing end-of-pipe abatement equipment in terms of foundry employment is generally very small. New tasks are taken on by existing staff. Process change has a greater effect on employment. *Working conditions* are usually improved while the *level of employment* generally falls.

7. Environmental controls on air emissions in the UK will lead to job creation through regulatory enforcement and the manufacture of bag filters. However, the controls could lead to job losses in the foundry sector itself. These are likely at least to balance job gains and could be rather higher. The aggregate estimates represent only a small fraction of total employment in the UK foundry sector.

Competitiveness, Quality and the Environment

Competitiveness and Environmental Performance

8. Companies and sectors which pro-actively pursue higher standards of environmental performance and management may prove more resilient to environmental pressures which do arise. *If this is the case, attention to environmental matters can be said to protect rather than threaten employment*. The study provides weak evidence for this hypothesis: those firms which have paid more attention to quality management tend to be more profitable; there is some correlation between the attainment of quality certification and attempts to achieve environmental management standards; and firms which have directed more attention to environmental performance and management are generally more profitable. These facts together suggest, but do not conclusively prove, a positive correlation between competitiveness and environmental performance.

Sectoral Comparisons

9. In comparison with automotive component manufacturers, foundries are characterised by: lower levels of labour productivity; greater environmental pressure; more problems of recruitment and labour turnover linked partly to a poorer working environment; and less focus on formal quality/environmental management standards.

10. Automotive component plants are more attractive sources of employment than foundries in terms of wealth creation, quality of employment and environmental impact. The foundry sector is beset by a cycle of decline. Factors such as lengthy delivery times, inability to recruit skilled labour and poor environmental conditions are inter-connected and mutually reinforcing. Quantitative performance indicators are symptomatic of these difficulties but do not capture all of the social, environmental and cultural factors which underlie the decline of the sector.

Regional Comparisons

11. Foundries and automotive component plants are generally more profitable in the West Midlands than they are in the Basque Country. Basque plants benefit more from financial subventions. In addition, the legal form of many Basque foundries appears to enable plants to operate unprofitably for some time.

12. In the foundry sector, metal melting has potentially the highest environmental impact. The use of cleaner electric melting technology is more widespread in the Basque Country reflecting historically low electricity prices and the need to import coke. However, when a specific technology is compared - for example cupola melting - environmental impact is higher in the Basque Company and environmental pressures, whether from regulators, communities or customers, appear to be lower.

13. Public policies in both countries are designed to give firms an opportunity to adapt to higher environmental demands. The UK has used a five-year regulatory timetable for compliance with higher standards. This has been backed by information/ dissemination/demonstration measures providing tangible assistance to firms. Spain has chosen more direct support for environmental technology reflecting poorer economic performance and the recent removal of tariff protection. These approaches reflect national circumstances and differences in economic/policy culture.

Plant Level Comparisons

14. In the UK, there is little or no correlation within a given sector between profitability and productivity measured either in physical terms or in terms of net output per employee. This reflects the heterogeneity of output at the plants concerned. There is a positive correlation between quality certification and profitability in Basque firms. Quality certification is too widespread in the UK to enable any comparable conclusion to be drawn.

15. There is little or no correlation between the use of 'clean' technology (electric melting) and profitability in UK foundries. The choice of melting technology depends on product mix, energy prices and raw material costs and little can be concluded from this lack of correlation.

16. There appears to be no correlation between profitability and the tendency of UK automotive manufacturers to adopt a certificated environmental management system (for example BS7570). On the whole, the most profitable companies are gaining business from international competitors, notably from German firms. Less profitable firms appear to be losing contracts to plants in Eastern Europe, Turkey and Asia.

The Foundry Industry

Key Features

17. The foundry industry in the UK has been in long-term decline. Since the late 1980s, Basque production has increased although employment has continued to decline.

18. The principal environmental impacts of foundries arise from: metals melting; mould and core making; and casting operations. Metals melting gives rise to emissions of combustion gases, particulate matter, VOCs and metallurgical fume to the atmosphere. Electric melting is cleaner than melting in traditional cupola furnaces charged with coke and limestone.

19. Technical changes in the industry have implications for environmental releases. The use of electric melting is increasing and is reducing atmospheric emissions. However the selection of melting technology is very site specific. Electric melting is favoured when a wide range of alloys are cast, production is in smaller batches and good quality steel scrap is available. The relative prices of coke and electricity are also a major factor. For that reason, electric melting has been more common in the Basque Country.

Environmental Pressures and Responses

20. In both Spain and the UK, foundries are affected by environmental rules and regulations and by support for the adoption of cleaner technologies.

21. Until recently, the only rules affecting cupola furnaces in the UK related to the opacity of releases to air. New formal emission limits must be met by April 1997. Spain has had formal emission limits in place since 1975 but there is little evidence of any systematic monitoring of emissions or enforcement activity.

22. In the UK, foundries can receive technical information under the Environmental Technology Best Practice Scheme as well as financial support for demonstration projects and more innovative environmental measures. The Scheme addresses waste minimisation, improved sand reclamation techniques, energy efficiency and yield improvements. The Spanish Environmental Technology Industrial Programme (PITMA) supports investments allowing plants to meet or exceed regulatory standards. Four of the ten foundries interviewed had received support under this programme. The Basque Environmental Department also provides grant aid to support the installation of environmental equipment.

23. The more significant response to environmental pressure is taking place in the UK. In response to tighter air emission limits, plants are: installing end-of-pipe abatement technology (bag filters); switching to electric melting; or closing down. The end-of-pipe solution will be most common.

24. Basque foundries are investing to reduce fumes from moulding and finishing processes. Many of these investments are motivated by health and safety concerns. All of the investment identified at specific foundries was being supported under the PITMA programme.

25. No foundries in either region were planning to adopt externally verified environmental management systems such as BS7750 or EMAS.

Automotive Components

Key Features

26. In the UK, automotive component output has been growing while employment has been falling. Production in the Basque country was severely hit by recession in the early 1990s but has since recovered. There are strong relationships between the main automotive assembly companies and their suppliers.

27. Environmental impacts are mainly associated with the production of liquid and solid wastes including used metal working fluids, swarf, grinding/milling dust and sludge from effluent treatment plant. The only significant atmospheric emissions are VOCs from paint shops. The use of ozone-depleting substances for cleaning has declined substantially.

Environmental Pressures and Responses

28. Legislative pressure on companies is weak and relates mainly to the treatment and disposal of liquid and solid wastes. Legislation preventing firms discharging liquid waste directly into rivers has only recently been introduced in the Basque country.

29. There is some evidence that supply chain pressures are beginning to affect environmental performance in the automotive components sector. Two Basque companies had received inquiries from major automotive assemblers though these did not result in any change in practice. Only one Basque company was interested in installing an environmental management system. Supply chain pressure has helped to eliminate the use of ozone-depleting chemicals in the UK. Almost all UK companies were aware of BS7750 and four were intending to implement the system because the standard would be a condition for ‘doing business’.

30. Many interviewees were unaware of the quantities of waste produced at their plant and the associated costs of disposal, though others had invested to cut waste disposal and/or water costs. Some companies are contracting out environmentally sensitive work such as machining, heat treatment, plating and painting. The environmental implications are mixed, depending on the competence of the contractors.

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1. INTRODUCTION

1.1 Objectives

This report describes the conclusions of a project on *The Impact of Environmental Pressures on Employment in Small-Medium Sized Enterprises: Foundries and Automotive Parts Suppliers*. The project was funded by the European Foundation for the Improvement of Living and Working Conditions, a European Union institution based in the Republic of Ireland. The objectives of the project were:

- to identify the sustainability policies and specific environmental measures, including supply chain pressures, which are having an impact on SMEs in the foundries and automotive parts sectors;
- to describe the techniques (e.g. changes in labour practice, training requirements and/or capital investment) being adopted or considered by firms which will promote sustainable development;
- to analyse the direct employment consequences, in terms of both the level and quality (skills/qualifications) of employment;
- to examine the employment implications of any significant changes in the pattern of purchases of goods and services; and
- to examine the consequences of different regulatory regimes, levels of compliance, productivity, skills, external pressures and other relevant factors.

The study looks at two sectors, foundries and automotive components, in two European regions: the Basque Country of Spain; and the West Midlands in the UK. 40 firms were interviewed in total, along with trade associations, regulators and local/provincial agencies.

The choice of case studies illustrates the interplay between sustainability pressures on the one hand and employment on the other in two contrasting sectors dominated by SMEs. Foundries were chosen because activities carried out by firms in this sector have significant environmental impacts relative to those in other sectors in which SMEs play a major role. Atmospheric emissions associated with melting metals and other processes linked to casting present significant environmental challenges for many firms.

Automotive component manufacturing gives rise to lower levels of environmental impact. The main problem is the production of liquid and solid wastes. However, component manufacturing is but one part of the wider automotive industry which as a whole is sensitive to a range of environmental issues arising from automobile manufacture and use. Automotive assemblers have become interested in the environmental performance of their suppliers. The assemblers already place considerable pressure on their customers with respect to price, quality and just-in-time (JIT) delivery schedules.

The choice of these two particular sectors allows inter-firm linkages to be examined further up the supply chain, as automotive components manufacturers may in turn place their suppliers under pressure. The automotive industry is the largest consumer of foundry products (castings). Previous research by the author suggests that foundry customers can inadvertently influence the environmental performance of a foundry.

The choice of two different regions of the EU allows the environmental performance of the two sectors, and the implications for employment, to be explored under different policy regimes. Industrial and employment/training policy is relevant as well as environmental rules. It is hypothesised that different regulations and policies will influence the relationship between environmental pressures and employment. In particular, it casts some light on: a) whether there is a significant link between environmental pressure and employment; and b) whether that link is positive ('win-win') or negative (an employment-environment trade-off).

1.2 Methodology

The information was gathered through statistical sources and semi-structured interviews with Managing Directors or Heads of Production at selected companies in each of the two sectors and regions. Trade associations and regulators were also interviewed. The interviews typically lasted between one and a half to two hours, and involved a tour of the foundry or factory.

Interviews schedules were designed to gather data under the following main headings:

- **Company data,** i.e. its main activity, products and markets, ownership, sales distribution, cost structure, turnover and profits.

- **Environmental management,** i.e. whether they had an environmental management system, whether they carried out environmental audits, and the time devoted to dealing with environmental matters.

- **Quality Management.** Information was sought on quality accreditations, the motivation for obtaining them, whether obtaining the standards lead to any process change and the effect on quality. An attempt was made to draw out any information relating to the influence of customers including possible synergies or conflicts between customers' quality demands and the companies' environmental performance.

- **Employment structure and training.** The interviewees were asked to categorise the types of employees working in the company, prompted if necessary by standard tables in the questionnaire. In order to try and form a picture of the skills and training required for the shop floor employees, the interviewee was asked about the typical qualifications or experience expected for a new recruit, how they were trained when they arrived, and an estimate of how long it might take before they were competent and whether there were any problems with recruitment for certain types of foundry work. Interviewees were also asked about their training policy/strategy, and whether they were participating in any government training initiatives.

- **Environmental pressure.** The interview generally covered environmental investment and plans to modify processes in order to meet regulatory requirements. Interviewees were also asked about the employment implications (gains or losses of employment as well as changes in job quality) of any action necessary to achieve compliance.

- **Employment effects.** Ongoing technical change unprompted by regulatory pressures can have both environmental and employment implications. Interviewees were therefore asked about the employment effects of any changes in the production process, irrespective of whether the investment was driven by environmental pressure.

- **Waste generation and waste disposal costs.**

- **Market trends.** Interviewees were asked about any recent changes in their order books. If new contracts had been awarded, the interviewee was asked where this work had been made previously, and conversely if work had been lost, where it had been moved to.

There was a marked difference in the ease of obtaining financial information between the two regions. Nine out of ten of the West Midlands foundries were happy to give financial information, and the cost structure of the company, whereas this information was only given by one Basque foundry, and two Basque automotive component companies.

A total of 40 company interviews were conducted, ten for each sector (foundries and automotive component) in both regions (the Basque Country and the UK). For reasons of commercial confidentiality these are simply identified by code:

- The West Midlands foundries are referred to as WM-F1 to WM-F10

- The UK automotive component companies are referred to as WM-AC1 to WM-AC10.

- The Basque Country foundries are referred to as PV-F1 to PV-F10.

- The Basque Country automotive component companies are referred to as PV-AC1 to PV-AC10.

The original intention was to match pairs of plants in the two in order to facilitate productivity/performance comparisons. As described later, this attempt failed largely because of the heterogeneity of output at foundries, but even more so in the automotive components sector. The majority of the interviews took place in the Basque country first. UK firms were selected as far as possible to match firms already interviewed in Spain. The selection was carried out in this manner: a) because there are fewer plants in the Basque country; and b) it was anticipated, correctly, that there would be greater difficulties in gaining access to Basque firms than UK firms.

1.3 The selection of the foundry sample

The UK foundries were selected to match Basque foundries according to the following parameters (in order of importance).

a) *Serving similar customers*. As foundries usually serve a variety of customers the important factors included whether the foundries provided castings for certain key customers.

b) *Size* (number of employees); and

c) *Metals melted*. The main categories were grey iron, nodular or spheroidal graphite iron (referred to as SG iron), other irons, steel alloys and aluminium.

There is a risk in such studies that plants will be 'self-selected' because only those with high levels of environmental performance will provide access. In fact, there were only two-three refusals in the UK, with a somewhat higher refusal rate in the Bsque Country. Plant managers were often interested in the competitiveness aspects of the study.

The choices were made using the British Foundry Association (BFA) Castings Buyers Guide, the Foundry Yearbook and Castings Buyers Directory 1994.[2] The BFA buyers' guide covers metals cast, casting weights, markets, facilities and quality approvals for their 84 members. The Yearbook covers metals cast, casting weights, foundry processes, facilities and specialities at several hundred foundries. Tables 1.1 and 1.2 show the characteristics of the foundries visited. The following industry-standard codes indicate product markets:

SCOEM: safety critical castings for automotive original equipment market

NSCAuto: non safety critical castings for the automotive OEM and aftermarket (AM)

tool: castings for the automotive industry, but not for inclusion in vehicles, e.g. forging dies, machine tools etc.

truck: castings for the off road or commercial automotive industry (e.g. tractors, lorries)

Other: Other industries typically general engineering, water, mining etc.

Job: Typical jobbing foundries, those serving a very wide range of foundries, typically storing several thousand patterns

G: spheroidal graphite or nodular iron (known generally as SG iron)

TABLE 1.1: SUMMARY OF UK FOUNDRIES INTERVIEWED

Foundry	Customers	No. of employees	Turnover £m (1994)	Tonnage per year	Metals cast
WM-F1	(SCOEM), (truck) & (Other)	409	22.5	26,750	Grey iron and SG
WM-F2	(SCOEM)	295	16	36,800	Grey iron
WM-F3	(SCOEM)	120	6.5	800	Aluminium
WM-F4	(Other) mining quarry etc.	104	8	2,100	Steel alloys
WM-F5	(Other) & (Job)	100	4	4,600	Grey iron
WM-F6	(Job) & (tool)	71	2.5	2,250	Grey iron
WM-F7	(NSCAuto) & (Other)	92	2.6	1,800	SG, grey iron and steels
WM-F8	(NSCAuto) & (Other)	150	7	1,300	Aluminium
WM-F9	(SCOEM)	225	15		Aluminium
WM-F10	(NSCAuto), (truck) & (Job)	251	9.6		Aluminium

2 *Foundry Yearbook and Castings Buyers Directory 1994.* Ed J Mitchell. Foundry Trade Journal. 1994.

TABLE 1.2: SUMMARY OF BASQUE FOUNDRIES INTERVIEWED

Foundry	Customers	Employment	Turnover m Ptas (1994)	Tonnage per year	Metals cast
PV-F1	(NSCAuto), (Truck) and (Other)	450	2500		Carbon Steel
PV-F2	(SCOEM)	226	3000		Grey and nodular iron
PV-F3	(Truck), (Other) & (Job)	85		6000	Grey Iron
PV-F4	(Other)	196	2400	10500	Steel alloys
PV-F5	(Job) (Other)	92	900	4500	Grey Iron
PV-F6	(NSCAuto), (Other) & (Job)	76	1400	15000	Grey Iron and SG
PV-F7	(NSCAuto) & (Other)	130	2000		SG Iron and malleable and chrome alloy castings
PV-F8	(SCOEM)	130	over 1000	6000	SG
PV-F9	(NSCAuto)	150		4000	Aluminium
PV-F10	(NSCAuto)	315	6000	13000	Aluminium

It was possible to match some West Midlands foundries quite closely with specific Basque foundries, but for several the match was poor. A particularly good match was achieved between foundries

WM-F2 and PV-F2 The only significant difference between the two are that PV-F2 has a large machining shop, employing 110 people, and it also melts SG iron, whereas WM-F2 only casts in grey iron.

WM-F4 and PV-F4 There is a good match between alloys cast and markets, although WM-F4 makes some very large castings. The interview at WM-F4 mentioned that the Basque foundry used to be a key competitor of theirs, although their markets had changed slightly since then.

WM-F5 and PV-F5 This was a very good match indeed. Both were medium volume grey iron repetition foundries of a similar size, serving similar markets and even using similar processes. One of the most significant differences was that the Basque foundry was located in a residential area, whereas WM-F5 was situated on an industrial estate.

WM-F6 and PV-F6 These are similar in terms of size and markets, both making large castings up to several tonnes in size. The Basque foundry had the facility for SG iron, whereas WM-F6 only melted grey iron.

WM-F7 and PV-F7 These were a fairly good match in terms of size, market and metals melted.

1.4 Selection of Automotive components manufacturing companies

One of the objectives of the project was to examine the role of the supply chain in transmitting environmental (or other) pressures. Automotive component manufacturers are located between car assembly customers and foundries in the supply chain. Previous research by the author has suggested that foundry customers can inadvertently influence the environmental performance of the foundry. In order to explore supply chain effects it had been intended to pick automotive components manufacturers that were likely to buy castings.

The selection of matching firms in the UK proved to be much more difficult than expected. The Kompass database contained a very large number of firms, but was difficult to use, as it included firms involved in automotive components even if this was a small proportion of their overall business. There were also a very large number of different headings into which, say, a clutch manufacturer could fall. Companies were selected using the Kompass Data Base, the IMS Directory of European Automotive Suppliers 1994, The PRS European Automotive Directory 1991 - 2 and the Buyers Guide 1993 to the Motor Industry of Great Britain.

The UK automotive components companies were selected to match with the Basque firms according to the following parameters (in order of importance).

a) *Manufacturing similar products*: It proved very difficult to locate firms producing similar products. Originally it had been intended to select firms falling within the following Product Code categories on the Kompass database: product code (pc) = 39-520 P (motor vehicle steering suspension, hub, axle and brake components); pc = 36-420 D (power transmission equipment, drive shafts); and pc = 40-150 P (Internal combustion engine components and spare parts). However, these categories include a variety of firms and simple adherence to these categories would have resulted in meaningless comparisons. The Basque firms included manufacturers of clutches, catalytic converters and carburettors, camshafts, axles, bearings (both in assemblies and separately), suspension system assemblies, gear systems and pumps and steering systems. Some UK SMEs manufacturing similar products were found, but matching was frequently problematical. Attempted were therefore made to match firms according to the main manufacturing processes. For example camshafts and crankshafts both require machining and thermal hardening, but not assembly; steering systems, clutches and suspension systems require machining and assembly and possibly painting; axles require forging (or bought in forgings), welding, machining and thermal treatment.

b) *Serving similar customers*: This was the second most important consideration as quality requirements vary significantly between the Original Equipment (OE) market and the Aftermarket (AM) spare parts market. OE customers place their suppliers under greater pressure with respect to quality, price and other factors such as Just-in-time delivery, whereas AM suppliers usually supply to distributors. The categories used were **OE**, **AM**, and **trucks**, including off-road and commercial vehicles such as tractors and trucks.

c) *Size (number of employees)***:** The size distribution of automotive components manufacturers in the UK and the Basque country varies, and many of the companies tended to be larger in the UK than in Spain.

d) *Location:* Given the difficulties in matching firms, about half the UK firms were chosen from outside the West Midlands.

It was difficult to obtain interviews in the automotive components sector. Initially 18 UK companies were contacted and ten were finally interviewed. These ten did not necessarily represent the best matches with the Basque due to access difficulties. Tables 1.3 and 1.4 provide a brief profile of the firms interviewed. Due to the diversity of different components, even within the same category, it was not appropriate to compare information on physical productivity between matched plants.

TABLE 1.3: SUMMARY INFORMATION OF UK COMPANIES INTERVIEWED

Company	Markets	Non-auto market	Products	Employees	Turnover £m (1994)
WM-AC1	OE	No	Engine valves		19.7
WM-AC2	N/A	No	Exhausts	112	6
WM-AC3	OE & AM	No	Camshafts	149	14
WM-AC4	AM & trucks	Yes	Gears	79	3
WM-AC5	OE	Yes	Bearings,	400	50
WM-AC6	AM & trucks	Yes	Suspension systems	125	5.5
WM-AC7	OE	No	Steering systems	700	100
WM-AC8	AM, OE & trucks	No	Press work	170	10.5
WM-AC9	AM & trucks	(Yes)	Crankshaft, cylinder liner and hydraulic valves	200	9
WM-AC10	trucks	No	axles, wheels and transmission components	42	3.1

TABLE 1.4: SUMMARY INFORMATION OF BASQUE COMPANIES INTERVIEWED

Company	Markets	Non-auto market	Products	Employees	Turnover m Ptas (1994)
PV-AC1	AM and truck	No	Clutches and brake parts	63	1,010
PV-AC2	OE	No	Carburettors, valves, filters and others	177	4,000
PV-AC3	AM	No	Camshafts and connecting rods	73	630
PV-AC4	AM	No	Axles	30	250
PV-AC5	OE & AM	No	Ball bearings and roller bearings	180	
PV-AC6	AM	No	Suspension systems	223	2,674
PV-AC7	OE & AM	No	Suspension systems	460	10,550 (1995 forecast)
PV-AC8	OE	Yes	Roller bearings and bearing pins	360	
PV-AC9	AM, OE & truck	No	Gear systems and pumps	125	1,200
PV-AC10	AM & truck	No	Steering mechanisms	41	600

1.5 The structure of the report

The remainder of this report is divided into six sections. Section Two describes economic characteristics and structure of the of the foundry and automotive component sectors in the Basque Country and the West Midlands. This information is derived mainly from published statistical sources which sometimes cover only Spain and/or the UK as a whole. The section also contains some information on the competitiveness of the individual firms interviewed in order to provide important background relating to environment/employment interactions.

Section Three provides information on public policy initiatives and regulatory requirements which are relevant to the two sectors. The policy areas include: industrial policy (including financial support and information provision); environmental regulation (emission controls, waste charges); and employment and training. The latter covers training schemes in both regions as well as the nature of the employment and training policies specific to both sectors.

Section Four focuses on the foundry industry covering; technical information (the processes, their environmental impact and ongoing technical change, environmental policy, environmental investment and quality management.

Section Five focuses on the automotive components sector, covering environmental impacts, environmental policy, supply chain pressure and finally environmental performance.

Section Six looks explicitly at the impacts of environmental pressure on employment at the plant level. The UK foundry industry, upon which new environmental rules are beginning to bite, is discussed in greatest detail. The net employment effect of recent environmental legislation is estimated. This approach was neither relevant nor appropriate for the Basque foundry industry.

Section Seven analyses the data collected at the plant level to draw conclusions about the relationship between productivity, competitiveness and environmental performance. The analysis takes account of comparisons between regions, sectors and individual plants.

Section Eight draws conclusions from the comparison between the two regions. The section covers sustainability policies and environmental pressures, direct impact on employment at plant level, implications of significant changes in pattern of goods and services (for the UK foundry industry) the consequences of different regulatory regimes and differences in productivity between the two regions.

2. THE FOUNDRY AND AUTOMOTIVE COMPONENT SECTORS

2.1 The Foundry Industry

2.1.1 The different types of foundry

The foundry industry is divided into ferrous and non-ferrous foundries. Ferrous foundries specialise in either iron or steel. The majority of non-ferrous foundries cast aluminium, although there are also zinc, bronze and copper foundries.

Foundries can be further classified according to the type of work they undertake. Foundries which make one-off or small batches of castings, are referred to as *jobbing* foundries, and those doing runs of thousands of castings are known as *repetition* foundries. There is no sharp distinction between jobbing foundries and repetition foundries. Repetition foundries are often referred to as high, medium or low volume, according to batch size. Many foundries undertake both jobbing and repetition work. Figures 2.1 and 2.2 show the classifications of ferrous and non-ferrous foundries respectively.

Aluminium is the most important non-ferrous metal for the automotive sector. Aluminium foundries are often classified according to the main moulding method used, e.g. as a die casting foundry or sand foundry, although many aluminium foundries may use more than one method. Die casting is only possible for alloys with a lower melting temperature, i.e. aluminium, zinc and magnesium.

FIGURE 2.1: CLASSIFICATION OF FERROUS FOUNDRIES

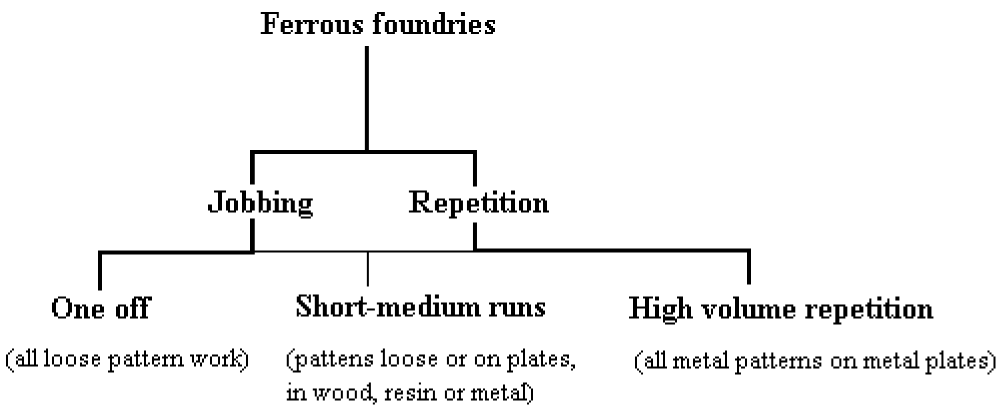
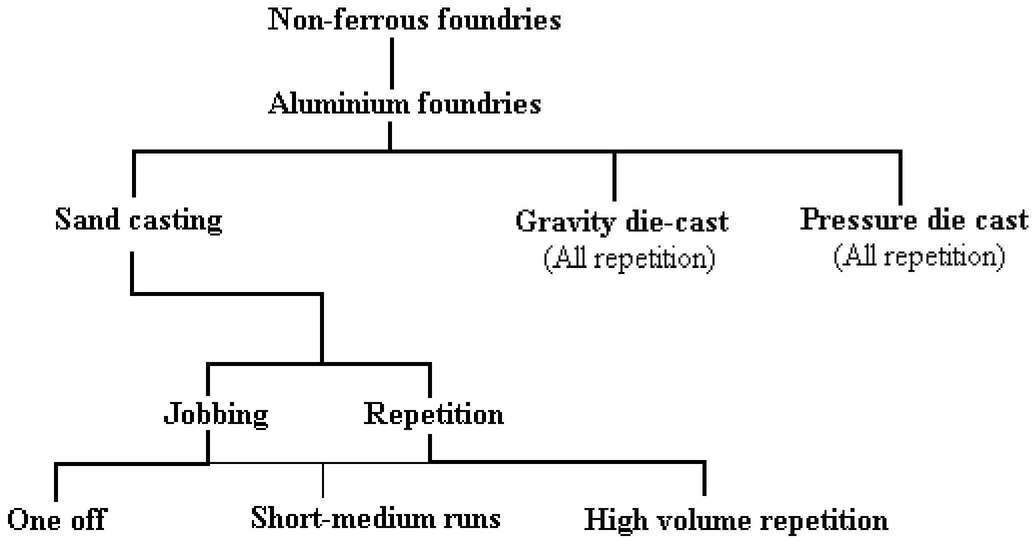


FIGURE 2.2: CLASSIFICATION OF NON-FERROUS FOUNDRIES



Relatively few foundries specialise exclusively in automotive castings. This partly reflects strategies of diversification pursued since the 1980s recession. The managements of many foundries perceive automotive customers[3] as difficult and demanding. They put a great deal of pressure on foundries to reduce prices and have exacting quality requirements. However the automotive castings market is relatively buoyant and many companies have full order books and are working at near or maximum capacity.

2.1.2 Trends in the UK Foundry Industry

The foundry industry suffers from poor economic performance and has been in decline for several decades. In the UK, the average rate of return on capital in ferrous foundries was 12.5% in 1991/2, but 29.5% of foundries had a negative return.[4] Over the same period the average rate of return for non-ferrous foundries was 7.7%, whilst 22.2% of foundries had a negative return. The industry's competitiveness is under threat because of increasingly international sourcing combined with lower labour costs and higher levels of investment in competitor countries in southern Europe, Turkey and the Far East.

The weaknesses of the automotive foundry sector are listed in a DTI report on the UK casting industry published in 1991:[5]

- lack of investment in new plant and equipment;
- key labour shortages, especially of skilled technical personnel, in long established foundry producing regions coupled with problems of management succession;

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3 Professor Colin Appleby. Dry bag filtration on cupolas in the UK iron founding industry - a market assessment. Draft report to DTI. University of Wolverhampton. March 1994, page 35.

