R&D Cooperation by Swedish Contractors

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Abstract: A survey of technical and administrative research and development (R&D) performed by Swedish contractors indicates that total R&D in 1989 reached 1.6% of total value added. Large firms in the industry show higher R&D intensities. Reasons for undertaking development work and preferred patterns of collaboration are ranked by eleven contractors in the survey. Increasing competitive power is the main reason given, regardless of firm size. Contractors also agree on the importance of owners as partners in development projects. Given this background, experiences from the first seven years of the joint employer and union Development Fund of the Swedish Construction Industry (SBUF) are reported. Data on all 264 finished projects, their applicants, participants, and themes are analyzed. Rising educational levels, structural change in the industry, and applications of advanced technology, including information technology, appear as long-term trends that affect the future of contractor R&D in Sweden.

Introduction

Porter (1990) mentions three commonly used arguments for cooperative research in industry: independent research by a number of firms is seen as wasteful and duplicative, access is gained by cooperation to economies of scale in research and development (R&D), and lack of appropriability of results will lead to underinvestment in R&D by the individual firm in the absence of cooperation. However, Porter goes on to interpret the Japanese experience as showing that there are two much stronger reasons for cooperating, which are not based directly on considerations of R&D efficiency. Instead, cooperative R&D signals the importance of emerging technical areas, and it stimulates proprietary firm research. Several conclusions can then be drawn from the case in Japan. Cooperative research should thus be in areas of more basic research, not close to the firms' proprietary sources of advantage. Only a modest portion of firms' overall research should be cooperative. Also, Porter recommends that cooperative research take place through separate and independent entities accessible to most firms in industry.

Since construction firms differ from manufacturing firms in many respects, we may expect that these recommendations are only partly applicable to construction R&D. Pavitt (1984) presented a useful classification of R&D conditions in various industries when analyzing 2,000 significant U.K. innovations since 1945. He distinguishes between firms that are supplier dominated, production intensive, and science based. Most contractors tend to fall into the first category, perhaps with some specialized activities sharing the characteristics of the second category, and only rarely approaching the science-based type of firm. Pavitt next points to how firms can be classified according to: (1) Sources of technology; (2) requirements of users; and (3)

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possibilities for appropriation. Among the examples given in his investigation, we find housing, in which suppliers are seen as technology sources, users are price sensitive, and recourse to nontechnical appropriation such as trademarks, marketing and design is necessary. The fundamental polarity of either the science-cum-technology push or the demand pull can be identified here, but it is also obvious that the broad range of products and services offered by contractors fall into more than one of the slots defined by Pavitt. Instead, a more complicated picture is typical in construction firms (Nam and Tatum 1989). In the Swedish case, it is unwise to generalize across all types of new housing production; it is even more dangerous to assume a single pattern across all kinds of contractor activities. Therefore, it is of considerable interest to look at actual patterns of R&D cooperation among contractors. In the present case, we confine the discussion to Sweden, although the results are believed to be of wider application.

Before looking closer at the major Swedish scheme for cooperation in construction R&D, a short explanation of the historical background, in particular government support over the years, is necessary. Results from a survey of contractor R&D efforts in 1989 serve to put cooperation in a broader Swedish perspective.

ORIGINS OF COORDINATED R&D

Cheap, mass-produced housing of a good quality has been a political priority in Sweden at least since World War II, when a government committee for building research was set up. Production of multiunit structures under industrialized conditions was encouraged both by using generous subsidies and by rationing of scarce resources. Housing output responded with a steady increase for many years (see Table 1), peaking in 1970. Beginning in the 1940s, a large number of development projects covering all aspects of housing production were launched. Several projects were concerned with more efficient site operations and were thus of immediate interest to contractors. The basic approach was that of importing methods, equipment, planning, and attitudes from heavy construction into housing. Research content in the site-oriented studies was usually limited, although a comparison of production methods and costs in the three largest Swedish cities was accepted as a doctoral thesis (Jacobsson 1955). The setting for these investigations soon evolved into an institutional form without ties to the technical universities; and in 1960, the National Swedish Institute for Building Research was created alongside the Council for Building Research, which was to coordinate and fund R&D projects.

