Paper for Design Studies (revised version)

The Commercial Impacts of Investment in Design

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A survey of 221 small and medium-sized UK manufacturers which received a government subsidy to employ a professional design consultant to help develop new or improved products or graphics showed that 60% of all projects and 90% of the implemented ones were commercially successful. Other benefits included firms' gaining design management skills and some impact on the UK's trade balance. However, there is still a long way to go before industry makes full use of Britain's design expertise.

Keywords: design, product development, government, investment, small firms

1 DESIGN AND COMPETITIVENESS

In 1983 Britain became a net importer of manufactured goods for the first time since the Industrial Revolution. By 1989 the UK's trade deficit in manufactures reached a peak of £17.2 billion, nearly half of which was due to the deficit in cars, textiles, clothing and consumer electronics - all products with a high technical and/or design content[1,2]. This poor competitive performance of British manufacturing industry has been studied and discussed for over three decades. For much of this time attention has been focused on the issues of productivity, prices, exchange rates, etc. in determining economic performance. Over the past decade, however, there has been an understanding of the growing role of 'non-price factors', such as product quality, prompt delivery, marketing effort and, increasingly, environmental impact, both in the international competitiveness of nations and the business performance of companies. As we showed in our report, *Design and the Economy* [3], one of the most important non-price factors in

competition and business performance is how well a company's products are designed.

The term 'design' is often misunderstood because it includes disciplines ranging from engineering, product and industrial design to fashion, textiles, graphics, interiors, exhibitions and architecture. What is common to all these types of design is that they involve the creation of concepts, plans and instructions, usually in response to a brief provided by a firm or client, that enable a two- or three-dimensional object to be made. The design of the object is the specific configuration of elements, materials and components that give it its particular attributes of function, shape, etc., and determine how it is to be made and used.

Design decisions therefore affect not just non-price factors, such as a product's performance, reliability, appearance, safety, ease of use, etc., but they also affect price factors , through their influence on how economic the product is to manufacture and its life-cycle cost to the user[4].

In Britain there has been official recognition of the economic importance of design since the last century and certainly since the establishment, in 1944, of the Council of Industrial Design, which in 1970 became the Design Council. However, over the past decade there has been significantly increased UK Government interest in the role of design in helping to arrest the declining competitiveness of British manufacturing industry. Following a seminar on 'Product Design and Market Success' in January 1982 - chaired by the then Prime Minister, Margaret Thatcher - there have been several Government initiatives to promote management awareness of the benefits of good design and to support design investment in British industry. The most important of these initiatives was the Department of Trade and Industry's *Funded Consultancy Scheme/Support for Design* programme administered by the Design Council.

This programme derives from the fact that the UK has perhaps the strongest design consultancy industry in the world[5], yet UK industry, and especially smaller firms, is not making proper use of this national resource. The Funded Consultancy Scheme (FCS) therefore provided funds to enable small and medium-sized manufacturing firms to engage a professional design consultant for a limited period at zero cost or at a subsidized rate to help with the development of new or improved products, components, packaging, product graphics or technical literature. Support for Design (SFD), which succeeded the FCS, extended the scheme to the service sector with a reduced

level of individual subsidy. The programme began in July 1982 and by April 1987 had involved nearly 5000 projects and £22.5 million of Government funding before being incorporated in 1988 into the DTI's wider *Enterprise Initiative* [6]. Under the 'Design Initiative' support for graphic design projects was later withdrawn.

2 THE COMMERCIAL IMPACTS OF DESIGN STUDY

It is in this context that a team from the Design Innovation Group at the Open University and the University of Manchester Institute of Science and Technology (UMIST) conducted a three-year study of the benefits, costs and risks of investments in professional design expertise in small and medium-sized manufacturing firms in the UK. This study of the 'Commercial Impacts of Design' arose from previous work undertaken by the group[4,7] and that of others[8,9] together with an invitation from the Economic & Social Research Council and the Design Council to bid for funds to undertake research on how non-price factors, especially design, affect the international competitiveness of British industry.

This study surveyed a sample of firms that took part in the FCS and SFD programme with the aim of obtaining information on the commercial returns on investments in a variety of projects involving professional design expertise at the individual product level. One probable reason for scepticism in British industry about the value of design is that, prior to our work, there was no information available on the benefits, costs and risks of specific investments in design and product development at the product or project level. Such information is needed if industrial managers are to assess the commercial value of design and decide how much to invest in research, design and development relative to other demands on funds. It is also needed by bodies such as the Design Council and the Department of Trade and Industry (DTI) who wish to promote the effective use of design in British industry.

