

# Factors Affecting the Process of Collaborative Product Development: A Study of UK Manufacturers of Information and Communications Technology Products

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*Product development is inherently risky, particularly when new technology is involved. Although collaborative product development is promoted as a means for reducing or at least sharing risk, such partnerships present their own challenges. Collaboration can also accentuate many of the risks inherent in product development. For example, any product development project requires effective communication among development team members. In a collaborative effort, this challenge is even greater because the development team spans organizational as well as functional boundaries.*

*Dale Littler, Fiona Leverick, and Margaret Bruce describe the results of a survey that was conducted to identify the risks and benefits of collaborative product development as well as the key success factors for such relationships. The main reasons cited for collaborating on product development projects include satisfying customer requirements, taking advantage of market opportunities for which the firm lacks necessary skills and technical expertise, and responding to changes in technology. Other reasons for collaboration include reducing the cost and risk of product R&D, improving time to market, and gaining access to new markets.*

*In addition to the risks associated with product development by a single company, the partners in a collaborative effort face several other challenges. For example, one company might gain inside knowledge of its partner's unique skills and expertise. Despite the cost and time involved in managing the collaboration, such a relationship usually results in less direct control over product development. Of particular concern are the difficulties of coordinating the divergent management styles and budgeting processes of the collaborating firms.*

*Collaboration requires frequent communication among all involved parties. The likelihood of success is greatly enhanced by the presence of a product or collaboration champion. Other success factors include ensuring that partners contribute as expected, creating the perception of equal benefits among partners, and building trust between partners. Firms that are more experienced with collaboration also cite the importance of flexibility in corporate systems and management style, fit with existing businesses, and the choice of a partner.*

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## Introduction

The contribution of new product development to business competitiveness has been frequently stressed, with some authors recently suggesting that its importance is increasing [5,29,49]. Such a growing concern has been accompanied by a volume of research into the process of developing new products. However, common to much of this research is a recognition that product development is highly risky, especially where new technology is involved, and that new product failure rates are unacceptably high [8,9,49].

Indeed, it has often been suggested that new product development is becoming not only more important to organizations, but also more complex, often involving many different areas of skill and expertise as markets and technologies converge, product lifecycles shorten, and technological change becomes increasingly rapid—leading to pressure to reduce product development periods. It is also suggested that industries are becoming more international so that there are pressures on businesses to market products in a number of regions simultaneously [5,33,41,52].

Collaborative product development has been promoted as a means by which some of these problematic aspects of the product development process can be lessened [24,25]. Collaboration has been defined in

various ways, and even a brief examination of the literature reveals that there is little agreement on terms [27]. Our interest is in relationships between two or more independent organizations, specifically aimed at developing a product or a series of products. An organization might collaborate with partners at various stages of the value chain, such as its customers, competitors, or suppliers. The projects may take a variety of forms and involve a range of timespans but are likely, initially at least, to be relatively structured and focused and to involve some type of written agreement.

Collaboration, however, raises certain issues. Although product development itself has been shown to be often complex and difficult, with a multitude of factors impinging on its outcome [30], many of these difficulties are likely to be accentuated in collaborative product development. For instance, developing productive and communicative relationships between the individuals involved in the product development process becomes more complicated when these individuals span organizational boundaries as well as different functions such as R&D and marketing. Collaborative product development also raises unique challenges of its own, such as how to protect proprietary knowledge and how to deal with the loss of control over the product development process cooperation with external agencies almost invariably means.

Indeed, there is a body of evidence suggesting that, due at least in part to some of these potentially problematic issues, a significant proportion of collaborations of whatever type do not meet the expectations of one or more of their participants [26,32]. To what extent, then, is collaboration yielding the advantages for product development widely acclaimed? Does collaboration enhance the efficiency and effectiveness of product development or rather does it make the process of product development more costly and complicated? What are the risks experienced by companies involved in collaborative product development? Are there factors which, if in place, can increase the likelihood of effective collaborative product development? To what extent is the management of collaborative product development different to the management of unitary product development?

In addressing these questions, this article draws on research carried out into the role of collaborative product development among UK-based suppliers of information and communication technology (ICT) products, for which collaborative product development arrangements have a significant role [15,38]. The validity of

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this focus is reinforced by a study of 4182 technological alliances by the Maastricht Economic Research Institute, which concluded that such alliances were concentrated in information technology and biotechnology sectors, with a significant proportion also in telecommunications [15].

The research program has included an extensive mail questionnaire survey of collaborative product development practices in over 100 UK firms as well as detailed case studies of a number of major collaborative product development projects. The major objectives of this article is to analyze the factors affecting the outcome of product development collaboration, focusing on particular aspects of the questionnaire survey.

First, we review a variety of perspectives in the literature relating to collaboration exploring, in particular, the alleged benefits of collaborative product development; the less commonly cited risks; and the factors which, it is claimed, lead to successful collaborative relationships. We proceed to present some of our own findings, focusing primarily on the factors that appear to discriminate between product development collaborations regarded as more or less "successful" by the parties involved. As a prelude to these results, we also present some descriptive statistics on the difficulties and costs our sample had encountered in collaborative product development and on respondents' views of the benefits of collaborative product development.

## Perspectives on Collaboration

### *Benefits of Collaborative Product Development*

Various reasons have been advanced for engaging in collaborative product development. One of the most frequently mentioned is that of speed. Considerable attention has been focused on the importance of reducing the time taken to develop products [7,44,45, 51]. Collaboration has been promoted as one way in which this might be achieved [3,13,14]. Indeed, Hagedoorn [23] studied 4192 collaborative relationships among European companies and found that reduction of product development periods was one of the two most important motives for their formation.

A second benefit of collaborative product development advanced is that of cost reduction. Sharing the risks and costs of product development through collaboration has been advocated by a number of authors

[18,21,40]. Wind and Mahajan [54] suggest that the costs of internal product development can easily outweigh the extra costs involved in collaborative product development, such as searching for and evaluating collaborative partners.

Securing access to new skills or technologies or gaining information for product development is another frequently mentioned benefit of collaboration [24,25,54]. The apparently increasing complexity of technological and product development and convergence of industries [5] provides a strong motive for such collaborative product development relationships.