During the 1960s, the technology of mass housing was rapidly leaving the

TABLE 1. New Multiunit Housing Completed, Annual Averages 1951–85

Period (1)	Units in structures with three units or more (2)
1951–55	38,455
1956–60	46,623
1961–65	54,661
1966–70	65,908
1971–75	52,419
1976–80	14,995
1981–85	18,077

precompetitive stage. In-house development by contractors was gradually seen as a superior solution, partly due to the insight that management, learning, and human relations were increasingly important as soon as the basic technical obstacles to industrialized production methods had been removed. Other features of the total package for government support of innovations in production (like subsidized loans for heavy site equipment) lost their efficiency with the first signs of market saturation in the 1960s. Earlier, they had been crucial for a growing construction equipment industry in Sweden, notably with products like climbing cranes for assembling concrete prefabricates and elevators for site use (Fredriksson and Lundmark 1980). Consequently, government funding of building research was less and less concerned with construction-site problems, being used for a broad spectrum of R&D activities instead, sometimes with only a tenuous relation to the original objectives.

Industry organizations tried to point out that further encouragement of improved and innovative housing would have to stress new types of market incentives to be of interest to contractors (*The New* 1969). The automobile industry and its methods of product development was held forth as a paradigm for the residential sector. Design and production should be integrated. There was a new emphasis on "productification" with identifiable brand names and marketing efforts, but also on the importance of serial production, homogenous product lines, and the need for stability in activity levels. However, demand for new multiunit housing was to decline (see Table 1), and mass production fell away.

In 1954, a special levy, a building research fee, was imposed by legislation on all building employers to finance government-coordinated building research. The levy base was expanded almost two decades later so as to include heavy construction, but in practice relatively small resources were devoted to projects directed at contractors and with active contractor participation. With the oil embargo in 1973 and the consequent rises in energy prices, the government mechanism for coordinated building research was to a great extent turned toward the issues of energy conservation and energy production in the built environment.

Within specialized research fields, contractors had participated in several initiatives over the years. This applies to cooperation with the mining industry in the Swedish Rock Engineering Research Foundation (Befo) and, to take another example, in a partnership with manufacturers in the Swedish Cement and Concrete Research Institute. Facilities for cooperative R&D were also provided within the Construction Industry's Organization for Working Environment Safety and Health (Bygghälsan, which was founded in 1967).

In 1981, the Swedish Riksdag decided to abolish the building research fee, mainly for reasons of administrative convenience. It was now felt among contractors that the time was ripe for an independent scheme for R&D cooperation, adding to what would now be tax-financed building research. This new industry scheme was intended to create a climate for development in member firms, encourage cooperation between contractors and also between contractors and firms from other industries, emphasize technology and production issues, not least in relation to the technical universities, and, finally, to strengthen the position of private enterprise in the construction sector. We return to the SBUF scheme later in this paper.

R&D BY CONTRACTORS

Despite attempts in the early 1980s by the Central Bureau of Statistics and the Royal Swedish Academy of Engineering Sciences (Swedish construction under international competition 1984) to measure the extent of R&D performed by construction firms, there has remained a lack of dependable data that can be compared with the manufacturing industry. Since there is a strong tendency not to isolate development from other activities in the construction industry, broad mail surveys to ascertain the level of efforts have proved to be inefficient. The response rate was discouragingly low in a recent attempt in Denmark (*R&D* 1990). This is not unexpected given the analysis by Kleinknecht (1987) of the strong downward bias in R&D statistics for small Dutch manufacturing firms. Simple questionnaires are usually responded to correctly only when there is a readily identifiable group of research staff and a separate budget for R&D activities in the firm. When the National Federation of Swedish Contractors initiated a pilot study of development activities among the firms in the industry, another approach involving a small number of firms and interviews was chosen (Bröchner et al. 1990).

Survey Design

The survey was intended to estimate the volume and character of development activities during 1989 within all Swedish building and heavy-construction contracting firms with 50 employees or more. For sampling purposes, firms were divided into medium size (with 50–499 employees) and large (with 500 or more employees). Only 11 firms were included in the sample: the four largest firms, two firms randomly selected from other large firms, and, finally, five medium-size firms chosen at random.