This paper summarises the main findings of this research. A full report of the aims, methodology and results of the study is available from the Design Innovation Group[10].

3 THE SURVEY SAMPLE

The sample is drawn mainly from the companies that took part in the FCS plus some from SFD. In total, 221 projects were surveyed either by face-to-face interview or via a postal/telephone survey. Since the study aimed to provide general information on the commercial impacts of design in manufacturing, the sample was designed to be representative of small and medium-sized firms across *all* UK manufacturing sectors rather than of firms participating in the FCS/SFD programme. As the FCS was restricted to firms with 30-1000 employees and the SFD to firms with 1-500 employees, the majority (60%) of the firms in the study are small, employing under 100 people, a third are medium-sized, with 100-500 employees, and only 4% employed more than 500 people (Table 1). A further study would therefore be needed to assess the commercial impacts of design in large firms.

Table 1 Size of firms in the sample[10]

FIRM SIZE (number employees)	NUMBER IN SAMPLE	PROPORTION OF SAMPLE (%)
< 20	43	21
20 - 99	82	39
100 - 499	76	36
500 +	8	4

Sample: 209 firms (12 'no answers' excluded)

Who does design and development?

Prior to their subsidized project, in over half the firms (55%), design and development was undertaken by full-time, in-house research, design and development (RD&D) staff, either alone or with some external assistance. In a third of firms (32%), design was carried out by managers or other individuals whose main job was not RD&D and who often had no technical or design qualifications, either alone or with external assistance (what Gorb and Dumas term 'silent design'[11]). In 10% design was done externally by consultants, sub-contractors or customers and 5% had no prior design experience at all. However, the pattern varied with the type of design work - most engineering design projects tended to be undertaken by in-house RD&D staff, while graphic design projects usually involved 'silent design' by managers and/or external inputs from consultants, suppliers, etc. Product design projects tended to involve a mixture of in-house RD&D, 'silent design' and external

inputs. Comparison of this data with that from other surveys[e.g 12] indicates that the firms in our sample may be considered as typical of small and medium-sized UK manufacturers in their use of design/development staff. The results of this study should therefore be generally applicable.

For most firms, the FCS/SFD project was the first time they had employed a professional design consultant. Over two-thirds (68%) of firms had not previously employed a design consultant in any capacity whatsoever. In addition, other firms were employing a design consultant in a new discipline for the first time (for example several companies experienced in employing engineering design consultants used the scheme to employ an industrial designer). The experiences and results from this survey therefore very much represent firms in the early stages of the learning curve in using and managing external professional design expertise.

Types of projects

Each project was classified in terms of the inputs of design expertise involved and the type of design output that resulted (see Figure 1). On the *input* side most projects involved work by in-house RD&D and other staff as well as by the subsidized design consultants. Nearly half (47%) of the projects mainly involved inputs of various *product design* skills (e.g. textile and furniture design); 29% mainly involved either *engineering design* (e.g. electrical, mechanical) or combined *engineering and industrial design* work (e.g. electronics plus ergonomics); the remaining 24% mainly involved *graphic design* skills. It is this classification by design input that is mainly used in the analysis of results given in this paper.

On the *output* side, three-quarters of the projects involved the development of new (49%) or redesigned (27%) *products*, ranging from wind turbines, lasers and electronic components to kitchenware and shoes. About a quarter (22%) were *packaging and graphics* projects, ranging from food packaging to the design of technical manuals. The remaining 2% were feasibility studies and projects which produced a range of concepts rather than a specific design.

Figure 1 Inputs of design expertise to and outputs from the subsidised projects sampled[10]

Project costs

Information was gathered, for as many projects as possible, on the costs of the design work (including any technical and market research) and of all the subsequent costs of developing that design and launching it onto the market. The mean total investment, including all research, design, development, plant, tooling, marketing and other costs, for projects that went into production, was £60,500. For non-implemented projects the figure was £8,300. In both cases, this includes the FCS/SFD subsidy which averaged about £4,500[6]. Clearly these were not projects with huge budgets, but typical of ordinary product development and other design work in small and medium sized firms.