4 ICC Business Ratios.

5 UK Casting Industry. *DTI automotive castings report 1991; The Challenge for the 1990's* Appleby and Benson. 1991.

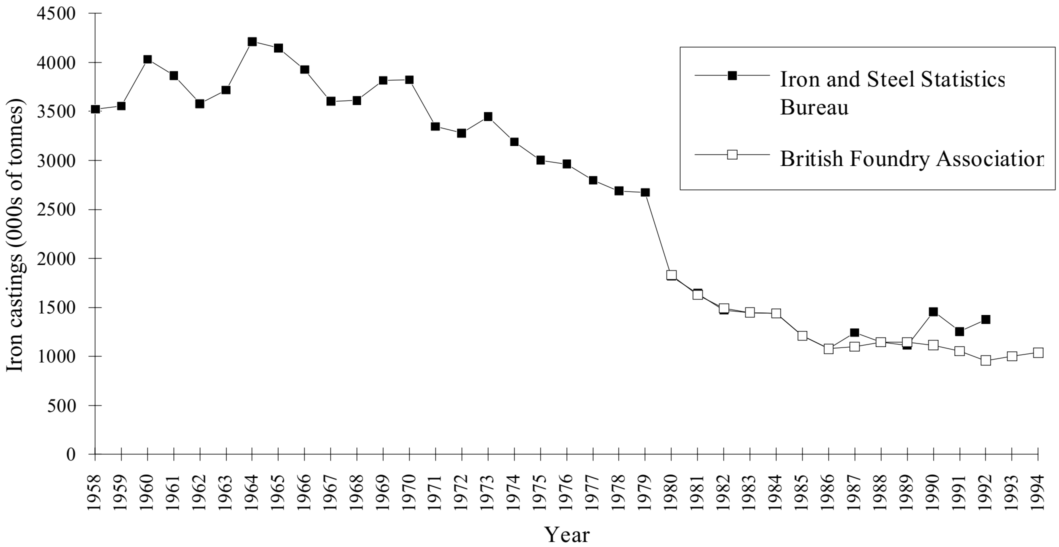
- major and disproportionate decline in training in UK; lack of support for off-the-job training providers, poor image of foundry sectors;

- poor performance in relation to quality standards such as BS 5750; frequent ownership and management changes in automotive castings leading to customer uncertainty; and

- lack of investment in pollution control equipment; closure orders on some automotive casters; compliance problems with standards based regulations

The foundry industry has been in decline since the middle of this century. The decline in tonnage of iron castings produced is shown in Figure 2.3. The trend is exaggerated slightly as improvements in design and casting technique allow unit weight reductions, e.g. thinner walled castings.

FIGURE 2.3: IRON CASTINGS PRODUCTION IN THE UK



The numbers of foundries has declined similarly. Foundries have been closing at a rate of 1.5 per week since the 1940s.[6] There are around 800 (ferrous and non-ferrous) foundries remaining in the UK.[7] The number of ferrous foundries has been declining while the numbers of non-ferrous foundries has increased slightly as shown in Figure 2.4.

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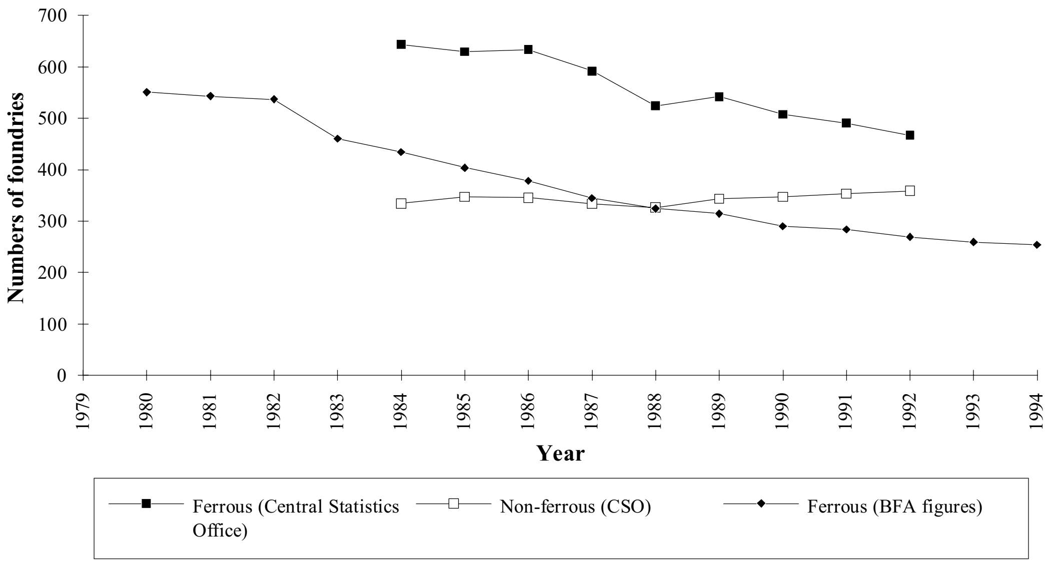
6 Norman Gledhill, BFA.
7 Business Monitor PO 311. Report on the Annual Census of Production 1992. Foundries. Central Statistics Office, HMSO, London 1994.

FIGURE 2.4: NUMBERS OF FOUNDRIES IN THE UK



Product substitution is contributing to the growth of non-ferrous foundries. Castings once made in iron may now be cast in other materials. Non ferrous metals are themselves under threat from composites and plastics. Within the aluminium foundry sector, substitution is taking place from sand casting to gravity die casting and from gravity die casting to pressure die casting. Process substitution is also occurring. Some cast products can be substituted by those using alternative metal working techniques, such as forging, pressing, welding and screwing.

The foundry sector is dominated by foundries employing less than 10 people (Table 2.1). The majority of these smaller foundries are non-ferrous. The size structure of foundries has changed since 1980, with the greatest decreases of employment taking place in very small foundries (below 20 employees) and very large foundries (employing over 200). This suggests both that individual foundries are employing fewer people and that the smallest firms are less viable.

Figure 2.5 shows the markets for UK iron foundries.[8]

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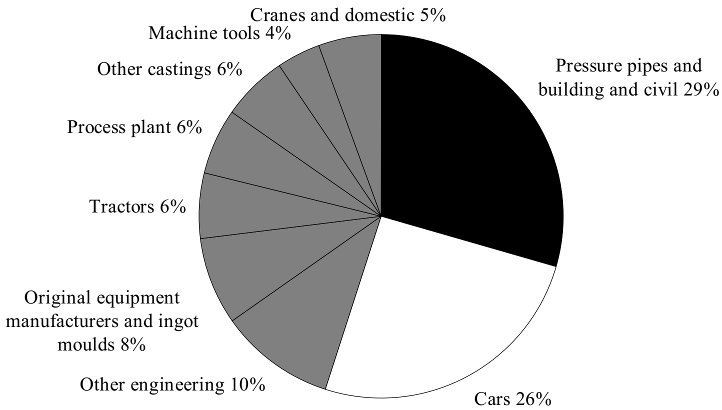
[8] Business Monitor POS 1. Annual Iron Castings Enquiry 1990 Benchmark : Supplementary Results. Government Statistical Service HMSO 1991.

TABLE 2.1: SIZE STRUCTURE OF UK FOUNDRIES (FERROUS AND NON-FERROUS)

Number of employees	1980	1985	1990	1992
1-9	612	359	271	277
10 - 19	269	186	140	141
20 - 49	252	198	201	190
50 - 99	146	106	109	108
100 - 199	104	71	78	70
200 - 299	48	27	26	17
300 - 399	21	11	12	10
400 - 499	15	7	7	5
500 - 749	20	7	6	8
750 - 999	7	5	5	
1000 - 1499	7			
1500 - +	3			
Total number of foundries	**1504**	**977**	**855**	**826**

FIGURE 2.5: MARKETS FOR UK IRON FOUNDRIES



2.1.3 Economic Performance in the UK

Table 2.2 shows that there is no correlation between size of foundry and value added productivity. However, there are differences between value added productivity in ferrous and non-ferrous foundries as shown in Table 2.3. Net output per employee is greater in ferrous foundries.

The highest level of net output per head occurs in the largest size category in Table 2.2, reflecting the dominance of ferrous foundries in this size range. Table 2.3 shows that there are only about 20% more ferrous foundries than non ferrous foundries, yet ferrous foundries account for over two thirds of the total employment and gross output of the foundry industry. The greatest *physical* productivity is found in ferrous foundries which are towards the larger end of the size range, see table 2.1

TABLE 2.2 SIZE STRUCTURE AND PRODUCTIVITY OF UK FOUNDRIES 1992

Number of employees	Number of businesses	Gross output £ million	Net output £ million	Net output per head £
1-9	277			
10 - 19	141			
20 - 49	190			
50 - 99	108	670.9*	377.7*	23,040*
100 - 199	70	421.9	233.3	23,987
200 - 299	17	216.6	115.2	27,510
300 - 399	10	129.6	77	23,526
400 - 499	5	95.7	56.2	24,564
500 - 749	8	412.8	235.9	29,309
Total	826	1947.5	1095.3	25,323

* = total for employment range of 1 - 99.

TABLE 2.3: FERROUS AND NON-FERROUS FOUNDRIES

	Activity 3111 Ferrous	**Activity 3112 Non Ferrous**
Enterprises	431	345
Businesses	467	359
Gross output	£1350,900	£595,700
Net output	£769,000	£326,300
Employees	29,700	14,200
Net output/employment	£25,897	£22,951
Gross value added at factor cost	640.5	278.9
Gross value added at factor cost per head	£21,571	£19,620
Wages and salaries per operative	£13,009	£11,836
Wages and salaries per administrative, tech and clerical	£16,612	£18,696

TABLE 2.4: SIZE STRUCTURE/PHYSICAL PRODUCTIVITY - IRON FOUNDRIES

Number of employees	**1-19**	**20-49**	**50-99**	**100-299**	**300+**	**Total**
Number of foundries	104	104	67	67	14	356
Employment (000s)	1.2	3.3	4.8	10.4	7.5	27.2
Tonnage (000s)	46	113	202	591	502	1455
Output/employee (tonnes)	38	34	42	57	67	53

Table 2.5 shows that net capital expenditure per head in the ferrous foundry industry is below the manufacturing industry average.

TABLE 2.5: CAPITAL EXPENDITURE OF FERROUS FOUNDRIES

Year	Total employment (thousand)	Plant and machinery acquisition (£m)	Total net capital expenditure (£m)	Net capex/head (£m)	Capex/head average (manufacturing industry)
1988	36.2	45	50.6	1399	2083
1989	36.5	64.2	69.8	1913	2401
1990	35.5	64.7	67.6	1904	2430
1991	31.1	54.9	60.2	1937	2449
1992	29.7	33.5	48.1	1620	-

2.1.4 The Foundry Industry in Spain

The Spanish foundry industry is composed of roughly 520 establishments. The number of foundries has declined. There were nearly 600 firms in 1989. This drop occurred in all employment ranges considered, and the size structure of the industry did not alter significantly.[9] Employment declined by 20.4% during the period 1989 - 1992. In 1992, 19,173 people were employed, whereas in 1989 24,101 people were employed. The decline in employment occurred predominantly in the unskilled and semi-skilled workforce, with a drop of 23.6%, whereas the 'white collar' workforce declined by only 5.1%. Output contracted by 4.4%. Although some gains in output levels are noticeable over the period of study, the volume of production remained below that of 1989 (Table 2.8).

TABLE 2.6: NUMBER OF ESTABLISHMENTS IN THE SPANISH FOUNDRY INDUSTRY

Employment Range	1989	1990	1991	1992
< 20	377	359	357	342
20-49	119	113	114	100
50-99	39	39	36	33
100-499	53	50	46	44
>499	6	6	5	4
TOTAL	594	567	558	523

Source: INE Encuesta Industrial

9 INE. Encuesta Industrial

TABLE 2.7: EMPLOYMENT IN THE SPANISH FOUNDRY INDUSTRY 1989-1992

Employment	1989	1990	1991	1992
Blue collar workers	20,014	18,884	17,279	15,296
White collar workers	4,087	4,181	3,722	3,877
TOTAL	24,101	23,065	21,001	19,173

Source: INE Encuesta Industrial

TABLE 2.8: VALUE ADDED AND PRODUCTION IN SPANISH FOUNDRIES, 1989-1992 (Million pesetas)

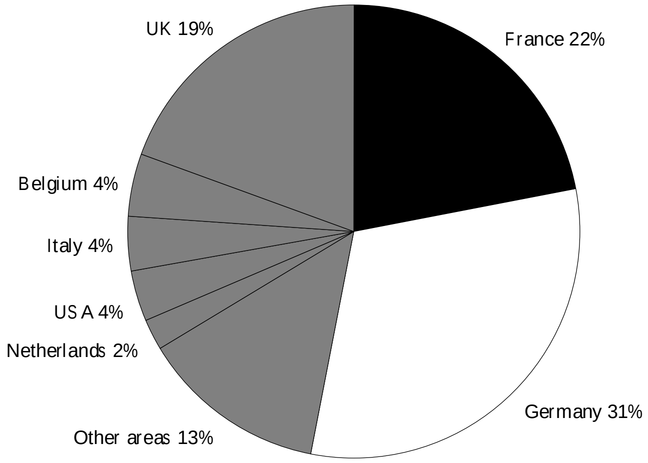
Item	1989	1990	1991	1992
Value Added	83,823	82,851	82,630	83,794
. Earned surplus	23,680	21,269	22,651	22,642
. Labour costs	60,143	61,582	59,979	61,152
Intermediate Consump-	110,964	108,196	100,858	102,457
tion	74,624	69,444	61,466	52,626
. Raw materials	13,463	13,807	13,754	14,187
. Energy	21,861	23,652	23,706	27,011
. Services purchased				
Production	194,787	191,047	183,488	186,251

Source: INE Encuesta Industrial

Foundries have been set up close to sources of raw materials, leading to a strong concentration of this type of industry in specific regions of Spain, particularly because of the availability of iron in the Basque Country. However, foundries are found in other regions of Spain, such as Catalonia, Aragón, Navarra and Asturias. The Basque country is also the centre for important consumer sectors such as the machine-tool industry and the automotive industry. As a result of the Basque regions close proximity to important groups of customers, it continues to dominate in terms of both employment and output, with one-third of all foundries located within the Basque country. Several foundries are situated in the area of Durango, which is neighbouring the most important machine-tool area of Spain (Eibar-Elgoibar area).

Exports account for about one third of total foundry output (Figure 2.6). The export of castings rose during 1988-90. This may be due to pressures on other foundries within the EU, particularly those in Germany, which were under increasing environmental pressure and suffered from the high value of the German currency.

FIGURE 2.6: DISTRIBUTION OF SPANISH FOUNDRY EXPORTS 1994



Spanish foundries have for many years operated old-fashioned technologies. The introduction of new technologies has probably helped to increase exports through an improvement in productivity. Exports have become a major goal of Spanish foundries. An export association (Fundigex, located in Bilbao) has been established with the aim of putting member firms in touch with new markets. Likewise, the adoption of more up-dated technology has contributed to the reduction in employment levels.

The Spanish accession to the EC in 1986 was a significant step for Spanish foundries. Although foundries are not considered by the European Commission to be one of the most sensitive sectors of the Spanish economy many sensitive sectors use castings. Pressures on users of casting will also affect foundries.

Even though the Spanish and Portuguese enlargement took place in 1986, tariffs were reduced gradually over the period 1986-1992 as shown in Table 2.9. However, from 1993 onwards there are no trade barriers (by means of tariffs) between Spain and the rest of the EU.

TABLE 2.9 REDUCTION OF TARIFFS BETWEEN SPAIN AND THE EU, 1986-1993.

DATE OF APPLICATION	% TARIFF REDUCTION
March 1986	-10.0
January 1987	-12.5
January 1988	-15.0
January 1989	-15.0
January 1990	-12.5
January 1991	-12.5
January 1992	-12.5
January 1993	-10.0
TOTAL	-100.0

Source: *1992: L´Europe et la libre circulation des merchandises*, 1988

2.1.5 Main economic indicators in Spain

The Basque foundry industry is dominated by SMEs. Nearly two-thirds of Spanish foundries have less than twenty employees. There are a greater number of non-ferrous foundries, but they tend to be smaller than ferrous foundries. Ferrous foundries account for the majority of employment.

TABLE 2.10: NUMBER OF FIRMS BY EMPLOYMENT RANGE 1993

TYPE OF FOUNDRY	EMPLOYMENT RANGE				
	< 10	10-19	20-49	>=50	TOTAL
Ferrous foundries	17	15	11	37	80
Non-ferrous foundries	55	16	10	11	92
TOTAL	72	31	21	48	172

Source: EUSTAT: Directerio industrial

Due to the fact that foundries have existed in the Basque Country for many years, it is common to come across foundries in villages and urban areas. This situation can lead to complaints from people of the villages where these companies are located.

The legal form of many foundries is that of Labour Joint Stock Societies (SAL). This is a legal form in which at least 51% of its social capital belongs to the workers employed in the society. Many foundries that were previously Joint Stock Societies have been transformed into SALs when facing difficult economic situations. In this sense, many workers have become shareholders of their firm through the investment of unemployment benefits.

During the 1989-93 period, production has grown by 2.9% (Figure 2.7), well below the growth experienced by the whole of Basque industry (+9.5%). However, production has grown by 5.0% in physical terms, indicating that the price of castings has dropped over the period of study.[10]

According to the Basque Foundries Association (AFV), the unfavourable trend in the price of castings was due to the poor economic performance of the vast majority of the consuming sectors. Key sectors such as the automotive industry have been operating well below their production capacity. These sectors have exerted an important downward pressure on the price of castings, and foundries, due to their small size, have had little bargaining power with customers such as the automotive industry. There have also been increases in the price of raw materials, sometimes by up to 70%. The overall result has been a cut in foundry profit margins. As indicated by Table 2.12 profitability has been considerably reduced over the period 1991-1993, and the foundry sector as a whole lost 10,234 million pesetas. Cash-flow has also been affected by a downward trend. This poor performance is characteristic of many firms during this period, due to the recession.

TABLE 2.11: PRODUCTION OF BASQUE FOUNDRIES BY TYPE (tonnes)

Type of Foundry	1989	1993	1994
Iron	236,816	246,124	300,271
Steel	44,889	49,008	58,319
Non-ferrous	-	19,091	20,427
TOTAL	281,075	314,223	379,017

Source: INE Encuesta Industrial

10 The gap between the increase in economic and physical terms should not be so high since information on non-ferrous foundries is missing for 1989. However, it is worth noticing the small share of the latter in total output.

FIGURE 2.7: TURNOVER OF BASQUE FOUNDRIES 1989-93

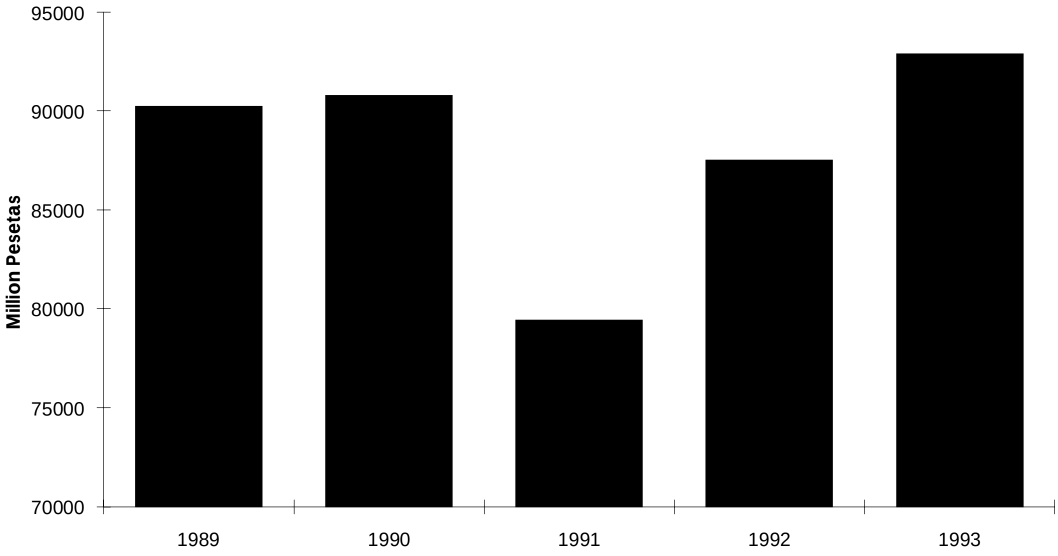


TABLE 2.12: PROFITS AND CASH-FLOW IN THE BASQUE FOUNDRY INDUSTRY, 1989-1993 (Million pesetas)

	1989	1990	1991	1992	1993
Profits	2,114	1,706	-2,467	3,046	-4,721
Cash-Flow	5,510	5,854	2,250	2,172	1,189

Source: EUSTAT. Cuentas Industriales

Employment fell by 25.8% in Basque foundries over 1989-93, with the number of people employed dwindling from 10,672 to 7,917 (Table 2.13). This reduction of the labour-force compares unfavourably with that of the Basque industrial sector generally, where the drop was only 13.1%.

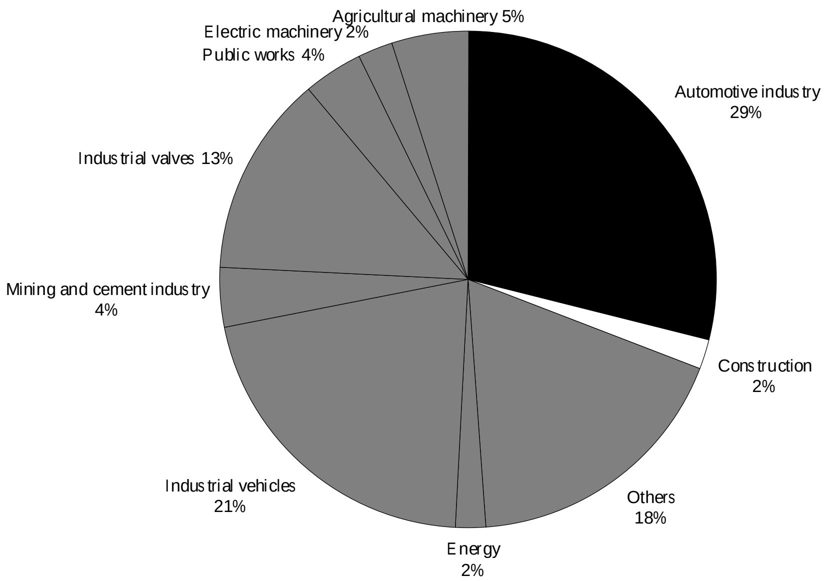
TABLE 2.13 EMPLOYMENT IN THE BASQUE FOUNDRY INDUSTRY, 1989-1993.

1989	1990	1991	1992	1993
10,672	10,152	9,413	8,766	7,917

Source: EUSTAT. Cuentas Industriales.

Figure 2.8 shows that three markets account for nearly two-thirds of total Basque foundry output: automotive industry (29%), industrial vehicles (21%) and valve industry (13%). The remaining sectors have a lower share on the overall production of the Basque foundries. Nevertheless it is necessary to highlight that the situation changes considerably depending on the types of foundries taken into account.

FIGURE 2.8: MARKETS FOR BASQUE FOUNDRIES



2.2 Automotive Components

2.2.1 The restructuring of the automotive industry

The automotive industry has been undergoing a process of globalisation for several decades. It has undergone two major shifts which have had profound implications for employment and training. The first of these changes, from craft to mass production, occurred at the beginning of the 20th century.

The mass production paradigm was characterised by economies of scale and production line assembly. Assembly jobs were repetitive and de-skilled. There was also a high degree of vertical integration, with the aim of co-ordinating an extremely complex process with multi-year lead times and enormous capital investment. Mass production led to a fall in the number of US assembly companies until only today's 'big three' remained - General Motors, Chrysler and Ford. Europe and Japan are the other two important automotive industry regions, although other countries in East Asia are catching up rapidly.

The second shift was from mass production to lean production. This began in Japan and was well developed by the 1980s though it is still diffusing into Europe. This has resulted in a profound restructuring of the automotive industry. The effects of the changes are still filtering through the supply chain, and are significant in the context of this study.

Japanese-style lean production is based on a new approach to labour relations and organisational structure, reducing the number of layers of management and focusing attention on shop floor work groups. The search for quality and the emergence of an increase in networking activity amongst firms led to the introduction of Just-In-Time (JIT)/Total Quality Control systems for organising the production process. The lean production model is characterised by:[11]

- integrated single piece production flow, with low inventories, small batches made just-in-time;
- defect prevention rather than rectification;
- production is pulled by the customer and not pushed to suit machine loading;
- team based work organisation with flexible multi-skilled operators and few indirect staff;
- active involvement in root cause problem solving to eliminate all non-value adding steps, interruptions and variability; and
- close integration of the whole value stream from raw material to final product, thorough partnerships with suppliers and dealers.

The superior productivity of the Japanese model is not disputed, although there is debate about how easily it can be transferred into the European and American workplace. Table 2.14 contrasts several indicators of efficiency in car production, typical of companies in each region.[12]

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11 Womack, JP., Jones, DT. and D. Roos. *The Machine that Changed the World*. Rawson Associates. New York. 1990.

12 Data from Jones, D. "*Measuring up to the Japanese: Lessons from the Motor Industry*". University of Wales Review: Business and Economics. Vol. 5. 1990. In Wells and Rawlinson Op Cit.

TABLE 2.14: PERFORMANCE OF AUTOMOBILE ASSEMBLERS IN JAPAN, AMERICA AND EUROPE

	Japan	North America	Europe
Assembly hours/car	17	25	36
Defects/100 cars	60	82	97
Design lead time (months)	46	60	58
Engineering hours/car (million)	1.7	3.1	3.0
Assembler stocks (days)	0.2	2.9	2.0
Supplier stocks (days)	1.5	8.1	16.3
Number of suppliers per assembler	340	1500	1500

The move towards lean production has been accompanied by a profound restructuring of the automotive industry over the last two decades. Assemblers are R&D effort back along the supply chain and are reducing the numbers of suppliers. Components account for around 70% of the value of the car. There is an increasingly pyramidal supplier structure, with fewer main suppliers and more supplier 'tiers'.

At the top lie the assembly companies such as Ford, Rover, Nissan and Volvo. Underneath lie 'first tier suppliers' which typically supply sub-assemblies which can simply be bolted on to the car. The Japanese have reduced the number of "first tier" suppliers to a greater extent than has been achieved by European, and North American assemblers. Assembly companies have supplier selection and reduction programmes and it is predicted that there will be fewer than 200 global direct first-tier suppliers by the year 2000. First tier suppliers tend to be large companies. All but one of the companies interviewed which supplied direct to assembly companies were owned by large multinational 'first tier' suppliers. There is a larger number of 'second tier' companies which provide components and sub-assemblies to the first tier companies.

The foregoing description applies to the Original Equipment Market (OE), i.e. new cars. Automotive component suppliers also produce for the spares market, usually referred to as the aftermarket (AM). These companies are often dedicated to a single component or sub assembly which they manufacture for a large number of models.

2.2.2 The structure of the UK components industry

The component industry is diverse. A wide variety of different materials is incorporated in vehicles, including iron and steel (68%), plastics (10%), aluminium (4.5%), other non-ferrous metals (3%) and other materials (14.5%). Often the automotive market represents only a small proportion of a company's work. The nature of ownership of companies also makes classification difficult. These problems lead to a wide range in the estimates of numbers of firms in this sector. [13]

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[13] P Wells and M Rawlinson. *The New European Automobile Industry.* Macmillan Press Aug. 1994.

The types of company relevant to this study are metal working engineering firms, typically supplying steering assemblies, suspension assemblies, axle and brake components, power transmission equipment, internal combustion engine components and spare parts. The principal activity of these companies is machining and, to a lesser extent, assembly.

