2 Product Innovation

Product innovation means different things to different people. Some, for example, tend to think in terms of a product which is 'first of its kind', whether in the UK or in some larger market. Naturally, few small firms achieve innovation of that degree. And such radical innovation is not necessarily more important than the steady, incremental improvements to existing ranges of products, which far more firms take part in. Indeed, since about 1970 there seems to have been a steady swing towards product improvement rather than totally new products, throughout the industrial world[1]. We felt there was good reason, therefore, to adopt a broad rather than a narrow view of product innovation. As we stated briefly in the Introduction, we defined it as

> development of new products, changes in design of established products, or use of new materials or components in manufacture of established products.

In other words, anything which is new to the business and its product range is counted as innovation, even if similar products are available elsewhere or if the change is an incremental one.

How much product innovation?

The senior executives responding to the survey were told our definition and asked to look back over the preceding two years (a period finishing in late 1985). They were asked, first of all, whether they had brought in *any* change in products within this period.

We found that some product innovation, in our broad sense, had been carried through in this period by 57 per cent of our whole UK

sample. In other words, out of every 10 small firms, six were likely to be (to some degree) innovators, while four were likely to be non-innovators. However, as noted in the Introduction, we must be careful not to generalize from this figure, which could be substantially affected by non-response to the survey. This is because firms not involved in product development and innovation might be less likely to find the survey interesting than would firms which were innovators. The result would therefore tend to overstate the proportion of firms which were innovators.

We are on firmer ground when we turn to comparisons of various groups within the survey. We designed the survey in the expectation of finding higher levels of innovation in the East Midlands than the North-East. If non-response acts selectively to reduce the proportion of non-innovators in the sample, then the expected difference between the two regions would be weakened. If a difference persists despite this, it can be regarded as reliable. In fact, we found that 60 per cent in the East Midlands, as against 54 per cent in the North, had brought in new products. This difference is in the expected direction, but it is not striking, and on that basis alone it would be unsafe to claim any distinct advantage for the East Midlands.

Because our definition of innovation was a broad one, a firm could be counted as innovative even if it had made only a marginal product improvement. But we checked this in other ways. The firms were asked a more detailed question, to classify the innovations by type. They indicated whether their innovation was

(i) a modified version of an existing product range

(ii) a new model in the existing product range

(iii) a new product outside the existing range but in a similar field of technology

(iv) a totally new product in a new field of technology.

Evidently, as one moves up the scale from (i) to (iv), the degree of innovative effort and risk-taking on the part of the firm is likely to increase significantly. This is not to say that developing totally new products is ‘better’ than incremental improvement; that would depend

on the business circumstances of a particular firm. But it does represent a greater degree of commitment.

Quite large proportions of those firms reporting innovation had, in fact, brought in new products of types (iii) or (iv) where the innovative effort was higher. The findings are summarized in Table

Table 2.1 Levels of product innovation, by region

column percentages

	East Midlands	North East
A modified version of an existing product	36	33
A new model in the existing product range	29	33
A new product in a similar field of technology	35	23
A totally new product in a new field of technology	18	14
Base for percentages	*55*	*43*

2.1.

In the East Midlands, 35 per cent of firms had introduced 'a new model in a similar field of technology', and 18 per cent 'a totally new product'. The corresponding proportions for the small firms in the North were 23 per cent and 14 per cent. Firms in the two regions were equally likely to be making the simpler kinds of innovation (types (i) and (ii)), but the East Midlands firms were more likely to be making the more difficult kinds of innovation. So a regional difference is beginning to emerge.

Patented innovations

Although our basic definition of innovation adopted the firm's point of view, we also wanted to assess innovations by means of recognized criteria. One of the most widely used criteria for innovation is patenting. We therefore asked the firms whether or not any newly launched products, within the two-year period, had been patented. Patenting is expensive, so firms would only attempt to protect developments likely to be of value in the wider market-place.