On average the engineering/engineering & industrial design projects cost nearly double the graphics ones, with product design projects in-between. This is not surprising, as the more technical a project becomes, usually the more investment is required to assess its feasibility and put it into production. With the FCS/SFD contribution being between £2,000 and £5,000, non-implemented product and graphics projects lost little more than the Government subsidy. For engineering projects, firms usually had to put in more of their own resources before deciding whether to proceed to production.

4 PROJECT OUTCOMES

The outcomes of the projects were analysed at several levels - (a) *implemention* (i.e was the new or improved design put into production), (b) *financial returns* on the total investment, and (c) *indirect benefits*. Outcomes therefore ranged from complete successes, through various types of partial success and failure, to bad failures

Overall, Table 2 shows that half of the projects could be considered completely successful - they were commercially successful and also produced indirect benefits, such as the firm's managers learning how to use designers more effectively. A small proportion (10%) of projects were partially successful - they were successful commercially but produced no spinoff benefits. A further 21% might be considered as part successes and part failures - they were projects which made a loss yet produced worthwhile indirect benefits. A fifth of the projects, however, were definitely failures - they both made a financial loss and produced no indirect benefits.

Table 2 Classification of successful and failed projects in the sample[10]

	With indirect benefits	Without indirect benefits
Project commercially successful	COMPLETE SUCCESS 50%	PARTIAL SUCCESS 10%
Project made a loss	PARTIAL SUCCESS/FAILURE 21%	FAILURE 19%

Sample: 178 projects with quantitative or qualitative data

Implementation

Two-thirds (65%) of the subsidized designs were implemented by being put into production and marketed . This is similar to the figure of 68% implemented projects from a parallel survey conducted by the Department of Trade and Industry (DTI)[6]. Like the DTI, we found a higher rate of implementation of graphics projects than product or engineering/engineering & industrial design ones (Table 3).

Table 3 Implementation of subsidized projects according to design input

DESIGN INPUT	IMPLEMENTED (%)	NOT IMPLEMENTED (%)
Product design	63	27
Engineering/Engineering & Industrial design	56	44
Graphic design	80	20
ALL PROJECTS	65	35

Sample: 221 projects

This statistically significant (chisquare $p<0.03$) difference in implementation rates is not surprising given that the FCS provided only 15-30 days subsidized consultancy (and the SFD considerably less). This was insufficient for most product/engineering projects, which usually required much additional design/development effort by the firm, but often enough to complete design work for a packaging/graphics project. In the Conclusions we return to the issue of the amount of subsidy available.

Financial returns

Other studies have surveyed firms participating in the FCS/SFD programme and the Design Initiative[6,12,13]. But this is the only research to have succeeded in producing data on the financial benefits, costs and risks of design and product development projects.

We obtained sufficient data on costs, sales and profit margins to calculate the payback or loss on 91 projects and partial or qualitative information for 90 others. If firms did not have, or were unwilling to release, financial data on their project, we used a number of qualitative indicators to assess its commercial success.

Overall, of the projects for which we had quantitative or qualitative data, 60% could be considered 'commercially successful' while 40% made a loss (see Table 2). Considering the different inputs of design expertise, fewer graphics projects (18%) were loss-making than product design or engineering/engineering & industrial design ones (43% and 57% respectively) and this difference was highly significant statistically (chisquare $p<0.001$) . However, it should be noted that most of the loss-making projects were not implemented, usually involving little more than the loss of the FCS/SFD subsidy. For the 120 *implemented* projects for which we had quantitative or qualitative data 89% were commercially successful and only 11% loss-making.

The subsample for which we had full quantitative financial data was analysed in more detail. In particular we calculated the time it would take from the market launch of the new or redesigned product for profits from sales to recover the total investment (the payback period). This is the measure we found to be most widely used and understood by the type of firms we were dealing with. Some key results from this analysis are shown in Figures 2 to 4.

Figure 2 Profitable and loss-making projects according to design input - <u>all</u> projects[10]

Figure 3 Profitable and loss-making projects according to design input - <u>implemented</u> projects[10]

Figure 4 Payback periods on profitable, implemented projects according to design input

This subsample slightly over-represents the proportion of commercially successful projects due to different response rates for the financial data in the face-to-face and the postal parts of the survey. The difference involved is not very large, although it needs to be noted.

