4 HISTORICAL DEVELOPMENT OF THE UK FOUNDRY INDUSTRY

4.1 Brief history of the foundry industry

The technique of metal working by melting and casting was established in Britain about 4000 years ago and Cornwall provided one of the few European sources of the tin required to make bronze (Coles and Harding 1979). Working of wrought iron followed by the mid-first millennium BC, but the production of cast iron did not occur until the 15th century and was initially limited to simple items such as grave slabs, fire backs and cannon balls (Gale 1969).

The main growth in casting of ferrous metals came with the industrial revolution. A series of technical breakthroughs in the 18th and 19th centuries enabled cast iron, and later steel, to be produced in large quantities at a much lower cost than wrought iron (Gales 1969, Tweedale 1986). These rapid technological advances were driven by the demands of the industrial age and the need for reliable metal components for steam engines, textile production, mining, machinery, ships, railways and armaments. The widespread use of iron castings for agricultural, domestic and architectural uses also contributed to the growth of the industry in the 19th century.

The industry continued to expand during the first half of the 20th century, as engineering requirements increased and the development of motorised vehicles resulted in new markets for cast products. Standardisation of hydraulic fittings just prior to the first world war led to increased output of brass castings (Tyler 1921); while the development of aluminium alloys around the same time soon resulted in successful outlets in the electrical industry, motor-boat and art casting markets. Aluminium alloys provided a lighter or cheaper alternative to other metals (Mortimer 1931), an advantage that continues to the present day.

Military conflicts stimulated demand, which peaked during the Second World War. In the early 1940's, the Ministry of Supply set up 36 completely new specialised foundries, mostly for production of bombs and track links (Jackson 1967). From 1940 to 1944, government contracts absorbed 98% of the total output of iron castings, amounting to over 12 million tonnes of components for marine and rail transport, tanks and ships, army vehicles, grenades, bombs, machine tools, etc. (FTJ 1945a, b). Production of steel castings more than doubled to meet the war demand.

Following the war years, demand for non-military castings was brisk, the main restrictions being the availability of production capacity and usable scrap, as there were widespread shortages of pig iron (FTJ 1951; FTJ 1945a). In the early 1950's, the larger and strategically important iron and steel foundries were nationalised under the British Steel Company.

The production of iron, copper-based and zinc castings remained strong throughout the 1960's, but the whole sector entered a decline in the following decade as heavy manufacturing in the UK began to collapse (FTJ 1986). By 1980, production of iron and steel castings had fallen to 40% of their peak levels, but then stabilised for a period. Currently conventional casting production is in another period of dramatic change, resulting in further widespread closures and substantial reductions in output. Aluminium and some of the specialty non-ferrous alloys are the exceptions but are produced on a much smaller scale.

A comparison of production output from 1971 and the most recent year for which validated data is available is shown in Table 5 below. The actual tonnage of ferrous castings at the present time is considerably less than shown in the table, as many large foundries have closed in the last five years.

Table 5. Casting Production Output, Historical and Recent *

Metal / Alloy Group	Peak, tonnes (year)	1971 Output, tonnes [1]	1998/9 Output, tonnes
Iron	4,214,000 (1964) [1]	3,346,000	968,200 [3]
Aluminium	Unknown	133,000	169,300 [4]
Steel	616,000 (1943) [2]	260,000	96,800 [4]
Copper	Unknown	72,000	16,200 [4]
Zinc	Unknown	69,000	19,500 [4]
Magnesium	Unknown	1000	1400 [4]

** At the present time there is no mechanism for collection of UK output statistics*

Data Sources: [1] NEDO 1974; [2] FTJ 1945b; [3] Modern Casting 2001; [4] Modern Casting 2000

4.2 Types of foundries

Foundries can be divided into four main categories as described below.