However, marketing considerations may also play an important role in collaborating for product development, especially in the face of apparently increasing globalization of industries [5,54]. The rapid rate of product obsolescence does, according to some, focus attention on securing rapid access to markets so that new products can be marketed virtually simultaneously in several regions. Collaborative product development relationships may also be seen as a means of overcoming various barriers to entry to foreign markets [13,31].

Finally, we would suggest that the influence of imitation and "hype" must also not be ignored as a significant impetus toward collaboration in product development. If competitors are engaged in extensive collaborative product development, then there may be considerable at least implicit pressures to do likewise. Moreover, there appears to be an accepted view that collaboration leads to competitive product development, that in turn can affect organizations' propensity to cooperate.

### *Risks of Collaborative Product Development*

The process of product development itself is widely acknowledged as involving a high level of risk. The majority of these risks will also be a feature of collaborative development relationships. There may, however, be additional risks and disbenefits that attend collaborative product development, and it is dealing with these additional risks, we argue, that differentiates the management of collaborative product development from work undertaken by a single company.

First, there can be a leakage to collaborating partners of a firm's skills, experience, and general "tacit" knowledge that may form a significant part of the basis of its competitiveness. There is a danger that its part-

ners not only acquire the competencies that the firm brings to the product development, but also gain access to the knowledge and skills that the firm uses in other business areas [25]. A firm may also fire the opportunism of its collaborators by providing information and insights into possible markets and future possibilities that otherwise may have been its exclusive domain [16].

Second, entering into a collaborative arrangement is invariably likely to lead to a reduction in the direct control held by one organization over the product development project in question [24,48].

Third, although collaboration is frequently promoted as a means of reducing the cost and length of the product development process, Farr and Fischer [16] refer to the additional financial and time costs incurred in managing the collaboration, including the time involved in harmonizing what are likely to be fundamentally different management styles and budgeting processes of the collaborating parties.

Finally, there can be significant potential opportunity costs because undue effort and resources are directed toward the collaborative product development project, such that the maintenance of the collaboration itself becomes the prime objective, at the expense of the specific product development. Indeed, the collaboration may establish its own agenda that may differ markedly from that of its principals.

#### *Factors Increasing the Likelihood of "Successful" Collaboration*

Given the small but growing number of studies reporting dissatisfaction with the outcomes of collaborative product development by one or more of the parties involved [26,32,46], it is understandable that attention should be directed towards factors increasing the likelihood of success. Defining success in product development has been the subject of much research attention and has been shown to be less than straightforward [20]. Defining success in *collaborative* product development is similarly problematic and possibly even more so, given that the perspectives of two or more organizations are involved [12]. The most straightforward measure of the success of a collaborative product development project is likely to relate to whether or not the product was developed as planned and to cost and time allocations. The termination of an agreement cannot inevitably mean the collaboration has been unsuccessful, because the original objectives

may have been met [27]. Moreover, the objectives might change as product development progresses.

It also has to be recognized that "success" in collaborative product development, as in any product development project, can be multifaceted [6]. There can, for instance, be unintended advantageous side effects, whereas even a prematurely terminated collaborative product development project might yield beneficial experience and knowledge and assist in developing future products [28].

There has been considerable research into the factors affecting both the success of product development [4,30,54] and the outcome of collaborative projects. A number of factors that appear to have some bearing on the success of collaborative ventures have been identified and these will be briefly reviewed here. It is recognized that some of these factors might also have an impact on product development per se, whether collaborative or not, but other factors referred to here are clearly of importance specifically to collaborative product development, bearing directly on some of the risks of collaborative relationships identified earlier.

The first factor relates to the choice of partner. A particular issue here is the compatibility of the respective cultures of the cooperating organizations [50]. Lorange argues for compatibility of operating styles:

The member organisations [involved in a collaboration] must be able to communicate with each other, having a "language" that they all understand. They must have a working style which is complementary, in the way they go about reaching decisions, their problem solving style and so forth. Above all, their behavioral styles must be compatible [40].

There is also evidence suggesting that collaborations that are related to the existing activities of the cooperating parties are more likely to be seen as successful [2], whereas Farr and Fischer [16] emphasize the value of general experience of collaborations as a factor that enhances the probability of future collaboration "success."

Some have stressed the importance of clearly establishing the ground rules for collaboration, such as ensuring that there are clearly defined goals, objectives, and responsibilities for the collaboration that are fully understood by all parties involved [1,16,42,43]. Gyenes [22] stresses the necessity of preparing detailed and binding initial collaboration agreements in order that future ambiguity is avoided. Such advice corresponds with Cooper and Kleinschmidt's [5] recogni-

tion of the importance of early and upfront investment in any product development project. It also needs to be recognized, of course, that circumstances change and this alone suggests that there may be need for, first, frequent appraisal of the collaboration and, second, the scope for adaptability.

The importance of establishing the limits to the collaboration has also been noted to avoid the transfer of general knowledge and experience during the process of joint product development [25,43]. Hamel et al. advise collaborators to impose restrictions and exclusivity clauses in order to limit the transfer of core technologies [25].

There does, though, need to be a *balance* between protecting the proprietary interest of the firm while establishing trust and openness with its partners—these being regarded by many as critical ingredients in the continuation and effectiveness of interorganizational relationships [1,11,21]. The task for those involved in the management of collaborative product development is to balance these potentially conflicting issues as the project evolves.

Related to the establishment of clear ground rules for collaboration is the corresponding need for the monitoring of progress [36,50] such as through the establishment of “milestones”: significant points at which progress can be assessed. However, it is obvious, too, that at the outset it is difficult to plan for all the possibilities that might emerge as product development proceeds and this again highlights the need for frequent reappraisal and for a degree of flexibility.

The importance of allocating sufficient financial resources to a collaborative product development project is frequently emphasized [40], as has been the case for product development more generally [5]. Of course, it is often the allocation of *management time and effort* that can have a disproportionate influence.

The perceived mutuality of contribution and benefits from the various parties involved in a joint product development project has also been highlighted as important [2,10,42,43]. Assymetries are likely to lead to dissatisfaction, resentment and possibly termination of the agreement, although ensuring equality in outcomes is more problematic.