Figure 2 confirms the finding mentioned above that graphic design projects are significantly more likely to be profitable (chisquare $p<0.03$) than projects involving product design expertise or projects involving engineering or engineering plus industrial design. However, as is shown in Figure 3, once the projects are put into production, the likelihood of product or engineering projects being profitable is almost as great as that for graphics projects. Indeed, the difference in risk is not statistically significant (Fisher $p=0.33$). The main difference, as Figure 4 shows, is in the payback period, with graphics projects on average paying back somewhat faster than product or engineering projects.

Overall, in the quantitative sample, 69% of all the projects and 94% of those that were implemented paid back their total investment (i.e were profitable) with a mean payback period of 14.5 months (see Figures 2 - 4).

These figures indicate a very good case for investing in design projects. Graphics design projects appear to involve little technical uncertainty or financial risk. Although there is a relatively high risk of failure at the start of a product or engineering project, because most of the failed projects involved exploring ideas that were abandoned before being put into production, the financial loss (except for engineering projects requiring expensive feasibility studies) is likely to be quite small. And once a project has been implemented, the prospect of a rapid return on the investment becomes very good and the risk of financial loss small for *all* types of design.

International Trade

Investment in design is clearly worthwhile for the individual firm, but underlying government support for design is the desire to improve Britains

trade performance. The impact of these projects on international competitiveness is therefore of particular interest.

Of the firms for which export information was obtained, 70% reported exporting their FCS/SFD product or design, the average amount exported being £151,000/year, representing a fifth (19%) of total sales. This is encouragingly high. More detailed analysis provides some further interesting results[14]. Implemented engineering/engineering & industrial design projects on average produced much higher export ratios (41% of annual sales) than product design (10% of annual sales) and graphics projects (7% of annual sales). The probable reason for this pattern of export performance is that engineering projects were for capital goods for both home and export, product design projects tended to be for consumer goods aimed mainly at the UK market, while most packaging projects were food and drink products also for the home market.

One of the main benefits of the subsidized projects was that they enabled firms to enter new markets. Over a quarter (28%) of all projects resulted in firms entering a new market with their new or improved designs. For implemented projects, 15% of projects led to new export markets and another 1% of projects produced increased exports of products that before being redesigned were already selling overseas (Table 4).

Entering an export market is only one of several international trade impacts. Import substitution, where domestic sales were captured from foreign competitors, was a major factor in 21% of the implemented projects (Table 4). One example was the development of a combination bicycle lock (Figure 5) by an established UK lock manufacturer. The firm was convinced that a high-quality combination lock would find a market even though its price would be higher than Far-East imports. In the first year of production they sold nearly 50,000 locks in a British market that previously had been supplied entirely by imported products.

Figure 5 This combination bicycle lock designed with help from the FCS has sold well in a market formerly supplied almost entirely by imports

Another area of international trade impact is where a new or improved product enabled the firm to hold its own against foreign competition in a sector of the home market already dominated by imports. This category involved 25% of implemented projects (Table 4). An example was a project to improve the engineering and industrial design of a shoe repairing

machine. The company exported a third of its output, but in Britain the company's Managing Director noted that: 'the project maintained the company's position in a market where there is intense international competition'.

Overall, nearly two-thirds (62%) of implemented projects, and half (49%) of *all* projects, had some international trade benefits. Most, however, were indirect, involving import substitution or reinforcing a market sector already experiencing high import penetration.

Table 4 Impacts of subsidized design projects on international trade

Project enabled firm to:	All projects (%) (n=91)	Implemented projects (%) (n=72)
Enter a new export market	12	15
Increase exports	1	1
Capture UK sales from foreign competitors	16	21
Maintain UK sales against high imports	20	25
No/unknown trade impact	51	38
Total	100	100

Other factors influencing project outcomes

Of course the objection might be made that the financial and trade effects outlined above are not necessarily due to better design, since many other factors might have been involved. To check this firms were asked to rate the relative influence of design and other factors which might have affected the commercial outcome of the project. In only 15% of projects were factors other than design considered to be the main influence on commercial outcomes. These other factors were mainly marketing effort, pricing, technical quality, and market changes. So while one cannot attribute all the benefits to better design and development work alone, it is probable that design played the major part in most of the projects studied.