Table 6. Types of Foundries

Type	Description	Historic	Current
"Integrated" works	Facilities undertaking a range of operations, sometimes including production of castings.	✓	
"Captive" foundries	Plants producing castings for a single manufacturer	✓	✓ *
Medium & high-production foundries	Foundries producing high volume castings in a semi- or highly-automated and cost efficient manner.	✓	✓
"Jobbing" foundries	Foundries producing small batches and one-off castings.	✓	✓

** But the number remaining is much reduced, as many manufacturers are now sourcing their castings from overseas companies for cost reasons.*

4.2.1 Integrated works

Integrated works undertook mining, blast furnace production of pig iron, coke making and sometimes castings production. The main metal production operations are described in the DoE industry profile on "Iron and Steelworks" (DoE 1995a, with information on gas and coke works in DoE 1994a). By the late 18th century a number of large facilities were already in existence (Gale 1969, McCombe 1982, Chapman 1981, Turner 1967). The companies were massive, often employing several thousand workers, the majority of which worked in the mines. Pig iron was mainly produced for sale to external customers, with some retained for internal foundries that re-melted the pigs in cupolas or air furnaces for casting work.

Further large integrated works were established during the 19th century, including the first steelworks (Barraclough 1976) and continued to expand operations into the 20th century. Specialist plants diversified to produce a range of chemical products and gas from the by-products of coke production.

The production of solid pig iron ceased in the late 1960's (Chapman 1981) and production of coke for industrial use has also virtually disappeared. Chemical production, where undertaken, was gradually sold off to separate companies. Integrated works that incorporate a foundry process no longer exist in the UK and there is only one remaining plant that makes both bulk steel products and castings.

At integrated works, the range of contaminants present, and their concentrations, are likely to be considerably greater than at a stand-alone foundry operation. Activities such as coking works or chemical production, rather than the foundry processes, will have left the most significant legacy of contamination.

4.2.2 Captive foundries

Captive foundries are owned by a manufacturing company, which usually undertakes a variety of production processes. The foundry may be:

- in the same building as other manufacturing processes, such as coating, plating or assembly activities,
- on the same site as other operations, but in a self-contained building or plot,
- on a separate site from which castings are shipped to the main manufacturing facility.

In the first variation, a varied contaminant suite may be present at the site and the contribution of the foundry process difficult to distinguish. In the latter two cases, it should be possible to isolate the pattern and nature of contamination resulting from the foundry activities.

Captive foundries are often excluded from official statistics and may be difficult to identify without detailed knowledge of the company's operations. SIC codes used by the companies are usually associated with the finished product, e.g., valve manufacture, and the foundries are not listed in trade directories, as they do not take on external work.

4.2.3 Medium and high-production foundries

Medium and high-production foundries where some or all of the production process is automated are primarily a 20th century development. However, even in the 19th century, markets such as the textile sector that required large numbers of similar castings, led to the automation of mould production (McCombe 1984). In general, such foundries are well organised and managed, although the large scale of operations can result in significant impacts with regard to land contamination.

These foundries are currently coming into PPC control under Part A and will be responsible for preventing future contamination to land.

4.2.4 Jobbing foundries

Jobbing foundries, which take on batch and special order work, are the most common type although their overall output is a much smaller proportion of the total than the facilities already described. They range in size from a single work bay with a small furnace and a few employees, to much larger operations with three to six different production lines and as many as a hundred employees. Jobbing foundries often produce several types of alloys, so the designation "iron" foundry or "aluminium" foundry can be misleading.

The small foundries commonly found in urban areas can be assumed to be of this type and the majority of closed sites were probably iron foundries using cupola melting. The companies remaining in operation are generally regulated for air pollution only (Part B control under EPA and PPC regulations), and there is potential for on-going and future contamination of land albeit on a smaller and more localised scale than from larger facilities.

4.3 Distribution of foundries in Britain

The iron industry developed in areas where essential natural materials were readily available and the transport infrastructure for distribution of output existed. Areas where the Coal Measures are within working depth were developed from the mid-18th century (Barraclough 1976). The Coal Measures were a source of many essential raw materials including ironstone, used for production of iron in a blast furnace, and coal.