Essentially, collaborations are constructed and developed by the individuals involved. The “personal chemistry” [17] between the major players is likely to be a vital ingredient of any smooth and effective collaboration. The presence of one or more “collaboration champions” [34], or “mentors,” who has a wholehearted commitment to making the collaboration

work and a determination to overcome any difficulties has also been noted [42]. Such individuals, it is suggested, will be most effective if they have sufficient seniority or the support of top management [42]. They are likely to play a role akin to the “product champions” identified as important to the success of new product development [19].

A well managed collaboration, however, will not inevitably result in a remunerative outcome. The broader context within which product development takes place is also likely to have a significant bearing [42]. Changes in the various partners’ markets, in their competitive fields, in the range of technologies available, in the wider economic environment, or in the policies of government agencies can have a critical effect on the project, as can a redefinition of the collaborators’ own missions and objectives. Maintaining the necessary external focus may however be awarded subsidiary importance given the administrative demands of maintaining the collaboration and the often overriding desire to ensure the collaboration per se is perceived by the participants as proceeding successfully.

Table 1 contains a summary of the main factors, grouped by theme, which have been identified in existing studies as contributing to the likelihood of “successful” collaboration and are therefore likely to have a bearing on the management of collaborative product development projects.

## The Study

The purpose of the study reported here was to analyze various aspects of collaborations aimed at generating developments of existing or new products. The study was part of a wider program of research into collaborative product development in information and communication technology (ICT) sectors. The subjects of the study were UK-based manufacturers of ICT-based products. It was envisaged that a sample of firms drawn from the UK would have considerable experience of collaboration over time. Major areas of interest for the research included: the reasons for participating in collaborative product development ventures, the criteria used for assessing the performance of products developed collaboratively, the perceived benefits and disbenefits of collaboration for product development, and the factors likely to be important in leading to a perceived positive outcome.

All the companies in the sample, which was drawn

**Table 1. Factors Contributing to Collaboration "Success" Identified in the Literature**

Factor	Specified By
Setting up the collaboration (Choice of appropriate collaborative partner; specification of clear goals, responsibilities and accountabilities; establishment of "limits" in terms of the information to be shared as part of the collaboration).	Anderson and Narus [1]; Bleeke and Ernst [2]; Devlin and Bleackley [10]; Farr and Fischer [16]; Gyenes [22]; Hamel et al. [25]; Harrigan [26]; Lorange [40]; Lynch [42]; Lyons [43]; Nueno and Oosterveld [47]; Perlmutter and Heenan [50].
Process management (Frequent monitoring of progress; frequent consultation between partners and between marketing and technical personnel in particular; maintenance of flexibility; development of trust).	Anderson and Narus [1]; Bleeke and Ernst [2]; de Young [11]; Dodgson [12]; Gugler [21]; Lorange [40]; Lynch [42]; Lyons [43]; Perlmutter and Heenan [50].
Allocation of resources (Sufficient financial resources; sufficient staff resources).	Lawton-Smith et al. [34]; Lorange [39,40]
Personnel involvement (Involvement of senior management; "personal chemistry" between staff; presence of collaboration champion).	Devlin and Bleackley [10]; Forrest and Martin [17]; Lawton-Smith et al. [34]; Lincoln [36]; Lynch [42].
Ensuring equality (Of perceived contribution and benefits between partners).	Bleeke and Ernst [2]; Devlin and Bleackley [10]; Lynch [42]; Lyons [43].
Past experience of collaboration management	Farr and Fischer [16]; Lorenz [41]; Rice [53].
Assessing external factors (Attention paid to monitoring environmental changes).	Lynch [42].

randomly from appropriate UK trade directories,<sup>1</sup> are involved in some way in information technology or telecommunication sectors: that is, they are manufacturers of mobile communications components or equipment; computer component, hardware or systems manufacturers; or computer software producers. Between October 1992 and January 1993, a total of 300 companies were sent a copy of the questionnaire. In each case, the questionnaire was sent to the marketing director of the company, or, if none was specified, to the managing director. The recipients of the questionnaires were asked to pass them on to a more appropriate respondent, if this was thought necessary. One hundred six (106) complete and usable returns were obtained, a response rate of 36%, which is more than acceptable for a survey requiring a high level of detail.

All of the respondents had been involved to some extent in collaborative product development and some had considerable experience, having participated in several collaborative development projects over a period of some years. In the last two years, 61% of the sample had been involved in a major collaborative product development project. This may reflect a de-

gree of sample bias, in that respondents with a major involvement in collaborative product development would have been more likely to complete and return a questionnaire on the subject. Further details of the respondent sample are contained in Table 2.

The remainder of this article focuses on just two aspects of the study: first, the perceptions of the respondents of the effects of collaboration on the process of product development and, second, the major factors that affect the probability of securing a favorable outcome.

### Reasons for Collaboration in Product Development

The reasons why organizations might engage in collaborative product development were discussed earlier. Drawing on this literature, a list of reasons for entering into collaborative product development was identified, and respondents were asked to rate each of these on a five-point scale according to their importance. Table 3 presents the reasons in rank order, the higher ranks being the most important reasons for collaboration, as judged by respondents.

The main reasons were given as: responding to key customer needs, that is, in response to an initiative by an important customer; taking advantage of market

<sup>1</sup> *Computer Users' Yearbook*, 1992; *Software Users' Yearbook*, 1992; *Communications Users' Yearbook*, 1992.

**Table 2. Respondent Sample Details**

Characteristics	% of Respondents <sup>a</sup>
Nature of main business	
Telecommunications equipment manufacturers	43
Computer hardware/systems manufacturers	23
Computer component manufacturers	15
Computer software producers	19
Number of employees	
1-50	11.3
51-100	24.7
101-200	12.3
201-500	22.6
501-1000	10.3
1001 plus	20.6
Turnover (1992/3)	
Under £5 million	19.6
£5 million-£9.99 million	13.4
£10 million-£19.99 million	19.6
£20 million-£49.99 million	17.5
£50 million-£99.99 million	12.4
£100 million plus	17.5
Pre-tax profit (loss) (1992/3)	
Over £10 million	10.3
£5 million-£9.9 million	5.2
£1 million-£4.99 million	18.6
Up to £0.99 million	30.9
(Up to £0.99 million)	20.6
(£1 million-£4.99 million)	4.1
(£5 million-£9.99 million)	5.1
(Over 10 million)	5.1

<sup>a</sup> These sample details are derived from the responses of ninety-seven of the 106 respondents to the questionnaire, the remaining nine respondents wishing to remain entirely anonymous.

opportunities, for which sufficient skills or expertise are not possessed for the opportunity to be exploited independently; and responding to changes in technology.