Product innovation examples

Fabrication and Assembly Company (FAC) is an example of diversified, opportunistic development of new products. After being set up in 1972 it initially made bridge parapet anchorages, but found that this was too narrow a base on which to build a business. It subsequently tried knitting machine components and alternator casings, but these also were unstable markets. Better results were obtained with heat exchangers for the steel industry; and in 1978 water table cutting beds for oxy-fuel or plasma-arc cutting were introduced, with considerable subsequent development. In 1987, FAC was introducing a new machine to remove slag deposits from flame-cut steel, and was assessing the possibility of making a computerized handling system for heavy steel plates, under licence from Finland.

Farm Machinery Manufacturer (FMM) built up a successful business on the basis of one highly innovative idea. This was a cattle feeding system in which a transponder attached to the animal activated an electronically controlled feed dispenser. This led to a series of developments with increasingly sophisticated options. After this narrow specialization led to serious market setbacks in 1983, the company began to diversify, and developed a successful sow feeding system. It also began to apply its expertise to non-agricultural problems, for example the design of light-controlled pedestrian crossings for disabled people.

Specialized Knitting Machines (SKM) was based on a single technology (knitting) but was applying this to new or specialised problems. It established itself by buying the manufacturing and distribution rights of a range of machines from an American company. Subsequently it has developed a computer controlled jersey knitting machine, which greatly increased the range of patterns and styles which could be produced. It also developed a machine for knitting fibres of meat compound into a continuous material, which required knitting concepts new to the industry.

Incinerator Company (IC) is an example of both planned and opportunistic innovation. It began as a supplier and sub-contractor of fabricated components. Over a period it investigated the possibility of entering the market for advanced incinerators. However it was only when a customer firm, which was installing an incinerator, asked it to take over the contract with which it was having technical difficulties, that it was able to carry out its plan. The company subsequently introduced a new type of incinerator offering more complete combustion and reduced smoke emission. This had become the main source of the company's growth and had permitted it to enter export markets.

Moreover, patent applications are screened for originality, so that granting of a patent implies that the development is 'new to the market' in some significant respect. We also collected descriptions of the main items patented, so that we had some check on the nature of the main innovations.

Nearly four in ten of the innovating companies, and more than one in five of the entire British sample, had patented at least one product during the period. This again suggests that the intensity of innovation in many of these small firms was high. This criterion continued to show the East Midlands firms to be operating at a higher level of innovativeness than the Northern firms. In the East Midlands region, 42 per cent of the innovators, or 25 per cent of the whole sample, had patented a product; in the North East, 35 per cent of innovators, or 19 per cent of the whole sample, had done so.

The use of microelectronics

In the Introduction, we stressed the significance which we (along with many others) attach to the use of microelectronics technology. The mechanical engineering or machine building industry covered by this study has been traditionally quite separate from electrical engineering both in the UK and the FGR. We can reasonably suppose that a higher degree of innovativeness is involved when microelectronic components, rather than traditional components and assemblies, are used in firms in such an industry. This is especially so, because use of microelectronics is likely to have repercussions on other aspects of product design (through, for example, the elimination of mechanical parts). Accordingly, use of microelectronics in new products represents another objective indication of the level or intensity of innovation in these firms.

Nearly four in 10 of the innovating firms, or 22 per cent of the whole sample, had made use of microelectronics in new products. The penetration of the new technology among these small firms was, therefore, at very much the same level as the proportion taking up patents. Evidence available from elsewhere suggests that among all UK engineering establishments, some 45 per cent (twice the proportion as in the present study) were making use of electronics in new products

at around this time[2]. That however covers large firms as well as small, so that our finding is a reasonable one.

The most striking finding concerning microelectronics was the difference in use between regions (see Table 2.2). In the North, only 17 per cent of innovators used microelectronics, and this was only nine per cent (one in eleven) of the whole Northern sample. In the East Midlands, 55 per cent of innovators, or one in three of the whole sample, had used microelectronics in the past two years. The picture in this respect was completely different in the two regions, and provides the

Table 2.2 Product innovation and microelectronics components, by region

column percentages

	East Midlands	North East
Using microelectronics	33	9
No microelectronics	67	91
Base for percentages	*55*	*43*

strongest indication so far that the East Midlands was, as we expected, innovating at a higher intensity.

New materials in product innovation

As with microelectronics, the availability of new materials, such as alloys or engineering plastics, may offer small firms considerable opportunities for innovation. Indeed, there is expert opinion to indicate that new materials technology may become as important within the next decade as microelectronics now[3]. Meanwhile, use of new materials can, like microelectronics, point to a high degree of sophistication among small firms.