The most relevant Standard Industrial Classification for these companies is 353, motor vehicle parts, although the type of company of interest in this study is only a fraction of the total represented by SIC 353. Table 2.15 gives a picture of the size structure of the industry.[14]

TABLE 2.15: THE UK VEHICLE COMPONENTS INDUSTRY (SIC 353)

Number of employees	Businesses	Employees (thousand)	Gross output (£m)	Net output (£m)	Net output /head
1-9	764	2.3			
10 - 19	139	1.9			
20 - 49	148	4.7			
50 - 99	97	6.9	796.30	377.40	£24,052
100 - 199	68	9.7	419.10	244.70	£25,108
200 - 299	25	6.2	513.20	175.10	£28,037
300 - 399	23	8	352.90	229.70	£28,770
400 - 499	11	4.7	955.30	135.40	£28,516
500 - 749	27	16	321.60	432.90	£27,014
750 - 999	7	5.8	623.70	129.40	£22,267
1000 - 2499	9	11.2	304.50	304.50	£27,229
> 2500	3	8.6	189.90	189.90	£22,096

Figure 2.9 shows that the UK industry has changed dramatically over the last few decades, with a dramatic fall in the level of employment and an improving level of quality (albeit starting from a low level). Between 1980 and 1987, the vehicles and parts industry shed around 185,000 jobs, or 45% of the employment in 1980.[15]

This was accompanied by an increase in labour productivity brought about partly through closure of the least efficient (larger) plants but also increased productivity at the individual plant level. Many firms simplified their organisational structure, improved labour utilisation through tightening up job standards and reduced down time through staff breaks. The introduction of new technology also contributed towards increasing productivity. The reduction in employment disproportionately affected unskilled and semiskilled employees, as well as clerical, secretarial and supervisory staff.[16]

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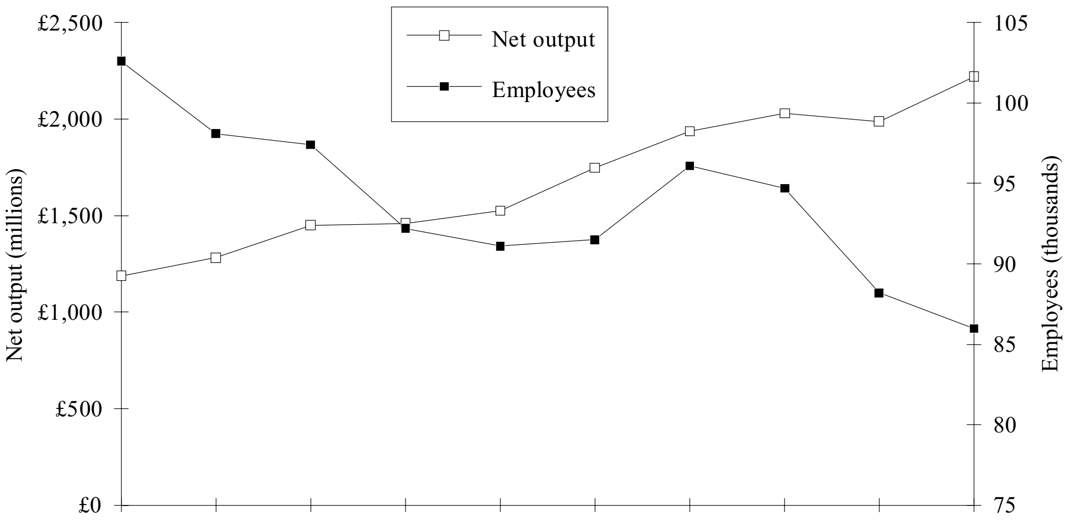
14 Report on the Census of Production, 1992 PA 351. Motor vehicle Parts. Central Statistics Office, 1994.

15 Amin Rajan and Marc Thompson. *Economic Significance of the UK Motor Vehicle Manufacturing Industry*. A report by the Institute of Manpower Studies to the Society of Motor Manufacturers and Traders Ltd.1989.

16 Amin Rajan and Marc Thompson. *Economic Significance of the UK Motor Vehicle Manufacturing Industry*. A report by the Institute of Manpower Studies to the Society of Motor Manufacturers and Traders Ltd.1989.

The automotive industry supports large numbers of jobs and has a large 'multiplier' effect on other sectors. For every job in vehicle manufacturing, 1.4 jobs are supported in direct suppliers and 2.8 jobs in the economy as a whole.

FIGURE 2.9: EMPLOYMENT AND OUTPUT TRENDS IN MOTOR VEHICLES PARTS (SIC 353)

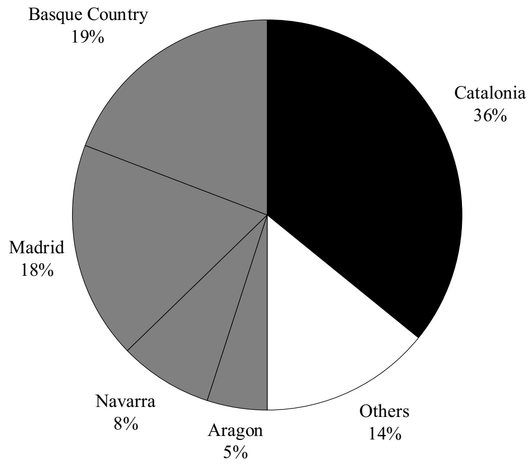


2.2.3 The structure of the Basque Components industry

The information in this sector was provided by the Spanish Automotive Components Industry Association (Sernauto) and refers to Spain as a whole. Information specific to the Basque country is not available.

The Spanish automotive components industry is composed of about 650 firms. The geographical distribution of firms shows an uneven distribution across space (Figure 2.10). Three regions account for nearly two-thirds of firms: Catalonia (36%), Basque Country (19%) and Madrid (18%). The development of the Spanish automotive components industry was originally linked to the emergence of a national car industry in the early 1950s around SEAT. Now it is completely in the hands of trans-national firms and groups. VW, Opel and all operate in Spain. Although only one vehicle manufacturer (producing vans) operates in the Basque Country (Mercedes Benz in Vitoria), the importance of the automotive components industry is explained by the dominance of metalworking in the Basque region.

FIGURE 2.10: REGIONAL DISTRIBUTION OF AUTOMOTIVE COMPONENT FIRMS



Growth in the Spanish economy during the period 1986-1989 was followed by an economic slump during the 1990s. The automotive components industry was severely hit by market sluggishness due to dependence on the car industry and therefore on the general economic situation. In 1993, turnover fell by 14.4% compared with 1992 and GDP fell for the first time since the mid-1980s (Figure 2.11). Although there are few statistics available for 1994, the car and automotive components industries appear to have recovered well, due at least in part to the Renove programme which offers a financial incentive to owners of old cars (ten years or more) to purchase new vehicles.

Spanish exports of automotive components industry have grown relative to domestic sales since the mid 1980s (Figures 2.12 and 2.13). Exports accounted for 28.6% of in 1986 compared to 59.8% in 1994. The growth of exports is to some extent explained by Spain's entry into the EU in 1986. About three-quarters of exports go to the European Union, namely Germany and France. The increasing importance of exports is also explained by the widespread investment of foreign capital in the Spanish automotive components industry. The Spanish stake in the overall capital of this industry is below 15% with the most outstanding foreign investors being firms from the EU, especially France and Germany.

FIGURE 2.11: TURNOVER OF THE SPANISH AUTOMOTIVE COMPONENTS INDUSTRY 1989 - 1993

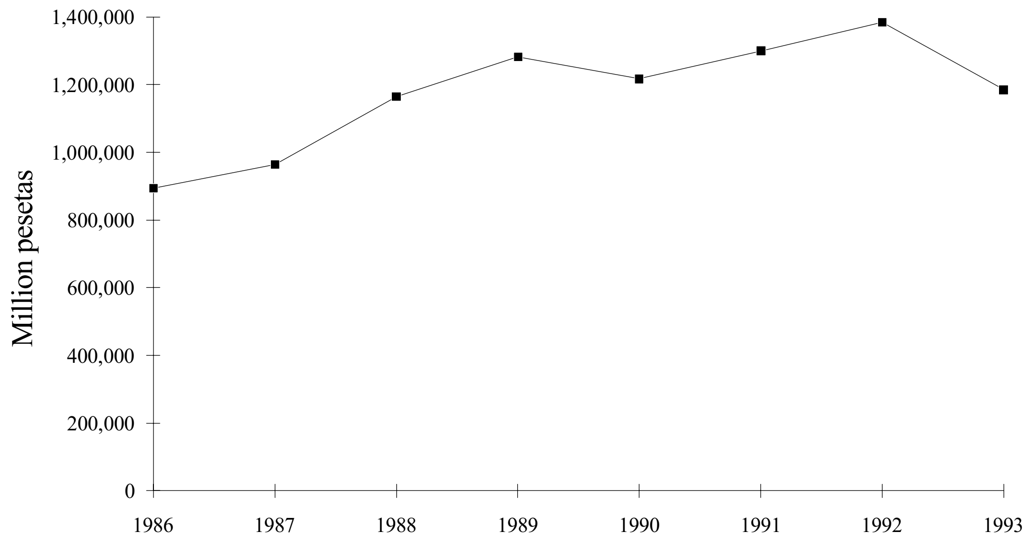


FIGURE 2.12: DISTRIBUTION OF SALES BETWEEN EXPORTS AND THE DOMESTIC MARKET

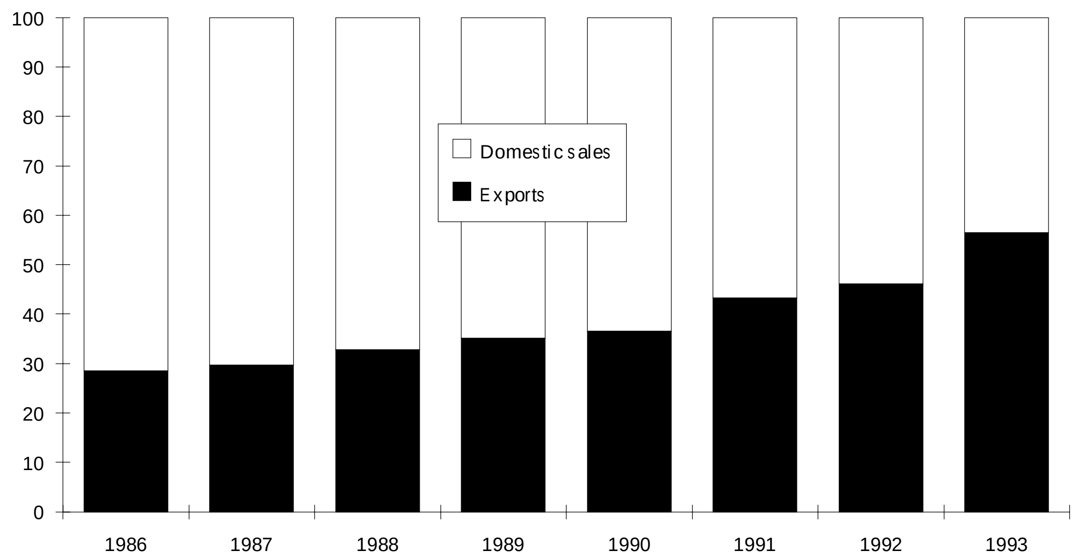
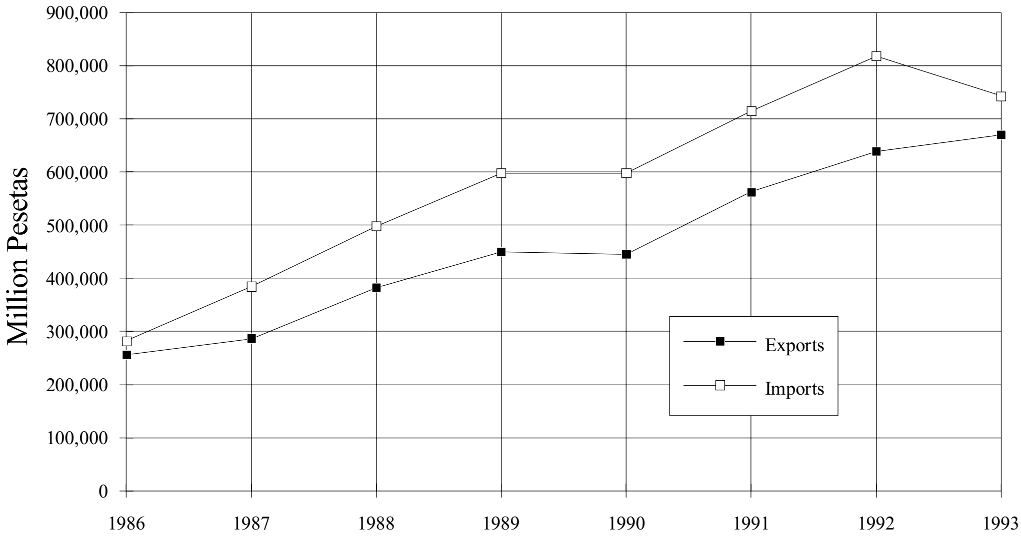


FIGURE 2.13: EVOLUTION OF AUTOMOTIVE COMPONENT EXPORTS AND IMPORTS



3. PUBLIC POLICY

3.1 Overview

Three broad types of public policy may influence the interaction between environmental performance and employment: industrial policy; environmental policy; and employment/ training policy.

Due to Spain's less favoured economic condition, economic policy has been traditionally at the top of the agenda, whilst environmental issues have been given a lower priority. The need to satisfy European legislation, as well as the growing belief that environmental requirements may not represent a cost but an opportunity for firms, is beginning to change this situation. Environmental policy has become increasingly important from the mid-1980s onwards. At the same time, industrial policy measures, both at the federal and the regional level, have played an important role as tariff barriers between Spain and the rest of the EU have been dismantled and as Europe has emerged from recession in the early 1990s.

In recent years, the British Government has not, in general, favoured financial support for industry, preferring to allow market forces their full play. However, the foundry industry in particular has benefited from government programmes which have stimulated the flow of information about better industrial practice and which have, in some cases, permitted support for environmental consultancy and demonstration projects. The UK's Environmental Protection Act 1990 and Environment Act 1995 have thoroughly revised the legislative framework for the implementation of environmental controls. The 1990 Act provides the legislative basis for new rules on atmospheric emissions from foundries and for waste disposal.

The remainder of this section discusses successively: relevant industrial policy measures in the two countries; environmental controls; and employment/training policy.

3.2 Industrial Policy

3.2.1 UK Support

Foundry 2000

The UK Department of Trade and Industry operates a programme, *Foundry 2000*, which is specifically aimed at maintaining and improving the competitiveness of the foundry sector. The initiative was launched in March 1995. The objective of the scheme is to enable the industry to 'take stock of its competitive position, to develop a vision of what it needs to do to be world class in the next century and to take action to achieve this'.

The initiative will have two phases. The first phase will compare the performance of the UK foundry industry with international competition, look at what the industry needs to do to improve its performance and identify ways in which each foundry can increase profitability. The second phase is concerned with practical steps to improve competitiveness. The consultants report from the first phase was due at the end of November 1995, and the second phase was launched in January 1996.

A total of 47 foundries participated in the first phase. Participation was possible at either one of two levels. Full participation, at a cost of £3,000 gave access to the consultant's report and strategic programme for the UK industry, plus an individual benchmarking assessment of the foundry's performance, highlighting its strengths and weaknesses. Partial participation, at a cost of £1000, included the consultant's report, but no foundry specific analysis. Around half of the 47 foundries were full participants.

It had been hoped that a larger number of foundries would participate. The initiative may over-represent the more proactive foundries. However the British Foundry Association believe that the results will prove beneficial for the industry as whole.

Environmental Technology Best Practice Scheme

The joint Department of Trade and Industry/Department of the *Environment Environmental Technology Best Practice Scheme* provides support for a range of sectors, but the foundry industry was selected as one of the first areas for special assistance. The foundry scheme focuses on waste minimisation in order to promote both the environmental performance and competitiveness of UK industry and commerce. There are several elements;

- **telephone helpline** providing up to two hours free advice to companies
- **environmental performance guides** presenting data on environmental performance in a particular industry sector, technology or operation.
- a **good practice** scheme which promotes awareness of and confidence in cost effective measures which improve environmental performance.
- a **new practice** scheme which accelerates the adoption of environmental technologies and techniques; and
- a **future practice** scheme which provides grants of up to 49% for R&D to stimulate the development of innovative environmental measures.

Companies able to satisfy the criteria for the selection of good practice or new practice projects are eligible for a payment of up to £10,000 or £50,000 respectively. New practice assistance must not exceed 25% of the total project cost.

The scheme was set up in 1994. So far there have been three publications: an environmental performance guide on chemically bonded sand reclamation; an environmental performance guide on greensand reclamation; and a good practice guide on thermal reclamation.

In addition, the Energy Technology Support Unit (ETSU) had been promoting improved energy efficiency at foundries for some time. This work has now been re-located within the Best Practice Programme. ETSU has published several guides which show foundries how to improve their energy efficiency and thereby improve environmental performance. These have addressed: the efficiency of cupola and electric melting; molten metal handling and distribution; and improving foundry yield.

DEMOS

In the past, other schemes have helped to demonstrate technologies unfamiliar in the UK. The first dry bag filter fitted to a cupola at a UK foundry (Chamberlin and Hill foundry Walsall) received a grant under the Department of Trade and Industry's Environment Management Options Scheme (DEMOS). A dry bag filter is capable of reducing the particulate emissions from cupolas down to below 20mg/m3. This scheme aims to promote the widespread adoption of technologies and 'best practice' techniques with broad potential for environmental benefits. Grants of up to 50% of eligible costs were available for projects that proved the practicability of new techniques or illustrated best practice based on proven techniques. In this case, Chamberlin and Hill were using a technology proven abroad, where it was used at foundries melting clean scrap. They demonstrated that the technology could be used for melting cast iron scrap contaminated with oil.

3.2.2 Support in Spain and the Basque Country

The PITMA Programme

The PITMA programme (Environmental Technological Industrial Programme) was launched in 1989 by the Spanish Ministry of Industry. The objective of the programme was: a) to assist manufacturing firms in overcoming environmental problems; and b) to promote the emergence of an environmental industry. The programme aims to help the development and diffusion of new clean air technologies. The beneficiaries of the programme are public and private sector companies, company associations, private non-profit making institutions and individuals. Five out of the ten foundries visited stated that they had been supported under the PITMA programme. However, no automotive component manufacturers had received support.

Financial support is in the form of non-returnable grants (Table 3.1). The grant varies according to the size of the firms and the type of assistance (A, B, or C). SMEs receive a higher percentage of their investment than do large firms. The three types of financial support are:

- *assistance type A* is for firms affected by severe environmental problems. Support is given for the acquisition of better equipment and transforming existing production process.

- *assistance type B* provides support for innovation and environmental audits in firms that already satisfy environmental requirements.

- *assistance type C* provides either training on environmental issues or promotes the diffusion of environmental information amongst manufacturing firms.

Information on PITMA programme grants is not available beyond 1992, although the programme was still running in 1994. During the period 1990-1992, 1,229 projects were supported out of 2,570 projects proposed. The support given by the programme has amounted to 13,000 million pesetas which has resulted in a total investment of more than 349,000 million pesetas. The PITMA programme has supported the diffusion of environmental services by means of a data base (BRISA) of information on firms providing environmental services.

TABLE 3.1: PITMA PROGRAMME - GRANT COVERAGE AS A PERCENTAGE OF TOTAL ENVIRONMENTAL INVESTMENT

ASSISTANCE	SIZE CLASS	
	SMEs(1)	Large firms
Type A		
Minimum standards of environmental protection	25%	15%
Higher standards of environmental protection	30%	25%
Type B		
Basic research	60%	50%
Applied research	40%	30%
Type C	100%	100%

(1) SMEs are firms with no more than 250 employees and turnover less than 20 mECU.

Source: Ministry of Industry and Energy

The main features of the PITMA are as follows:

- roughly two-thirds of the financial support has been devoted to solve problems related to air pollution and water pollution.
- despite the programme being targeted at SMEs, the latter account for only 38.3% of the overall funds provided. The bulk of the money has been taken up by large firms.
- although most of the funding is given to large firms, a growing amount of money is being directed towards SMEs. Support in 1992 was nearly twice as high as in 1991 and three times as high as in 1990. Likewise, the share of public aid in total SMEs environmental investment enjoys a significant upward trend (table 3.3).
- more emphasis is being put on projects subject to assistance type B.

The first PITMA programme ended in 1994 and a new programme (PITMA II) has been launched for the period 1995-1999. PITMA II has similar aims and objectives to PITMA.

TABLE 3.2: INVESTMENT GENERATED BY THE PITMA PROGRAMME 1990-1992 (million pesetas)

AREAS	INVESTMENT
Land pollution	42,000
Atmospheric pollution	120,000
Water pollution	115,000
Others	72,000
TOTAL	349,000

Source: Ministry of Industry and Energy

TABLE 3.3: SMEs BENEFITING FROM THE PITMA PROGRAMME 1990-92 (m pesetas)

	1990	1991	1992
Investment (A)	32000	36000	39000
Public Aid (B)	863	1493	2620
Aid Ratio (%)	2.7	4.1	6.7

Basque Country initiatives

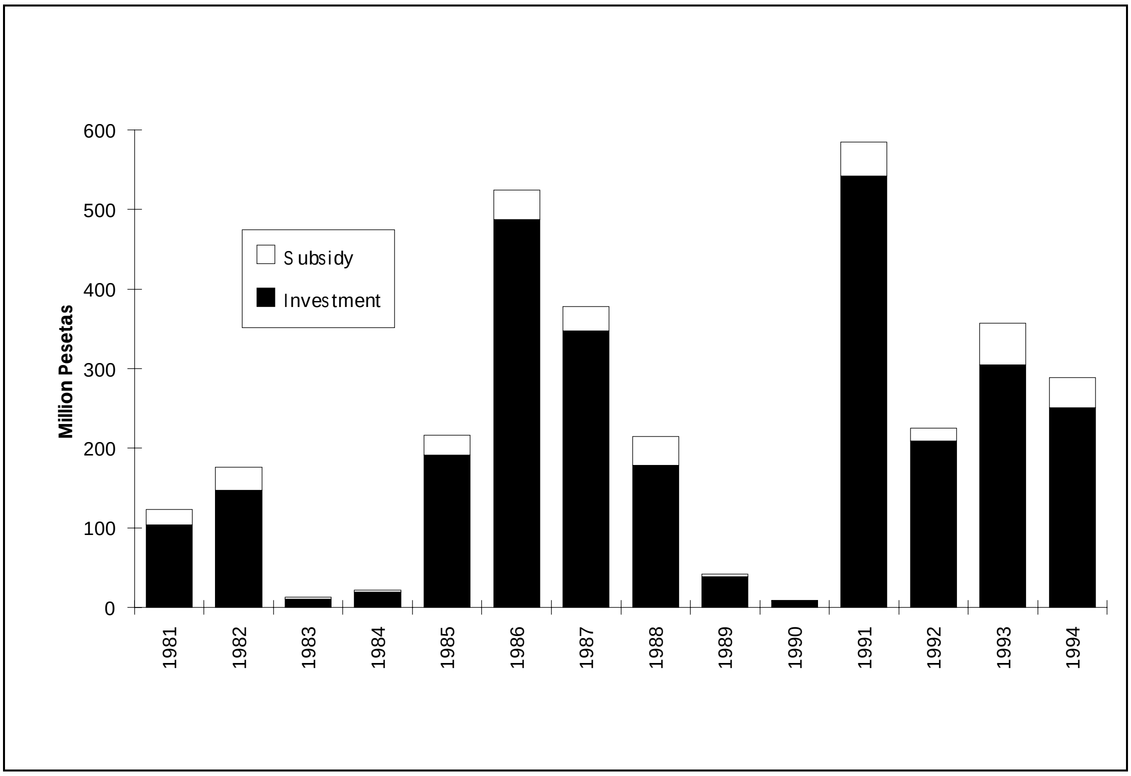
The Basque authorities provide financial support that might help firms to improve their environmental performance. The types of investment supported and the percentage covered by public aid are shown in Table 3.4. Environmental investments made by the Basque Foundry industry amounted to 2,835.6 million pesetas over the period 1981-1994 (Figure 3.1). The support provided by the Basque Environmental Department as a whole covered 11.8% of such investment. Environmental investments accounted for 6% of the total investment of the Basque foundry industry over the four-year period 1990-1993. Table 3.5 shows that the majority of environmental investment has been spent on abating air emissions.

TABLE 3.4 SUBSIDIES LINKED TO THE IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE.

TYPE OF INVESTMENT SUPPORTED	% OF PUBLIC AID OVER TOTAL INVESTMENT
Purchase and installation of environmental equipment	Up to 30%
Move from polluting to less/non polluting fuels	Up to 30%
To carry out environmental audits	Up to 60%

Source: Environmental Department, Basque Government

FIGURE 3.1: ENVIRONMENTAL INVESTMENT AND SUBSIDIES WITHIN THE BASQUE FOUNDRY INDUSTRY



Source: Environmental Department. Basque Government.

TABLE 3.5: ENVIRONMENTAL INVESTMENTS WITHIN THE BASQUE FOUNDRY INDUSTRY BY MAJOR AREAS 1981-1994 (m Pesetas)

AREA OF INVESTMENT	INVESTMENT	%
Air	1,412.3	92.9
Water	104.9	6.9
Solid waste	3.4	0.2
TOTAL	1,520.6	100.0

Source: Environmental Department. Basque Government

3.3 Environmental Policy

3.3.1 UK Environmental Policy

Air

Air pollution controls are currently having a significant impact on UK foundries. By way of contrast, automotive component suppliers are little affected, apart from controls on VOC emissions from paint shops.

Environmental regulation has only recently begun to have a significant impact on foundries. Prior to the Environmental Protection Act 1990, the Clean Air Acts of 1956 and 1968 provided the only environmental controls on iron foundries. Although many foundries had grit arrestment plant fitted in order to comply with this legislation, impacts on the environment were still significant. Attempts were made to introduce more effective environmental controls to this sector by the Working Party on Grit and Dust Emissions, which proposed particulate emission limits in 1974. However:

> 'Industry lobbying succeeded in keeping the regulations of the statute book for the rest of the decade - and then for the whole of the 1980s as well. By any token the sector has benefited from a very long period of grace'[17]

Foundries are now scheduled as 'Part B' processes under the Environmental Protection Act 1990. Part B processes, regulated under Local Authority Air Pollution Control (LAAPC), require an authorisation from the local authority in order to operate. Local authorities are given guidance on what authorisations should contain through Process Guidance Notes produced by central government.

There are three sets of process guidance notes relevant to foundries.[18] These specify quantitative emissions limits, as well as containing general requirements on monitoring, sampling and emissions measurement, materials handling, process operation, chimney height and general operations. The most significant emission limits refer to particulate matter from melting operations and VOCs and ammonia from mould making, coremaking and casting operations.

The guidance notes were issued in 1991, and foundries were required to apply for an authorisation from their local authority by March 1992. The authorisation process takes place in two stages. The initial authorisation gives permission for the operator to continue to operate the existing process on the basis of the existing level of pollution control achievable using the plant and equipment existing at the process at the time of authorisation.

The second stage requires 'upgrading', whereby operators bring their process up to the standards described in the process guidance notes. This is when the real impact of the

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17 Die cast for iron foundries by new pollution control rules, ENDS 194, March 1991, pages 13-16.

18 Secretary of State's Guidance-Electrical and rotary furnaces. Department of the Environment. PG 2/3(91). July 1991; Secretary of State's Guidance-Hot and cold blast cupolas. Department of the Environment. PG 2/5(91). July 1991; Secretary of State's Guidance. Iron, steel and non-ferrous metal foundry processes. PG 2/4(91). July 1991.

legislation will take place. Foundries must upgrade by April 1997. Both electric and cupola melting must comply with an emission standard of 100mg/m^3 if melting capacity is four tonnes/hour or greater. No emission limits are specified for smaller plant to which wet arrestment plant or more efficient fume arrestment plant must be fitted. Modest upgrading may be necessary to achieve compliance with the existing legislation and/or any interim standards included in the process guidance notes. New equipment must comply with the relevant process guidance note as soon as it is commissioned.

Process guidance notes are reviewed every four years to allow for developments in abatement technology. The new standards for 2001 have not yet been finalised but the most significant changes are likely to be:

- a reduction of the particulate emissions limits from both electric melting and cupola melting from 100mg/m^3 to 20mg/m^3. Foundries will have until 2001 to comply with the new limit.

- a refinement to the cut-off point for emissions limits for small cupolas. In the first guidance notes, no emissions limits were specified for cupola melting furnaces with a capacity of less than 4 tonnes an hour. From April 2001, it is likely that smaller furnaces with a total production rate of more than 100 tonnes per week will have to comply with the particulate emission limit of 20 mg/m3.

- emissions limits for VOCs and ammonia will remain the same, but will be extended beyond investment casting and sand reclamation. This restriction has taken some pressure off foundries, which might otherwise have been required to make large compliance investments.

Emissions to air are not an issue for the majority of components manufacturing companies, unless they have paint shops. Large painting operations are prescribed as Part B process under the Environmental Protection Act 1990. Paint shops are regulated 20 tonnes or more of paint are sprayed or five tonnes or more of organic solvents are used over a 12 month period.

Water

Both foundries and the manufacture of automotive components give rise to liquid wastes. Emissions to water are regulated by HM Inspectorate of Pollution (HMIP) or the National Rivers Authority (for surface waters) and the local water company in the case of discharge to the sewer. Disposal to the sewer is the most likely route.

The statutory provisions covering discharges to sewers are the Public Health (Drainage of Trade Premises Act) 1936, the Water Act 1973 and the Control of Pollution Act 1974. Enforcement is carried out by the regional Water Companies. The local water company issues consents which specify the minimum quality of the effluent discharged. This may specify quantities, flow rates, pH, temperature and suspended solids levels. In setting these parameters, the water company can ensure that effluent will not adversely affect the receiving sewage treatment works. Some companies have large effluent holding pits which are sampled by the water company before they are emptied to the sewer.

The charge for trade effluent is based on the Mogden Formula:

Total charge per Cubic metres =

Unit cost of reception and conveyance of sewage +

Unit cost of preliminary and primary treatment +

(COD sample/COD average effluent) x unit cost of biological oxidation treatment +

(suspended solids sample/average effluent suspended solids) x unit cost of treatment and disposal of sludge

Companies therefore have an incentive to reduce the quantity of effluent they discharge and to improve its quality (i.e. to reduce chemical oxygen demand and suspended solids).

Solid Waste

Foundries and automotive component manufacture both give rise to the production of solid waste. Under the Environmental Protection Act, waste producers are bound by a ‘duty of care’. This places responsibility for the waste on the waste producer until the waste is transferred to a licensed waste disposal facility. The waste producer is therefore encouraged to use a reputable contractor. Most waste from the two industries goes to landfill.

Special (toxic) wastes must be accompanied by a statutory consignment note, a copy of which must also be sent to the waste disposal authority or waste regulation authority, under the Control of Pollution (special waste) regulation 1980.

Contaminated Land

Some form of liability for damage caused by contaminated land may be introduced in the future, although the Government has so far rejected this idea. However the government suggested that the principles of liability should first be tested in the courts. The manufacture of metal goods has been listed by the House of Commons Select Committee on the Environment[19] as a land use which may give rise to contamination. The Committee urged the Government to consider the creation of a statutory liability framework.