Also considered important were reducing the risks and costs of product research and development, these being the fourth and sixth most highly rated reasons respectively. Improving time to market was the seventh most important reason for collaborating in product development.

### The Effect of Collaboration on the Product Development Process

This study also aimed to assess the extent to which the potential benefits of collaboration alluded to in Table 3 are being realized. In particular, we were interested in whether the reductions in product development

**Table 3. Importance of Reasons for Collaborating in Product Development**

Reason for Collaboration	Average Score
In response to key customer needs	4.11
In response to a market opportunity	4.10
In response to technology changes	3.78
To reduce research/development risks	3.76
To broaden product range	3.67
To reduce research/development costs	3.65
To improve time to market	3.58
In response to competitors	3.48
In response to a management initiative	3.34
In order to be more innovative in product development	3.31
In order to be more objective in product development	3.16
In order to conform with standards	3.12
Due to a collaborative corporate culture	2.88
In order to achieve continuity with prior products	2.35
In response to key supplier needs	2.06

costs and time through collaboration were perceived by respondents as being achieved in practice. Respondents were asked to indicate their level of agreement with a number of statements concerning the role and influence of collaboration on various aspects of the product development process. A five-point scale, ranging from "strongly agree" (1) to "strongly disagree" (5) was used. In Table 4 the percentage of the respondents *strongly agreeing* or *agreeing* and *strongly disagreeing* or *disagreeing* with the statements is indicated.

As Table 4 shows, a high proportion of respondents felt that collaboration can have a negative effect on the process of product development. Of respondents, 51% expressed the view that collaboration makes product development more costly; 41% considered that collaboration makes product development more complicated and more difficult to control and manage; 41% of respondents did *not* consider that collaboration makes product development more efficient; whereas 58% did not agree that collaboration accelerates the product development process.

Respondents tended to consider that collaboration does not necessarily lead to product developments that are more effective responses to market requirements, presumably for those collaborations not involving customers. It may be that much attention is directed in product development collaborations toward devising a formula and manner of operation that is acceptable to all partners. There is likely to be much compromising

**Table 4. The Effect of Collaboration on the Product Development Process***We asked:**From Your Experience, How Does Collaboration Affect the Process of Product Development?*

Collaboration Generally . . .	Agree/ Strongly Agree (%)	Disagree/ Strongly Disagree/ (%)
Makes product development more costly	51	22
Complicates product development	41	35
Makes it more difficult to control and manage the product development process	41	38
Makes product development more responsive to supplier needs	36	26
Makes product development more efficient	35	41
Emphasizes accountability in product development	30	44
Allows product development to adapt better to uncertainty	27	43
Accelerates product development	25	58
Makes product development more responsive to customer needs	22	50
Allows product development to respond better to market opportunities	15	63
Enhances the competitive benefits arising through product development	12	65
Facilitates the incorporation of new technology in product development	7	70

to meet the requirements of the various parties and any changes to, for example, product specification, may only be secured after considerable further negotiation. In this scenario, it would not be surprising that the cooperative venture has its own inertia and that it can become somewhat divorced from the needs of potential customers.

### The Major Risks of Collaborative Product Development

The study also aimed to gather opinions on the perceived risks of collaborative product development. Respondents were asked to indicate the major risks which, in their experience, attend product development collaboration. An open-ended question format was used, and the responses obtained were categorized by the researchers. The results are given in Table 5.

The risk of giving proprietary information to a col-

**Table 5. The Major Risks of Collaborative Product Development***We Asked an Open-ended Question:**In Your Experience, What Are the Major Risks of Collaborative Product Development Relationships?*

	% of Respondents Mentioning Factor
Leakage of information	33
Loss of control/ownership	31
Development takes longer	31
Differing aims and objectives lead to conflict	27
Other party pulls out/becomes less committed	23
Collaborators can become competitors	11
Increased costs of development	10
Collaboration continues after commercial benefit has gone	3
Products become too specified to single customer's needs	2
Other	10

laborative partner was the most frequently mentioned risk of collaborative product development (by 33% of all respondents), supporting the emphasis in the literature on establishing limits to the scope of a collaboration. Such information may include market intelligence, experience or general "tacit" knowledge, any of which may comprise all or part of a firm's unique contribution to its competitive position. The 11% of respondents mentioning the risk that collaborators can become competitors highlights the issue. One participant's experience is described in Exhibit 1.

The risk that a partner pulls out of a collaborative product development project or, often more frustratingly, becomes less committed to the project or changes its view of the project's objectives were also

#### Exhibit 1. A Respondent's Experience: The Risks of Collaborating With Competitors

A major manufacturer of communications systems and related equipment recently terminated a two-year collaboration with a direct competitor. The two organizations had worked for the past two years on the development of an innovative communications product.

This joint product which we spent two years working on was never fully developed. The project was just too close to the main core competitive competencies of both of us and there was far too much secrecy and politics for the relationship to develop in a beneficial way.



identified as significant factors, these risks being identified by 23% and 27% of respondents respectively. These are general difficulties when a commitment to progress is not shared by one's collaborators. As one respondent stated:

Eventually, we thought we were the only company involved to which success was of prime importance. There were certainly differing priorities in the respective organisations and [one company] went on to become something of a competitor.

A number of respondents also identified the problems involved in terminating such relationships or moving to a new and potentially more committed partner to continue developing the product, especially where issues of internal property rights are involved. This is reflected in the comment contained in Exhibit 2.