Indirect benefits and impacts

For many firms the indirect impacts of undertaking a project involving a professional design consultant were as important as the direct financial ones. Our analysis revealed a variety of learning effects, spinoff benefits, and changes in attitudes towards design.

Attitudes towards design

A third (33%) of firms said that their attitudes to design had improved as a result of the projects, including cases where the project had not been implemented. Of these 20% became generally aware of the commercial importance of professional design. In 6% of cases manufacturers of engineering or other products became aware of the contribution that industrial design could make to their commercial success. For example, the chairman of a firm that used an industrial design consultancy to help redesign its crash helmets (Figure 6) previously felt that design was `a waste of money'. Now he admits `the whole management team is aware of the contribution of visual design and packaging to sales'). A further 8% of projects made the firm aware of new design possibilities and the importance of external design ideas - even a firm whose main business was product design commented `we remain confident of our ability to evolve new designs, but are now aware of how powerful an effect objective scrutiny from a professional design consultant can have'.

Figure 6 Motorcycle crash helmet redesigned with help from the FCS to compete with imported Italian helmets. The new design is on the right.

Employment of designers

Perhaps more important than changed attitudes are changes in the resources devoted to design. The results are encouraging. As noted earlier only about half (55%) of the firms employed in-house RD&D staff prior to the FCS project and two-thirds (68%) had no previous experience of using design consultants. Following the subsidized projects nearly half (47%) of all firms increased their use of professional design. 19% use design consultants more; another 20% either introduced in-house designers for the first time or increased their in-house design capacity and 8% increased use of both in-house and consultant designers. The effect was that by the time of the interview nearly two-thirds of firms had in-house RD&D staff compared to about half before their FCS/SFD project. In addition there was greater

reliance on design consultants relative to other external sources such as suppliers and customers, plus an increased use of teamwork, for design/development work. A surprising result - meriting further investigation - was that few (8%) of firms decided to use the FCS/SFD consultant again for subsequent projects.

Managing design

Another important indirect benefit was that the projects helped firms to learn how to use professional design consultants. Three-quarters (75%) of firms reported learning one or more design management lessons. Of these 15% learned the importance of choosing an appropriate consultant; 33% the importance of a clear and detailed brief (`results are only as good as the brief you give a consultant' was a typical comment); 10% the importance of regular contact with the consultant during the project; and 16% learned other lessons such as ensuring that consultants are aware of manufacturing constraints.

A variety of other indirect benefits resulted from the projects. Among those mentioned were that the project provided the ideas or technical basis for other products or designs (23%); led to changes in the management of product development (9%); improved the company's external image and credibility (8%); taught in-house staff useful design skills (8%); and improved confidence within the company (4%). Some firms benefitted in several ways. As the MD of a manufacturer of swimming aids said, `The funding started a whole chain of developments in the company. Four products and their packaging have been designed since FCS plus a new logo. The project gave us impetus and confidence to move ahead.'

Examples of successful projects

Below are examples of successful projects representing the four main categories of design input. All four projects were financially successful as well as generating indirect benefits for the firms concerned.

PRODUCT DESIGN. Company A, a small ceramic giftware manufacturer, used the FCS to employ a professional designer to redesign the shapes and surface patterns of its range of ceramic kitchenware which originally had been designed mainly by the firm's Sales Director. The total project cost was £14,000 and in the first year sales of the redesigned range reached £280,000 compared to maximum sales of £188,000 achieved by the old range.

Although there were no savings in production costs or increased profit margins, payback on the project was just two months and the Managing Director believes that, without the FCS subsidy enabling them to produce the new range, the firm may not have survived in the highly competitive ceramics market.

ENGINEERING DESIGN. Company B makes wire fencing and its Managing Director had the idea of providing customers with a wire joining device in order to give the company's products a competitive edge. The SFD project was used to employ engineering design consultants to explore possibilities for joining devices, including a prototype device already developed by the firm, that could be made for about 5p. The SFD work only got the project started and considerable design and development was required before a practical product emerged. The 'Gripple' is a simple but ingenious device that grips wires using spring-loaded ball bearings - and in later versions toothed rollers - set in a die-cast zinc alloy tube (Figure 7).

The company invested over £200,000 in developing and introducing the Gripple and a further £400,000, with help from several further grants, in getting it into mass production. The company also developed a special tool, the 'Grippler', again with help from design consultants, to tension wires joined by Gripples.