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[19] House of Commons Select Committee on the Environment. *1st Report Contaminated Land*. January 1990.

3.3.2 Spanish Environmental Policy

Air

The 38/72 Law on Environmental Air Protection and the 833/1975 Decree which implements this Law provides the legislative framework for the Spanish programme on air pollution control. The 1975 Decree established air quality standards and emission limits for particular groups of industrial activities. For some environmental matters, regional bodies are in charge of the process of implementation and monitoring of environmental legislation. Moreover, very often they can introduce more severe environmental requirements than those established by national legislation. Implementation of air quality standards is the responsibility of the Environment Ministry in the Basque Country. Implementation of emission limits falls to the Ministry for Industry.

Three groups of industrial activities are taken into account depending on their polluting capacity: Group A for highly polluting activities, Group B for activities considered as being intermediate and Group C for the less polluting activities.

Foundries belong either to Group A or to Group B depending on furnace capacity. Foundries with furnaces with a capacity of above 10 tonnes per hour are classed as Group A and foundries with smaller furnaces belong to Group B. Groups A and N differ only in the licensing and control requirements - emission limits are identical. Moulding processes and sand-casting activities are in Group C.

The only specific regulation for foundries is for particulate emissions from cupola melting. Emission limits for cupola melting were introduced in 1975. The current emissions limit for small cupolas is 250 mg/Nm^3, and for larger cupolas 150mg/Nm^3, as shown in Table 3.6.

Other types of furnaces and processes are not subject to specific rules must meet the emission limits shown in Table 3.7. These generic limits must also be met by firms belonging to the automotive parts industry.

TABLE 3.6: EMISSION LIMITS OF SUSPENDED PARTICLES FOR CUPOLA MELTING PROCESSES

TYPE OF CUPOLA (Tonne/hour capacity)	EMISSION LEVELS (mg/Nm^3)		
	Existing installations	New installations	1980 forecast
< 5 and > 1	800	600	250
> 5	600	300	150

Source: Decree 833/1975

TABLE 3.7: EMISSION LIMITS FOR ACTIVITIES NOT EXPRESSLY REGULATED

POLLUTANT	EMISSION LIMIT	UNITS
Particulate matter	150	mg/Nm^3
SO_2	4,300	mg/Nm^3
CO	500	ppm
NO_X	500	ppm
Fluoride		
- Pasture areas	40	mg/Nm^3
- Other areas	80	mg/Nm^3
Cl	230	mg/Nm^3
HCl	460	mg/Nm^3
SH_2	10	mg/Nm^3

Source: Decree 833/1975

Water

Law 29/85 and Decree 849/86 provide the legal framework for water management in Spain. Under this regulatory framework the 'Hydrographic Confederations' are in charge of licensing and controlling water waste processes. There are a collection of ordinances regulating the dumping of several dangerous substances into water. These ordinances have been adapted from EU legislation, although Decree 749/46 established limits and the tax levied.

The 849/86 Decree makes a distinction between two different types of waste water: industrial and urban waste water. Urban waste water is classified into three types depending on the area where the waste is discharged into the river: non industrialised areas, areas of intermediate industrialisation and areas which are very industrialised. Industrial waste water is classified according to the level of pollution it is likely to cause - low, medium or high - and the quality of the water into which it is discharged. Basque Country firms are required to meet the toughest demands. However, where technical problems prevent compliance firms are allowed to operate under less restrictive limits.[20]

The water bill is dependent on both the quality and the quantity of water discharged into the river and is calculated according to the following formula:

$$\textit{Water bill (pesetas)} = V \times k \times 10^{-5} \times 500{,}000$$

[20] To a large extent, the Hydrographic Confederations establish the water bill by means of an individual analysis of every firm.

Where: V is Amount of waste discharged into the river per year (m^3); and k is a constant affecting firms according to the criteria laid out in Table 3.8.

TABLE 3.8: DETERMINATION OF THE WASTE WATER BILL

TYPE OF WASTE	DEGREE OF ENVIRONMENTAL REQUIREMENT (Waste limits)		
	Low	Medium	High
Urban:			
. Non-industrialised area	1.0	0.20	0.10
. Intermediate degree of industrialisation	1.2	0.24	0.12
. Very industrialised area	1.5	0.30	0.15
Industrial:			
. Less pollutant	2.0	0.40	0.20
. Intermediate pollutant	3.0	0.60	0.30
. Very pollutant	4.0	0.80	0.40

Source: Decree 849/86

Waste

Solid waste management (namely municipal solid waste) has been the most dynamic environmental protection activity over the last few years within Spain. However, there are some areas in which a more intensive effort is needed. More than two million tonnes of toxic and dangerous industrial waste are directly discharged into the sea and rivers. The *National Plan on Industrial Wastes* represents an important attempt to solve this problem. As described above, a charge for discharging liquid wastes to the sea and rivers was introduced in some parts of Spain in 1986. However, solid industrial waste is a problem where sufficient efforts have not yet been made.

Together with the National Plan on Industrial Wastes, national authorities have launched several *sectoral Plans* which focus on particular industrial sectors. The objective is to make recommendations for each sector in terms of what action is needed to overcome their environmental problems. All firms producing toxic or dangerous waste have to make an annual declaration of the types and amounts of waste produced.

The 20/1986 Basic Law on Toxic and Dangerous Waste and Decree 833/88 form the legal framework for waste management. Decree 27/1989 made the Basque Environmental Department the body responsible for waste management across the Basque Country.

3.4 Employment and Training

3.4.1 Overview of Training in the UK

Current training initiatives

Government provision for industrial training changed at the end of the 1980s. The previous Industrial Training Boards were replaced by Training and Enterprise Councils (TECs). These rely heavily on government funding although they were intended to derive a substantial proportion of their revenue from local employers.

TECs are led by employers with optional trade union representation. Most of them are spent training people who would otherwise be unemployed. All funding, whether in the form of grants to businesses or training for the unemployed, has to be directed towards the acquisition of National Vocational Qualifications (NVQs). Companies can receive grants from their local TEC for up to 50% of the cost of training.

The NVQ scheme is a training initiative based upon testing the competence of employees in a work situation. The scheme is not concerned with the actual method of training,. It is based on the premise that there are different learning routes and that a standard cannot be defined by the learning route taken. There are 5 levels of NVQ, ranging from: Level 1 applicable to a basic operator; Level 2 for an operator with higher skills; Level 3 for a craftsman and technicians; Level 4 for technician engineers; and Level 5 for professional engineers, scientists and technologists.

The National Council for Vocational Qualifications, established in 1986, works with industry to specify the relevant criteria of assessment for individual employment sectors. At the moment foundry skills are catered for as an option in the 'Engineering Material Processing' NVQ at Level 2. This allows candidates to select their main option from coremaking, moulding or pattern making. There is also a specific NVQ for high pressure aluminium die casting. The assessment is undertaken by an assessor registered by EnTra, the Engineering Training Association.

Investors in People

The Investors in People (IiP) Standard was developed in 1990. To gain the standard, companies must plan and implement training systematically and relate training to company strategies and the needs of individuals and the business. Research conducted by the Institute of Manpower Studies has shown that IiP is having a positive effect on training and development and can play a key role in improving business practice.[21] A study carried out by the Engineering Employers Federation indicates that many companies believe IiP will help them to implement Total Quality Management.[22]

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[21] Spillsbury, M, Meager, N and J Hillage. *Evaluation of Investor in People in England and Wales* . Institute of Manpower Studies, BEBC Distribution, Dorset. 1994.

[22] Ann Bailey and Martin Janes of the Engineering Employers Federation. *Investors in People. A survey of experience in the engineering manufacturing industry* . January 1995.

The Investor in People standard is based on four key principles

- **Commitment** from management to develop all employees in order to achieve business objectives. Each business should have a written business plan setting out goals and targets and considering how development needs will be assessed and met.

- **Regular planning and review** of the training and development needs of all employees. Targets should be set and national standards should be linked, where appropriate, leading to the achievement of NVQs.

- **Action** to train and develop individuals on recruitment and throughout employment

- **Evaluation** of the company's investment in training and development to assess achievement and to improve future effectiveness

Adherence to these four key principles is assessed using 24 indicators. The TECs provide guidance and support for companies seeking to attain the standard and may also undertake assessments. An alternative assessment route is through a Local Enterprise Company or Investors in People UK

Modern Apprenticeships

The *Modern Apprenticeship* scheme is relatively new. A limited number of prototype schemes, included Engineering Manufacturing, were launched in Autumn 1994. The scheme aims to provide work-based training to NVQ Level 3 or above for school leavers. The funding arrangements are agreed locally between the TEC and the employer, but the latter normally meets the cost of wages or allowances. The aim is that Modern Apprentices are given employed status at the beginning of their training, but where this is not possible 'the apprentice will be clearly linked to an employer, or group of employers, and paid an allowance'.[23]

3.4.2 Overview of Training in the Basque Country

The Spanish Education System is basically structured round two different routes. Students who intend to follow Higher Education (University), must complete four years of secondary school and pass their A levels. Students entering vocational education can obtain a FPI degree after completing three years of Further Education, and an FPII degree after an additional two-year period.

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[23] A guide for Employers. *Modern Apprenticeships.* Crown Copyright, 1995. Ref. MA L2.

The vocational education system is based on college education with very little on-the-job training, although the amount and quality of practical teaching varies between different educational centres. The Spanish system is often criticised for being incapable of responding rapidly to the labour requirements of industry.

Students entering Higher Education (University) can follow one of two types of engineering degrees. A 'Technical Engineering' degree (*Ingeniería Técnica*) is obtained after completing four years of study, while an 'Engineering' (*Ingeniería*) degree requires a six year period of study.

Science degrees are obtained after a five year period of study, although this is changing, and many Universities are aiming to reduce the study period by one year.

4. ENVIRONMENTAL PRESSURES ON FOUNDRIES

4.1 Foundry Operations

4.1.1 Overview

The operations undertaken at a typical sand casting foundry are shown in Figure 4.1. Prior to casting operations, metal must be melted. Depending on the melting technology used, this can be the foundry activity with the greatest environmental impact, notably in relation to atmospheric emissions. The most important melting technologies are: coke-fired cupolas; electric arc furnaces; and electric induction melting. The nature of these technologies and the nature of the environmental releases are described below.

Casting operations also require the preparation of moulds and cores. Moulds are of two halves each made from sand. These are put together, along with any cores if the casting has hollow sections. Cores are inserts placed in the mould, which give the casting its internal shape. Molten metal is poured in. Once it cools and solidifies it can be knocked out of the crumbling sand mould.

Figure 4.1 shows that some metal is returned to the furnace after the knockout process. This is because not all of the metal which is poured into the mould ends up as the casting. There are also runners and risers, which together make up 'foundry returns'. The runners are the pipes which feed the metal into the mould. Risers are reservoirs of metal within the mould which continue to feed the casting with molten metal as it solidifies. Risers are necessary because metal contracts as it solidifies, and faulty castings would result if metal were not available to fill the gap caused by shrinkage. Runners and risers account for perhaps half of the net weight of the metal in the mould. Scrap (faulty) castings are also returned to the furnace.

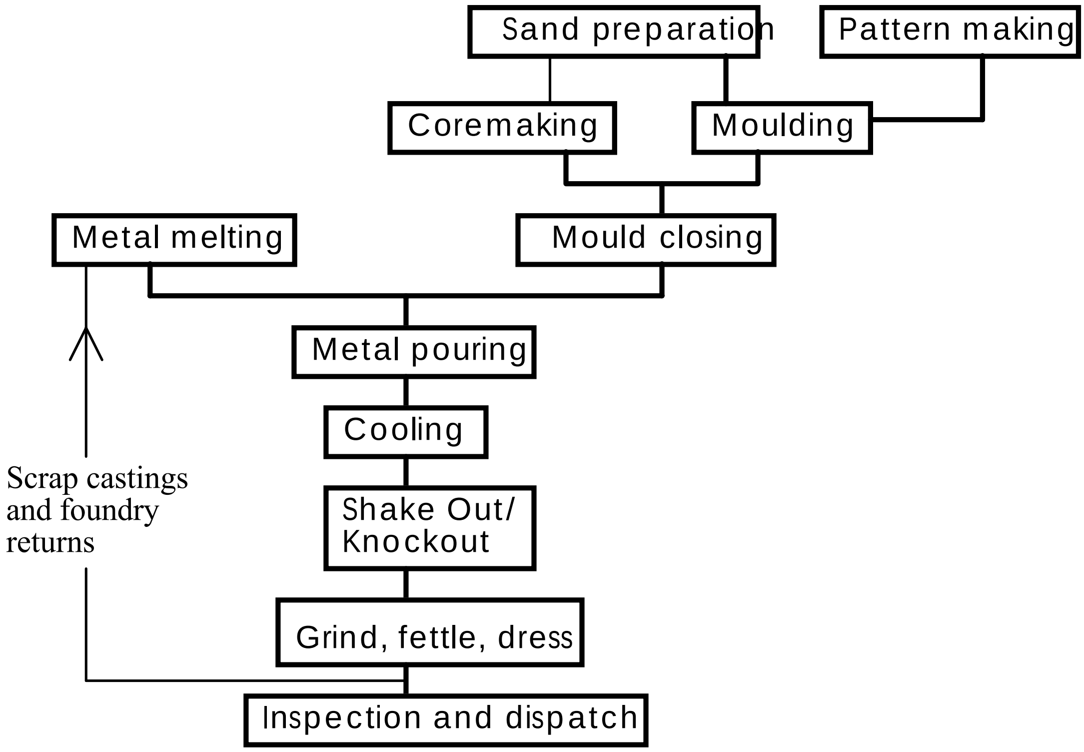
The ratio of good castings produced to total metal melted is known as the *foundry yield*.

- foundry yield (%) = total weight of good castings /total weight of metal melted

Yield usually stands at around 50 - 70% because of the runners and risers. However several other factors can lead to foundries not achieving a good yield. Castings may be rejected and sent back to be re-melted because they are faulty. Castings rejected within the foundry are referred to as 'internal scrap' and those returned by customers as 'external scrap'.

Improving the foundry yield and reducing scrap rates not only avoids the emissions associated with melting metal which goes to make faulty castings but also emissions from all the other processes. Yield and, even more so, scrap rates are a useful plant-level indicator of 'quality' and the efficiency of foundry operations. However, it is difficult to compare scrap rates and yields across foundries producing different mixes of products. Yields/scrap rates are however useful indicators to measure progress at individual plants over time. Monitoring yields/scrap rates is obviously a prerequisite for plant level improvements in quality.

FIGURE 4.1: FOUNDRY OPERATION FLOW CHART



4.1.2 Repetition ferrous foundries

Repetition foundries may be large and highly automated, such as those that serve the automotive industry, or smaller, old-fashioned and labour intensive. No old fashioned foundries were visited for this study.

The majority of repetition moulding in ferrous foundries is performed in greensand. Greensand is a mixture of sand, clay and water. It retains its shape once an impression has been made due to the bonds between the damp clay and sand. Greensand is recycled, re-entering the mould making cycle once the spent mould has cooled and replacement water and clay has been added and mixed in. However a large volume of sand has to be disposed of to compensate for the influx of new sand used to make the cores. Cores have to be made using chemically bonded sand since greensand cores do not have the necessary strength.

Shell moulding is also used at repetition foundries casting ferrous metals. In this method, a particularly fine grained sand pre-coated with a heat-setting resin mixture is cured whilst in contact with a heated pattern plate. The small grain size and free flowing nature of the shell sand enable it to produce very accurate and intricate castings with a good surface finish. Shell moulding is used for high quality repetition work, in particular for automotive castings such as camshafts and crank-shafts. The shell process is also used to make cores.

4.1.3 Repetition non-ferrous foundries

A wider variety of techniques is used in repetition non-ferrous foundries. Die-casting is generally preferred to sand casting. Die casting involves pouring molten metal into a closed metal die. Once the metal has solidified the two sides of the die are opened and the casting ejected. There are many advantages to die-casting. It is a relatively cheap method of producing large runs of relatively simple castings, particularly in aluminium, where the lower pouring temperature leads to less corrosion of the die. However, dies are expensive to manufacture and die casting is economical with large production runs.

It is possible to produce fairly complex die-castings, especially if sand cores are used, although there are technical constraints. Larger, complex castings, particularly those incorporating complex or numerous cores, are often cast in sand moulds.

Greensand casting exists, although it is used predominantly for higher melting point metals such as copper. Chemically bonded sand rather than greensand tends to be used for lower melting point non-ferrous metals. Chemically bonded sand is a mixture of sand, resin and catalyst. A variety of different chemical bonding systems exist. The chemical constituents are similar but the catalysts, and hence the method of setting the moulds, differ. Air-setting systems use liquid catalysts and cures at ambient temperature, setting after a variable length of time. Cold box systems use a gaseous catalyst which is passed through the sand-resin mixture. Other methods such as hot box systems and shell moulding require heat.

4.1.4 Jobbing foundries

As discussed in Section 2, the classification between repetition foundries and jobbing foundries is not distinct, but a continuum. The foundry industry produces castings ranging in size from a few grams to tens of tonnes in a variety of different alloys. They may be required in quantities ranging from one-offs upwards.

Jobbing foundries usually have large pattern stores where they store their customers' patterns. The pattern is a positive shape of the casting, and is used to give the mould or the core its shape. The patterns are almost always owned by the customer. A jobbing foundry may have to store many thousands of patterns and this may require one or more large buildings dedicated to this purpose.

The most characteristic feature of jobbing foundries is their flexibility. Some types of patterns are specific to a particular moulding or coremaking technology. In order that jobbing foundries can use the customers patterns, jobbing and low volume repetition foundries have to be flexible and must be able to use a variety of different mould and coremaking techniques so that they can use their customers' patterns.

4.2 Environmental Impacts

Foundries can have a major environmental impact on their local surroundings. The most significant emissions are particulate matter and smoke from cupola melting and odour from the coremaking and casting processes. In the West Midlands, these emissions are the cause of the largest number of complaints to the pollution control divisions of local authorities. The industry also generates large amounts of solid waste, although much of it is of an inert nature.

4.2.1 Cupola melting

The cupola is the traditional melting furnace. Metal is charged at the top of the furnace, along with coke and limestone. The limestone is a slagging agent which removes the impurities. It floats as a viscous fluid on top of the molten iron. Air is introduced at the bottom of the furnace. The metal charge is in direct contact with the combustion gasses, which pick up particulate, smoke, volatile organic matter and metallurgical fume as they move up through the cupola.

Cupola melting (with simple fume arrestment) generates persistent plumes of dirty brown smoke which can be seen from a great distance, as the following quote from the Pollution Control Manager of Sandwell Metropolitan Borough Council indicates:

> If one climbs to the top of the Rowley Hills, a granite outcrop in the heart of the West Midlands, and looks out over the surrounding West Midlands conurbation on any working day, one outstanding feature is immediately apparent, and that is the outpouring of copious amounts of metallurgical fume from cold-blast cupolas at iron foundries.[24]

In the open setting of the West Midlands conurbation, cupolas can be seen from a distance and the persistent fume they emit drifts over long distances. Depending upon the weather conditions the plume may drift upwards eventually dispersing and contributing to the overall poor air quality in the region, - or it may be blown from the cupola down over nearby housing. Many foundries are located in the middle of residential areas. The situation will be transformed as a result of the Environmental Protection Act which sets an emissions limit for cupola emissions which will render them invisible. Much of the reduction in environmental impact of cupola melting so far has come about through the closure of foundries.

The situation in the Basque country is very different. Not only is there less cupola melting, but it is also less conspicuous due to the nature of the landscape. Plumes are less visible because they are concealed by the mountainous terrain. The area is also less densely populated.

4.2.2 Electric melting

Electric induction melting is an option which offers several benefits over cupola melting, most notably an increase in the flexibility of melting options and a reduction in emissions. The Metal is heated as a result of electric currents induced in the metal charge by strong magnetic fields. These furnaces are highly efficient at the point of use because heating takes place within the metal charge and heat losses, because of the absence of combustion gases and gases and lower radiative losses. Emissions from electric furnaces are invisible if clean scrap is charged.

Over the past few decades electric melting has gained in importance relative to the traditional coke-fired cupola furnace, although the cupola still dominates, accounting for about 70% of all the iron melted in UK foundries. In the Basque Country electric

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[24] ENDS Report 194, March 1991. page 13.

melting predominates. This is not due to environmental concerns, but because electric melting is a more economical melting option given the historically low price of electricity compared with coke.

4.2.3 Mould and coremaking

The main environmental impact of the process of making the moulds and cores is odour. This is not a problem when making moulds in greensand, but can be very significant with certain chemically bonded sand systems. Systems cured with amine gas (the Isocure/Cold Box system) and liquid amine are particularly problematical.

4.2.4 Casting, knockout and dressing operations

Both chemically bonded sand and greensand emit VOCs during the pouring and casting process. During casting, greensand moulds give off a complex mixture of organic components and carbon monoxide from the breakdown of a coal dust additive. The binding chemicals from chemically bonded sand are vaporised during the casting process, giving off a highly noxious, odorous gas.

Once the casting has solidified it is shaken or knocked out of its mould. This process creates further VOC emissions, as well as particulate matter.

The casting is then cleaned up or 'dressed', that is extraneous material is cut off and surfaces may be ground to make them smoother.

4.3 Technical Change in Foundries

Ongoing technical change has affected both environmental performance and the nature of employment at foundries. The major changes in foundry technology over the last few decades have been: a) the introduction of electric melting; and b) the adoption of new chemical binder systems. Automation at repetition has also had a very significant effect on employment. More recently sophisticated software for predicting the solidification of metal within a mould has been developed, which could have a beneficial effect on foundry yield.

4.3.1 Cupola to electric melting

The introduction of electric melting is the most significant development in terms of the environment as the fume from cupolas, the traditional melting technology, can be a major, local, environmental problem. Electric melting is a cleaner method of melting iron than the traditional cupola and it also requires less labour. In 1989 it was estimated that 25% of all iron castings produced in the UK were made from electric melted metal.[25] Many foundries went over to electric melting during the 1980s.

Although it has been forecast that increasing environmental controls will favour the uptake of electric melting, economic and operational considerations are likely to be of greater significance in determining melting options. The most significant advantages and characteristics of cupola and electric melting are summarised in Table 4.1.

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[25] Energy Consumption Guide 11. *Electricity consumption in coreless induction melting furnaces in iron foundries.* Energy Efficiently Office. Best Practice Programme. March 1991.

TABLE 4.1: PRINCIPAL FEATURES OF CUPOLA/ELECTRIC INDUCTION MELTING

Cupola	**Electric induction furnace**
Can melt a wide variety of metal charges	Can only melt good quality steel scrap
Can only produce grey iron. SG iron can be produced after de-sulphurisation treatment.	Can produce a wide variety of iron and steel alloys.
Metal output is continuous, and suited to continuous flow processes (typical repetition foundry)	Metal output is in batches, more suited to jobbing foundries
Produces fume which requires end-of-pipe abatement	Produces no fume if clean scrap is melted

Electric melting offers an increase in flexibility in terms of alloys which can be produced. The batch characteristics of electric melting make it more suitable for jobbing or low volume repetition foundries producing a range of different cast irons, rather than repetition foundries dedicated to grey iron.

The running costs of the two options depend on energy costs and the cost of metal. Although electric melting is more flexible in terms of the alloys which can be produced, the basic charge has to be steel scrap. Cupolas however are more flexible and can be charged with pig iron and various qualities of scrap iron or scrap steel. Cupola melters are therefore less susceptible to price fluctuations in steel scrap than electric melters.

The cost of energy is the other major factor. In the UK, foundries pay between 3.8 pence and 5.8 pence per kilowatt hour for electricity,[26] and around £130 - £140 per tonne of foundry coke. The sensitivity analysis shown in Figure 4.2 shows how the cost sensitivity of the two options to different energy prices. The vertical axis represents the extra energy cost of a cupola melt in terms of £ per tonne of metal melted. The horizontal axis shows different electricity prices. Any combination of electricity costs and coke costs giving a point below the £0 line indicates cupola melting is cheaper in terms of energy costs, for any point above this line cupola melting is more expensive.

The results depend upon the efficiency of the cupola and the electric furnace with which it is being compared. The analysis below is for a medium sized cupola, melting at around 6 tonnes an hour. Larger cupolas are likely to be much more efficient than this, and smaller cupolas less efficient. This subject is dealt with in greater detail elsewhere.[27]

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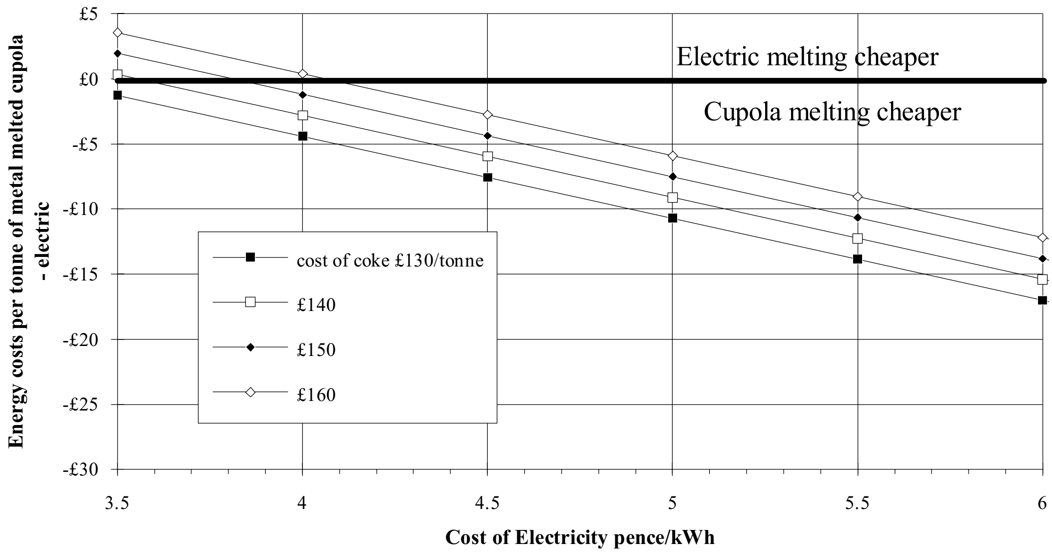
26 Information from the British Foundry Association.

27 Gaynor Hartnell. *End-of-pipe abatement or process change? the case of cupola melting.* Paper submitted to the Foundry Trade Journal, Forthcoming January 1996.

FIGURE 4.2: MELTING CHOICE AND ENERGY PRICES (MEDIUM CUPOLA)



4.3.2 Greensand moulding to chemically bonded sand moulding

The traditional method of moulding at foundries has been greensand moulding by hand. This was a skilled craft occupation. This skilled task has been replaced by automation at repetition foundries, and by the use of chemically bonded sand at jobbing foundries. Both of these trends have resulted in the de-skilling of moulding.

Chemical binding systems were introduced during the 1950s and there is now a wide variety of different chemical binding systems available. The trend away from greensand moulding at jobbing foundries has been heavily influenced by the shortage of skilled greensand moulders. Air setting processes now dominate at jobbing foundries. Moulding using chemically bonded sand requires less skill, as the sand does not have to be impacted around the pattern so firmly and carefully.

The environmental impact of this trend is mixed. Chemically bonded moulds give rise to VOCs and gaseous emissions of the catalysts, which can be unpleasant both within and outside the foundry. However chemically bonded sand can be reclaimed more economically than greensand, and so there has been a positive effect on the volume of waste moulding sand going to landfill. Some types of binding systems are more toxic than others, however, and so the impact upon waste generation has been mixed.

The major impact of the automation of greensand moulding at repetition foundries has been a reduction in employment levels. It has also improved quality, which implies a positive effect on the environment as foundry yield is improved, and therefore less metal has to be melted to produce the same number of acceptable castings.

4.4 Environmental Pressure and Performance

4.4.1 Key differences between the regions

The UK and the Basque regulatory approaches are very different. As noted in Section 3, emissions limits have only been introduced recently for cupola melting in the UK. The real impact of the legislation will be felt after 1997. Emission limits for cupolas have been in existence in Spain since 1975. UK emission limits are now more stringent than those in Spain.

The key difference between the two regions, however, is in enforcement. There was no evidence of enforcement at any of the foundries visited in the Basque country. In the UK however, the legislation is being enforced. New installations already have to comply with the emission limits, and foundries are currently entering into contracts to be supplied with abatement technology to meet the April 1997 upgrading deadline.

The main impact of the environmental legislation in the UK will be felt on ferrous foundries. Melting clean scrap in non-ferrous foundries will not require fume abatement. The lower melting temperature of the majority of non-ferrous alloys also means that less VOCs are given off during the sand casting process. Gravity and low pressure die casting process are relatively environmentally benign compared to sand casting, although there are emissions from the die lubricants used in the pressure die casting process. Coremaking however is subject to the same environmental pressures and some non ferrous foundries use cores identical to those used in sand casting foundries.

The single most expensive environmental investment required is likely to relate to cleaner melting. This is also an investment which can be attributed solely to environmental pressure. On the other hand, many changes in core making and moulding may be prompted by health and safety rather than environmental concerns, although the benefits are felt in both areas.

Most West Midlands foundries are leaving the most expensive elements of upgrading, fume arrestment, until last. However a substantial amount of investment has already been made in some foundries either to meet the existing legislation, in response to public complaints or because new equipment has been commissioned. The standards specified in the Process Guidance notes have to be met in full in the case of newly commissioned equipment.