### Factors Affecting the Outcome of Collaborative Product Development

Given the substantial emphasis in the literature on the factors leading to collaboration success, we carried out our own analysis of the factors affecting the outcome specifically of product development collaborations. This was approached from two angles. First an analysis of the factors discriminating between respondent-nominated examples of "successful" and "less successful" collaborations was undertaken. The issue of identifying "successful" collaborations is one which has received some attention in the literature and was discussed earlier. In our analysis, examples of "successful" and "less successful" collaborations were self-nominated by respondents in order to avoid the

difficulties of classification by the researchers. Further discussion of the way in which "success" was defined by respondents is contained in Leverick and Littler [35]. Second, survey respondents were asked freely to indicate the factors which, from their own experience in collaboration management, contributed most to successful product development collaboration. The use of this second approach to the research issue mirrors that of Link [37] who, by asking respondents themselves to nominate general product development "success" factors, actually discovered at least two factors previously unidentified in the literature.

#### *Factors Discriminating Between Self-nominated Examples of Successful and Less Successful Collaborations*

Table 6 contains a list of twenty factors that, after a review of the literature, were considered by the researchers as suggested influences on the outcome of product development collaborations. Respondents were asked to indicate the extent to which each of the factors shown in Table 6 was present in a self-nominated example of a "successful" collaboration and a "less successful" collaboration using a scale of 1 (strongly disagree) to 5 (strongly agree). In order to achieve a measure of the importance of each factor in discriminating between successful and less successful collaborations, the mean scores of each factor were calculated for both the successful and less successful collaborations. Here, the results of this exercise are summarized by listing the difference between the mean scores achieved by each factor.

Further analysis was carried out by focusing on the responses of those organizations in the sample with proportionally more experience of collaborative product development in the last two years.<sup>2</sup> The purpose of this exercise was to examine whether different factors become more or less significant in discriminating between successful and less successful collaborations as organizational experience in collaboration is accumulated. The difference between the mean scores for the respondents classified as having *proportionally more*

#### **Exhibit 2. A Respondent's Experience: The Risk of a Partner Losing Interest**

Company X, a telecommunications equipment manufacturer with little previous experience of collaboration product development, entered into a collaboration with a software house in 1990 to produce an innovative radio system. Two years on, the project was still some way from completion and Company X, although keen to continue development of the product with an alternative partner, has not yet found an acceptable way to implement this, as their original collaborator is effectively blocking the move.

After nearly two years our partner has still not delivered as promised. The project became a back-burner for them, mainly due to financial restrictions they have been encountering. Due to internal property rights issues, it is very difficult to move to another partner.

<sup>2</sup> "Experience in collaboration" was proxied using the responses to one particular question in the questionnaire that required respondents to estimate the proportion of major new product developments that had been carried out collaboratively over the past two years. Responses were categorized as either "under 25% of product development" (63% of respondents) or "25% of product development or over" (37% of respondents). It was this 37% of respondents that was classified as having "more experience of collaborative product development." It is important to note that what was being assessed here was *organizational* experience of collaboration, rather than the experience of individual respondents.

**Table 6. Factors Discriminating Between Successful and Less Successful Product Development Collaborations**

Factor	Difference in Mean Score (LESS experience)	Difference in Mean Score (MORE experience)
The collaborating partners failed to contribute as expected	2.17	2.67 <sup>a</sup>
There was a lack of frequent consultation between the collaborating partners	1.67	1.64 <sup>e</sup>
Benefits between the collaborators were perceived as "evenly" distributed	1.21	1.43 <sup>a</sup>
The relationship was perceived as being very important to the collaborators	1.17	1.14 <sup>e</sup>
There was a champion for the collaboration	1.07	1.27 <sup>a</sup>
There was little "trust" between the collaborating partners	0.67	2.14 <sup>b</sup>
A long-term view of strategic benefits was taken	1.10	0.86 <sup>c</sup>
There was little consultation between marketing and technical personnel	1.17	1.05 <sup>c</sup>
There was clear project planning with defined "task milestones"	1.14	0.76 <sup>c</sup>
Adequate staff resources were made available to the collaboration	0.89	1.19 <sup>a</sup>
Little attention was given to marketing issues	0.73	1.24 <sup>b</sup>
Sufficient budgetary resources were made available to the collaboration	0.66	0.90 <sup>a</sup>
Senior management were closely involved in the collaboration	0.50	0.95 <sup>a</sup>
Sufficient time resources were made available to the collaboration	0.71	1.10 <sup>a</sup>
Corporate systems and management style were flexible	0.43	1.33 <sup>b</sup>
Specific roles and responsibilities were not clearly allocated	0.82	0.23 <sup>c</sup>
The product development did not fit naturally with existing businesses	0.30	1.00 <sup>b</sup>
There was little previous experience of collaboration management	0.17	0.23 <sup>c</sup>
Purely financial measures of progress in the collaboration were avoided	0.37	0.24 <sup>c</sup>
The product or concept being developed was highly innovative	0.73	1.09 <sup>a</sup>

<sup>a</sup> More important in experienced respondents (difference of 0.1 to 0.5).

<sup>b</sup> Very much more important in experienced respondents (difference of >0.5).

<sup>c</sup> Less important in experienced respondents (difference of 0.1 to 0.5).

<sup>d</sup> Very much less important in experienced respondents (difference of >0.5).

<sup>e</sup> Equal importance in less and more experienced respondents (difference of <0.1).

and *proportionally less* experience of collaborative product development are both presented in Table 6.

Table 6 indicates that a number of factors were established as particularly influential in contributing to collaboration success, regardless of the extent of organizational collaboration experience. The most powerful discriminating factors between successful and unsuccessful collaborative product development projects were whether: the collaborating partners contributed as expected; there was frequent consultation between partners; benefits were perceived as evenly distributed; the relationship was perceived as important by all parties involved; there was a "collaboration champion"; and whether there was a substantial degree of trust between collaborating parties. Clearly, it is possible to influence all of these factors to a greater or lesser degree. These findings are therefore of some considerable importance to companies hoping to increase the probability of achieving a relatively successful collaboration.