Managers responsible for research and development—which in small firms means the managing director—were subjected to intensive interviews in the sample firms. The response rate was 100%. Interviews were based on a structured questionnaire; R&D was defined in accordance with current OECD practice, although both technical and administrative R&D was included. It was found inappropriate to use a narrow technical focus, since contractors share characteristics of both services and goods production. As a consequence we expected—and this was ultimately confirmed by responses given—that construction firms spent more resources on process innovations than on product innovations.

The questionnaire included a 3 × 3 matrix. There were three rows that categorized employees according to level of formal education and three columns with process stages. The principle behind the matrix was that it would be easier for respondents to assess nine cell-specific R&D coefficients. Given the total number of man-years for each matrix cell, the total R&D effort of any firm can be estimated.

Volume of Activities

Table 2 shows that large firms are estimated to have spent about 380,000,000 Swedish Crowns (SEK) on research and development during 1989 (US$ 1.00 is close to SEK 6.00). The corresponding figure for medium-size firms is SEK 80,000,000; and if we assume that small firms with less than 50 employees have spent SEK 30,000,000, we obtain a total sum of SEK 490,000,000 for all Swedish contractors.

Due to the extensive practice of subcontracting in construction, any comparison with R&D figures for other industries should preferably be made on the basis of R&D intensities, defined as the relation between R&D expenditure and total value added by the firm. We find that there is an obvious correlation between firm size and R&D intensity for the firms

TABLE 2. Estimated R&D Intensities among Swedish Contractors, 1989

	Number of Employees			
Item (1)	0–49 (2)	50–499 (3)	500+ (4)	Total (5)
R&D performed	30[a]	80[a]	380[a]	490[a]
Of which externally funded	0[a]	3[a]	32[a]	35[a]
Total value added	8,500[a]	5,300[a]	16,200[a]	30,000[a]
R&D intensity (R&D divided by value added)	0.4%	1.5%	2.3%	1.6%

[a]In million SEK; US \$1.00 ≈ SEK 6.00.

TABLE 3. Estimated R&D Intensities in Manufacturing and in Construction, 1987

		R&D/Value Added		
Industry (1)	R&D operating costs (MSEK)[a] (2)	Total (3)	Process R&D (%) (4)	Product R&D (%) (5)
Manufacturing				
Building materials	340	1.4	0.1	1.3
Other manufacturing	15,688	10.3	1.0	9.3
Construction contractors	380	1.6	1.3	0.3

[a]In million SEK; US \$1.00 ≈ SEK 6.00.
Note: Sources are "Research" (1989) and Bröchner et al. (1990).

covered by the survey. The presence of externally funded R&D is also tied to firm size, large contractors being large recipients, but nevertheless, internal financing is almost the rule, covering 93% of all R&D expenditure. The remaining 7% are covered by funding bodies such as the SBUF, the Council for Building Research, and other government agencies.

Although the R&D definition used in the survey is broader in scope and not confined only to technical R&D, a comparison with figures from the Swedish manufacturing industry is instructive. In Table 3, the distinction between product and process innovation is highlighted. Within those parts of manufacturing industry that are dominated by building materials, nearly 10% of R&D costs can be assigned to the development of new or improved processes and more than 90% to product development. It is the reverse in construction firms: according to the present survey, about 80% is spent on process development, but we may assume that the proportion would be slightly lower if we had excluded administrative R&D.

Who Carries Out R&D?

Large firms with 500 or more employees carry out the majority of all contractor R&D, being responsible for almost three quarters of total R&D among Swedish contractors. Measured by employee man-years in R&D, about 1,400 was the figure reached by firms with 50 or more employees. Slightly more than 60% of the effort was related to the actual construction stage of the total process. Smaller firms appear to spend almost all their development resources on the construction stage proper. The larger ones

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have a greater proportion of design-and-build projects, which seems to explain why their R&D profile is more evenly distributed across early and late stages of the process. Some R&D activities lack stage-specific characteristics. This applies to parts of administrative development work as well as to work carried out on quality-assurance systems. Fig. 1 shows the stage dependence of R&D and also the formal education of employees: those with a secondary education make up the bulk of staff involved in R&D.