Table 4.2 and 4.3 show past and planned environmental investments at the 20 foundries visited in the Basque Country and the West Midlands. The following sections discuss in more detail the specific environmental measures which are being undertaken.

TABLE 4.2: INVESTMENT REQUIRED BY UK FOUNDRIES

Foundry	Melting method	Investment already made	Future investment
WM-F1 Grey iron & SG, repetition	Cupolas for grey iron, electric for SG	£2,000k new cupolas and fume arrestment (£600k of which was purely for bag filter)	Better scrubber (~£20k) for ecolotec cores, possible cost of abating magnesium fume from the SG iron treatment process.
WM-F2 Grey iron, repetition	Cupolas	£75k + labour for filter on the dressing shop (partly H&S driven),	£400k+ for fume arrestment on cupolas
WM-F3 Aluminium repetition	Electric	£40k amine scrubber, (installed cost)	£20k bag filter for reclamation unit. Around £2k for monitoring equipment and additional costs for sampling.
WM-F4 Ferrous alloys repetition	Electric	Additional running costs of £100k for Alphaset rather than furane air setting sands	£45k on extraction, £146k bag filters and monitoring. Possibly additional £200k for chimney alterations
WM-F5 Grey iron, repetition	Cupolas	£15k for second hand dry bag filtration from the fettling shop. The dust extraction was health and safety driven.	£62k new cupolas, £150 - 200k for fume arrestment. £15k on a second hand amine scrubber, not yet installed, which they suspect may not be adequate for the task.
WM-F6 Grey iron, Jobbing	Cupolas	None explicitly for environmental performance	Are not sure whether to fit a bag filter at £450k or invest in electric melting at a total cost of £750k
WM-F7 Ferrous alloys repetition	Cupolas for grey iron, electric for alloys	£5k on monitoring, £85k fume extraction and treatment	
WM-F8 Aluminium repetition	Electric	No significant investment	Possibly £400k for VOC emissions abatement plant (now unlikely because of change in guidance notes)
WM-F9 Aluminium repetition	Electric	No significant investment	May have to spend £300-400k in a "worst case scenario" on VOC abatement (now unlikely because of change in guidance notes)
WM-F10 Aluminium repetition	Electric	a running cost of £156k per year extra waste disposal costs for using CO_2/Silica system for environmental reasons alone.	£40k for fume arrestment for melting, copper

TABLE 4.3: ENVIRONMENTAL INVESTMENT IN BASQUE FOUNDRIES

Foundry	Melting method	Investment already made	Future investment
PV-F1	Electric	40-50mPta particulate arrestment for moulding and finishing. No grant	
PV-F2	Electric	60mPta particulate arrestment for shakeout	35mPta to extract bentonite from particulate from shakeout. Grant
PV-F3	Electric	Investments needed but they couldn't afford them	
PV-F4	Electric	Dry filter particulate arrestment for shakeout/fettling booths. Grant	
PV-F5	Cupolas	Not carrying out fume arrestment on cupolas. Grant would be only 5%.	
PV-F6	Cupolas & rotary furnace		
PV-F7	Electric	12 mPta arrestment for shakeout. 5 mPta sand treatment 6 mPta fume arrestment from furnaces. 25% in grants.	New arrestment and extraction equipment and new flooring
PV-F8	Electric	Extraction equipment totalling 40 mPta (probably mostly H&S). 15-20% grants.	
PV-F9	Electric		
PV-F10			

4.4.2 Cupola emissions

Basque Country

In the Basque Country there is no regulatory pressure for foundries to improve their environmental performance. There is specific environmental legislation for particulate emissions from cupolas, as well as a general particulate emission from any industrial process, although this legislation is not enforced. None of the foundries visited had any contact from the Industrial Department in relation to their emissions.

This difference in the enforcement of regulations between the two regions may be partly explained by the extent of the problem of cupola emissions. Cupola melting is the predominant means of melting in ferrous foundries in the UK, whereas in the Basque Country electric melting dominates. The relatively small number of cupolas in the Basque Country are also made less visually dominant by the nature of the landscape.

There were a number of examples of recent switches to electric induction melting. Foundry PV-F7 is located in a residential area. It abandoned cupola melting in June 1992. The reasons for moving to electric melting were: a) it is a superior method of producing SG iron; b) it reduces labour requirements; and c) it reduces emissions. There had been no pressure from regulators.

Another process change with environmental implications has been the move from electric arc furnace, to electric induction furnaces. Electric arc furnaces are used for melting steel. PV-F4 had moved away from electric arc furnaces in 1993 in order to reduce labour costs, improve emissions and energy efficiency and improve flexibility. The only disadvantage was the increase in the cost of the cleaner scrap necessary for the electric induction furnace.

There was also relatively little evidence of public complaints about foundries. Of the two cupola melters interviewed, PV-F5 was located near to housing (with a block of flats just across the road) whilst PV-F6 was not located near housing (with the exception of one cottage about 20 metres away). There had been public complaints against foundry PV-F5, but only regarding the amine smell from the core making process. The cupolas themselves apparently were not regarded as a problem by the local people. The foundry had abandoned the use of the amine cold box coremaking process in response to the complaints, and had transferred to the less odorous Betaset process. According to the interviewee at PV-F6 the residents of the cottage near them had complained about them, but indicated that they were not taken very seriously because 'they are always complaining'.

West Midlands

Cupola melters in the UK are in the process of upgrading their processes as a result of the Environmental Protection Act. They face the option of abating cupola emissions with end-of-pipe bag filter technology, converting to electric melting or closing. Although electric melting is seen as an option for meeting emissions limits, relatively few foundries seem likely to convert to electric melting on environmental grounds alone.

Placing the interview sample in a wider context, the British Foundry Association (BFA) estimates that there are 43 foundries in the UK with cupolas of over 4 tonnes/hour capacity, which emit a total of 650 tonnes/annum of particulate matter. These foundries must comply with new emission limits in 1997. They estimate that this would be reduced to 195 tonnes/annum with the current emissions limit of $100mg/m^3$ and 53 tonnes/annum with the proposed lower emissions limit of $20mg/m^3$. They estimate that there are also 51 cupolas having a capacity of less than 4 tonnes per hour, but producing a total of over 100 tonnes of iron per week. These will be covered by emission regulations from the year 2001.

A recent assessment of the market for bag filters assumes that 15 of the 60 known cupola melters with a capacity of less than 4 tonnes an hour will choose to retain cupolas and fit bag filters and that 30 larger cupola melters - all grey iron melters and half of those melting both grey iron and SG - will choose to retain their cupolas. Foundries melting SG iron only are assumed to convert to electric melting.[28]

Out of the six ferrous foundries interviewed five melt with cupolas (see Table 4.2). There are two large repetition foundries (WM-F1 and WM-F2) which melt at 12 and

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[28] Professor Colin Appleby. *Dry bag filtration on cupolas in the UK iron founding industry- a market assessment.* draft report to DTI. University of Wolverhampton. March 1994

14 tonnes/hour respectively, two low volume repetition foundries (WM-F5 ad WM-F7) melting at 4 and 2.9 tonnes/hour respectively and WM-F6, a jobbing foundry, with a 6-8 tonne/hour cupola. WM-F7 also has an electric furnace for steel alloys.

Of these five foundries, only one WM-F6 is considering the electric option. WM-F6 is a jobbing foundry and the batch output of an electric furnace is more convenient. At the moment they only use their cupola for three days a week. The Managing Director is convinced that the foundry needs to invest in electric melting because of the other benefits it will bring. He is unsure whether the foundry owners (a small holding company with no previous investment in foundries) will be prepared to spend £750,000 on an electric furnace. The capital costs of a bag filter would be £450,000.

The other four foundries are retaining their cupolas and investing in bag filters. Foundry WM-F7 is an exception because its cupolas fall below the 4 tonne/hour size threshold and emission limits will not apply until 2001. Foundry WM-F5 is in the size range predicted to possibly move to electric melting. The commitment to cupola melting at foundry WM-F5 is demonstrated by the fact that they are having to replace their existing cupolas, at a total cost of £62,000 with a further £150-200,000 for bag filters. They considered electric melting, thinking it would be beneficial only if they were considering going into other metals, or if they were only melting a couple of days a week.

The remaining iron foundries melt electrically because it suits their metal demand. Foundry WM-F4 melts exclusively by electricity and produces specialist alloys. Foundry WM-F7 melts grey iron in a cupola, but also uses electric melting for specialist alloys. Foundry WM-F1 has a cupola for grey iron but also uses electric melting for SG iron.

The tightening of the emissions limit effectively ties the foundries to dry bag filtration as the 'best available technology not entailing excessive cost' (BATNEEC). Even with an emissions limit of $100mg/m^3$ many foundries had intended to invest in this technology, as it has advantages over alternative wet and dry filtration options. Other potential technologies such as ceramic filtration, and filtration through a filter cake supported on stainless steel mesh have not been proven.

The capital cost of a dry bag filter varies according to the size of the cupola. The capital cost varies between around £200 - £400,000 for cupolas of less than 4 tonnes an hour capacity. The running costs are estimated at £7-13,000 for electricity, £4-£8,000 maintenance and £6- 10,000 for bags. For a larger cupola capital costs are estimated at around £400 - £900,000 with running costs of £15 - 150,000 for energy, £8-18,000 for maintenance and £10,000 for replacement bags.[29]

As part of the four yearly review of the process guidance notes the BFA provided the Air Quality Division of the Department of the Environment with some information on the likely impact of the proposed Process Guidance Note changes. This information is summarised in Table 4.4.

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[29] BCIRA response to questions raised by Simon Smith in his letter to Mr N Gle dhill (of the British Foundry Association) 15th February 1995.

According to the BFA, the investment required appears to be in the order of £27 - 57 million for cupolas alone. This is around 70% - 170% of the ferrous foundries plant and machinery acquisition expenditure for 1992, and 50% - 120% of the total net 88capital expenditure of the ferrous foundry industry (Table 2.5).

An alternative estimate is that the total market for bag filters, taking into account the likelihood that some cupola melters will choose to move to electric melting will be £15 million between 1994 and 1997 for cupola melters of over 4 tonnes/hour capacity, and £8 million from 1997 to 2001.[30]

TABLE 4.4: BFA COST ESTIMATES FOR DRY BAG FILTRATION

	Large cupolas		**Large cupolas**		**Small cupolas (< 4 t/h, > 100t/w)**	
	100 mg/m³ (current limit)		**20 mg/m³ (proposed new limit)**		**20 mg/m³ (proposed new limit)**	
	min	max.	max.	min	min	max.
capital	£400,000	£900,000	£400,000	£2,000,000	£200,000	£400,000
energy	£15,000	£150,000	£15,000	£120,000	£7,000	£13,000
maintenance	£8,000	£18,000	£8,000	£40,000	£4,000	£8,000
water	£10,000	£10,000	-	-		
bags	£10,000	£10,000	£10,000	£10,000	£6,000	£10,000
BFA estimated industry capital costs	£14-15m		£37m		£10.2- £20.4m	
BFA estimated industry running costs	£3m		£2.8m		£2.8m	

30 Professor Colin Appleby. *Dry bag filtration on cupolas in the UK iron founding industry- a market assessment.* draft report to DTI. University of Wolverhampton. March 1994

4.4.3 *Abatement of other foundry emissions*

Other important foundry emissions are: a) particulate matter from shakeout (where castings are shaken out of their sand moulds), fettling and other dressing processes; and b) VOC emissions from coremaking and mould making. These emissions are different from cupola fume as they occur *inside* the foundry and pressure may come primarily through health and safety considerations. If the particulate emissions from shakeout and dressing emissions were not extracted from the foundry, the internal working environment would be intolerable. Once the emissions have been extracted there may or may not be treatment.

The extraction from the shakeout process may be so laden with particulate that the foundry will act without legislative pressure. For example the foundry car-park or grounds could become too dusty, or the dust may re-enter the foundry buildings.

Amine cured coremaking and mould making processes in particular can cause problems. The amine has a very characteristic and pungent smell which can be overpowering if not extracted from the foundry. It is often a cause of public complaint outside the foundry. Pressure to either install abatement equipment (an amine scrubber) or to change the core/mould making process to a less odorous alternative can come from foundry employees as well as the general public. Tables 4.1 and 4.2 summarise also investments that foundries have made, or are intending to make, in areas other than melting.

Basque Country

In the Basque Country, investments related to processes other than melting predominate. It should be emphasised that the initial driving force for some of these investments is not environmental pressure but health and safety. Interviewees often confused health and safety with environmental pressure. Many Basque interviewees, when asked about environmental expenditure, gave information about fume extraction even if this fume was not subsequently treated.

Basque firms are making environmental investments - or investments with an environmental benefit - *without* legislative environmental pressure. These are due to pressure from workers, pressure from the public or because the emissions would cause operational problems if they were not abated. With the exception of PV-F1, all investment was supported with grants from the PITMA programme.

Foundry PV-F5 moved away from the amine core making process to the less odorous Betaset process due to public complaint. Several of the other Basque foundries also used amine cold box cores, (PV-F2, PV-F3, PV-F4 & PV-F7). (In the West Midlands, WM-F1 transferred *to* amine cold box cores from hot box cores 'due to cost and environmental criteria'.) Foundry PV-F2 had an amine scrubber, but knew that it did not function effectively. Foundries PV-F 3, PV-F4 and PV-F7 did not have amine scrubbers and were not under any pressure to install them.

West Midlands

The expenditure incurred by ferrous foundries in the UK has mainly been for: a) abatement of particulate matter extracted from foundry processes, such as fettling or sand reclamation; b) amine scrubbers; and c) some environmental monitoring costs. Few of the UK non-ferrous foundries interviewed believed they would have to make substantial investments to upgrade, although two out of the four believed that it would cost around £400,000 if VOC emissions had to be abated. However, the definition of processes for which VOC emissions limits will apply were revised during a review of the process guidance notes. Emission limits will now apply only to investment casting and sand reclamation plant, so these non-ferrous foundries do not face these high costs.

One of the non ferrous foundries had to install an amine scrubber. This investment was required before the upgrading deadline as the foundry had introduced *new* coremaking equipment.

Two of the foundries, WM-F10 and WM-F4, have incurred additional running costs as a consequence of changes made to their sand moulding processes. In the case of foundry WM-F4 the environment *inside* the foundry had been the more significant factor in the decision, whereas foundry WM-F10 had been the subject of complaints from the houses which surround it on three sides.

Foundry WM-F10 converted from chemically bonded sand moulding to inorganic moulding systems (CO_2/silicate system and greensand) with shell cores. Prior to this they used core making and moulding systems which emitted VOCs and odours during the mould making and casting process. This change has brought no advantage in terms of quality or cost and they have lost some of their customers as a result. The change also resulted in an increase in the cost of sand disposal. They were previously reclaiming some of the chemically bonded sand. The interviewee believed that the quantity of sand they now dump had trebled, costing them an additional £12,000 per month.

4.4.4 Reduction of solid waste

Foundries generate a large volume of solid waste, the majority of which is used moulding sand. Waste sand is inert, although phenols can be leached into water courses if significant amounts of chemical binders are present. Most foundry sand is landfilled.

All greensand foundries, and many foundries using chemically bonded sand, *recycle* their sand. However recycled sand can only be used to make moulds: cores have to be made with newly purchased sand or *reclaimed* sand, which is of similar quality to new sand. Despite the fact that sand is recycled, foundries still dispose of sand because: a) some sand must be dumped to make way for new core sand; and b) after a number of cycles the sand quality deteriorates.

The amount of waste sand generated by a foundry is equivalent to the amount of new sand purchased - and the latter is often known with greater accuracy than the former. The cost of sand disposal is increasing, and this is placing increasing pressure on foundries to *reclaim* their moulding sand. Sand can be reclaimed by a number of different treatments.

Sand reclamation could be described as an environmental investment, although the driving force is avoiding the cost of landfilling rather than environmental improvement. If sand reclamation plant is introduced it is usually necessary to install arrestment plant for particulate matter and possibly VOCs.

4.5 Quality Management and Environmental Management Systems

Improving quality is seen as an important factor in maintaining or improving competitiveness and may also have an indirect effect on environmental performance. If improving quality is achieved though increased attention to the manufacturing process, then foundry yield may improve though reduced scrap rates. If the scrap rate is reduced then a smaller amount of metal will have to be melted and fewer moulds and cores made to produce the same number of good castings. There is therefore a reduction in environmental impacts..

There may also be negative environmental impacts of an increase in quality. For example if a very good surface finish is required, the foundry may have to use shell moulding, a process which emits more VOCs than greensand moulding.

Interviewees were asked about their quality management and the influence of customers (see below) in order to investigate possible connections between these factors and environmental performance and competitiveness. Interviewees were asked if they had the quality standard BS 5750 (or international equivalents such as the ISO 9000 series), why they obtained it and how effective they felt it had been. They were asked how the standard compared with other customer quality certificates they might have and about other implications of customer pressure in order to see if there was any environmental pressure, either explicitly or indirect, exerted by customers.

When asked whether achieving good quality (irrespective of whether standards are held) has any indirect effect on environmental performance, the response was varied. Some interviewees maintained that there is no connection between achieving high quality and the environmental performance of a foundry and that emissions can be regarded as external to the foundry. Others maintain that environmental performance is tied in with well organised manufacture and would therefore have a beneficial effect. Correlations between competitiveness, quality and environmental performance are discussed in Section 6.

The majority of UK foundries had the BS 5750/ISO 9002 standard as shown in Table 6.1. Nevertheless, many UK foundries were sceptical of the benefits. Few believed that it necessarily improved quality. Many interviewees echoed a ‘conventional wisdom’ of the industry that it was a ‘licence to produce scrap’. There was, however, a recognition that it does improve traceability, ‘so if you do produce scrap, you can find out exactly how you did it....’.

The motivation for obtaining the standard varied. In some cases it was demanded by customers, in other cases the foundry that it would improve their market position in the long run. In the latter case the benefit was perceived to be a marketing one, rather than a means of improving quality *per se*.

Interviewees were also asked whether they had, or intended to achieve the environmental management standard BS7750 or any of the international equivalents, such as the EU Environmental Management and Auditing Standard. BS7750 is modelled on the BS5750 quality standard and has many procedural similarities, notably the quest for 'continuous improvement'.

Although some foundries stated that they carried out their own environmental audits, *none* had achieved BS 7750 or were intending to. In some foundries the audit consisted of a full materials flow (often carried out to assist with a decision on whether to reclaim sand). At others, the audit comprised emissions sampling data. The president of the British Foundry Association was sceptical about whether BS 7750, or any other environmental management systems, would be 'self propagating' in the way that BS 5750 had been. Under a self-propagating standard, companies that obtain certification will pass the requirement on to their suppliers.

4.6 Environmental Pressure through the Supply Chain

It has been postulated that firms located within supply chains will increasingly be subjected to environmental pressure by their customers. However, there was no evidence of explicit environmental pressure exerted through the supply chain at *any* of the foundries interviewed. Environmental performance of the foundry seems not to be of concern to the customer. Only foundry WM-F10 in the West Midlands had been asked about its environmental performance. In this case a customer was using the enquiry as an indirect means of ascertaining whether the foundry was intending to stay in business after the April 1997 upgrading deadline.

The president of the British Foundry Association recalled that some members had received letters from first tier automotive companies about two years ago asking them to verify that they did not use certain compounds in their foundry. No foundry members had been asked these questions recently. He emphasised that it would be difficult for the foundry to know whether certain chemicals were contained in the products used.

4.7 Conclusions

UK foundries are under significant environmental pressure from air pollution control legislation. Many are currently in the process of deciding how to meet emissions limits. Customer pressure does not appear to be an issue. The majority of foundries are fitting end-of-pipe abatement equipment in response to legislative pressures with a minority of foundries choosing to change from cupola to electric melting. Environmental pressure has already led to some changes which improve the working conditions within foundries and, at plants which have already been upgraded, dramatic improvements in the external environment.

Although Basque foundries are making environmental investments, there is no regulatory pressure on them, as enforcement is absent. The majority of these investments are driven by health and safety concerns rather than by environmental pressure.

The lower profile of environmental pressure in the Basque country is partially due to the fact the environmental impact of the foundry industry is lower than in the UK. The majority of Basque foundries use electric induction melting rather than cupolas. The nature of the Basque landscape may also be a factor. Many foundries are located in small villages in hilly/mountainous terrain whereas the West Midlands conurbation is locate in a wider flatter landscape in which cupolas form one of the most visually dominating features.

Significant improvements in the environmental performance at a foundry will not necessarily make foundries more competitive. There is scope for good housekeeping measures, which will benefit both environmental and economic performance, but to achieve emissions limits end-of-pipe abatement will be required. There are few process change options which will avoid the need for end-of-pipe control, and where they exist they are usually expensive in terms of capital and/or running costs. The preference for end-of-pipe pollution abatement, rather than process change at foundries, is often a rational decision. The exception to this is process change in core making systems. Some foundries in both regions have moved away from processes using odorous white gas. This has been driven by public pressure.

5. AUTOMOTIVE COMPONENT MANUFACTURE

5.1 Environmental Impact of Component Manufacture

Automotive component manufacture covers a wide range of activities few of which, in themselves, have a significant environmental impact. The sector is less sensitive to environmental regulations than is the foundry sector. The main environmental impact of component manufacturing companies is the generation of liquid and solid waste. Emissions to air are generally not a problem, though the problem of VOC emissions from paintshops has recently become more important. Only a few of the companies visited had paintshops.

Companies in this sector generally comply with the legislation described in Section 3. They do not perceive it as an environmental pressure, but more of an unavoidable cost of doing business. In many cases, interviewees, despite being the heads of production, did not know much about the quantities of waste produced or the cost of disposal.

5.1.1 Processes and waste generation

Metalworking fluids

The major process undertaken at automotive manufacturers (with the exception of UK-AC12) is metal machining. Machining involves bringing the part into contact with the cutting edge of a metalworking tool in order to perform a machining task, such as drilling a hole, grinding smooth a surface or tapping a thread. In order to protect the cutting tool and machined part during the operation, the surfaces are kept cool and lubricated with metal working fluid.

There are three types of metalworking fluids:

- *neat oils* which are used undiluted.
- *soluble oils,* which are diluted with water to give an oil in water emulsion. The diluted fluids have a milky appearance.
- *synthetic coolants* which are polymer rather than oil based. These are diluted prior to use to give a clear fluid.

Metalworking fluids are unpleasant from both the environmental and health and safety point of view. They contain a large number of additives, including emulsifiers, surfactants, corrosion inhibitors, lubricity additives, bactericides, biocides fungicides and dyes, which can make them biologically hazardous. Metalworking fluids can give rise to skin irritation from direct contact, eye irritation and sometimes respiratory difficulties from exposure to mists. Employees can become sensitised to the chemicals contained in the fluid or to the bacteria which may contaminate it. The biocides protect them from bacterial contamination but this may de-stabilise the emulsion making the fluid smelly and ineffective in use.

During use, the fluid becomes contaminated with swarf and fines from the machining process. Many companies continually recycle their fluids by removing the material through a filter. Eventually metalworking fluids ‘go off’ or become infected by bacterial growth. Where there is access to the surface of the coolant reservoir, the bacterial scum can be skimmed off the surface. Eventually however, the entire batch has to be removed and replaced. There is an incentive for companies to use metal working fluids for as long as possible because of the expense of purchasing new oils and disposing of waste.

Soluble oils are expensive to purchase, at around £3 per litre, and after dilution there is a very large volume of liquid to be disposed of. There are two options, chemical splitting and ultra filtration, for separating oil from the water prior to discharge down the sewer.[31] Used metalworking fluid should not be discharged directly to the sewer. The separated oil is disposed of through an authorised waste contractor to a licensed site. Sometimes undiluted fluid is taken away by a waste contractor.

Neat oils can be sold to a waste oil contractor or reclaimed on site. The oil can be disposed of through a waste contractor, incineration or burning in a boiler. Synthetic coolant can be disposed of to the sewer if it is diluted enough to bring the emission parameters within the discharge limits set by the water company.

Swarf

Swarf consists of thin spirals of metal removed during the machining process. Swarf is has sharp edges, and is usually covered in a thin layer of cutting oil. It is generally collected separately from other wastes, and sold to a scrap metal dealer.

Grinding/milling dust.

Grinding/milling dust is metal powder which has been ground from the piece being machined and has been separated from the metalworking fluid. Removal of the dust can be carried out by magnetic separation or filtration through a thin fabric fleece. The dust is of no value as a scrap material and is therefore disposed of to a waste contractor.

Waste sludges from effluent treatment plant

Companies that undertake plating operations or other processes, such as phosphate hardening, generate liquid wastes which, if neutralised in an effluent treatment plant, give rise to sludges. These are removed by a waste contractor.

Other wastes

A variety of other wastes may be produced, including organic solvents, degreasing residues, domestic type waste and packaging. These have to be removed by a waste contractor.

5.1.2 The use of ozone depleting substances

Most engineering firms used ozone depleting substances for cleaning until recently. Tri-chloroethane is one of the most widely used ozone depleting cleaning agents. Although the 1992 Copenhagen Amendment of the Montreal Protocol banned the *production* of tri-chloroethane by 1996, there is no ban on its *use*. Many companies now recycle and are therefore using it only at a very low rate. Others have moved towards tri-chloroethylene or to mixtures of organic solvents which do not contain halogens.

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31 see Castrol. *The Disposal FO Used Metalworking Fluids*. Castrol (UK) Limited, Swindon. 1991.

There are other cleaning technologies, such as alkaline water based washing, which do not use solvents. The UK Engineering Employers Federation believes that, on the whole, the engineering industry has solved the problem of finding alternative cleaning methods. They make available to their members a list of 85 companies producing alternatives to solvents.

5.2 Environmental Pressure and Performance

5.2.1 Environmental performance of UK companies

Many of the companies interviewed did not regard themselves as under environmental pressure from regulation. They comply with the legislation outlined in Section 3 but perceive it as an unavoidable cost of doing business rather than an environmental constraint. Although many companies produce environmentally noxious wastes, there seemed not much interest in taking action to reduce the amounts generated, especially amongst the smaller companies.

The majority of companies had simple effluent treatment plants which had been built at the same time as the rest of the plant. Only a few had invested in environmental plant recently. Most of these treatment plants are for precipitating solids and removing oils and are relatively simple.

Company UK-AC5 had recently invested in new separation equipment to separate swarf from cutting oils more effectively. This had enabled greater quantities of better quality swarf to be sold as a by-product and had greatly reduced expenditure on cutting oils. The plant was commissioned in 1990 at a cost of £1,445,000. Previously they spent £58,000 annually on oil. With the new recycling process they did not have to buy any new oil for 3 years, making a saving of £175 k. The scheme achieved a payback within two years.

Company UK-AC4 purchased second hand treatment plant to remove grinding dust prior to the disposal of diluted metalworking fluid. This resulted in a reduced water bill. This was also the motive for company UK-AC3 investing in a water-oil separating treatment plant.

Some companies sub-contract more environmentally problematic aspects of the process. Company UK-AC4, a manufacturer of transmission gears, mainly carry out machining operations, contracting out heat treatment and plating work. Company UK-AC8, a pressings company, has been sub-contracting all painting operations although they do intend to invest in a paint shop and a treatment plant soon. The paint shop (including treatment plant) will cost £140,000, which they would expect to recover within 12 months. Finally Company UK-AC1 had contracted out nitriding.

According to the Engineering Employers Federation sub-contracting environmentally sensitive processes is a trend amongst engineering companies. This can be beneficial for the environment, depending upon the type of company contracted to do the process. If the work moves to a well organised, environmentally responsible company, specialising in an environmentally problematic process in order to benefit from economies of scale and expertise, then the move is positive. On the other hand if it is contracted out to a less environmentally responsible operation the impact is negative. Painting processes may be contracted out in order to get below the size threshold for regulating solvent use. In this case the move enables the company to avoid investing in a treatment plant.

5.2.2 Environmental performance of Basque companies

Basque firms are now expressing more concern for the environment. Table 5.1 shows environmental investments recently undertaken by the Basque firms interviewed. Until recently there has been very little pressure on them to improve their environmental performance. Discharging liquid effluents directly into rivers was a relatively common practice until the mid-1980s. Some companies continued to dump liquid waste, for example Company PV-AC9 which continued river dumping until 1992. Several companies have had a treatment plant only for the past decade or so, and a further three are considering similar measures. It is now common practice for cutting oils and cutting fluids to be collected by an authorised carrier.

Most of the companies visited disposed of their liquid wastes in the following way. Company PV-AC4 showed little concern about its liquid waste. They disposed of their cutting fluids along with the swarf. The swarf was piled on the ground outside the factory building and metalworking fluids were simply poured on the top.

Company PV-AC6 is in the process of deciding between two options for disposing of its liquid waste. It could install a treatment plant at a cost of 10m Pesetas. Alternatively it could continue to pay a licensed contractor at a cost of 15 Ptas/litre. If the company decided to install the treatment plant, in case of enjoying the support of a grant (covering no less than 15-20% of total investment) the payback period would not be longer than five years.

Several companies (PV-AC3, PV-AC5, PV-AC 7, PV-AC8 and PV-AC9) are thinking of installing a treatment plant for regenerating the cutting fluids used and Company PV-AC2 has already introduced it.

It is clear that the introduction of treatment plants and/or recycling equipment has important benefits for firms either saving an important amount of the money paid for removing the liquid waste or reducing the water bill. As Company PV-AC9 put it:

> A couple of years ago we introduced a water recycling plant with the aim of reducing the money paid for discharging waste into the river. Prior to the installation of this plant the tax paid used to amount to 600,000 pesetas per year. After introducing the plant the money paid has been reduced to a minimum (less than 30,000 pesetas per year).