In fact, slightly fewer firms in our sample had used new materials in product innovation than had used microelectronics. Overall, the proportion was 30 per cent of innovators, or 17 per cent of the whole sample. The small firms in the East Midlands were again more frequently users of new materials than those in the North East: indeed, with usage covering 22 per cent of all East Midlands establishments, they were nearly twice as high as the North, with only 12 per cent.

How size of firm affects innovation

We now have an initial picture of the extent and quality of product innovation in the British sample. But there is a further, important complication which has to be taken into account, before we can sum up the regional contrast and begin comparisons with the FGR. This is the effect of size of establishment. Although all our firms were 'small', their sizes still varied quite substantially. The range will be larger still when the firms from the FGR are brought into the picture.

Other things being equal, larger establishments would be expected to have more product innovation than smaller ones. This is nothing to do with controversies about whether there is a better 'climate of innovation' in small or in large firms. It is a statistical effect. Proportional to its resources, a smaller firm may be more innovative, but in absolute terms, a larger firm is the more likely to have an innovation coming on stream in a given period, simply because of its wider range of activities and markets.

As we were not able to measure value added, and as one in five of the sample was unable or unwilling to give a figure for sales turnover, the best measure of firm size available to us was number of employees. Where sales turnover was available, we found that it correlated very highly with numbers of employees in this sample[4], so the use of number of employees will also give a good reflection of size differences in terms of sales.

As Table 2.3 shows, size measured in terms of numbers of employees was clearly related to product innovation within the UK sample as a whole. And the differences were quite large. Only 45 per cent of establishments with less than 20 employees reported any product innovation. The comparable figure for the 20-49 size band was 59 per cent and for 50 or more employees, 74 per cent.

Table 2.3 Levels of product innovation, by size

column percentages

	Number of employees		
	11-19	20-49	50-99
New or modified products in past two years	45	59	74
Base for percentages	*43*	*29*	*26*

When it came to the more refined measures of innovation, taking account of its intensity, the picture was a little more complex. When the smallest firms (those with less than 20 employees) engaged in product innovation, they did so at quite a high level of sophistication, compared with firms in the 20-49 size band. They were *more* likely to be engaged in completely new products rather than updates, they were *more* likely to be patenting their products, they made *more* use of new materials, and they were as likely to be using microelectronic components.

On the whole, however, it was still the largest of the three groups (50-99 employees) which had the highest quality of innovation as well as the greatest frequency. The smallest firms were polarized into non-innovators and highly active innovators, while the establishments at the top of our size range were more consistently producing new products. The intermediate size group (20-49 employees) appeared to be at a particular disadvantage in terms of innovation. One could speculate that the smallest firms have the benefit of individualism, the larger firms the benefit of more resources and systems, while the intermediate group lacks the best of either world. This however would be no more than a tentative interpretation.

The proportion of the smallest establishments was actually higher in the East Midlands sample than in the Northern sample. The differences between the regions in their amounts and types of innovation cannot be attributed to differences in size, since, if anything, the larger average size in the North should have led to more innovation rather than less - which is the opposite of what has been shown. In fact, the very small East Midlands establishments had a strong performance in terms of innovation, which contributed to the overall qualitative superiority of the East Midlands picture.

Financial and growth indicators, and product innovation

Although the size of a firm, measured in terms of its work-force, is closely related to its sales turnover, the agreement between the two measures is by no means perfect. Sales are worth considering separately, if only to check that we reach the same conclusions as with numbers of employees. Moreover, financial and growth indicators (unlike number of employees) can give some impression of the impact of innovation on competitive performance.

Apart from sales turnover, we were able to calculate sales per employee for 71 firms in the sample, and we also got information about whether the firm had been on an increasing profit trend over the previous five years, and whether it had expanded its work-force over this period. All this information is summarized in Table 2.4.