Reasons for Development Efforts

Survey respondents stated unanimously that the primary reason for engaging in R&D was to increase the competitive strength of the firm. In addition to this basic reason, a further seven factors were ranked according to importance for undertaking R&D. Weighted rankings, given separately for each firm size group are displayed in Fig. 2. The ambition to be involved at an early stage in construction projects is mirrored among large firms by the high rank given to contractual factors, or more precisely, the design-and-build principle as a reason for R&D. The image of the firm is said to be very important, both the external image projected and how the firm is perceived by its own employees internally. Medium-size firms tend to put a relatively high weight on the development of computer support as an independent motive for engaging in R&D. Otherwise, the technology push from new building materials plays a minor role, something that is also true for government codes and regulations. The access to external funds for R&D was not seen as important by any of the five medium-size firms included in the survey.

Taken as a whole, most of the reasons stated fit into the picture given in Tatum's (1987) discussion of forces and opportunities for innovation in the construction firm, but there is more emphasis on image among Swedish respondents. Swedish contractors may be slightly closer to the large Japanese contractors in their reasoning, being more concerned with motivation and other human aspects of in-house R&D; although, in contrast to the present survey results from Sweden, responsibility to society receives the heaviest

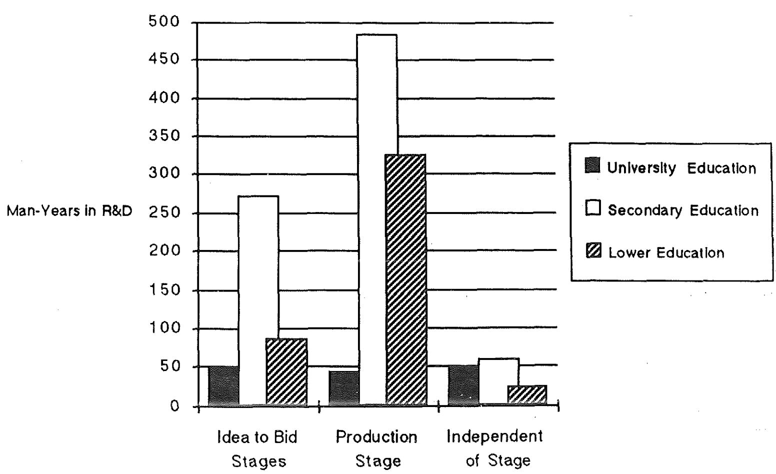

FIG. 1. Man-Years in R&D by Process Stage and Level of Education, 1989

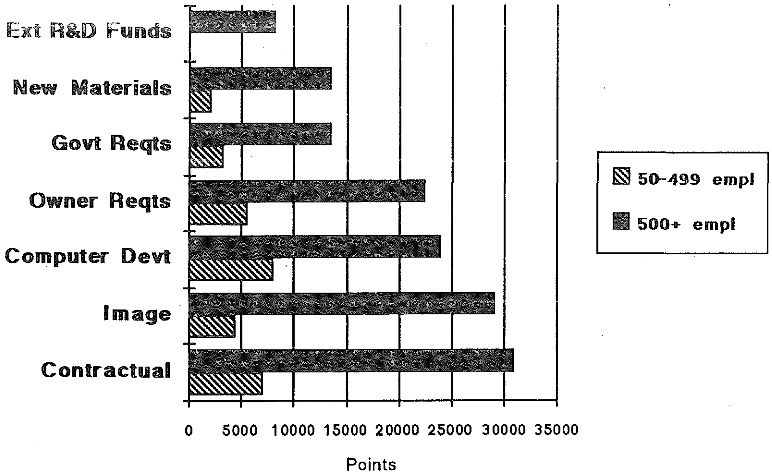

FIG. 2. Reasons for Undertaking Development Work, 1989

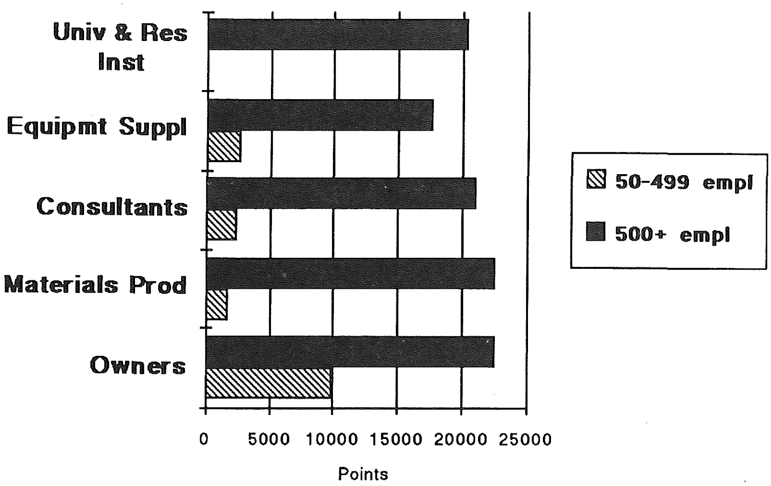

FIG. 3. Collaboration Partners by Importance, 1989

stress in Japanese firms according to Hisatomi (1990), who lists main reasons for engaging in construction R&D.

Collaboration Preferences

When asked about their preferred partners in R&D projects, collaboration with owners was assigned the highest rank, especially by medium-size firms (see Fig. 3). Vertical collaboration with suppliers is mentioned as important, which probably reflects the need for user tests of many innovations stemming from equipment and material suppliers (Habermeier 1990). Earlier Swedish studies of how contractors—in particular, site managers—adopt technical innovations support these findings (Fredriksson and Larsson 1984). Large contractors may in a sense be less dependent on outside cooperation, but on the other hand their range of partners in R&D activities is broader. Additional answers given by individual respondents revealed that industry organizations, special trade contractors, and foreign contacts had been of some importance in this context.

Survey in Perspective