At this point, it is worth briefly noting two issues. First, it is clear that there is some overlap between the factors contributing to "successful" product develop-

ment per se and the factors contributing to successful *collaborative* product development. Of the factors identified, the need for consultation between all those involved in developing a product; the level of importance attached to the project by those involved; and the need for a "champion" for the project have all been previously identified as affecting product development outcome [4,30] and therefore it is not surprising that they are also identified as strong discriminators here. Of perhaps more interest, therefore, are the factors related specifically to the collaborative aspect of joint product development, specifically evenly distributed benefits and trust between partners.

Second, correlational tests show that there is at least some degree of multicollinearity between variables. In particular, the three factors relating to resource allocation ("adequate staff resources were made available to the collaboration"; "sufficient budgetary resources were made available to the collaboration"; and "sufficient time resources were made available to the collaboration") were highly correlated, as were the two factors relating to consultation between partners ("there was a lack of consultation between the collab-

orating partners” and “there was little consultation between marketing and technical personnel”).

Bearing these issues in mind, when the responses of organizations with proportionally *more experience* of collaborative product development are considered, a number of factors increased considerably in their discriminatory power. Most notable were the following (see Table 6):

- the presence of trust between collaborating parties;
- the attention paid to marketing issues;
- flexibility of management systems and style;
- the fit of the project with existing businesses.

The importance of paying attention to marketing issues and of the relatedness of a product development project with existing businesses are again factors that are frequently cited as affecting the outcome of product development per se. The role of trust in successful collaborative product development, though, is clearly important. This becomes the second most powerful discriminator among organizations with proportionally more collaborative product development experience. It is interesting to contrast this finding with one presented earlier: that a major risk of collaboration is seen to be the leakage of information outside the remit of the collaboration. This is perhaps supportive of the emphasis in the literature on the need in collaboration management to balance the establishment of trust with the need also to protect the proprietary interests of the firm. Although the creation of a climate of trust might appear to be in direct conflict with the notion of establishing limits to the skills and knowledge exchanged in product development collaborations, it seems feasible that over time, as trust is built up, the need to limit the scope of the collaboration might decrease. Similarly, as trust, experience and success builds between partners, what was initially a specific project can lead to larger, extended collaborative relationships. It is important to note at this point the importance of developing a wide base of trust between organizations that is not specific to individuals, given that such individuals may leave the company or the specific collaborative project in question [13].

It is also worth commenting on the role of flexibility in collaborative product development projects. “Flexibility” had little discriminating power between the “successful” and “unsuccessful” collaborative projects of less experienced respondents; however,

among organizations with proportionally more collaborative experience it becomes the fifth most powerful discriminating factor. The nature of the product development collaboration may need to be adjusted and even redirected with changes in its operating environment. Moreover, what might start out as a highly structured relationship with clearly defined responsibilities and objectives in terms of developing a product may evolve into a more fluid, open-ended relationship as collaborating parties develop mutual respect and trust, the collaboration is seen as successful and more widespread mutual interests are recognized by the participants.

#### *Respondents' Own Experience of Factors Affecting Collaboration Outcome*

Respondents were asked to indicate the major factors that, in their experience, contributed most to the success of collaborative product development. An open-ended question format was used and the responses obtained were categorized by the researchers. These categorized responses were then grouped further to reveal that six types of response were particularly frequently mentioned: *choice of partner*, *establishing the ground rules*, *ensuring equality*, *process factors*, *people factors* and *environmental factors* (see Table 7). It should be noted here that these grouping are somewhat arbitrary and are significant only for the purposes of simplifying the presentation of results. However, they do reflect, to some degree, an existing emphasis in the literature on collaboration and are closely related to the previous research findings grouped by theme in Table 1 earlier. As before, the responses of the organizations with proportionally more collaborative product development experience are contrasted with those with proportionally less experience.

Factors relating to the initial choice of collaborative partner are an area of considerable interest as these are issues specifically related to collaborative product development. They were clearly more likely to be stressed by the more experienced respondents, being mentioned by 43% and 21% of respondents with more and less experience of collaboration respectively. Compatibility of the respective organizational cultures, modes of operation, and areas of expertise, the need for mutual understanding between partners and the need for past collaborative experience were the specific factors mentioned.

Assessing the compatibility of the cooperating

**Table 7. Respondent Specified Factors Affecting Outcomes of Collaborative Product Development**

*We Asked an Open-ended Question:  
In the Light of Your Experience, What Factors Contribute to the Success or Failure of Product Development Collaborations in General?*

	More Experienced Respondents (% Mentioning Factor)	Less Experienced Respondents (% Mentioning Factor)
Choice of partner	43	21
Culture/mode of operation	15	14
Mutual understanding	15	14
Complimentary expertise/strengths	20	4
Past collaboration experience	3	—
Establishing the ground rules	63	64
Clearly defined objectives agreed by all parties	43	54
Clearly defined responsibilities agreed by all parties	20	29
Realistic aims	15	11
Defined project milestones	18	7
Process factors	33	61
Frequent communication/consultation	23	29
Mutual trust/openness/honesty	23	25
Regular progress reviews	15	18
Ensuring collaborators deliver as promised	—	29
Flexibility	5	4
Ensuring equality	53	32
Mutual benefit	35	21
Equality in power/dependency	18	14
Equality of contribution	—	21
People factors	50	50
Commitment at all levels	25	25
Collaboration champion	8	11
Top management commitment	13	21
Personal relationships	10	18
Staffing levels	5	4
Environmental factors	30	11
Market need for product	25	11
Other environmental factors	5	4

organizations in terms of culture and mode of operation was noted by a number of respondents as an issue meriting consideration at the outset of a collaboration and, ideally, in advance of any cooperative agreement being made. Of course, this is often going to be problematic, as has been discussed earlier. See also Exhibit 3.

It was factors concerned with the process of initially setting up the collaborative development project—establishing the ground rules—which were by far the most frequently mentioned in the survey as contributing to success by both more and less experienced respondents. Whereas such factors are clearly important in any product development project, it is suggested that they achieve a heightened importance in collabora-

tive product development, where two or more parties need to be clear about their objectives and responsibilities. Of these factors, the need for clearly defined objectives agreed by all parties was mentioned most frequently (43% of more experienced respondents; 54% of less experienced respondents).