Table 2.4 Financial and growth indicators, by region and for innovators and non-innovators

	East Midlands	North East	Innov-ators	Non-inn-ovators
				median averages
Turnover (£m.)	0.50	0.79	1.0	0.36
Sales/employee (£ 000)	24.6	20.8	25.0	18.4
				column percentages
Profits increasing	56	44	57	43
Work-force increasing	60	51	52	62

Note: For the turnover data in the first row in the table, missing values have been estimated using the relationship between number of employees and turnover. The sales per employee figures are based only on those firms which provided complete data for both.

The first row of figures in the table, relating to *sales turnover*, confirms the picture obtained from the previous analysis, which was expressed in terms of numbers of employees. The East Midlands firms were also smaller than those in the North-East in terms of sales turnover, and the innovative firms were larger than the non-innovators. The two kinds of comparison are different, however, because innovation could *lead to* higher sales as well as being a result of larger financial resources.

Comparison in terms of *sales per employee* gives, perhaps, a clearer indication of the performance of the firms. Indeed, sales per employee is generally considered to be a good measure of performance, although less satisfactory than value added per employee. Despite their smaller size, the East Midlands firms appeared to have somewhat higher sales per employee than those in the Northern sample. This could result

from the generally more favourable economic climate in the East Midlands, but could also reflect higher levels of innovation. As the table shows, innovative firms had higher sales per employee than non-innovators, so that there seems to be a positive effect on sales turnover from innovation quite apart from sheer size. But though these findings are plausible and consistent with others already discussed here, the wide range of variation in sales and in sales per employee renders them statistically non-significant[5]. They would need to be confirmed by further research.

We did not ask firms to tell us their profits in figures: instead, we asked them whether their profitability over a five-year period (1981-85) had increased, decreased, or remained the same. Profitability, as one would expect, was related to innovation, with higher proportions of the innovators experiencing a rising trend. Similarly, more of the East Midlands establishments reported increasing profitability than was the case in the North.

As before, to understand this finding one should take into account the two-way influence likely to flow between finances and innovation. Innovation should on average help to maintain and improve profits, otherwise firms would not do it. But innovation may also depend upon finances - both sales turnover, providing a cash flow for current development work, and retained profits, to finance new projects.

We asked firms how they financed product development, and this topic will be discussed more fully in Chapter 5. For the moment, the essential point is that internal funds were the most important source. This reinforces the general argument just advanced about innovation feeding upon financial success.

The final row of Table 2.4 concerns growth in terms of the total size of the work-force, and gives a different picture from a purely financial view of performance. The majority of firms in the sample had increased their work-force over the period of 1981-85, which presumably reflects the general economic recovery from the recession which prevailed at the start of the period. However, those firms which had innovated were if anything *less likely* than non-innovators to have increased the size of their work-force. This ability to restrict the size of the work-force while increasing profits would be consistent with the higher sales per employee for the innovators.

This finding does not in itself show that innovation tends to reduce or retard employment *in total*. Innovators may be more likely than non-innovators to create employment indirectly, both by buying in more materials and services, and by generating more income for consumption or re-investment. It does seem important to appreciate, nevertheless, that innovation does not necessarily lead to any internal expansion of jobs in these small firms. The implications of innovation for firms' requirements for skilled and qualified workers will be considered separately in Chapter 4.

Why some firms had no new products

On average, it seems, the innovators do better financially than the non-innovators. Is a lack of new products, then, an indication either of lack of enterprise or of financial weakness which shackles development? Not necessarily.

Those without any new products during 1983-85 were directly asked to state the main reasons for this lack. The reason most frequently given was 'making to the customer's order', and another frequently given explanation was that customer industries demanded standard products. In other words, so far as these small firms were concerned, their market was not one which required new or modified products. A lack of innovation arose from giving the customers what they wanted.

However, other non-innovating firms (a much smaller number) stated that they had been unable to find suitable new products, with a proven or reliable level of demand. In these cases, some search for new products was implied, but it had failed. Alternatively, one can interpret these cases in terms of an unwillingness to bear risk.

Only one firm out of 42 non-innovators stated that inability to obtain development capital was the reason for lack of new products. The reasons given, therefore, point to customer markets and customer relationships as the key to product innovation or non-innovation, rather than access to finance. Market relationships will be the theme of Chapter 5.