As a consequence of a wave of mergers and acquisitions in recent years, the structure of the construction industry in Sweden has reached a degree of concentration in which economies of scale in R&D should be more obvious. The number of technical university graduates working within the large construction groups has increased; today, more than 1,600 civil engineering graduates are employed by them. Closer and more durable ties between the individual construction worker and the individual construction firm have strengthened the incentives for employers to raise training levels, since competitors are less likely to benefit from worker mobility. Taken together, these slow but dynamic factors imply that construction firms today are much better at responding to an environment that offers rewards for R&D efforts.

The future development of contractor investment in R&D will therefore be largely determined by market demand for construction. Responses in the survey suggest that a consideration of long-term profitability of R&D is the main motivation for engaging in it. Sometimes, especially in large heavy-construction projects, development work pays off within the economic framework of the single project, but other development initiatives need recurrent orders before the economic outcome is satisfactory. Nevertheless, most development work by contractors is carried out within contracts or in close conjunction with ongoing construction tasks. The contractual arrangements are therefore important. Whenever the owner specifies in great detail the construction technology to be used, the contractor will assume the part of a pure services producer and share the accompanying R&D attitudes. There is little that encourages anything other than administrative innovation and perhaps some insignificant changes in production technology under those conditions. Contractor initiatives for product development presuppose the existence of economic means for new alternatives. This is why design-and-build arrangements serve as vehicles for innovation demand pull. There is at present a strong trend in Sweden to increase the proportion of public-sector work submitted to competitive tendering. Here, it is of vital importance that the Swedish tradition of contractor influence on design, e.g. on bridge design, is preserved and developed. Strong disincentives to innovation may arise when design is insulated from construction, judging from U.S. experiences (Murillo 1988). A further degree of integration is when construction and real-estate ownership is joined, as has increasingly been the case for Swedish contractors, both large and small. Being responsible for operations and management of the finished products can act as a stimulus to further R&D activities.

Besides the contractual arrangements, the geographical extent of markets for construction is important. The lowering of trade barriers and the creation of a single European market carry the promise of greater economic returns to innovative technical and administrative expertise among contractors. Serial effects are more easily attained when the geographical base for activities is broadened.