The creation of extensive networks of railways and canals further supported industrial growth. Areas of early industrial development included:

- The Scottish Central Lowlands, particularly after the Forth and Clyde Canal was opened in 1790 (McCombe 1982).
- The Black Country (West Midlands) where resources of iron ore, coal, clay, limestone and sand were all available at shallow depths and in large quantities (Gale 1982).
- Sheffield, which became the centre of the steel foundry industry and developed rapidly from the 1840's (Barraclough 1976, Tweedale 1986).

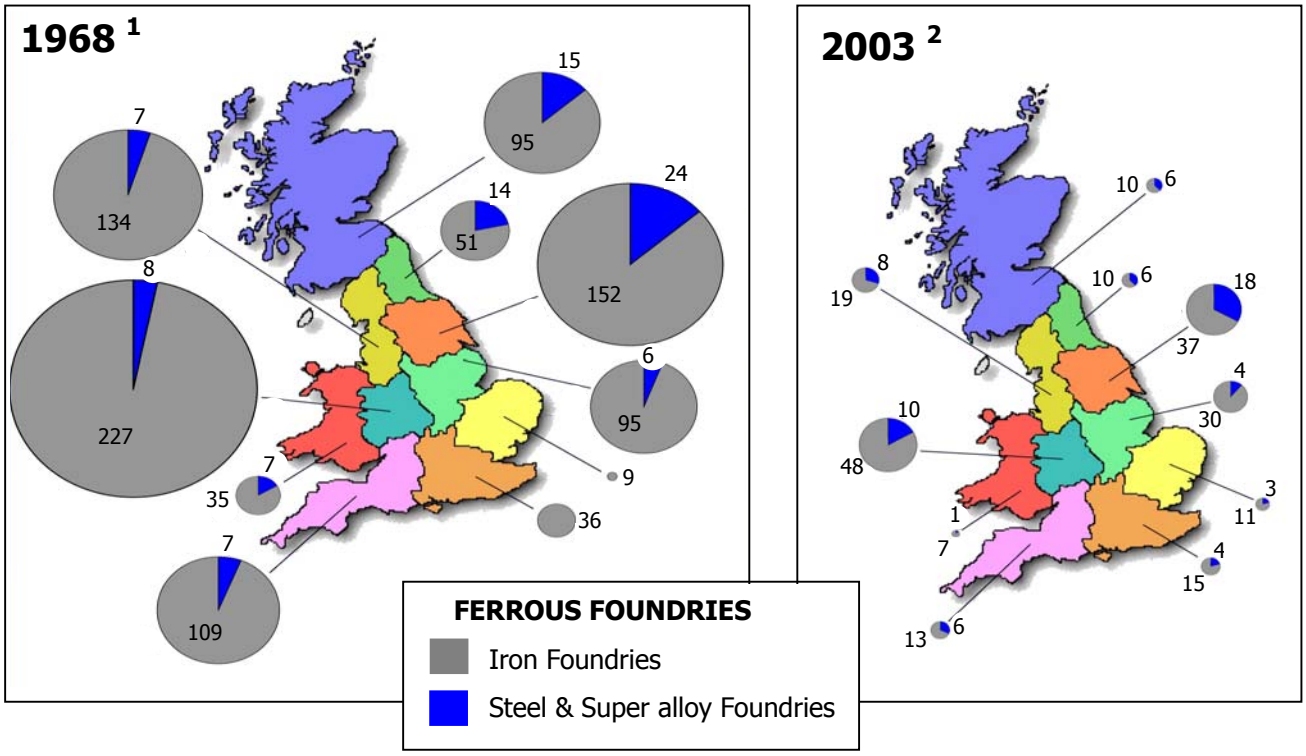
In the 20th century as transport networks improved, location close to essential raw materials became less of a consideration.