This was a factor that was not specifically tested for in our analysis of the factors discriminating between more and less successful collaborative product development. However, other similar factors relating to establishing the ground rules for the collaboration were found to be significant in our discriminatory analysis: in particular, ensuring that there is clear project planning with defined task milestones.

Five factors relating to the process of collaboration

### Exhibit 3. A Respondent's Experience: Dealing With Organizational Differences

Comtel and ATN collaborated for three years on the development of Product Z. The two organizations have not found doing business together to be easy. Comtel considers itself to be "marketing led" and "flexible," whereas ATN is seen as "engineering oriented," "rigid and inflexible," and "excessively formal." Negotiating with ATN is described by Comtel as "painful in the extreme."

[ATN] always brought lawyers with them who argued about the use of words, whereas we just wanted to get things done.

There is little doubt among managers at Comtel that the differences in culture between the two organizations have considerably slowed progress. Comtel has dealt with the situation simply by learning to live with the differences in culture and accepting that "that's the way ATN is."

In the end you have to accept it. If [ATN] has to have everything in writing because they're scared stiff of getting the sack otherwise, you have to accept it.

Comtel has been able to effect such an acceptance throughout its own organization primarily through the significant role played by its technical director, who has expended considerable effort to keep the relationship going when differences in operation threatened to break it up.

product development were consistently mentioned by survey respondents: the need for frequent communication, mutual trust, regular progress reviews, ensuring collaborators deliver as promised, and flexibility. Again, some of these factors are clearly important to all cases of product development. The importance of frequent consultation between parties is one of these. It was also one of the most significant factors found in our earlier analysis to be present in successful collaboration product development projects. Survey respondents point to the fact that the time and cost spent on building up mutual understanding and in checking on the progress of the collaborating parties can prevent significant and often far more costly difficulties later in a collaboration.

However, the importance of establishing trust between collaborating parties assumes considerably more importance in collaborative product development relationships, although such issues are also apparent in the relationships between marketing and technical personnel in any product development process. Trust was mentioned here by 25% and 23% of less and more experienced respondents respectively. As Dodgson [13] emphasizes, it is important to focus on developing a "trust" between organizations that is independent of the individuals involved.

Managing to ensure equality, or, more importantly, perceived equality between parties, was a factor found to be of importance by both our literature analysis and by respondents themselves. It was also more frequently mentioned by respondents with proportionally more experience of collaborative product development, 53% of more experienced respondents giving responses relating to this factor. Somewhat surprisingly, the emphasis among the more experienced respondents appeared to be placed on equality of *benefits*, whereas among less experienced respondents equality of *contribution* was stressed. No immediately obvious explanation of this result is apparent. It may be that what is of significance is that the benefits received by each collaborator are seen to equate to the contribution made.

Factors relating to the personnel involved in product development collaborations were indicated as contributing to the success of such relationships by 50% of all respondents. "People" issues are of interest in all product development projects, but achieve a heightened significance where relationships span organizational boundaries. Of the "people factors" stressed, the need for commitment from all personnel involved at all levels was seen as the most important. A number of these respondents warned that it only takes one key individual to block collaboration progress. The need for a "champion" or mentor for the collaboration was also stressed, confirming the finding of our earlier analysis that the role of the collaboration champion may be an important contributing factor to a successful outcome. As one respondent noted:

The mentor requires an unshaken belief in the collaboration. The mentor is a negotiator extraordinaire who will bridge the organizations which are joining in partnership. It is the mentor who has the commercial acumen to manage the legal and commercial relationships to bring about a harmonious collaboration. A key responsibility of the mentor is to bring together a collaboration which can operate in harmony.

Finally, the influence of factors in the wider collaboration environment, although not the most frequently mentioned factor, was stressed by many respondents, significantly, mainly by those respondents with proportionally more collaborative product development experience. One situation is illustrated in Exhibit 4. Of more experienced respondents 30% (as opposed to 11% of less experienced respondents) identified such "external" factors as contributing to the success of collaborative product development projects. A number

#### Exhibit 4. A Respondent's Experience: The Influence of the Collaboration Environment

Telzone and Pace collaborated for 18 months on the development of Product Z, an innovative product. On both sides there was a strong corporate emphasis on maintaining close communication and good working relationships and "making the relationship work." Face-to-face meetings between established "development teams" in each organization were frequent, with periodic meetings between the respective managing directors of the two organizations. The relationship was described as:

essentially a joint process, where a product is developed that each party has made an investment into.

Market response to Product X was highly disappointing and, due to poor sales, it was withdrawn from the market within 18 months. It was the impact of factors outside the scope of the collaborative process that had a significant impact on this outcome. Although considerable attention was paid to the internal management of the collaboration, it was only when Product Z was launched that it became apparent that it was not offering customers appreciable advantages over products that were already available. It may be that collaboration processes concentrated too much on ensuring interorganizational harmony and on preserving social relationships rather than on the development of a marketable product.

of factors outside the specific remit of the management of the process were mentioned by respondents as having an important influence on the outcome of collaborations, the most frequently mentioned (by 17% of respondents) being market or customer preferences. It is important that consideration of customer needs, which has been so frequently stressed as a contributor to new product performance, is not neglected in a collaborative product development project.

To summarize the results presented in Tables 6 and 7, the survey supports the view that there are a number of factors that discriminate between successful and less successful collaborative product development projects. Some of these factors are of importance in all product development projects, whether collaborative or not and these are as follows:

- having frequent communication between those involved in development;
- the product development relationship being perceived as important;
- having in place a product or collaboration champion.

Other factors are of *unique or heightened relevance in collaborative product development projects*. Our analysis pointed to the importance of:

- ensuring partners contribute as expected;
- the perception of even benefits between partners;
- building trust between partners.

For those respondents with proportionally more experience in collaborative product development, a number of factors assumed heightened importance in one or both of the analyses performed. These factors included the role of trust between collaborating organizations, the role of flexibility in corporate systems and management style, the fit of the product development project with existing businesses, the choice of collaborative partner, ensuring equality of benefits, and the role of wider environmental influences on collaboration outcome, especially issues of marketing and customer preferences.