Finally, it must be stressed that the survey clearly shows that externally financed and coordinated R&D activities are no more than the tip of an iceberg. Most in-house development is internally financed.

SBUF Cooperation Scheme

When the Development Fund of the Swedish Construction Industry (SBUF), was set up as an independent scheme in 1983, its given aim was to promote development work in the construction industry. It was a fundamental belief that "by means of new methods, better plant and equipment for site operations in the fields of building, special trades and heavy construction it will be possible to improve efficiency, to achieve a more accurate quality, and to establish a higher degree of safety in construction work." Founding members were the Employers' Federation of the Swedish Construction Industry, BPA AB, the Association of Swedish Earth Moving Contractors, the Association of Swedish Plumbing, Heating and Mechanical Contractors, the State Employees' Union, and the Swedish Building Workers' Union.

In 1990, the fund spent about SEK 30,000,000, corresponding to about US$ 5,000,000 on support for development projects. Associated with the vacation pay system for construction workers, a voluntary levy of SEK 0.18/hr (= US 3¢/hr) worked provides this sum. Firms and individuals belonging to member organizations apply with proposals for project grants. Support decisions are taken by the board of SBUF subject to recommendations from committees on building, special trades, and heavy construction with highways. At present, about 250 projects amounting to a total of SEK 75,000,000 are going on in some 60 contracting firms, often in collaboration with other firms, research institutes, and universities. Cofinancing with government support, mostly from the Swedish Council for Building Research, occurs frequently.

Reports from projects are screened by the relevant committee, which also recommends how results should be disseminated. SBUF publishes about 30 information sheets each year, reaching all firms and almost all construction sites in Sweden. Folders, videotapes, and more traditional reports are also made available to members. The first grants were awarded in 1983; at the end of 1990 no less than 264 projects had been finished with approval from the board of SBUF. During 1989, an evaluation of projects supported throughout the initial years was performed, partly by a general analysis of 153 finished projects and partly by an in-depth study of the effects of six selected projects (Bröchner et al. 1989). In what follows, the results of the earlier evaluation are brought up to date.

Project Applicants

Nearly two-thirds of all 264 finished projects are based on support applications from member firms with a national coverage, joining building and heavy-construction activities (see Fig. 4). All large contractors are to be found among the applicants. Some of the firms included under "Special Trade Contr" also work on a national scale. The category "Collaborating Firms" groups together consortia and industry organizations; some of the projects represented elsewhere in Fig. 4 include more than one contractor when carried out, but this is a question of project participation. In the sixth category ("Individual," Fig. 4), there are four projects concerning equipment initiated and performed by individual construction workers.

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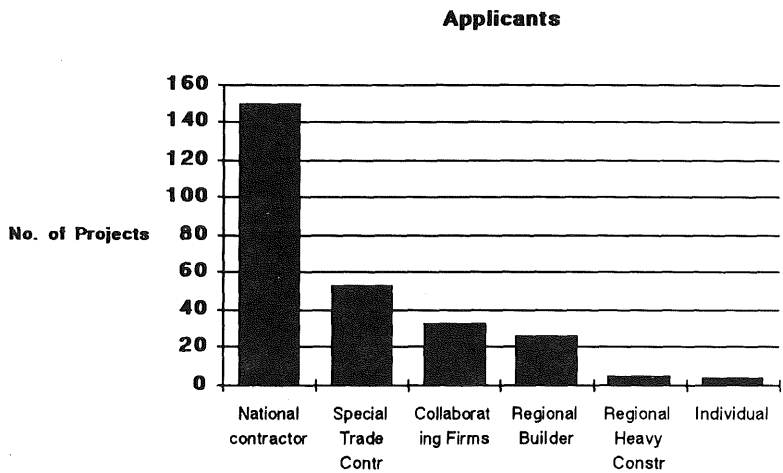