The German comparison

We now have a first outline sketch of product innovation in the two British regions. Some obvious questions come to mind. Does

innovation always proceed in a similar way? What weight should be placed on the various measures of innovation, which to some extent provide different pictures of regional differences? These are not easy questions to answer. But with the aid of the evidence from the linked study in the Federal German Republic (FGR), we can at least make a first, provisional attempt.

Compared with the British sample, product innovation in the German sample seemed at first sight higher. In the same two-year period in which 57 per cent of the British sample reported new products, 85 per cent of the German sample did so. Against this, the limitations and especially the different size ranges of the two samples (see Chapter 1) have to be borne in mind. If attention is confined to the British firms with 50 or more employees, then the proportion with some innovation is 74 per cent, considerably closer to the German figure. The more basic difference between the two samples is that there were some British firms which were not looking to develop new products, because they saw no market for them. This was not the case in the FGR. Those German companies which had not brought a new product to the market during 1983-85 were, in all cases, trying to do so, but had not achieved their goal. (More than 80 per cent had new products partially developed, but not successfully completed as yet.) In a real sense, product innovation was universal in the German sample.

It is difficult to judge whether the German innovations were of a higher standard than the British or represented a more intensive commitment. But the indications coming from the survey do not reveal any marked differences in this respect. About one in five of German innovators were going for completely new products, similar to the proportion found among the British innovators. The remaining German firms were about equally divided between those making modifications of detail to existing products, and those making substantial improvements in their functioning.

In the British sample, as we have seen, 22 per cent overall, but one-third in the East Midlands, had innovated with microelectronic components. For the German sample, the overall proportion was one-third, while in the case of the Baden-Wurttemburg (BW) region, it was in excess of one half. In overall terms, therefore, the German firms were ahead of the British in their use of microelectronics. Against this,

it has to be remembered once again that the British sample covered smaller firms than did the German sample. If the comparison is confined to firms which innovated, then the difference in levels of use of microelectronics more or less disappears. British innovators and German innovators (which means nearly all the German firms) had about the same inclination to use microelectronics. Moreover, the use of microelectronics among innovative firms in the East Midlands was about level with that of the firms in the BW region.

Just as microelectronics separates the East Midlands from the North in a particularly clear way in Britain, so, in the FGR, it separates the more southerly BW region from Nordrhein-Westfalia (NW). To give more reliability to such a comparison within the relatively small sample of German firms, each innovator there was asked to estimate the proportion of new products in which electronic components were applied. The average for this indicator in the NW region was 14 per cent; in the BW region it was no less than 49 per cent.

Conclusions

At the beginning of the Introduction we pointed out that small firms have attracted increasing attention as important sources of product innovation. Among our samples of small or small-to-medium sized firms, product innovation was extremely common, even though we were covering only the mechanical engineering or machine building industry and not the 'high-tech' areas of electronics or instrumentation. In the Federal German Republic, virtually all the firms were engaged in innovation: it was a day-to-day activity. In the British sample, the proportion was lower but this was substantially accounted for by differences in average size; and even among British firms with less than 20 employees, there were many with a high commitment to product innovation.

Following on from this, we have also shown that much of the product innovation was 'in depth', involving improved functions, completely new departures, patenting, or the use of microelectronics within the design. Although some of the innovation consists only of minor details, this by no means applies to the majority of the innovations revealed by the study.

In this Chapter we have begun to explore regional differences in product innovation. And we have immediately shown that, at least so far as the particular regions selected were concerned, the differences were not of a gross kind. Innovations were widespread among small firms even in the economically depressed regions of the North-East or of Bochum/Dortmund. Yet differences of important *qualitative* types did exist. In Britain, every comparison of a qualitative kind showed that the small firms in the East Midlands were innovating at a *higher intensity* than the firms of the North-East. And in the Federal German Republic, the qualitative difference was particularly clearly brought out by the relative use of microelectronics components.

These findings set much of the agenda for subsequent chapters. Clearly, we cannot be content with a programme limited to contrasting innovators and non-innovators. In the German sample, there would be few indeed in the latter group; and in both countries, the interesting distinctions only become apparent when one looks into the *type* and *quality* of innovation. Our aim must be, not only to clarify the conditions for innovation, but also to understand what leads to innovation of differing intensity and effectiveness.