#### Conclusions

As has been noted, it is widely argued that collaboration brings a range of benefits to the product development process. These include the acquisition of a wider range of skills and competencies and a reduction in the costs, risks, and time taken to develop products, the latter seen as especially important given the widely held view of the rapid pace of technological and market change and the consequent shortening of product life cycles and the need to market products quickly, ahead of competitors. The costs of collaborative product development have received less explicit consideration. However, some authors *have* outlined the risks joint development brings, such as leakage of company skills and assets to a partner and, although stressed less frequently, the financial and time costs of administering a collaboration and a reduction in direct control over the direction the product development takes. Against this background, the quest to identify factors contributing to collaborative product development success has been extensive and has tended to focus on collaborative "inputs" (such as choice of a suitable partner, establishing clear objectives for the collaboration, allocating sufficient resources and drawing up procedures for accountability and control), and ongoing collaboration management factors (such as ensuring frequent communication between partners, frequently monitoring progress, building a climate of

“trust,” and attempting to ensure equality of contribution and benefit).

It is evident from our study of collaborative product development in information and communications technology sectors that the “downside” of collaboration has been encountered by many of the participants. Over 40% of respondents expressed the view that, in their experience, collaboration makes product development more costly, more complicated, less efficient, more time consuming, and more difficult to control and manage. However, negative views of collaboration were clearly not universally held and, indeed, analysis pointed to the possibility that some of the major risks of collaboration are lessened as experience in collaboration is gained.

Although the research was not primarily oriented to generating formulae for achieving “successful” collaborations, a number of factors *were* highlighted as discriminating between more and less successful collaborative product development arrangements. Some were factors that would be of importance to any product development project; others assume particular significance to specifically *collaborative* product development.

Although these results are clearly of interest to those involved in the management of collaborative product development projects and support some of the advice contained in previous literature in the area, a note of caution should be sounded. First, the measurement of collaborative product development “success” is no more straightforward than the measurement of unitary product development success, and is probably even more difficult, as has been discussed earlier. The value of a collaborative product development project that does not meet the objectives set out for it could be measured in terms of the experience in collaboration management gained, although our analysis did not clearly point to past experience in collaboration management as a factor significantly affecting collaboration outcome. What might be of considerable importance, then, is the establishment of procedures by which organizations can learn from past experience of collaboration management.

Second, it would appear inappropriate to suggest that there are a set of mechanistic “rules for success.” There are so many intangible and unpredictable factors specific to a collaboration that might affect the manner in which it develops. The nature of the product being developed, the past experience of the developing parties, or the size of the organizations involved may all have an influence. In the survey reported here the

focus was on specific collaborative projects aimed at developing a single product or a group of products. However, collaborative product development may often be more realistically depicted as an evolutionary process with its form, scope, and the reasons for its initiation and continuation changing considerably over time. Whereas the establishment of ground rules, objectives, and responsibilities for collaboration were found to be of considerable importance, this might also be balanced with the equally important role of maintaining flexibility among collaborating parties. Thus, there is clearly a tension between agreeing to a tight operational procedure and at the same time providing the freedom to deal with the unanticipated, such as changes in the environments of the parties to the collaboration or particular unpredicted technical problems. It was such flexibility, more than any other factor, which was found to increase in importance as a discriminator between examples of successful and less successful collaborations as experience in collaboration management was gained. In collaborations regarded as successful by respondents, the establishment of ground rules was an important starting point but this was not to say that they may not be adapted as the collaboration progresses. What starts off as a single focused collaboration to develop a product may have the potential to develop into a less formal and more general exchange relationship as trust and confidence grows. Indeed, we suggest that collaborations are often likely to proceed from the tightly focused to the relatively open-ended in this way. Under this scenario, the costs and benefits of collaboration are understandably difficult to quantify as so many are intangible, and consequently the assessment of collaboration beyond the achievement (or not) of specific aims and objectives is largely a matter of judgment and individual perspective.

Third, there must be a point where the value of a collaboration to a company concerned with product development should be questioned, especially given the more negative experiences of collaborative product development reported by respondents here. It is as well to be aware that there are likely to be substantial social, personal, and political drivers to ensure that a collaboration is perceived as “successful” by those concerned. This may have the effect of focusing efforts too much on the internal processes of collaboration rather than on the benefits it is bringing to product development itself. Attention can be directed to building up personal relationships, ensuring good communication, and the development of planning and control

methodologies, but at the expense of market, competitive, and other factors in the wider collaboration environment that may also have a bearing on the eventual performance of the product being developed. The role of such factors in influencing the outcome of product development collaboration was one stressed by respondents to the survey with proportionally more collaborative experience. We suggest that there is a case for viewing collaboration product development as an extreme case of new product development per se. Thus, as is the case for all new product development, the importance of upfront investment made in the early stages of the project is paramount. Such investment in the case of collaborative product development refers to such factors as effort made in the identification and selection of a collaborative partner, the acclimatization necessary to adjust to each other's ways of working, and time spent in establishing procedures to deal with unpredicted eventualities, such as establishing a program of frequent meetings between parties. That is not to say that investment in such upfront work negates or lessens the need for retaining flexibility. Collaborative arrangements, like any aspect of company strategy, will always be subject to the unpredicted. Much is also likely to depend on the personnel involved in the collaboration and the manner in which they interact with each other. Freeman recognizes the critical contribution of such personal and sociological influences, arguing that:

... cultural factors such as language, educational background, shared ideologies and experiences and even common leisure interests continue to play an important role in networking'' [18].

Overall, it might be concluded that effective product development collaboration management is concerned with balancing diverse and sometimes contradictory influences: managing to achieve a balance between establishing initial ground rules concerning objectives and responsibilities for the collaboration and maintaining the flexibility for the collaboration to develop in unplanned yet beneficial ways; between erecting boundaries around proprietary knowledge and skills and building a climate of trust; between putting in place internal management and procedures to promote the smooth functioning of the collaborative relationship and ensuring the wider environmental and market factors are not neglected; and between monitoring the progress and outcome of the collaboration according to the objectives set for it and recognizing the wider nature of outcomes and the more intangible

benefits collaboration can bring. Whatever balance of concern applies in a particular collaborative relationship, it is evident that management of that relationship will have a crucial influence on its eventual success, whether in the longer or shorter perspective.

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