It seems both the existence of higher tax pressure expectations (shown in *.) together with cost-saving decisions which has led to the investments in recycling plants. In those cases where firms are doubtful to carry out these types of investments it might be argued that it is not clear that it is going to be possible to make a return.

Those companies owned by foreign multinationals tended to express a greater awareness of environmental concerns. In general, foreign owned companies seem to be more concerned about waste management. This situation is particularly clear in the cases of companies PV-AC2, PV-AC5, PV-AC7 and PV-AC8. As company PV-AC5 put it:

> 'Our environmental performance improved following take-over by an American multinational. They want our environmental behaviour to be as good as the other firms they own. They have a rule within that all types of waste have to be stored separately, so we had to change the way things were done at our company since all waste used to be dumped mixed'

The concern of foreign capital with the environment has brought about changes in the environmental performance of Company PV-AC8, although it was in compliance with legislation. At the German owner's request, company PV-AC8 introduced a new type of furnace similar to those used by other companies in the group. The emission levels were below of those of the furnaces used before, although the new furnaces are more expensive to run and maintain.

Another factor that seems to have some influence on the environmental performance of firms is their location. Company PV-AC10 pointed out that the key factor underpinning the improvement of its environmental performance was the move to a new location. Following its move from a highly polluted location to a greenfield site, the company would not dare to dump waste into the river.

Solid waste is less of an issue for Basque automotive companies than liquid wastes. However at some firms solid waste was relatively important (companies PV-AC1, PV-AC3, PV-AC5 and PV-AC8). In general, firms keep their waste in a skip and pay an authorised carrier to collect the waste. The cost of disposal varies depending on the type of waste. However company PV-AC1 which produced asbestos residues contaminated with heavy metals found it difficult to find a waste contractor which would deal with their waste. There is no place in the Basque Country where this type of waste can be dumped. The company finally discovered that the waste could be dumped in Catalonia where there is an important concentration of firms affected by the same problem as company PV-AC1.

Company PV-AC1 is producing less asbestos waste than it used to for two reasons. Firstly because products containing it are prohibited in some markets and secondly because of a change in their process.

5.3 Quality Management and Environmental Management Systems

5.3.1 The importance of quality

Quality has been a very important issue for automotive components companies for a long time. The concept of total quality management was developed within the automotive industry. Customer quality approvals such as Ford Q1 preceded BS5750 and many are more demanding than the British standard. In the majority of cases, companies had customer quality approvals before they achieved the BS5750. Since Part 2 of the British Standard has been introduced, making it equivalent to ISO 9002, some customers have ceased to operate their own standards and have instead accepted BS5750/ISO 9002, making additional requirements only when necessary.

In general, most firms agree that quality is the main factor underpinning competitiveness. If they cannot achieve the necessary quality, then they stand no chance of winning a contract. For the aftermarket quality is less important, particularly when products are destined for less developed areas such as Central and South America. In these cases, the key factor is the price of the product and to some extent the ability to meet delivery dates. Companies PV-AC4 and PV-AC10 compete in such markets and therefore differed from the other firms interviewed. Company PV-AC4 stated that it could not survive in the long-term by selling old-fashioned products and plans to change to higher quality products.

Table 5.2 shows that the Spanish automotive parts industry ranks highly compared to several other countries in terms of quality and physical productivity while the UK lags. However this study is based on a very small number of firms.

TABLE 5.1: MAIN INVESTMENTS LINKED TO ENVIRONMENTAL ISSUES

COMPANY	TYPE OF INVESTMENTS
PV-AC1	No environmental investment is worth being mentioned.
PV-AC2	A cutting fluid recycling system was installed at a cost of 5.7 million pesetas with the aim of reducing both the purchasing costs and disposal costs of the cutting fluids.
PV-AC3	The company is planning to introduce some recycling system in order to reduce the utilisation of cutting fluids.
PV-AC4	No environmental investment is worth being mentioned.
PV-AC5	The company is thinking of installing a water treatment plant at a cost of 10 million pesetas.
PV-AC6	It introduced a water treatment plant for liquid effluent due to the risk of being seen doing something illegal.
PV-AC7	A waste water treatment plant was introduced in order to reduce the water bill.
PV-AC8	A recycling plant was introduced a couple of years ago with the aim of reducing the water bill. Likewise, as a result of a decision taken by the German owners, the furnaces used in the production process were changed although they were complying with legislation.
PV-AC9	It is thinking of installing a water treatment plant for regenerating cutting fluids at a cost of three million pesetas.
PV-AC10	The company has not carried out any environmental investments.

Source: Interviews.

One area of advantage enjoyed by the Spanish automotive components industry has been that of lower labour costs than its European competitors. However decision-making centres are often located outside Spain and there can be risks from competitors further afield. Company PV-AC8, owned by a German multinational, was worried by the decision taken by the owners to set up a new plant in Taiwan, where labour costs are even lower than in Spain.

TABLE 5.2: COUNTRY ANALYSIS OF PRODUCTIVITY AND QUALITY IN THE AUTOMOTIVE COMPONENTS INDUSTRY

Country	Productivity1	Quality2	Labour costs3	Labour Costs4
Japan	65.1	193	24.89	47
US	54.8	263	16.98	50
Spain	86.0	314	12.66	27
Germany	38.2	885	25.10	100
France	57.4	897	15.30	40
UK	36.3	1,650	13.74	60
Italy	44.0	1,976	16.32	51
Mexico	21.5	..	2.10	12

1: Units per hour (indexed)
2: Defective units (pieces per million)
3: Costs per hour (US$).
4: Costs per unit (indexed).

Source: The Second Lean Enterprise Report. Andersen Consulting, University of Cardiff and the University of Cambridge.

5.3.2 Quality management in UK firms

Interviewees were asked: a) if they had BS5750; b) why they had obtained it; c) how effective they felt it had been; d) how the standard compared with other customer quality certificates they might have; and e) about other implications of customer pressure, in order to see if there was any environmental pressure, either explicitly or indirect, exerted by customers. The situation is summarised in Table 5.3.

There was a mixed picture with regard to quality standards. A few of the larger companies supplying the original equipment market placed greater value on assembly customers' quality assurance accreditation, and consequently had obtained BS5750 relatively recently. UK-AC1 is shortly to be audited for the BS5750 Part 1 standard which they are pursuing as part of a European group. Ironically, although they already had several assembly customers' approvals, they found the process of moving towards BS5750 very difficult.

In contrast, many of the smaller companies had obtained BS5750 some time ago, as they believed it was necessary in order to stay in business. However some smaller companies had been reluctant to be audited, but had felt that they had no alternative. Company UK-AC6 believes that the standard had not improved quality but had tied them into unnecessary expense. Other small companies believe the opposite. Company UK-AC9 for example, claims that the standard has saved them money as well as benefiting customers.

The majority of companies have a range of quality approvals. In some BS5750 appears to be replacing first tier customer quality accreditations, but in most cases separate assembler accreditations remain.

TABLE 5.3: QUALITY ACCREDITATION IN UK COMPANIES

Company	Markets	Products	Employees	BS 5750/ISO 9002?	Assemblers QAs?	Other customers' QAs?
UK-AC1	OE	Engine valves		No (to be audited shortly)	Yes	Yes
UK-AC2	N/A	Exhausts	112	Yes	No	No
UK-AC3	OE & AM	Camshafts	149	Yes	Yes and working towards another	Yes
UK-AC4	AM & trucks	Gears	79	Yes (this year)		BS5750 has superseded
UK-AC5	OE	Bearings,	400	Yes	Yes	Yes
UK-AC6	AM & trucks	Suspension systems	125	Yes		Yes
UK-AC7	OE	Steering systems	700	Yes	Yes	Yes
UK-AC8	AM, OE & trucks	Press work	170	Yes	Yes	
UK-AC9	AM & trucks	Crankshaft etc.	200	Yes		Yes
UK-AC10	OE/ trucks	Axles, wheels	42	Gaining shortly	Yes	

5.3.3 Quality management in Basque firms

Table 5.4 summarises the situation in the Basque companies. Only three companies interviewed have already obtained an ISO quality standard. Six of the remaining companies believed it was important to obtain the standard and were either in the process of working towards it or intended to start on it in the future. Only PV-AC10 showed no interest in obtaining the standard. This firm focuses on obsolete after-market products sold in Central and South America.

The quality requirements for the after-market are less stringent than those for the Original Equipment market. Company PV-AC6 used to manufacture for the OE but after being taken over by a multinational group moved to the aftermarket. As the interviewee of this company pointed out:

> 'Quality requirements set by car manufacturers were considerably more stringent not only than those from the after-market but also than the ones established by the ISO 9000. It was a decision taken by the multinational that has a major stake in the company who decided that we should obtain the ISO 9001 certificate'

On the basis of the information provided by firms concerning internal and external defect rates, it appears that a good level of quality exists. Of course, firms failing to meet the high quality standards demanded by car manufacturers or first-tier suppliers risk losing orders.

Interestingly, only one firm (Company PV-AC1) out of ten visited was under pressure from an automotive assembly company to reduce its number of suppliers. The customer making this demand was Nissan. It seems that car manufacturers are increasingly concerned about reducing not only the number of suppliers of their own first-tier suppliers but also the number of the latter involved in the production process of car manufacturers.[32]

TABLE 5.4: QUALITY ACCREDITATION IN BASQUE COMPANIES

Company	Markets	Products	Emp-loyees	BS5750 / ISO 9002	Assemblers QAs	Other customers' QAs
PV-AC1	AM and truck	Clutches and brake parts	63	Working towards, pressure from owners	Yes	Yes
PV-AC2	OE	Carburettors, valves, filters and others	177	Hopes to be audited in 1995	Yes	
PV-AC3	AM	Camshafts and connecting rods	73	Working towards ISO 9000		Assessed during visits
PV-AC4	AM	Axles	30	Will be working towards ISO 9000		
PV-AC5	OE & AM	Ball bearings and roller bearings	180	Hopes to be audited for ISO 9002 in 1995		
PV-AC6	AM	Suspension systems	223	The group to which it belongs has ISO 9001		
PV-AC7	OE & AM	Suspension systems	460	Achieved ISO 9001 in 1994		
PV-AC8	OE	Roller bearings and bearing pins	360	Achieved ISO 9000 in 1994		
PV-AC9	AM, OE & truck	Gear systems and pumps	125	Will be working towards ISO		
PV-AC10	AM & truck	Steering mechanisms	41	Not interested		

5.3.4 Adoption of leaner production methods in UK firms

The majority but not all of the companies visited were aware of lean production, and had either introduced JIT management techniques such as kanban, or were at least required to carry out deliveries on a JIT basis. Companies, such as UK-AC1, producing very small parts which are not problematic to store in large numbers may not be under pressure to deliver on a Just-in-time basis. UK-AC1 keep stocks and perhaps their customers do too.

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32 A good example is that of Mercedes-Benz. This company is located in the Basque Country and will start producing a new industrial vehicle (T-0) in 1996 in which the number of suppliers is expected to amount to 179 firms (123 of them from Spain). This represents to halve the number of suppliers that are being involved in the production of the current MB-100 van.

Suppliers often introduced cellular manufacturing and kanban systems in response to customers' suggestions. In several cases assembly companies had spent considerable time on the shop floor, working with the company to introduce quality and productivity improvements.

UK-AC3, UK-AC5, UK-AC7 and UK-AC8 have introduced cellular manufacturing, with help from their customers. Often not all the machines can be moved to the ideal position within the cell, at least initially, as it would be very expensive to move them. Those companies which have not completed the movement of machines do intend to complete the process eventually. The companies introducing cellular methods are all supplying the original equipment market, although not all suppliers to this market have introduced cellular manufacturing. UK-AC1 is hoping to introduce cellular methods in the future, although they are having to proceed slowly along this path because of the sensitivities of the strongly unionised workforce.

Suppliers to the aftermarket have not introduced cellular methods and often claimed that JIT was problematic to operate in the AM. Long lead times for steel and forgings and castings was stated as a reason. Secondly the products are often supplied to warehouses anyway and are not needed JIT for an assembly line.

A few companies are in the process of introducing kanban systems with their suppliers. Company UK-AC8 are hoping to rationalise the number of steel suppliers they use (from 12 to seven or eight), and expect that this process will be determined by which suppliers are prepared to work on a kanban system with them.

5.3.5 Adoption of leaner production methods in Basque firms

In the Basque country two firms, PV-AC2 and PV-AC8, were making their deliveries on a JIT basis for some of their customers. At PV-AC1 manufacturing had been reorganised to introduce production cells within the factory, and the interviewee was very pleased with the result.

5.4 Environmental Pressures through the Supply Chain

5.4.1 Environmental pressures, quality and just-in-time production

Customers can have a very powerful influence over a range of suppliers' activities. Customers are concerned with quality and price but their influence can stretch to changing manufacturing processes and organisational aspects of the company. Supply chain pressures could, therefore, have an impact on environmental performance and employment at supplier companies.

The relationship between automotive assembly companies and their suppliers has traditionally been adversarial. There has always been a strong pressure on component suppliers to improve quality and reduce price, although assemblers have now adopted a more co-operative approach. Automotive assembly companies are also putting pressure on many of their suppliers to deliver on a Just in Time (JIT) basis. It has been argued that 'greening' will occur as a consequence of lean production and total quality management:

> 'The increasing intimacy of assembler/supplier relationships, as a consequence of new lean production and quality management, is seen as likely to stimulate the propagation of environmental best practice along the supply chain.'[33]

Total quality management and lean production principles could lead to a reduction in wastage and therefore pollution. Improving the design of component parts so that they can be manufactured more easily (with less resources) and improving quality can lead to a reduction in scrap rates.

However there are other aspects of the lean production system which do not point towards environmental benefits. Increased flexibility and smaller batch sizes can lead to increased waste production in processes such as painting. If colours are changed frequently then paint lines have to be washed more frequently, resulting in a greater quantity of paint sludge waste. There is also an increase in traffic associated with carrying smaller amounts of components to customers on a JIT basis. The environmental implications of leaner production are therefore mixed.

5.4.2 Environmental management standards and the supply chain

The supply chain is potentially a very powerful means of putting pressure on industry to improve its environmental performance.[34] Indeed, for companies located within a supply chain, there is no other mechanism whereby green purchasing exercised by consumers can reach them, as they do not sell direct to the consumer. This is the case for the majority of manufacturing companies, as industry spending dwarfs consumer spending, by a factor of about 2:1.

One way in which automotive assemblers might influence the environmental performance of their suppliers is to require them, by analogy with the requirement to adopt quality standards, to adopt an environmental management standard such as BS7750, the EU Eco-Management And Audit Scheme (EMAS) or the new series of ISO 14000 standards.

BS7750 requires companies to assess their environmental impact and take action to reduce it continuously. It shares features with EMAS. Companies which achieve BS7750 accreditation will be encouraged to require their suppliers to achieve the standard thus, in theory, propagating higher standards of environmental performance along the supply chain. There is no evidence from this study that adopting BS7750/EMAS automatically leads to the use of cleaner technology, but the standards provide a framework within which clean technology adoption is encouraged.

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33 Dion Vaughan and Craig Mickle. *Environmental profiles of European business.* The Royal Institute of International Affairs/Centre for Exploitation of Science and Technology. Earthscan Publications Ltd. London. 1993.

34 New, S, Green, K and B Morton, University of Manchester. *Understanding the Dynamics of Green Supply.* Paper presented at the 1995 Business Strategy and the Environment conference. September 20th and 21st, Leeds University.

There is pressure to harmonise environmental management systems with the introduction of an international standard, ISO 14001. BS7750 may eventually be withdrawn once an international system is finalised.[35]

A simple requirement that all suppliers should achieve an environmental management standard would not necessarily be in an automotive assembler's interest, although Rover, as part of its RG2000 Programme encourages suppliers to adopt BS7750. A company attempting to improve the environmental performance of its supply chain would generally rank suppliers in order to prioritise efforts. They might also be interested only in strategic suppliers with whom they expect to have a long term relationship.

5.4.3 Evidence of environmental pressure on UK firms

Against expectations, relatively little evidence of supply chain environmental pressure was found amongst the companies interviewed. Only two companies, UK-AC1 and UK-AC5, had had any communications with a customer on the issue.

UK-AC5 is periodically sent letters asking them to verify that they do not use certain compounds. These letters came from Ford in 1993 and Nissan in 1995. The customers also requested that the communication be passed on up the supply chain. All their suppliers were able to give the verification in response to the Ford enquiry in 1993 and they are waiting for replies to the 1995 communication.

This enquiry did have a direct influence on the company. It was using a CFC oil which was on the list of compounds to be avoided. They called in Shell who recommended they used a less environmentally damaging alternative. The other oil was cheaper than the previous oil and the transfer was not a problem. All of the suppliers that responded to the first enquiry undertaken by company UK-AC5 at the request of Ford were able to verify that they were not using any of the compounds on the list. The question of whether Company UK-AC5 should carry on dealing with them therefore did not arise.

UK-AC1 had received letters from all their assembly customers which they were also asked to send to their suppliers. They had not stopped using any chemicals as a result of this process, although they had already stopped using tri-chloroethane as a result of concerns about health and safety.

These letters are a 'paper exercise' and customers have no way of knowing that their suppliers are being honest. It may even be difficult for the supplier to know whether the specified chemicals are used in the manufacture of their products.

Almost all of the companies interviewed had heard of BS7750 and companies UK-AC3, UK-AC6 and UK-AC7 were intending to install it. UK-AC5 intended adopting either EMAS or ISO 14000. The driver for achieving a standard sometimes came from the companies' owners and sometimes from customers. Company UK-AC6 believed that it would be a requirement in the future. Companies did not mention the identification of potential cost savings as a motivation.

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[35] *Final ISO draft still weaker than BS7750 and EMAS*. Page 37 - 38. ENDS Report 246 July 1995.

Despite Rover's stated strategy of encouraging their strategic suppliers to achieve BS7750, the two companies supplying Rover maintained that Rover had *not* requested them to achieve the standard. UK-AC3 intends to go for the standard in the future but the interviewee maintained that this was not in response to any pressure from Rover.

UK-AC3 decided to go for BS7750 after hearing a sister company talk about its experience of gaining the award at a seminar on environmental issues held by the parent company. UK-AC3 felt that they had already done more towards improving environmental performance than their sister company. They have documented what changes they have made. These include eliminating some of the more environmentally problematic chemicals, reducing noise and improved oil spillage protection. Being in the process of securing RG2000 was also given as an important reason for going for BS7750, although the interviewee was not clear why. Rover had not requested or encouraged them to go for the standard, and the interviewee maintained that RG 2000 contains no more on the environment than the other assembler accreditations which the company already has.

5.4.4 Evidence of environmental pressure on Basque firms

Only two Basque companies had experienced a customer taking an interest in their environmental performance. Company PV-AC5 was visited by Ford and given a mark (seven points out of ten) for its environmental performance. Ford did not demand any changes after the environmental assessment. Company PV-AC7 was questioned by major customers (Nissan, Mercedes-Benz and Volkswagen) about its environmental performance but not subjected to an assessment. The questions had no implication for orders from its customers.

The adoption of an environmental management system (EMS) was low on the list of priorities of Basque companies. In general, firms did not seem to have much idea of what the introduction of an EMS means. There was only one company out of ten visited (PV-AC1) that had thought of installing an EMS. This company showed more concern about its environmental actions. The company had signed undertakings to implement the Montreal Protocol. at the request of the main shareholders, a British multinational.

Some Basque firms (for example PV-AC3) had received offers from companies aiming at introducing an EMS. In this respect, firms only focus on the environmental area when dealing with investments linked to the improvement of their environmental performance. A good example is that of Company PV-AC5 in which the interviewee highlighted that:

> 'We are not thinking of introducing an EMS. Nevertheless, at the moment as a result of the need to implement the environmental rules of the American multinational to which we belong, I am devoting more time (about an hour a day) to environmental aspects.'

5.4.5 Automotive component manufacturers' influence over foundry suppliers

Customers in the automotive components sector may influence the environmental performance of a foundry indirectly, either because of the nature of their pattern equipment or because of quality requirements, for example specifying particular types of surface finish.

Pattern equipment generally belongs to the customer rather than to the foundry. The pattern equipment is often specific to a certain type of foundry process technology, for example shell pattern equipment can only be used to make shell moulds. In this case, the customer is tying the foundry to the shell process.

Although companies UK-AC3 and UK-AC9 used castings as a raw material, the pattern equipment was owned by the component manufacturers' *own* customers i.e. the automotive assembly companies. Company UK-AC4 reported problems in finding new foundries to take on their work, because their pattern equipment was not compatible with other foundries' moulding equipment. This is probably not much of a problem for castings for the automotive market as most foundries which supply this market are large highly automated repetition foundries, often using identical moulding equipment.

All of the companies using castings made quality visits to the foundries supplying them. The purpose of the visits was to point out problems rather than to suggest solutions. There is unlikely to be expertise on foundry processes at the customer company. However, company UK-AC7 used to have a foundry on site and expertise remained within the company.

More Basque automotive components companies owned their patterns. When existing patterns need to be modified, the foundry and the company share the cost. In the opinion of the interviewee at PV-AC10, the company would not take its patterns elsewhere or put much pressure on a foundry to reduce prices because castings only form a tiny part of the foundry's total work and the company is not an important customer as the foundry is concerned.

5.5 Conclusions

The majority of automotive component companies do not feel under a great deal of environmental pressure. Air emissions are not an issue. With the exception of painting operations, none of these companies' processes are regulated. The most significant environmental impact is the disposal of solid waste and waste water and the possible contamination of land. The majority of companies regard the generation and disposal of wastes as a necessary and unavoidable cost of doing business. Many did not seem interested in the idea of reducing the amounts of waste they dispose of.

Basque firms have been behind those in the UK in their environmental performance as the problem of water pollution has been dealt with only relatively recently. Some of the Basque companies interviewed are considering investing in water treatment plants for the first time. Others have their wastes collected by a waste disposal contractor.

For UK automotive component companies, customers are potentially the most important source of environmental pressure. Health and safety issues can also be a driving force for moving towards less environmentally damaging processes. Customer pressure may not be explicitly environmental. The major pressures are towards improving quality, reducing price and adopting leaner production methods. The result of increased pressure is to push in the direction of total quality management (TQM) which is likely to have positive environmental spin-offs, although they should not be overstated. A better integration of TQM into manufacturing production will only go so far towards improving environmental performance. The most significant impact will be to reduce scrap rates and encourage better co-ordination in the design phase to give parts which require less resources to manufacture. Environmental effects of leaner production may not always be positive. For example the environmental consequences of JIT delivery may be negative.

Customer pressure focus more on the environment in the future as opportunities for competitive advantage are realised. Environmental pressure will take time to move through the supply chain and suppliers are likely to need education on environmental matters.

6. EMPLOYMENT AND TRAINING ISSUES

6.1 Foundries

6.1.1 The nature of foundry work

The working environment in foundries varies considerably, ranging from hot, noisy and smelly repetition greensand foundries, to relatively light and airy aluminium die casting foundries. The nature of the work varies also, but a large proportion of most foundry work is repetitive and physically demanding. A brief description of the nature of various foundry tasks follows.

Pattern shop: The majority of foundries have limited pattern shops, mainly dealing only with repairs or minor modifications to existing patterns. The ‘pattern shop’ usually located in a separate part of the building. Employees would typically be technicians, with a vocational qualification.

Furnacemen: The furnaceman’s major task is to make sure the cupola or electric furnace is charged. Manning a cupola involves additional tasks and therefore more experience. Furnacemen may also be responsible for pouring the metal into transfer ladles and sometimes administering metal treatment. The job is hot, often noisy and physically demanding.

Moulders: Moulding is one of the more skilled jobs, especially in jobbing foundries. Before the widespread introduction of chemically bonded sand, greensand hand was a skilled craft job. Chemical bonded sand is easier to manage and requires less skill to achieve a satisfactory mould. Moulders have to pack the sand around the pattern, remove the pattern, insert the cores and assemble the two halves of the mould. They may then have to lift the mould to the location at which it will be poured or move it along a conveyor track. In repetition foundries the moulder’s job varies according to the level of automation. With DISAmatic machinery, the mould is made and the two halves assembled automatically. Moulders in highly automated repetition foundries stand by the machinery, lubricating the pattern between each mould making cycle and possibly inserting cores.

Diecasters: With gravity die casting the diecasters generally stand by the diecasting machine, pouring metal into the die with a hand ladle, operating the die filling mechanism, initiating the die opening mechanism and then removing the finished casting. Some die casting is less automated, and the diecaster has to close the die manually, pour the metal and then open the die. The job is repetitive, physically demanding and hot. It also requires a steady hand.

Coremaking: The coremaker generally stands by a coremaking machine inspecting and hand finishing the cores when necessary, and then loading them onto a trolley. The job is monotonous and can be smelly, particularly with amine cold box cores. It is not physically demanding nor hot. The cores are delicate and have to be handled carefully and this job seems to be the only one in which women are occasionally employed.

Finishing and fettling: Finishing castings involves sawing off the runners and risers, grinding down parts of the casting which are proud and sometimes smoothing internal and external surfaces. Finishers generally stand in extraction booths to facilitate the removal of the small metal fragments. Their tools are either held by hand or hang down from above. The job is very noisy and dusty, although not especially hot.

Labourers: There are a also range of other jobs, including forklift truck driving, operating cranes, sorting castings into boxes, manning the sand preparation plant, cleaning up piles of sand and rubbish inside the foundry etc.

6.1.2 Employment structure

The employment structure of foundries in both regions is broken down in Tables 6.1 and 6.2 with direct employees being broken down according to categories described above.

TABLE 6.1: EMPLOYMENT STRUCTURE WITHIN UK FOUNDRIES

Labour breakdown	WM-F1	WM-F2	WM-F3	WM-F4	WM-F5	WM-F6	WM-F7	WM-F8	WM-F9	WM-F10
Pattern shop	6	11	65	2	1	2		2		2
Melting	7	10	6	6	5	4	2	6	9	15
Moulding	120	20	40	17	22	20	13	6		22
Coremaking	100	10	12	4	12	6	6	10	14	18
Shakeout and dressing	100	31	24	54	13	8	8	30	35	26
Machining / other direct / diecasters					4		10	20	63	37
Quality, lab/maintenance etc.	13	6	12	7	9			23	16	35
Management	13	7	14	9	4			5		5
Administration	9	26	10	5	3			10		16
Others	41	32	27		27	18	39	38	48	75
Total	**409**	**153**	**210**	**104**	**100**	**71**	2	**150**	**228**	**251**
Direct/total	**81%**	**54%**	**70%**	**80%**	**57%**	**56%**	**42%**	**49%**	**53%**	**48%**

TABLE 6.2: EMPLOYMENT STRUCTURE WITHIN BASQUE FOUNDRIES

Labour breakdown	PV-F1	PV-F2	PV-F3	PV-F4	PV-F5	PV-F6	PV-F7	PV-F8	PV-F9	PV-F10
Pattern shop	0	4					3			
Melting	25	30		17	5	6	6	10		
Moulding	30	13		25	12		14	20		
Coremaking	30	9		13	12	44	12	12		
Shakeout and dressing	140	62		45	41	20	46	20		
Machining / other direct / diecasters	110			17	6					
Quality, lab/maintenance etc.	25	56		3	10		7	20		
Management	5	3		4	6		5	7		
Administration	15	49		7		6		15		
Others	70	4		65			52	26		
Total	**450**	**230**	**85**	**196**	**92**	**76**	**145**	**130**	**160**	**315**
Direct/total	**74%**	**51%**	**n/a**	**60%**	**83%**	**92%**	**56%**	**48%**	**n/a**	**n/a**

6.1.3 Training in the UK foundry industry

Overview

In the past the larger foundries made their own patterns and trained people in house. This provide for the needs of the foundry industry generally.[36] Making the patterns requires an understanding of the founding process and metallurgy. Many foundry managers started off their careers as pattern makers and are therefore technically competent.

Now only large foundries have pattern repair shops and pattern making is usually contracted out to specialist pattern shops. Foundry WM-F5 used to have a pattern shop but stopped about 20 years ago. As the foundry became established their pattern shop became less busy because: a) they built up a collection of patterns; b) new technology enabled patterns to be made much more quickly; and c) the machine tool industry (its major market) began to decline.

Smaller pattern makers (with about 5 or 10 people) are not in a position to train people themselves. The result is that less people are being trained overall and the industry has lost a traditional route by which skilled personnel entered the industry.

There is a strong preference in the industry for the traditional apprenticeship training route - one year full time at college on a Business and Technology Education Council course (BTEC) and then day release for three years. Sandwell College specialises in training for the cast metals industry and runs a range of part time and full time courses, ranging from the BTEC to BEng Honours Degrees in Metals Technology. Technicians usually end up working in the pattern shop or drawing office or in supervisory roles in the foundry. Further studies may be encouraged to Higher National Diploma or Degree level. Foundries' approaches to apprenticeships are shown in Table 6.3.

Non-technical foundry workers either already have some experience or are recruited with no experience. For moulding and coremaking experience is preferred but, for the majority of other jobs, willingness to learn and the capacity to endure the working conditions are the only criteria.

Uptake of new training initiatives

Only two of the ten firms interviewed are putting their workers through NVQs. An attractive feature of NVQs is that the foundry can get grants from the local Training Enterprise Council (TEC) of up to 50% of the cost of training. The interviewee at foundry WM-F3 stated he was not very impressed with what he had seen of NVQs so far, and maintained there was an industry saying that it stands for 'Not Very Qualified'. Nevertheless they are putting some of their staff through the higher NVQ levels. They are doing NVQs because he believes it is expected of them, and it is tied in with how customers see them. They have two trained NVQ assessors who are working through grading foundry workers at the moment.