Figure 7 The 'Gripple' wire joining device

As well as adding value to the firm's fencing, the Gripple System has become a successful product in its own right, e.g for joining wires in vineyards. By 1990 some 3.5 million Gripples were sold in over thirty countries and the company began to make money on its initial investment. In 1991 the Gripple won the Prince of Wales Award for Innovation.

ENGINEERING AND INDUSTRIAL DESIGN. Company C is a major supplier of equipment used in professional sound recording studios. The FCS project involved the redesign of the existing desk and cladding of a sound mixing console with the aims of updating the appearance of the product to increase sales and of reducing costs to improve profits. The design consultant redesigned the desk and cladding replacing the old wood and steel structure by large plastics mouldings (Figure 8). The total cost of the project was £44,500, mainly in tooling.

Following the redesign, plus an electronics enhancement, sales of the product more than doubled from £1.4m to £3.4m, profit margin increased by 2% and

the company's already high world market share increased by 7%. Payback on the investment works out at under two months. There were also savings in stockholding costs as well as important indirect benefits perceived by the company such as improved customer confidence in their products. Another sound mixer in the range was later redesigned along similar lines.

Figure 8 Sound mixing console following redesign

GRAPHIC DESIGN**.** Company D produced a range of canned foods which had no identifiable packaging style. Retailers would therefore buy individual products rather than stocking the whole range. A design consultant was employed through the FCS to redesign the packaging in order to increase the firm's market share. The company's decision to invest in design came just in time since their main customers, large supermarkets, were no longer buying from smaller suppliers unless they could offer a range of strong brands. The redesigned packaging, involving an investment of £43,000, created this clear brand identity and resulted in an increase in annual sales from £12.7m to £13.9m. Although this 10% sales increase is relatively modest, payback was achieved in 6 months, and without the new packaging the firm considered that sales would have declined sharply. Following this project the company has significantly increased its use of in-house and consultant graphic designers and now view design as crucial to business growth.

5 WHY SOME PROJECTS FAIL

The main aim of the research was to assess the commercial outcomes of design projects. A secondary aim was to identify some of the the factors influencing those outcomes. We have analysed various factors which might have influenced the financial outcome, including firm size and its previous experience in using design consultants. Surprisingly none of these factors seem to have significantly affected whether a project was profitable or made a loss. What was more important was the overall management of the project and in particular avoiding the problems, such as those outlined below, which afflicted less successful projects.

Non-implemented projects

As mentioned earlier a third of projects (34%) were not implemented while a further 6% were implemented and made a loss. However, over half of this 40% of loss-making projects were only partial failures in that they produced indirect benefits.

We analysed non-implementation - the main cause of financial loss - against several variables including firm size, prior experience of using design consultants and reasons for applying to the FCS/SFD. Again no statistically significant differences were found, although fewer firms with over 500 employees failed to implement their projects than the smaller firms, probably due to better access to finance. What is important in analysing non-implementation are the particular circumstances which affected each project (see the examples of partially successful and failed projects below).

Firms gave one or more reasons for non-implementation. The most common were commercial and/or technical. Non-implementation in 16% of cases was due to changing market circumstances (e.g a competitor launched a better design). In a quarter (27%) of non-implemented cases the project was not considered commercially viable (e.g the design was considered too expensive for market acceptance) and in another 27% there were technical difficulties in development (e.g the designer was unable to meet the specification). Not surprisingly, technical problems and questions of commercial viability affected engineering and product design projects more than graphics projects. More worrying was the fact that 14% of firms simply could not afford to implement the design, even though judged to be commercially viable. This particularly affected product design projects - for example a luggage manufacturer could not afford to implement designs for a new range even though the firm's management believed that a new range was `desperately needed' to compete with French and US rivals. For these firms subsidizing design was not sufficient, further help was needed for the development and implementation of new products.