As castings are used for so many different applications, foundries have been established in many different locations convenient for their customer base. While there are obvious concentrations in the historically important manufacturing areas of the West Midlands, Yorkshire/Humberside, and Central Scotland, other significant clusters exist and single foundries occur in seemingly odd places. Historically, the Northwest had large numbers of foundries serving the textile industry, while the Southwest currently has the main concentration of investment foundries, which supply castings to the aerospace industry located in the same region. Many foundries, originally established on the outskirts of towns, have gradually been engulfed by residential developments as towns have expanded. Others still exist in rural or remote locations with no apparent explanation.

Figure 10 shows the distribution of iron and steel foundries in 1968 and 2003. Data on the historical distribution of non-ferrous foundries could not be found, but the current distribution is shown in the same figure.

The distribution maps confirm the widespread historical significance of the industry and the need to assess the potential for land contamination from foundry processes. Although current figures show the number of aluminium foundries exceeding iron foundries, that has only occurred within the last few years. Historically, the number of iron foundries far exceeded the total of all the other types, and peaked in 1949 when 1,938 sites were in operation (Farrant 1972), virtually double the number shown in Figure 10. The pattern of decline since that date has been gradual but unrelenting.

At the start of the 21st century, the future of conventional casting operations in the UK is in doubt as much production has been moved to third world countries with significantly lower wage structures and few regulatory controls. Even with the additional transportation costs, such foundries are able to undercut UK and EU producers by considerable margins. The size and nature of the future UK industry is likely to be quite different from its historical roots, with production concentrated in speciality markets, such as the high technology, defence and aerospace sectors with greater use of light non-ferrous alloys.



Estimated Numbers of Foundries by Year:

Main Alloy	1968 [1]	2003 [2]
Iron	943	200
Steel & Super alloy	88	66
Aluminium	ND	211
Copper	ND	26
Zinc	ND	30

ND = No data found

Source Data:

[1] NEDO 1972; [2] Cti 2003; [3] Farrant 1972

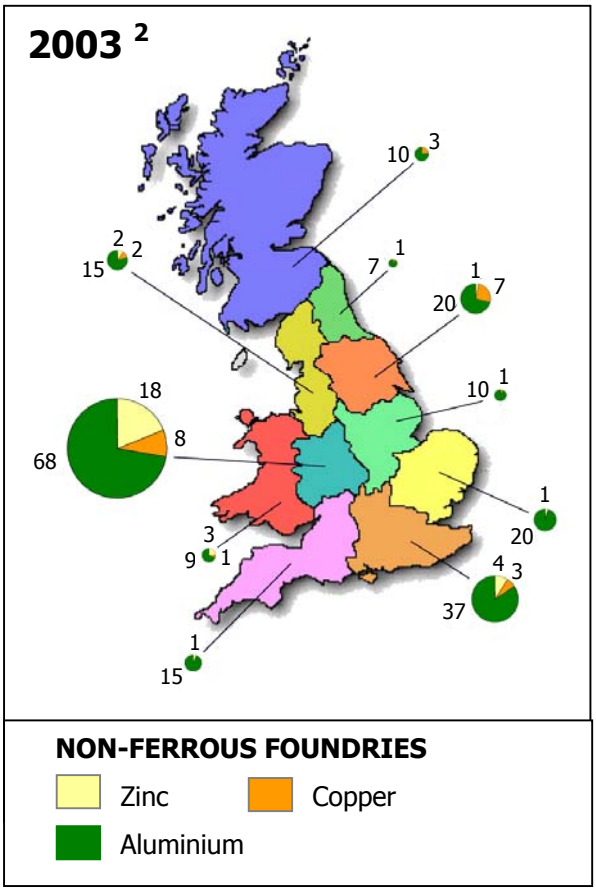


Figure 10. Distribution of Foundries in Britain