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[36] John Campbell. *Laying foundations for the future*. Foundry Trade Journal . April 1995. Page 176-178.

TABLE 6.3: APPROACHES TO APPRENTICESHIPS

Foundry	Emp-loyees	Policy on apprentices
WM-F1 .Grey iron & SG, repetition	409	They take on apprentices for electrical and mechanical type work.
WM-F3 Aluminium, repetition	120	They used to take their pattern makers and technicians from school and put them through 1 year full time at a local college. However the College have not done the full time 1 year course recently as they have not had enough people on the courses. The foundry have to put them on day release for 3 years instead, although they would prefer the 1 year full time.
WM-F4 Ferrous alloys repetition	104	They aim to recruit 2 or 3 each year, at the age of 16. They then do 1 year off site at Sandwell college followed by 3 years on the job with 1 day a week release to college. These are technical apprentices for moulding, machining or quality inspectors
WM-F6 Grey iron, Jobbing	71	At the moment they don't take on apprentices. They have recently received a leaflet on "modern apprenticeship" scheme and will invite the local TEC to come and talk to him about it.
WM-F7 Ferrous alloys repetition	92	They have 5 moulders who were trained as apprentices. Traditionally they used to take on 2 moulders/coremakers a year, and train them in this way. Years ago they used to only retain one out of 6. When the recession hit at the end of the 1970s then the lads who had been taken on tended to stay, and there is a nucleus who have remained with them.
WM-F8 Aluminium repetition	150	If they take on new people with "O" levels they generally go on to do ONCs, if they start with A levels, they may then be put straight onto HNDs
WM-F9 Aluminium repetition	225	They try to take on around 3 apprentices a year. They are then encouraged to go into the drawing office, and then may go on to get a degree or HND. It can be difficult to attract apprentices in the first place because of the image of the foundry industry.
WM-F10 Aluminium repetition	251	They take on apprentices, but try to discourage them from doing a year out, as it spoils them. They tend not to stay afterwards....They have a few apprentices coming to the end of their training. They were hoping to take on 2 or 3 apprentices as part of some modern apprentice scheme. However the local TEC has not got this organised in time, and it will be September by the time that they can take them on, which will probably be too late.

5% of the operators are doing NVQ Levels 1 or 2 at Foundry WM-F4. The interviewee believed however, that training programmes did not go far enough, and that they would be training their operators to a higher level anyway. It costs about £500 to put an operator though an NVQ, and they may be able to get half of this back, depending upon the financial situation of the TEC. Most of their female clerical workers are doing NVQ level 3. Several foundries which were not involved in NVQs mentioned their preference for ‘traditional’ training routes, and there was a general feeling that the qualifications do not go far enough for the companies needs.

There are more foundries participating in the Investors in People initiative than in NVQs, although none have achieved the standard yet. The initiative seems to be a low priority amongst almost all of interviewees, but the general attitude was more positive than that towards NVQs.

TABLE 6.4: FOUNDRIES INVOLVED IN INVESTORS IN PEOPLE

Foundry	Emp-loyees	Involvement in Investors in People
WM-F2 Grey iron, repetition	295	They are in the process of becoming Investors in People. They are well into the Action Plan stage, although it is on the back burner at the moment as they are so busy.
WM-F4 Ferrous alloys repetition	104	They have has 3 or 4 consultations with the their local TEC approved consultant, working towards becoming Investors in People. Part of this apparently involves asking the workforce about the training that they receive, and it is likely that some of the foundry workers would not realise that they had been trained and answer that they had not received training.
WM-F8 Aluminium repetition	150	They started off on the Investors in People award; he had hoped to link it to TQM. The TQM has gone very well but he has lost momentum on the IiP. He was a bit disappointed with some of the output from the consultants involved with Investors in People, and felt that they could probably have done better themselves.
WM-F9 Aluminium repetition	225	At the Survey stage for the Investors in People initiative
WM-F10 Aluminium repetition	251	They are involved in the investors in people initiative, and are committed with their local TEC. However they have been really busy recently and IiP is low on the list of priorities at the moment.

Recruitment problems

The unpleasant working conditions within foundries coupled with the declining size of the foundry industry has resulted in difficulties in recruitment. There is a general reluctance for school leavers to enter into apprenticeships because of the industry's reputation for poor working conditions and foundry closures. As a result fewer apprentices are entering the industry, and the recruitment of technical staff at higher levels can be problematic.

A couple of interviewees maintained that it was difficult to recruit because many potential employees were better off financially if they remained unemployed and claimed social security. The Managing Director of foundry WM-F3 was adamant that unemployed people in the area were better off drawing social security with a little 'moonlighting' on the side. At Foundry WM-F5 the piece rate wages did not encourage some of the younger moulders to work faster as the extra income would 'eat into their benefits payments'.

The difficulty in recruiting staff for the foundry pattern repair shop is illustrated in an excerpt from an interview from previous research on the foundry industry

> Some of our older patterns are in desperate need of repair. The pattern shop has a backlog of work of at least two years. We have managed to take on two more people at the pattern shop, but the skills are hard to come by, particularly as we do malleable iron, which needs a different running and gating system to other cast irons. Malleable iron is a shrinking market, there are only five or six foundries doing it, most of which are in the West Midlands area. Our best chance of getting new recruits is from other foundries which are shutting down.

Foundry WM-F5 also mentioned recruitment problems amongst pattern makers

> We are having difficulty recruiting people at the moment. Apparently our pattern maker has had an advertisement in the paper for three days, giving his home and work number, and not had a single call. They quote three or four weeks to get a pattern done, whereas it used to be two or three, and there have been several late deliveries. We now use six pattern makers.[37]

Problems with recruitment and retention of die-casters was mentioned at all non-ferrous foundries using the process.

> There is a very high labour turnover for die casters. In 1994 73 employees left. This looks like a 30% labour turnover, but it was all seven jobs (diecasters). It is particularly bad during hot weather, 26 diecasters have left since April. They are paid on piece rate, and seem to think that they can get better rates elsewhere. The foundry believe they pay better than most, and that the diecasters who leave don't find it better elsewhere.[38]

6.1.4 Training in the Basque foundry industry

Foundry workers often undertake a single and very often repetitive task and training is carried out on the job (Table 6.5). Additionally, as in many other industrial activities, the production process was often organised in a way that the distribution of workers lacked flexibility. Interviewees estimated that for many tasks it does not take long before a new recruit is 'up to speed' at a new job.

The majority of workers employed in Basque foundries lack any formal qualification. Many of the workers have been employed at the same foundry for many years. The majority of tasks are semi-skilled, and can be picked up easily, provided the new recruit can withstand the working conditions.

New training initiatives

A significant new training initiative has been started by the Azterlan Technological Centre. Azterlan was founded in 1975 as a laboratory centre focused on metallurgy. It is was a spin-off from an existing further education college.

Azterlan became aware that there was a lack of qualified workers in the production line, and a lack of training for more skilled foundry tasks. Traditionally, the role played by blue collar workers has not been considered worthy of much attention, being considered as easy. It was also felt that skilled/technical employees do not transmit any knowledge to direct employees. Azterlan has launched several training initiatives, some of which were in collaboration with AFV (the Basque Foundry Association). In 1991 Azterlan started a training course on foundry work at the request of the AFV. This course is still running. The course originated as a result of a study carried out by AFV, which identified a lack of knowledge and an adequate training system.

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[37] Quote from foundry WM5

[38] Quote from interview at company WM10.

TABLE 6.5 QUALIFICATION REQUIREMENTS AND LEARNING PERIOD

TYPE OF FOUNDRY	QUALIFICATION REQUIREMENTS	TIME NEEDED TO BECOME SUFFICIENTLY SKILLED
PV-F1. Carbon steel	None	No more than 3 months
PV-F2. Grey and Nodular Iron	None	Very variable
PV-F3. Steel	n.a.	n.a.
PV-F4 Carbon Steel	FPI/FPII	In general less than a week but 2 weeks for a machinist
PV-F5. Grey Iron	FPI/FPII	1-4 weeks
PV-F6 Grey Iron	None	l month for fettling 6 months for others tasks
PV-F7. Grey and Nodular Iron	n.a.	n.a.
PV-F8 Spheroidal and nodular iron	FPII	2 weeks
PV-F9 Aluminium die-carting	Usually none	n.a.
PV-F10	Usually none	n.a.

Source: Interviews.

Azterlan also carries out a special programme for retraining the existing workforce within foundries with the aims of involving all personnel in the production process. Workers are not only taught how to improve their working performance but they are also informed about other tasks apart from their own. The purpose of this is to improve the understanding of other work undertaken at the foundry and to improve the flexibility of the work-force. Every course lasts two weeks and it is carried out through 10 two-hour lectures. They are not compulsory and do not take place within working hours. Nevertheless, the response amongst workers has been good. This programme is being undertaken at only three Basque Foundries so far. According to Azterlan Technology Centre the results obtained so far are very good and they believe that other foundries will start showing an interest in introducing similar initiatives.

Azterlan has also introduced a new type of training system. It is an open system based on arms-length relationships with firms. Azterlan only keeps in touch with one person of each foundry interested in following this course. Such person acts as an inter-phase body in the training process between the Technology Centre and the firm. To a large extent, it is simply a way of providing a channel through which a firm can solve its training problems.

Recruitment problems.

To a large extent the unemployment situation has enabled foundries to recruit workers with better qualifications than before. In general firms tend to recruit people with FPI or FPII degrees for semi-skilled work. Recruitment is not a problem, given high unemployment.

6.2 Environmental Pressure and Employment Impacts in Foundries

An estimation of the net effect of environmental pressures on employment levels was possible only for the foundry sector in the UK. There are numerous difficulties with this task. One of the most difficult aspects is distinguishing environmental pressures from other pressures which may have influenced the company. A company can invest in environmental equipment, or move to an alternative process for a variety of reasons. For example, a foundry may invest in electric melting because it wants to melt a new alloy, or because it has a very small cupola, and electric melting is cheaper. In this case the driving force is not environmental pressure, although there will be environmental benefits. Many process changes which yield environmental benefits are driven by health and safety rather than environmental considerations.

The problem is greatest with respect to plant closures. A marginal company may close because it is unable to afford the necessary environmental investment to meet legislative requirements. If the company were more competitive it would have been able to make the investment. Environmental pressure may simply have brought forward the closure date.

Responding to environmental pressure obviously requires the attention of foundry managers. Recently foundry managers have had to spend time determining what is required to meet regulatory requirements. When asked how much time they spent on environmental matters the interviewees' answers ranged from one day a week, i.e. roughly 20% of their time, to 2% of time at the lowest. One UK interviewee mentioned that he spent 35 days in 1994 working on the upgrading plan to submit to the local authority, and eight days this year revising it.

Foundries' main response to environmental legislation has been to install end-of-pipe equipment such as filters and scrubbers. The employment effects on the direct labour force following end-of-pipe investment were generally minimal. Some interviewees maintained that the new equipment once installed 'took care of itself'. There were no examples of new staff being taken on exclusively to run environmental equipment. The extra tasks that were required, such as dealing with dust collection bags, were taken on by existing employees. Training to undertake new tasks was not an issue. Equipment suppliers would demonstrate how to empty dust bags etc.

However, foundry WM-F1 insisted that new environmental kit could not be just left to look after itself, and there were training implications for all those that would be using the kit. They have a full time person to take care of their environmental equipment (which includes five wet arresters, 'which cannot be left to chance'). He was taken on seven years ago. There is also someone who checks all the monitoring equipment daily.

For process change with an environmental consequence the effect on labour is likely to be more substantial and may effect the level and quality of employment. The labour requirement is often reduced following process change. Indeed the change may be motivated by the reduced labour requirement.

The change from cupola to electric melting reduces labour requirements. Operating an electric furnace simply involves putting scrap steel into the furnace until the furnace is full and the contents completely melted. The operation of a cupola is more complex and there are a number of additional tasks. The cupola lining has to be replaced at the end of each melting campaign, usually after each individual shift. Charging the cupola with metal is also more complex. A range of different charge materials can be melted, and the proportions of each component have to be calculated in order to give the correct metal specification. There is no opportunity to alter the chemical composition of the molten metal, as there is with electrically melted metal.[39]

Another process change that many foundries have undergone in both regions is transferring to chemically bonded sand systems. This is likely to have a positive effect on working conditions. At foundry WM-F4 the main reason for changing the binding system was to improve the working conditions

> ...using Alphaset rather than furane costs us an extra £100k a year, but we are happy to do this as it improves the internal environment in the foundry. The change was not motivated by the need to meet COSHH regulations, but because we felt it was better for the workforce and the right thing to do....

Many foundries have moved from core making processes using amine gas to less odorous systems. This is accompanied by an improvement in working conditions within the foundry.

6.3 Net Employment Change in the Foundry Sector

Only the UK foundry case study offers the opportunity of assessing the net employment effect of environmental pressure. As there is virtually no pressure on Basque foundries, the analysis of employment impact is not relevant.

6.3.1 Foundry closures

The most significant negative impact on the industry occurs when foundries close down. It is obviously difficult to place environmental pressure in context with other factors which may have led to a foundry's closure. The introduction of UK environmental legislation in 1991, with a deadline for upgrading by April 1997, offers the opportunity for an assessment of the numbers of foundries which may close. *However, it should be emphasised that the conclusions here are drawn from interview responses and the judgement of independent experts on the foundry industry. Until the actual situation is resolved in April 1997, no firm conclusions can be reached.*

Foundries were required to apply for authorisation under the Environmental Protection by March 1992. The application had to be accompanied by an application fee of £900. Continued operation after this date, without having applied for authorisation could result in a fine of £20,000. Although the application process may have made significant demands on the resources of very small foundries it was probably not too onerous for viable businesses. Foundries which found the process of applying for an application difficult were in many cases given considerable help by the local authority.

Some very small foundries ceased operations the day before the application. There are no statistics available on foundries of this size, and so gauging the closures and the consequent effects on employment would be difficult.

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[39] Unless the molten metal is transferred to an electric holing furnace. This practice, called "duplexing" is only carried out in very large foundries producing SG iron.

The last recession removed a large number of foundries which were not competitive, and left the industry ‘leaner and fitter’. It is likely that majority of foundries which survived this testing time will take the upgrading requirements within their stride. However, some foundries may operate until the upgrading deadline of April 1997 and then close. Foundries would be very reluctant to divulge information about their intentions to close. If a customer finds out that a foundry is closing they would start the process of moving their patterns to other foundries and therefore deprive the foundry of its last few months of business. Despite the commercial sensitivity of this information, at least three foundries are known to intend closing after April 1997. Some interviewees have maintained that they know of others who are closing.

It is difficult to estimate the number of jobs which may be lost through foundries closing because of environmental pressure. Independent estimates suggest that five West Midlands foundries may close. These are likely to be smaller foundries, or sections of foundries. For example foundry WM-F10 may close its small copper section.

It is difficult to predict how many jobs may be lost if five foundries close. Since 1980, the greatest number of closures of foundries has occurred amongst very small foundries (<20 employees) and very large ones (>200 employees). The range of uncertainty is very wide and perhaps 50-1000 jobs could be lost as a result of closures prompted by the Environmental Protection Act.

However if the castings made at these foundries continue to be made in the UK, there will be a positive employment effect at remaining foundries. For jobbing foundries, the inconvenience of sourcing the casting from abroad will usually outweigh any small cost advantage. For very large castings sourcing from abroad is unlikely, unless they are very high value castings made from special alloys. With repetition foundries there is more chance that work could move abroad. Grey iron repetition foundries are felt to be under most pressure, particularly from countries outside the European Union, such as Turkey, Eastern Europe or the Far East.

Some indication of the likelihood of castings work moving can be gauged by looking at the answers given when interviewees were questioned about recent changes in the order book or the outcomes of any recent quotes. Generally when a foundry picks up a new casting job, they have some idea where the casting was previously made. However it can be more difficult for them to find out where a job has been moved to. These answers are summarised in Table 6.6.

Many jobs had been picked up from other EU countries recently. Most of this work has come from Germany. Three foundries had picked up work from Germany, and one had picked up jobs from Germany, France, Italy and the USA. Although foundries are very wary of losing casting jobs, and are sensitive regarding divulging information about their customers, many interviewees admitted that customers seldom moved, though the threat was often employed.

TABLE 6.6: MOVEMENT OF CONTRACTS

Foundry	Employees	Changes in contracts
WM-F1 Grey iron & SG, repetition	409	Had gained some jobs from Germany, had not lost any jobs although some customers were pointing out that they had been given lower quotes from foundries in other countries.
WM-F2 Grey iron, repetition	295	Had neither gained jobs from nor lost jobs to other countries
WM-F3 Aluminium, repetition	104	Had gained some jobs from Germany and elsewhere in Europe.
WM-F4 Ferrous alloys repetition	100	Had gained some jobs from Germany, had not lost any jobs although some customers were threatening to move jobs.
WM-F5 Grey iron, repetition	92	Had gained some jobs from a German foundry
WM-F6 Grey iron, Jobbing	150	Had neither gained jobs from nor lost jobs to other countries, although customers were threatening to move jobs.
WM-F7 Ferrous alloys repetition	225	Had neither gained jobs from nor lost jobs to other countries, but have been surprised that have not got certain jobs they had quoted for.

6.3.2 Employment implications of changed purchasing patterns

The following paragraphs attempt to quantify the *indirect* employment effects in the equipment supply industry and local authority regulators. These estimates are extremely tentative and do no more than provide an order of magnitude indication. The assumptions are presented as transparently as possible.

A major positive impact on employment will be felt by equipment suppliers. The largest capital expense resulting from environmental pressure is that of fume arrestment for cupolas. This is estimated at around £15-37 million between 1994 and 1997, and a further £8 - 10 million from 1997 to 2005 as discussed in Section 4.

In order to estimate the potential employment effect of this expenditure (Table 6.7), data on gross output and employment from the Central Statistics Office was used.[40] PA 320 is the industrial classification for Industrial Plant and Steelwork, with activity 3205 corresponding to boilers and boiler house plant, process plant fabrications and other heavy fabricated steelwork in plate. This appears to be the most relevant classification for these equipment suppliers. Dividing gross output by the number of employees gives a figure which can be used to derive potential jobs created or sustained by this expenditure.

Not all of the contracts to supply environmental equipment will be won by UK suppliers. Some contracts will be awarded to German firms. The market penetration of bag filters is probably the highest in Germany, with estimates varying at between 62 and 95%.[41] Other European countries such as Austria, Switzerland and Holland also have high market penetration, although the foundry sector is smaller in these countries.

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40 Report on the census of production 1992, PA 320 Industrial plant and steelwork. Central Statistics Office. HMSO, 1994.

TABLE 6.7: ESTIMATE OF EMPLOYMENT CREATED IN EQUIPMENT SUPPLIERS FOR DRY BAG FILTER MARKET

Gross output of activity 3205	**Employment**	**Gross output/employee**
£2174.7 million	38.6 thousands	£56410
Estimate of capital expenditure	**Time period**	**Number of jobs (capex/£56410)**
£15 - 37 million (large cupolas)	1994-April 1997	250 - 650
£8 - 10 million (small cupolas)	April 1997-April 2005	140 - 180

Another positive effect on employment will be felt by environmental consultants and local authorities which are responsible for regulating foundries. The introduction of Local Authority Air Pollution Control was not accompanied by the recruitment of large numbers of staff, but by a shift in resources within Environmental Health departments. The fees charged for the authorisation of processes provide an indication of the resources put into the regulatory task.

Table 6.8 shows the results of an estimation of the total amount the foundry industry will have paid in LAAPC fees over the period 1992-1997. The accuracy of this estimate is affected by how many foundries may close and also how many will have to pay the fee for a substantial variation. It is assumed that 100 ferrous foundries will have to pay this fee, and that no non-ferrous foundries will.

As a proxy for how many Environmental Health Officer jobs this may create or sustain, the total fees obtained are divided by £50,000 to include benefits and overheads. This results in an estimate of 50 job years for the six year period.

There will also be a positive employment effect for environmental consultants. Many foundries used environmental consultants to carry out monitoring, and some also used their services to help with applications for authorisation or upgrading plans.

6.3.3 Net effect on employment level

Table 6.9 summarises the estimated impact on employment in terms of job years. The overall effect is acutely dependent upon the number of foundries which are assumed to close. The estimated numbers of jobs lost due to foundry closures ranges between 50 and 1000. However the closure of these foundries is likely to safeguard employment in other foundries.

It is likely that environmental pressure will simply accelerate the closure date for uncompetitive foundries. Assuming that these plants would have closed in any case within three years, then the job loss translates to 150 - 3000 job years.

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[41] Professor Colin Appleby. *Dry bag filtration on cupolas in the UK iron founding industry- a market assessment.* draft report to DTI. University of Wolverhampton. March 1994

TABLE 6.8: ESTIMATE OF FEES PAID BETWEEN 1992 AND 1997

		Ferrous (431 establishments)	Non ferrous (345 establishments)
1992/3	£900 application fee	£387,900	£310,500
1993/4	£570 annual subsistence fee	£245,670	£196,650
1994/5	£585 annual subsistence fee	£252,135	£201,825
1995/6	£600* annual subsistence fee	£258,600	£207,000
1996/7	£615* annual subsistence fee	£265,065	£212,175
1996/7	£100* upgrade charge	£43,100	£34,500
any time	substantial variation fee of £600	£60,000 (assumed 100 foundries)	(assumed none)
Total		**£1,512,470**	**£1,162,650**
Overall total		**£2,675,020**	

*estimated charge for 1995-1996

At the extremes there could be a net employment gain of 540 job-years, or a net employment loss of 2,510 job years, mostly spread over the period 1997-2000. There are around 43,900 employees in the foundry industry, and so the maximum negative effect would be around 2% of total industry employment spread over a three-year period. The maximum positive effect would be about 0.5% of employment. It should be emphasised that the extreme negative end of the range is considerably less probable than the extreme positive end because it rests on the following assumptions: a) that large firms close; and b) that there is no transfer of employment to other local firms as a result of closures.

The significant conclusion is: even where a potential employment effect as the result of tangible environmental pressure can be identified, the net impact is likely to be small. Those foundries which close are likely to have been less competitive in any event than foundries which survive and take on new orders. Any negative impacts are balanced by significant improvements in living and working conditions in the region concerned.

6.4 Component Manufacturing

6.4.1 The nature of component manufacturing work

The main categories of employment for operators in automotive component manufacture are either machining or assembly work. The work is repetitive and monotonous. The environment on the shop floor varied between different companies, with some companies well lit with an airy clean atmosphere, whilst others were dim and the air was filled with an oily smelling mist. The noise levels varied considerably between different shop floors, depending upon the manufacturing tasks being undertaken.

The majority of the direct workforce at these companies is not skilled, and many interviewees maintained that new recruits could be 'taken off the streets' and got up to speed with many tasks in a short space of time. The only qualities they would look for would be the ability to get up on time, good health, common sense etc.

TABLE 6.9: ESTIMATE OF NET EMPLOYMENT EFFECT

Job years lost	Jobs years created
510 - 3000 through accelerated closures 1997-2000	260 - 650 job years in equipment suppliers to supply market for bag filters up to 1997 180-350 job years for bag filters between 1997 and 2005 Other jobs in the equipment supply industry resulting from other environmental expenditure 50 Environmental Health officers over the period 1992 - 1997 Some environmental consultants
Total: 510 - 3000	Total: 490 - 1050

One of the most significant technical changes in automotive component companies has been the introduction of computer numerically controlled (CNC) machine tools. The direct effects on employment were found to be mixed, with some factories reporting losses in jobs, and some increases. It is estimated that there has been a net decreases in employment as a result of using microelectronics in manufacturing applications, of about 40-50,000 jobs per year between 1983 and 1987. When indirect effects on employment are considered, the impact on job numbers appears to be reversed.[42]

6.4.2 Employment structure

Table 6.10 and 6.11 show employment patterns in the companies interviewed in the UK and Spain respectively. Employment is divided into two categories: direct and indirect. Direct employees are identified with specific stages of the production process, i.e. operators or machinists. Indirect employment refers to all remaining personnel. The percentage of the total workforce accounted for by direct workers ranged from between 59% to 85% with an average of 73%.

Large companies usually have a more organised employment structure with people undertaking quality and R&D tasks. In small firms, there may be a small laboratory where quality tasks could be carried out. In some of the firms, the high level of indirect employment can be explained by the existence of a significant number of people involved in sales and marketing.

[42] page 107 Northcott Op Cit.

TABLE 6.10: EMPLOYMENT STRUCTURE WITHIN UK COMPONENT MANUFACTURING FIRMS

	Direct	Admin.	Others	Total	Direct/total
WM-AC1	252	63	78	393	64%
WM-AC2	66	23	23	112	59%
WM-AC3	90	29	20	139	65%
WM-AC4	67	4	8	79	85%
WM-AC5	320	33	47	400	80%
WM-AC6	85	20	20	125	68%
WM-AC7	603	16	146	765	79%
WM-AC8	140	30		170	82%
WM-AC9	135	39	26	200	68%
WM-AC10	33	9		42	79%

TABLE 6.11: EMPLOYMENT STRUCTURE WITHIN BASQUE COMPONENT MANUFACTURING FIRMS

	Direct	Indirect	TOTAL	Direct/Total
PV-AC1	43	20	63	68.2%
PV-AC2	107	70	177	60.4%
PV-AC3	40	33	77	51.9%
PV-AC4	24	6	30	80.0%
PV-AC5	130	50	180	72.2%
PV-AC6	128	95	223	57.4%
PV-AC7	366	94	460	79.6%
PV-AC8	226	34	260	86.9%
PV-AC9	80	45	125	64.0%
PV-AC10	17	24	41	41.5%

6.4.3 Training strategies of the UK components manufacturers

Uptake of new training initiatives

Three companies are very keenly pursuing government training initiatives, and have a very positive view of them (Table 6.12). Company WM-AC5 believes that NVQs are 'just right for them. They have trained eight assessors and are running pilot schemes. They are intending to get all the operatives in this department up to NVQ Level 1. The interviewee believes the scheme will be good at bringing people up to speed and the workforce are enthusiastic about it. This company has already achieved the Investors in People standard and are participating in the modern apprenticeship scheme, although they still send the apprentices to college for a one year full time as it is 'important that they gain the appropriate knowledge base'.

WM-AC1 is enthusiastic about government training initiatives. They are in the process of setting up a human resources team and are hoping to integrate training with the introduction of new human resources practices and leaner production methods. An employee based at a different company in the group is spending half his time at WM-AC1 trying to implement the changes. His other workplace was set up as a greenfield site, with all the latest human resource and lean production methods.

They are having to proceed slowly as the workforce is suspicious of the changes. They are intending to put 20 operators through NVQ Level 2 next. Although they committed themselves to Investors in People in the past, no action was taken. They are intending to re-commit themselves to obtaining Investors in People, and are asking union representatives to put their signatures on the commitment.

WM-AC3 have employed a group training association to manage their training strategy, and they are negotiating on WM-AC3's behalf for grants for NVQ training. They are also going for Investors in People, and believe they are mid-way through the process of achieving it.

Two UK companies did not participate in government training initiatives, as they did not fit in with their own training strategies. One of these companies, WM-AC7 had a very proactive approach to training. This company is located in a rural area, cannot rely on the local workforce to have the relevant skills and so relies on training in-house. For more skilled tasks they may take on older recruits. They see their approach to training as socially responsible, although they are criticised by trade unions and the local TEC.

The other company, WM-AC8, is located in the heart of the West Midlands and is able to recruit skilled employees when the need arises. They are not using the modern apprenticeship route. They put their apprentice through day release for 3 years to OND or HND level. The interviewee was not impressed by what he had seen of NVQs, and was not going for Investors in People, because he believed they already were 'investing in people'. Other companies were not following government training initiatives because they believed they had something better. However, they did not, in general, seem to have a coherent approach.

Recruitment problems

Few companies reported significant problems with recruitment. Larger companies in particular often reported having a very good reputation as employers, with many local people keen to work for them. These companies tended to have a low labour turnover.

Companies located in metal working areas such as the West Midlands had a larger pool of experienced workers from which to recruit from. Larger companies with good employment records tended not to have problems with either recruiting or retaining staff. Some smaller companies whose pay and prospects were not as good as larger companies experienced loss of workers to companies with a reputation for better pay and conditions.

TABLE 6.12: PARTICIPATION IN GOVERNMENT TRAINING INITIATIVES

Company	Markets	Other markets	Emp-loyees	NVQs	IiP	Modern apprentices
WM-AC1	OE	No	395	Will put 20 through NVQ2 in 1996.	Will re-commit.	Yes, 2
WM-AC2	N/A		112	clerical workers only	In process of applying	
WM-AC3	OE & AM		149	4 trainees	Halfway through	
WM-AC4	AM & trucks	Yes	79	No	No	Yes, 1
WM-AC5	OE	Yes	400	Running pilot scheme	Have the award	Yes, but still sending them for 1 year full time
WM-AC6	AM & trucks	Yes	125	No		
WM-AC7	OE		700	Not doing them (own training)	considering it	
WM-AC8	AM, OE & trucks		170	No	Not doing it	
WM-AC9	AM& trucks	(Yes)	200	No		
WM-AC10						

Companies located in areas where metal working or engineering was not so important to the local economy could not expect to recruit experienced or skilled workers, and therefore had to rely on training them themselves. In one instance there was less reliance on recruiting apprentices, but on employing local people without experience regardless of age, with the policy of training them in house, often to craft level. Other companies in such areas, recruiting apprentices, tended to be provide a significant number of engineering students for local colleges who sometimes had to start courses or were able to continue to run courses specifically for them.