FIG. 4. SBUF Project Applicants, 1983–90

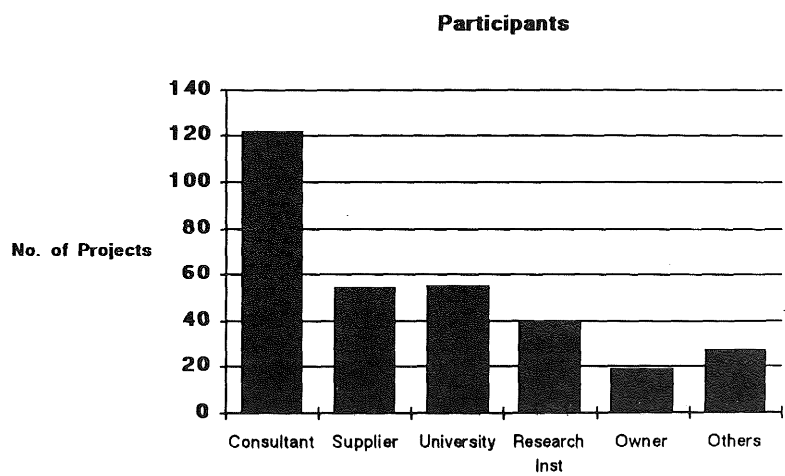

FIG. 5. SBUF Project Participants, 1983–90

Participants

Many projects, especially if they are large, have both a broadly representative reference group and a working group. In Fig. 5, we are concerned with project participants in a narrow sense: those who belong to the actual working group. These can be broken down into several groups: consultants, suppliers, universities, research institutes, owners, and others. It is common to find more than one type of external participant represented on the same project. No more than 14% of all projects have been completed without any external participants; such projects are usually found in large national firms, the grant being small and the project being directed toward equipment and production methods. University participation is evident in 21% of all projects. There is a bias toward materials and structures in projects with university participants, but nevertheless about one-half of all projects involving university staff deals with production methods and equipment. When it comes to projects concerning management or the admittedly few market analysis projects, university departments participate only rarely. Regional housebuilding contractors show above-average figures for using universities.

There is also a tendency to find university staff present in projects including owners. However, projects with owner participation are few (7%), although these are often large projects. In this case, grant applicants tend to be national contractors or regional highway and heavy-construction contractors, and the owner tends to be the National Road Administration. On the other hand, the degree of consultant involvement is low. In general, the proportion covered by the SBUF of total project cost is relatively small in projects with owner participation.

Project Themes

In the analysis, projects were assigned to four major themes: (1) Equipment and production methods; (2) materials and structures; (3) management; and (4) market analysis.

Characteristic profiles can be detected for these themes. Thus, it is found that projects concerned with equipment and methods often are larger than projects concerned with materials and structures. Also, equipment and methods projects are more frequent among regional builders and special trade contractors, whereas national contractors seem somewhat more interested in materials and structures. And, as we have seen already, university participation leans toward materials and structures. Research institutes and government agencies with R&D tasks are more strongly represented in the equipment and method theme. Consultants appear with almost equal frequency under themes 1 and 2; they effectively dominate themes 3 and 4. Suppliers are more often found in projects concerning equipment and methods than in materials and structures, and owner participation is equally infrequent in both these themes.

Committee Profiles

Each of the three screening SBUF committees for building, special trades, and highways with heavy construction has a specific profile, as is seen in Table 4. A single project may appear more than once in this table due to screening by two or sometimes even three committees. A small number of projects without a clear thematic profile were assigned to more than one project theme.

Building

Almost half of all projects passing through the building committee deal with innovations in equipment and methods, and the remainder is evenly distributed over materials and structures, as well as the management theme. Regionally operating contractors make up 16% of building committee applicants, a comparatively high figure. Consultants participate in exactly 50% of the building committee projects, universities in 25%. Suppliers of materials or equipment, to whom the SBUF scheme offers an additional possibility for user involvement in R&D, are found in 22% of the project stock. Owners are rarely involved in project working groups (3% of all building projects supported), which is an interesting contrast to the high value set on collaboration with owners in the survey of contractor R&D in general (see Fig. 3).

TABLE 4. SBUF Projects, by Technical Committee Subject Area, Finished 1983–90.