Managing design consultants

The above figures only partly reflect another important reason for non-implementation, namely problems experienced by the firms in managing design consultants. We have published another paper on this issue[15] which showed two problem areas. First, nearly a quarter (22%) of non-implemented projects were due to dissatisfaction with the consultant's

proposals (`I get the designer's sketchbook out when I want a laugh' said one manager). Sometimes this was due to inadequate technical skills on the part of the consultant, but often it was linked to the other problem area - namely deficiencies in the way in which the consultant was selected, briefed or managed. Some deficiencies usually delayed rather than prevented implementation, showing how vital it is for firms to persist with a design project if it is to succeed. But inadequate briefing of thedesign consultant (e.g when the firm omitted key design parameters), poor design work by the consultant (in some cases due to the project being passed on to an inexperienced junior designer) and disagreements among management about the value of the project almost inevitably led to project failure (see the examples below). Nevertheless, only 10% of firms experienced major consultant problems, which is encouraging given that most firms had not used design consultants before and a quarter had strong doubts about using them. These major problems occurred mainly in firms with under 50 employees, indicating that while small firms are most likely to lack specialist design expertise, they are most in need of advice to use external resources effectively.

Examples of partially successful and failed projects

Below are some examples of projects displaying various degrees of partial success, partial or complete failure caused by one or more of the factors mentioned in the section above.

PRODUCT DESIGN. This manufacturer had developed shatterproof laminated mirror panelling for the commercial sector and wanted to break into the retail market. A famous firm of design consultants was briefed, but the work was passed to a junior designer who was not present at the briefing. She treated the project as one of purely aesthetic design and ignored the innovative technical characteristics of the product. The firm considered the work as 'very expensive and unprofessional' and did not implement the design ideas. However, as a result of this experience the firm has learned how to manage design consultants and have set up their own design team.

ENGINEERING DESIGN. (a) A supplier of motor vehicle components produced manual car seat adjusters and wanted to develop a powered adjustment mechanism. The design produced by the consultant, a powered version of the manual system, was insufficiently robust because the brief failed to mention that powered seat mechanisms have to operate under load whereas manual ones do not. Developing robust new gearing for both powered and manual adjusters took the firm's in-house designers a further two years.

(b) A general engineering company used the FCS to update the design and to reduce manufacturing costs of its range of crane bucket grabs. The consultant's recommendations were not implemented because of management changes and a decision by the company to run down its design and development department.

ENGINEERING AND INDUSTRIAL DESIGN. The company makes radio remote control units for industrial cranes and the FCS project involved the redesign of the casing and controls of a controller that was difficult to use and expensive to manufacture. The consultant industrial designer designed a vacuum formed plastic casing and introduced joystick controls. Although the new design halved the production cost, the casing was inadequate and the firm had to glue extra bits of plastic into it in order to make it strong enough to sell. The cost savings from the total sales of the redesigned unit did not even cover the investment in tooling. However, the company's managers did not view the outcome as entirely the consultant's fault as, in retrospect, they realised that they had placed too much emphasis on cost saving in the brief and that more resources should have been committed to the project at the beginning. The inadequate design produced by the consultant also stimulated the firm's in-house engineers to redesign the controller again with very satisfactory results.

GRAPHIC DESIGN. (a) This company had produced a telephone message book for in-house use and wanted help to develop a commercial range of message books. According to the company the FCS-subsidised graphic designer was determined to be 'original and creative and completely ignored the brief'. The uniform black-bound books he designed were felt not to suit the market. The company's Managing Director, with the help of a printer, therefore designed a range of twenty message books himself which in their first year sold nearly a quarter million copies.

(b) A Scottish food maufacturer used the FCS to design the packaging for a chilled food product. Although the consultant designer's work was excellent

the company could not afford to implement the design because of a financial crisis. However, when the company's fortunes improved its managers recognised the importance of packaging design and used the same consultant to design the packaging for a new range of frozen foods. The new range, which included batter-covered haggis, has been very successful.

6 CONCLUSIONS

This study shows that the Government's programmes of subsidized design consultants have encouraged a proportion of small and medium-sized UK manufacturers to make use of professional design, many of whom would not have done so without help. Although before the subsidized design project over half of the firms employed full-time, qualified in-house RD&D staff, in nearly a third design/development was undertaken mainly by individuals with main jobs other than RD&D, and in most cases this was the first time the firms had used a design consultant or drawn on specialist expertise in areas such as industrial design.

The study shows that, even in typical small and medium-sized firms such as these, the development of new and improved products, components, packaging, etc. using professional design expertise can be an excellent commercial investment. Two-thirds of the projects were implemented and 60% were commercially successful. Over 90% of a subsample of implemented projects for which we had detailed financial data were profitable with payback periods averaging under fifteen months and almost all recovered the total project investment in under three years. The risk of financial loss at the start of the product/engineering/industrial design projects was significantly higher than for projects involving graphic design. But once the product or design had been put into production the risk of loss was low for all types of design project.