There were only two companies which mentioned specific recruitment problems. Both these companies were located in relatively rural areas. Company WM-AC2 used to have a 40% labour turnover amongst their welders. This was because as they had been employing welders with Lloyds certificates, who were qualified to work on lucrative contracts in the North Sea, or in the local coal fired power stations when the opportunity arose. They now train welders themselves specifically for stainless steel and thin gauge steel welding, which does not lead to a Lloyds certificate. They have recently been recruiting for other jobs quite heavily, and further recruits will probably not be experienced as they have exhausted existing local skills.

6.4.5 Training at Basque firms

The majority of direct semi-skilled employees are trained on the job. Employees who have been in employment for some time do not usually hold any formal qualification. However, new recruits are usually asked to have either an FPI or FPII degree, even for semi-skilled work. Due to the high levels of unemployment, firms have a pool of well trained potential employees at their disposal from which they may choose. Only one company (PV-AC2) could not always find the skilled workers when needed.

Unemployment in the Basque labour-market accounts for 25% of the total active population and nearly 50% of those below the age of 25. Thus it is possible to ask for higher qualifications than those demanded by the job. Nevertheless, some companies do not ask for any FP qualifications when recruiting for semi-skilled work. There has been a trend towards taking on employees on a temporary basis. From the early 1980s onwards part-time employment has increased its share of total employment from about 5% (early 1980s) to over 30% (1994).

Some firms are growing concerned about the flexibility of their work force. Some companies experience difficulties in persuading their employees (particularly older workers) to become involved in more than a single task.

Only company PV-AC8 stated that it carries out training courses targeting the whole work-force:

> 'There is a policy established through which some course is carried out every week. It does not aim at providing a very specific training, rather the company wishes to inform all workers about different things happening at the company (e.g., the importance of quality). In other words, the company attempts to make operators concerned with various aspects of the production process'.

Company PV-AC9 asks a nearby college when new workers are needed. It has been happy with all previous recruits from this college. No other companies follow this approach.

6.5 Environmental Pressures and Employment in Component Manufacture

There appears to be very little impact on employment which can be attributed to environmental pressure. Although the majority of companies in this sector do not regard themselves as being under significant environmental pressure, many are considering installing environmental management systems. If a specific person deals with environmental matters, then this is usually along with Health and Safety. Sometimes, for example in companies WM-AC3 and WM-AC6, the interviewees found it difficult to distinguish environmental concerns from health and safety concerns.

The most important source of environmental pressure on these companies comes not from legislation, but from the supply chain. There have been examples of companies moving away from environmentally problematic chemicals as a result of customer pressure. Health and safety concerns have also played a role in companies' move away from some chemicals. Often the chemicals avoided in this context were environmentally problematic also. Obviously working conditions improve when unpleasant chemicals are avoided.

Very few firms in the UK have had to make investments in environmental equipment recently. Most companies had effluent treatment plants constructed when the factory was built. Some Basque firms have been investing in effluent treatment plants recently as they are now no longer allowed to discharge certain liquid wastes directly to the river. As with end-of-pipe investment in foundries, this tends not to create additional employment at the firm.

6.6 Conclusions

Training is recognised to be very important in promoting a competitive foundry industry in both regions. The UK industry is going through a crisis in training. As the number of foundries declines fewer people are being trained. Many colleges have stopped offering foundry related courses. In the Basque country a new training initiative specially for foundry workers was initiated in 1991 in recognition of the poor state of training in the industry.

Training seems to be slightly less of a problem for the automotive component industry in both regions, although there are still recruitment problems for certain jobs in the UK. The high level of unemployment in the Basque Country enables companies to recruit relatively well qualified employees, even for semi-skilled work. Not every company specifies that new recruits should have technical qualifications, as much of the work is so repetitive and that level of qualification is not necessary.

There are recruitment problems in both foundry and automotive component industry in the UK. In foundries the main problem appears to be recruiting and keeping employees in jobs with particularly unpleasant working conditions. For automotive component firms, recruiting at higher skill levels can be problematic.

The overall employment effects due to environmental pressure are likely to be small in comparison with the impacts of the general level of economic activity, structural change and technological innovation. The negative impact of environmental pressure on employment is more likely to be felt in material intensive industries with marginal plants, such as the foundry sector.[43] Despite this, the maximum change in employment attributable to environmental pressure in the UK foundry industry, and one which depends on an unlikely combination of assumptions, is of the order of 2% over the period 1997 to 2000. Very small increases in employment could occur among environmental equipment suppliers, environmental regulators and consultants.

It has not been possible to quantify the effect on employment for the automotive industry or for the foundry industry in the Basque country. The employment effects in these sectors will be even smaller.

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43 R-U Sprenger, 'Employment and Environment: Facts and Issues', Paper presented at the *Workshop on Employment Potential of Sustainable Development Policies*, European Foundation for the Improvement of Living and Working Conditions, Dublin, 20-21 April 1994

7. COMPETITIVENESS, QUALITY AND THE ENVIRONMENT

7.1 Overview

As noted in Section 1, the original intention of matching pairs of plants in the West Midlands and the Basque Country in order to compare productivity proved not to be possible because of the heterogeneous nature of output at the plant level in both sectors. Nevertheless, it is possible, from systematic inspection of the plant level data, to

reach some conclusions about the interaction between quality and competitiveness on the one hand and environmental management and performance on the other. The interviews results report in Sections 4 and 5 demonstrate that the achievement of a basic standard of quality is an essential component of competitiveness for plants operating within the automotive supply chain.

The conclusions derived in this section come from three types of comparison: between regions; between sectors; and between different plants operating in the same region and sector. Table 7.1 - 7.4 provide the basis for the analysis. Each table represents a given sector and region. Within each table, plants are arranged according to their level of profitability, defined as the ratio of profits to turnover. Plants which declined to provide profit information are placed at the bottom of the list. Each table contains information on:

a) physical aspects of production (type of product, output, scrap rates, degree of electric melting at foundries);

b) financial information (employment, turnover - converted to £ sterling, net output where available and profitability);

c) productivity (turnover per employee, net output per employee and physical productivity in tonnes per employee);

d) general information (adoption o quality standards, adoption of environmental management standards, recent gains/losses of business according to competing country).

7.2 Comparisons between Sectors

Tables 7.1 - 7.4 do reveal little new about cross-sectoral differences. After allowing for inter-regional differences, there appears to be little difference between the sectors in terms of broad levels of profitability. Labour productivity data (net output per employee) was available only in the UK. Labour productivity in the automotive components sector - £23,400 ± £8,800 - was significantly higher than in the foundry sector - £15,800 ± £10,500.

In the UK, both foundries and automotive component manufacturers had adopted quality standards such as the ISO 9000 series or BS5750. In the Basque country, only about half of the foundries had obtained quality certification while most of the automotive component plants had such standards, or were on their way towards achieving them. The adoption of environmental management standards such as EMAS, BS7570 or the ISO 14000 series was taking place *only* in the automotive components sector and *only* in the UK.

Coupled with direct observations from interviews, the cursory data analysis reveals that, in comparison with automotive components plants, foundries are characterised by:

- lower levels of productivity;
- more environmental impacts and hence greater environmental pressure;
- more problems of recruitment and labour turnover linked partly to a poorer working environment; and
- less focus on formal quality/environmental management standards.

Automotive component plants are more attractive sources of employment than foundries in terms of wealth creation, quality of employment and environmental impact. The components subsector is part of a dynamic industry. The foundry sector is on the other hand beset by a cycle of decline. Factors such as lengthy delivery times, inability to recruit skilled labour and poor environmental conditions are inter-connected and mutually reinforcing. Quantitative performance indicators are symptomatic of these difficulties but do not capture all of the social, environmental and cultural factors which underlie the decline of the sector.

7.3 Comparisons between Regions

The data in Tables 7.1 - 7.4 provides particularly strong evidence about differences between the West Midlands and the Basque country. The principal differences are as follows:

- plants in both sectors are more profitable in the West Midlands than they are in the Basque Country. On average, the ratio of profits to turnover was 7.3% in West Midlands foundries and 9.7% in UK automotive component plants. In the Basque Country, the comparable profitability levels were 0.1% and 0.4% respectively. The profitability of individual plants varies substantially from these averages;
- plants in the Basque Country benefit more from financial subventions which support investment in capital expenditure with beneficial environmental consequences. In addition, the legal form of many Basque foundries (Joint Stock Labour companies) appears to enable plants to operate unprofitably for some time.
- in the foundry sector, the use of cleaner electric melting technology (the activity with potentially the highest environmental impact) is more widespread in the Basque Country than in the West Midlands. This reflects historically low electricity prices. However, for a given activity - for example cupola melting - environmental impact is higher in the Basque Company and environmental pressures, whether from regulators, communities or customers, appear to be lower.
- The foundry scrap rate is a partial indicator of quality. On average, Basque foundries appear to have a slightly lower scrap rate (4.9%) than do those in the West Midlands (5.2%). However, several Basque plants did not appear to gather this information on a systematic basis, especially in relation to external scrap (returns from customers).
- the adoption of quality standards is much further advanced in the West Midlands than it is in the Basque Country.

- several UK automotive component manufacturers are considering adopting environmental management systems. This trend is completely absent in the Basque Country. Many plant managers did not appreciate the concept of environmental management systems.

7.4 Plant Level Comparisons

Plant level comparisons can be made only within a given region and sector. This is because of the impossibility of matching output and production patterns and the difficulty of collecting financial information in the Basque Country. The following conclusions can be drawn:

- based on UK firms, there appears to be little or no correlation within a given sector between profitability and productivity measured either in physical terms or in terms of net output per employee. This perhaps not surprising given the heterogeneity of output at the plants concerned. It would be reasonable to suppose that of productivity/profitability time series data for any given plant would be better correlated than cross-sectional data of the type presented here.

- based on the Basque firms, there appears to be a positive correlation between quality certification and profitability. This conclusion ignores plants which could/would not supply profit data. Quality certification is too widespread in the UK to enable any comparable conclusion to be drawn.

- based on UK foundries, there appears to be no little or no correlation between the use of 'clean' technology (electric melting) and profitability. The choice of melting technology however depends on product mix, energy prices and raw material costs - little may be concluded from this lack of correlation.

- a number of UK automotive manufacturers are seeking a certificated environmental management system (for example BS7570). There does not appear to be a correlation with profitability.

- there is no significant correlation between profitability and scrap rates in UK foundries.

- on the whole, the most profitable companies appear to be those which are gaining business from international competitors. In general, foundries are gaining business from German firms. Less profitable firms, or those which would not discuss profits, appear to be losing contracts to a greater extent. Contracts are being lost to plants in Eastern Europe, Turkey and Asia.

7.5 Conclusions

An important conclusion of the work deriving from Section 6 is that the direct employment impacts of environmental pressures, even those which are regulatory in nature, are likely to be relatively low. An important parallel hypothesis is that companies and sectors which pro-actively pursue higher standards of environmental performance and management will prove more resilient to environmental pressures which do arise. *If this is the case, attention environmental matters can be said to protect rather than threaten employment.* The empirical work provides weak evidence for this hypothesis. However, the various elements of the evidence can only be adduced from different subsets of the data collected:

- UK firms have directed more attention to environmental performance and management, both as a result of regulatory and customer pressure. UK firms are generally more profitable than those in the Basque Country.

- West Midlands firms have paid more attention to quality management than have Basque firms. Those UK foundries which have obtained quality certification tend to be more profitable. Based on a Basque/West Midlands comparison, there appears to be some degree of correlation between the attainment of quality certification and the attempt to achieve environmental management standards.

- To the extent that quality is a key component of competitiveness in the sectors studied, these facts together suggest, but do not conclusively prove, a positive correlation between competitiveness and environmental performance.

TABLE 7.1: WEST MIDLANDS FOUNDRY CHARACTERISTICS: BY PROFITABILITY

W Midlands Foundry (WM-F)	7	9	1	4	3	6	10	5	2	8
Physical										
Product	GI,SG	Al	GI/SG	Steel	Al	GI/SG	Al	GI	GI	Al
Output (tonnes/year)	1800	n/a	26750	2100	800	2250	n/a	4600	32000	2250
Total scrap rate (%)	4.8	5.5	6.0	4.0	5.0	3.0	n/a	9.5	1.7	7.0
% Electric Melt	35	100	0	100	100	0	100	0	0	100
Financial										
Employees	92	225	409	104	145	71	251	100	153	150
Turnover (£m)	2.6	15.0	22.5	8.0	6.5	2.5	9.6	4.0	16.0	7.0
Net Output (£m)	0.7	3.0	6.8	4.2	2.0	1.3	1.7	1.0	n/a	2.1
% Profits	18	10	8	7	5	5	5	0	n/a	n/a
Productivity										
Turnover/empl (£k)	28.3	66.7	55.0	76.9	44.8	35.2	38.2	40.0	104.6	46.7
Net output/empl (£k)	7.7	13.3	16.5	40.0	14.1	17.6	6.9	10.4	n/a	14.0
Tonnes/employee	19.6	n/a	65.4	20.2	5.5	31.7	n/a	46.0	209.2	15.0
General										
Quality Standards	5750	5750	Q1, 9002	9002	5750	5750, 9002	9002	9002, 5750	Q1, 9002	5750, 9002
Shifts in business	+Ger'y	- Rom, +Ger'y	+Ger'y	-	-	-	n/a	+Ger'y	-	-China /India

TABLE 7.2: BASQUE FOUNDRY CHARACTERISTICS: BY PROFITABILITY

Basque Foundry (PV-F)	**10**	**8**	**4**	**7**	**5**	**1**	**2**	**3**	**6**	**9**
Physical										
Product	Al	SG	Steel	GI/SG	GI	Steel	SG/GI	GI	GI/SG	Al
Output (t/y)	13000	6000	10500	3800	4500	12800	19000	6000	15000	4000
Total scrap (%)	5.0	3.0	5.0	5.5	5.0	6.3	6.0	5.0	3.0	0.0
% Electric Melt	n/a	100	100	100	0	100	100	100	0	n/a
Financial										
Employees	315	130	196	130	92	450	226	85	76	160
Turnover (£m)	30.8	8.7	12.3	10.3	4.6	12.8	15.4	4.3	7.2	8.7
% Profits	4.2	2.2	2.1	yes	0.0	-8.0	n/a	n/a	n/a	n/a
Productivity										
Turnover/empl (£k)	97.7	67.1	62.8	78.9	50.2	28.5	68.1	50.1	94.5	54.5
Tonnes/employee	41.3	46.2	53.6	29.2	48.9	28.4	84.1	70.6	197.4	25.0
General										
Quality Standards	9000	Q1, 9002	9002	none	none	none	9000	9002	9002	9002
Shifts in business					+ EU	-		- E Eur		- Prt'gl Turkey

TABLE 7.3: UK AUTOMOTIVE PLANT CHARACTERISTICS: BY PROFITABILITY

UK Automotive (UK-AC)	**4**	**6**	**3**	**8**	**1**	**7**	**10**	**9**	**2**	**5**
Physical										
Product	Gears	Suspen-sion	Cam-shafts	Press-ings	Valves	Steer-ing	Axle/ wheel	Crank-shaft	Ex-hausts	Bear'g Ass'bly
Financial										
Employees	79	125	159	170	395	770	42	200	112	400
Turnover (£m)	3.0	5.5	14.0	10.5	19.7	107.5	3.1	9.0	6.0	50.0
Net output (£m)	0.8	2.9	n/a	n/a	8.1	25.8	n/a	n/a	3.3	n/a
% Profits	17.0	16.0	15.0	7.6	5.9	4.7	1.8	yes	n/a	n/a
Productivity										
Turnover/empl	38.0	44.0	88.1	61.8	49.9	139.6	73.8	45.0	53.6	125.0
Net output/empl	10.6	23.1	n/a	n/a	20.5	33.5	n/a	n/a	29.5	n/a
General										
Quality	5750	5750	Q1 5750	5750	-	cust-omer	5750 9002	9002	5750 9002	5750
Environmental		going 7570	going 7570			going 7570				going 7570/ EMAS

TABLE 7.4: BASQUE AUTOMOTIVE PLANT CHARACTERISTICS: BY PROFITABILITY

Basque Automotive (PV-AC)	6	2	7	3	4	9	1	5	8	10
Physical										
Product	suspen -sion	carb'tr valve	suspen -sion	cam-shaft	axles	gears	clutch/ brake	bear-ings	bear-ings	steer-ing
Financial										
Employees	223	177	460	73	30	125	63	180	360	41
Turnover (£m)	13.7	20.5	54.1	3.2	1.3	6.2	5.2	11.0	17.3	3.1
% Profits	4.7	yes	yes	-1.6	-2.0	no	n/a	n/a	n/a	n/a
Productivity										
Turnover/empl (£k)	61.5	115.9	117.6	44.3	42.7	49.2	82.2	60.9	48.1	75.0
General										
Quality	9001	Ren'lt BMW	9001	going 9000	going 9000	going 9000	Q1	going 9002	9000	going 9000
Environmental	none	none	none	none	none	none	none	none	none	none

8. CONCLUSIONS

The conclusions presented in this section map on to the objectives of the project as laid out in Section 1.1.

8.1 Sustainability Policies and Environmental Pressures

Three principal sources of environmental pressure on firms were identified during the course of the study: regulatory requirements; pressure from customers, notably the automotive assemblers; and pressure from local communities. The nature and strength of these pressures varied between the two sectors - foundries and automotive components - and between the two regions - the West Midlands and the Basque Country. The key features are summarised in Table 8.1.

TABLE 8.1: ENVIRONMENTAL PRESSURE IMPACTING UPON SMEs

	Foundries		**Auto components**	
	West Midlands	**Basque**	**West Midlands**	**Basque**
Legislative	High	Non-existent	Medium	Medium (preventing river discharges)
Public pressure	Medium - high in some cases	Non-existent in majority of cases. Medium in a few	Low in majority of cases	Non existent
Customer pressure	Non-existent	Non-existent	Medium	Low

The UK foundry industry is under strong pressure from environmental regulations which take effect from April 1997. The rules primarily affect particulate matter emitted from metal melting operations. The three possible responses are: installing end-of-pipe technology (bag filters); switching to cleaner electric melting; or ceasing operations. Examples of each strategy have been identified, but the most common response will be the installation of end-of-pipe pollution abatement equipment. There has been some basic process change, but the driving force for this is usually quality, cost reduction, public pressure or health and safety concerns rather than environmental regulation.

There is very little legislative environmental pressure impacting upon *Basque foundries*. Legislation, although it existed for some time prior to the introduction of formal emission limits in the UK, appears not to have been enforced. Foundries do not monitor their emissions and have never been approached by the Basque Government Industrial Department which is responsible for implementation of the legislation. There is some environmental investment occurring in Basque foundries, although it is more likely to be health and safety driven. There has been some process change, but again the driving force is usually quality, cost reduction, public pressure or health and safety concerns.

UK components manufacturers are not under significant environmental pressure. Some larger, first tier suppliers are under pressure from their customers to avoid the use of certain chemicals. Health and safety concerns can also lead companies to avoid the use of environmentally problematic chemicals.

The most significant environmental pressure on *Basque components manufacturers* has focused on preventing water pollution. Many companies have recently stopped dumping liquid wastes (such as soluble oil metal-working fluids) directly into rivers. Few first tier automotive suppliers mentioned customer pressure, although there was some evidence of multinational owners influencing environmental performance.

8.2 Techniques Promoting Sustainable Development

A variety of changes in practice is promoting environmental sustainability within the two sectors. Some of the changes can be attributed directly to environmental pressure: many relate to technological and operational changes driven by competition in the marketplace. The more important changes driven by direct pressure are:

- investment in pollution abatement technology driven by regulation;
- switching to cleaner (electric) melting technologies to avoid pollution controls;
- switching to processes which reduce odour because of community pressures;
- ceasing, at the request of customers, to use substances which deplete the ozone layer;
- adopting environmental management systems.

Other changes include:

- the environmentally long-term switch to electric melting for market/cost reasons;
- switching to cleaner casting processes for cost reasons;
- investing in fume arrestment for health and safety/work environment reasons;
- improving quality, scrap rates and plant yields to meet customer requirements and reduce costs.

Reducing labour costs is a key motivation underlying investments which reduce costs overall. Some process changes, including the switch from greensand to chemical sand in casting, have potentially negative environmental impacts. The switch to chemical sanda can increase VOC emissions, odour and the toxicity of waste (although the *volume* of waste is reduced).

8.3 Direct Employment Consequences

8.3.1 Specific Policies

Even in the case of the UK foundry industry, where environmental pressure is strong, there has been little impact on employment resulting from foundries' responses to environmental pressure. Where environmental pressure has led to the installation of end-of-pipe abatement, there has been very little impact on employees. The installation of such new plant will not necessarily create any new jobs, as any tasks associated with the plant are usually carried out by the existing personnel. In the UK, jobs may be lost through foundry closures resulting from the application of environmental rules. The maximum loss of employment is 2% over the period 1994-2000. This is an extreme estimate and could be far smaller if jobs at surviving foundries are protected as a result. The direct job loss could be offset by job gains in equipment suppliers (see Section 8.3.2).

Where there is basic process change, there is more likely to be an impact on employment. However the driving force for process change may have nothing to do with environmental pressure. If there is a change in the level of employment, it is likely to be negative, although working conditions are more likely to improve. In some cases, the reduction in labour may actually be the driver for process change.

Environmental rules will push the industry towards cleaner technologies which could, in the long run, improve competitiveness - but could also accelerate closures and employment reductions. *In general, the effect on employment attributable to direct environmental pressure is not likely to be significant*, especially when compared to the employment effects of ongoing technical change and changes related to the state of the economy. Those plants which close are likely to have been less competitive in any event than those which survive and take on new orders. Any negative impacts are balanced by significant improvements in living and working conditions in the region concerned.

8.3.2 Trends in Employment

The significant change in employment in component manufacturing firms over the past 20 years has had little to do with environmental pressure. It has been caused by the restructuring of the automotive industry and the adoption of lean production systems. There have also been changes in foundry employment. Employment per unit of output has been declining in both countries.

Process change is reducing labour requirements. For example, in the foundry sector, older cupola furnaces require more labour than new electric induction furnaces. Process change is also reducing skill requirements. For example, charging a cupola is more skilled than charging an electric induction furnace because it is necessary to make judgements about combustion conditions etc. At the same time, the switch away from traditional greensand moulding has been reducing skill requirements because of increased automation and because chemical sand is easier to handle. In general, operational changes which make the foundry industry more competitive will simultaneously: a) reduce labour requirements; b) improve environmental performance; and c) reduce skill requirements.

8.4 Employment Implications of Changes in Purchase Patterns

The greatest impact on employment associated with end-of-pipe pollution abatement and process changes will be felt in the industries that supply equipment. Nevertheless, the employment implications, even in the foundry industry, are likely to be small. For example, the employment created or sustained as a result of installing bag filters on the UK's stock of cupola furnaces stock is likely to be between 260-650 job years in 1994-97 and a further 180-350 job years in 1997-2005. This must be balanced against the highly uncertain negative employment effects of some foundries closing.

8.5 Other Factors

8.5.1 Consequences of different regulatory regimes

The environmental profile of the Basque foundry industry is currently superior to that of the UK foundry industry due to the dominance of electric induction melting. This situation will change as increasing numbers of foundries upgrade their processes to achieve compliance with legislation. The environmental performance of the UK foundry industry will then become superior to that of the Basque country. Environmental pressure has not been an important factor in determining the choice of melting technology. Electricity prices have historically favoured electric melting in the Basque region.

Foundries in the Basque region have undoubtedly benefited financially from the weak to non-existent enforcement of environmental rules. Many Basque foundries with large cupolas are exceeding emissions limits. Some have no arrestment equipment at all. If emissions limits were enforced then these few foundries would incur costs.

In the Basque country there seems to be an implicit consideration of the environmental impact of a foundry in relation to its location. Foundries which are not a nuisance to people are not under environmental pressure. In the UK foundries will be subjected to the same environmental pressure regardless of location.

The UK foundry industry was the only sector to be profoundly affected by regulatory environmental pressure. The investment required for abatement equipment for cupolas alone is in the order of between £27 and 57 million. This represents between 70% - 170% of the ferrous foundry industry's plant and machinery acquisition expenditure for 1992, and 50% - 118% of the industries total net capital expenditure.[44]

Unlike other investments, bag filters for cupolas will bring no returns, other than allowing the foundry to continue to operate. Moving to electric melting and avoiding the costs of a bag filter could bring returns for foundries able to benefit from the other advantages associated with electric melting; i.e. jobbing foundries with a demand for metal melted in batches, or foundries entering higher value added markets for specialist alloy castings. However for the majority of UK grey iron foundries electric melting does not offer operational advantages and cupola melting is cheaper than electric melting, even after investing in a bag filter.

Environmental pressure on Basque automotive component companies has become important since direct discharge of liquid wastes to rivers has stopped. Firmsmust now pay for waste disposal, but the impact of disposal costs is not significant in comparison with other costs.

Policies in both countries are designed to allow firms an opportunity to adapt to higher demands in terms of environmental performance. The UK has used a five-year regulatory timetable to allow plants an opportunity to comply with higher standards. This has been backed by information/dissemination/demonstration measures providing tangible assistance to firms. Spain has chosen more direct support for environmental technology reflecting the poorer economic performance and the recent removal of tariff protection. These differences reflect differences in national circumstance as well as economic/policy culture.

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[44] Calculated by dividing these expenditures by those given in table *.

8.5.2 Competitiveness

It has been suggested that more competitive firms will be better able to make the necessary investments to improve environmental performance. Companies and sectors which pro-actively pursue higher standards of environmental performance and management would therefore prove more resilient to environmental pressures which do arise. If this is the case, attention to environmental matters can be said to protect rather than threaten employment. The empirical work has provided weak evidence for this hypothesis:

- comparing across regions, firms which have directed more attention to environmental performance and tend to be more profitable.

- firms which have paid more attention to quality appear also to have been more profitable. Firms which have sought quality certification are more likely to seek to adopt environmental management standards.

8.5.3 Productivity differences

It has been almost impossible to draw meaningful conclusions from comparing productivity, either across or within regions and sectors. This is always likely to be the case where output heterogeneous.[45] An attempt was made to match foundries in the West Midlands and the Basque country to facilitate any comparisons in physical productivity. Labour productivity data could not be obtained in the Basque Country.

Apart from the ferrous/non-ferrous distinction, there were differences in physical productivity between foundries producing ferrous castings. The tonnage per head varied between 20 and 241 amongst the West Midlands ferrous foundries interviewed (Table 8.2). Even at the aggregate level, physical productivity varies regionally, from 34 tonnes per head in the Northern region compared with 75 tonnes per head average for the East Midlands and East Anglia regions.[46]

It is difficult to explain the wide range in physical productivity. The foundries which are believed to be good matches are shaded in Table 8.2. There are three cases where there is believed to be a good match and data is available for the both Basque and West Midlands foundries. In each of these three cases, the Basque foundries appear to have greater physical productivity.

Possible explanations for variation in physical productivity differences in foundries believed to be good matches.

- The physical productivity varies considerably between PV-F4 and WM-F4. This is probably explained by the fact that WM-F4 produces both very large castings and very small castings, whereas the size range of the castings produced by PV-F4 is much narrower.

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[45] J E Birnie. *British-Irish Productivity Differences 1930s-1990s: ROI and UK Labour Productivity Levels in the Industrial Sectors.* March 1994.

[46] Business Monitor POS 1. *Annual Iron Castings Inquiry 1990 Benchmark: Supplementary Results.* Government Statistical Service. HMSO, 1991.

- WM-F5 and PV-F5 are a good match, and their physical productivity is similar.

- WM-F6 and PV-F6 are a good match in many respects and the large difference in productivity is surprising. Both foundries produce very large castings, although those produced at PV-F6 are up to 36 tonnes while the maximum at WM-F6 is only eight tonnes.

This variability in physical productivity between suggests that matched pair productivity comparisons are not an appropriate methodology for application in this sector.

TABLE 8.2: DIFFERENCES IN PHYSICAL PRODUCTIVITY: FOUNDRIES

Foundry	**WM-F1**	**WM-F2**	**WM-F3**	**WM-F4**	**WM-F5**	**WM-F6**	**WM-F7**	**WM-F8**	**WM-F9**	**WM-F10**
Employees	409	153	210	104	100	71	92	150	228	251
Tonnage	26750	36800	800	2100	600	2250	1800	1300		
Tonnage / employee	65	241	4	20	46	32	20	9		
Foundry	**PV-F1**	**PV-F2**	**PV-F3**	**PV-F4**	**PV-F5**	**PV-F6**	**PV-F7**	**PV-F8**	**PV-F9**	**PV-F10**
Employees	450	230	-	196	92	6	145	130		-
Tonnage	12,800	-	6000	10500	4500	15000	-	6000	4000	
Tonnage / employee	-	-	-	54	49	197	-	46	-	-

8.6 Further research

Two possible lines of future research are suggested by this study:

- it would be interesting to conduct a follow-in order up study on the UK foundry industry to investigate the actual response of foundries to environmental rules. This could include a statistical analysis of foundry employment and output and/or repeat interviews with the firms covered in this study.

- many foundries in the UK are winning contracts that were formerly held by German foundries. The German foundry industry has been subject to environmental pressure for a greater period of time. It would be useful to investigate the degree to which environmental pressure were contributing in any way to the apparent non-competitiveness of the German foundry industry at present.