Grant category (1)	Committee: Building (2)	Spec. Trade (3)	Heavy Con. (4)
All grants screened	152	42	86
Grants, by participants			
Consultant	76	24	28
Supplier	34	2	18
University	38	7	16
R&D institute	20	2	18
Client	5	0	14
Others	10	6	5
Applicant only	18	4	17
Grants, by applicants			
National contractors	94	6	57
Specialist contractors	21	17	16
Cooperating contractors	16	14	5
Regional housebuilders	24	4	4
Regional civil engineering contractors	0	0	5
Individuals	2	1	1
Grants, by themes			
Equipment & methods	75	10	50
Materials & structures	43	7	17
Management	40	26	11
Market analysis	2	3	1

Special Trades

Management issues form the dominant theme (62% of projects) for the special trades committee. Applicants are relatively often firms that collaborate, mostly through their trade association. Universities and research institutes are seldom seen as project participants; consultants appear in 57% of projects. The average SBUF grant stands for a relatively high proportion of total project costs in the special trades sector.

Industry structure differs markedly between Swedish building contractors and special trade contractors. Although there is a trend toward concentration in certain trades, the overall picture is quite different, with a vast number of small special-trade contractors, whose main potential for raising efficiency appears to lie in improving their management ability. Innovative technology rests more firmly with their suppliers.

Highway and Heavy Construction

Equipment and methods stand for no less than 69% of projects approved by the highway and heavy-construction committee. Large, nationally—and internationally—operating contractors hold a strong position among grant recipients. Participants are evenly distributed over most categories, although consultants are the most important single group here, as with the other committees. Research institutes are slightly more frequent project participants than university departments here.

In many ways, the specific pattern for projects within this sector seems to reflect the market structure, in which large public owners dominate.

Comment

Comparing the survey of contractor R&D in 1989 with the experiences from the SBUF scheme, we may recognize a pattern that differs markedly from the assignment of cooperative efforts recommended by Porter (1990), which we referred to initially in this paper. In Swedish construction, there appears to be a strong need for cooperation on issues of applied technology, more so than cooperation on fundamental research, which seems to be of greater benefit to other industries earlier in the chain from the extraction of raw materials. Recourse to independent research bodies and universities is frequent in Swedish cooperative R&D, although a majority of projects in the field of construction are carried out with no such involvement. There is also much to suggest that a deeper understanding of the role of R&D for contractors should begin by taking into account the varieties of market conditions for various subsectors of construction.

Conclusions

Historically, the construction industry in Sweden and many other countries has suffered from a reputation for backwardness when having its measurable efforts in research and development compared with innovation in manufacturing. The primacy of coordinative management and the fragmentation of construction firms and activities tend to obscure what is actually performed; and it has led to both external criticism and self-incrimination by industry representatives. Whatever the situation was in the 1940s, when organized forms for government support of development in construction were first launched in Sweden, the present situation is the outcome of profound but slow changes.

These changes have been so gradual as to be almost imperceptible to many industry participants, and they also tend to escape most outside observers of construction. First, there is the massive rise over the last decades in training and educational standards for all levels of employees in the industry, not just in the case of construction technology, but also as an outcome of recent programs for teaching business management to experienced staff. Second, with the accumulated effects of market concentration among suppliers and contractors, the number of firms has fallen, and among the numerous smaller firms, there is a tendency to specialize. Industry attitudes toward R&D are affected by changes in the means of competition brought about by market concentration. Finally, there is the technology push, the increased use—and increased skill in use— of more sophisticated construction equipment and more efficient information technology.

When acting in combination, these three slow changes imply that today there is a widespread ability among firms in the Swedish construction industry to look at R&D with more knowledgeable eyes, identifying which projects should be carried out within the firm or its usual network, which projects are best pursued in a cooperative environment such as provided by the SBUF scheme, and which should be of national interest, meriting government support. The surveys reported here indicate the complexity of perceived benefits of R&D in construction, as well as the distinct patterns associated with R&D in different fields.

There appears to be no set and fixed solution for organizing construction R&D. The respective roles of central government, industry-wide schemes, and of individual firms need redefining over time. In the Swedish context, it is the slow background changes that provide the impetus for new forms of organizing and performing R&D in construction.

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