This evidence on risks and returns should encourage UK firms and financial institutions to overcome their traditional reluctance to invest in design and product development.

Another important commercial benefit was that the projects enabled 28% of all firms to enter a new market and a further 30% to increase their market share. In terms of international trade the main benefit was import substitution. Nevertheless, 16% of implemented projects led to new or increased exports and a fifth of all sales of FCS/SFD products were exported.

Grossed up for the whole FCS/SFD programme this represents some £500m worth of exports over six years, for a government investment of £22.5m.

A majority (70%) of the FCS/SFD projects produced indirect benefits for the firms which participated. The experience of undertaking a project involving a professional design consultant not only improved understanding of and attitudes towards design in many firms, it encouraged nearly half to employ consultant designers for subsequent projects at their own expense and/or to increase their in-house design staff. Thus by the time of our survey nearly two-thirds of firms had full-time RD&D staff compared with just over a half before the subsidized projects. Other important indirect benefits included helping firms to learn key design management skills, especially how to select, brief and manage professional designers. In many cases the indirect impacts are of greater long-term importance than the short-term financial returns. As a loudspeaker manufacturer observed `the project helped open the door to using design. Our experience was going through the learning curve rather than direct benefit'.

The study, however, shows that nearly a fifth of the design projects studied were failures, neither being implemented nor producing indirect benefits. Poor design work by the consultants, often linked to problems in managing the design consultants, in particular inadequate briefing and internal disagreements within the firm about the project, were important factors associated with such `failed' projects. Although they suffered more from difficulties in managing consultants, small firms were no less likely to produce profitable projects than medium-sized and larger ones. Given the small amount of subsidy involved, successful projects (especially in product and engineering design - e.g the Gripple) depended as much on the willingness of the firm to persevere and invest its own resources as on the skills of the design consultants. Indeed one of the few criticisms of the FCS/SFD programme was that the level of support was too low, especially for engineering design, and that differential subsidies should be available.

There were inevitably some projects which failed despite highly satisfactory design work. A few projects foundered for lack of finance, but other projects failed mainly due to factors such as the strength of the competition, market resistance and changes of ownership. While this reinforces previous research[4,7] which showed that `good design' alone is not enough for commercial success, the main contribution of this study has been to demonstrate how important investment in professional design can be.

However, the wider economic and trade benefits can only be realised if a significant proportion of UK firms increase their investment in design and product development in the long term. Investment in design and development was one of first things to suffer in the recession of the early 1990s. Lack of awareness of the potential commercial returns among small and medium-sized British firms seems to be a major barrier to this investment. Another is the fact that most firms surveyed viewed their projects as a once-off investment rather than as a way of incorporating design into their long term strategy. This is one reason why the DTI's `Enterprise Initiative' provides subsidies to enable small and medium-sized firms to employ consultants to provide expert help not only with Design but with the whole range of business activities, including Business Planning and Marketing[13].

Unfortunately, such programmes only reach a small proportion of UK manufacturers which could benefit and the subsidies are low compared to those offered through similar schemes in other countries. In its 1991 report on manufacturing industry the House of Lords Select Committee on Science and Technology observed that 'DTI schemes such as...the Enterprise Initiative are worthwhile but are too small-scale to have appreciable impact'[16]. Finally , the fact that only very few of the projects subsidized under the Enterprise Initiative are in the field of Design shows that there are still large numbers of firms that need to be made aware that design can be as essential to their business as marketing and manufacturing. Clearly much more can be done to utilize Britain's undoubted design talent to relieve the growing trade deficit in manufactured products.

ACKNOWLEDGEMENTS

Most of the research reported in the paper was funded by the Economic and Social Research Council (Award WF20250021) as part of its Research Programme on the Competitiveness and Regeneration of British Industry and conducted by a joint team from the Open University and the University of Manchester Institute of Science and Technology. The authors would like to acknowledge the contribution to the work of other members of the Design Innovation Group, especially Claire H. Capon, who conducted much of the data analysis for the project, Margaret Bruce, Jenny Lewis and Vivien Walsh.

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