SWP 10/98 CUSTOMER SUPPORT AND PRODUCT INNOVATION: THREE EXPLORATORY CASE STUDIES

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ABSTRACT

Customer support is an essential element in the successful marketing of many types of products, from computer systems to white goods, since it plays a key role in achieving customer satisfaction. Therefore, it is a key issue to be considered during new product development. However, support has largely been neglected by researchers investigating new product development—there has been a steady stream of publications identifying the importance of considering manufacturing requirements at the design stage but comparatively little has been published on the ways in which customer support requirements need to be evaluated. This paper describes three case studies which illustrate the importance of evaluating support during new product development. This exploratory research was conducted at leading companies in different industries and it clearly demonstrates the key role of support in different markets and the complexity of developing products which are easy and economical to support. The research has implications for all managers responsible for product innovation, as it provides insights on how support planning should be a fully integrated component of new product development. The results also highlight the need for researchers to further investigate the role of customer support in new product development.

INTRODUCTION

Purchasers of many types of products, ranging from high-technology computer systems to white goods, require customer support at some time—assistance to help them gain maximum value from their purchases. Manufacturers need to ensure that appropriate levels of support are available for their products and typical forms of support include installation; documentation; maintenance and repair services (generally termed *field service*); user training; telephone support; and equipment upgrading. Customer support—also referred to as *product support* or *after-sales support*—is essential for achieving customer satisfaction [Lele and Sheth, 1987]; can provide a competitive advantage; plays a role in increasing the success rate of new products [Cooper and Kleinschmidt, 1993]; and can be a major source of revenue [Knecht et al, 1993]. However, support is a neglected area on which too little has been published [Hull and Cox, 1994], although, "increasingly, after-sales customer service is... being recognized as an important research priority" [Loomba, 1996].

This article reviews the literature on customer support and describes case study research which had two main objectives:

- To investigate the importance of after-sales support in achieving customer satisfaction in three different industries
- To determine the approaches taken by companies during new product development to ensure that products are developed which are easy and economical to support.

The results show that customer support is important in the three different markets—telecommunications, automobiles and vending machines. They also show that leading companies invest significant time and resources to evaluate support requirements during new product development (NPD). The research has implications new product development managers in any industry where support plays a significant role. Due to the importance of the area, further investigations are necessary and suitable areas and approaches are recommended to researchers.

CUSTOMER SUPPORT

From the literature, seven main elements of after-sales support can be identified over the working lifetime of products. These are: installation; user training; documentation; maintenance and repair; on-line support including software support; warranty; and upgrades. The main aspects of these elements are:-

- *Installation.* For many types of products, the first element of product support following the sale is installation. For large or complex products (e.g. computer systems), or products where safety issues are involved (e.g. medical devices) this may be performed by personnel from the manufacturing company. Increasingly, where product design allows it, customers themselves will install their purchases and manufacturers face the challenge of making this easy for customers who are not technically-minded. A good example of the importance of easy installation is that IBM realised in 1990 that their personal computer (PC) customers placed a strong emphasis on being able to unpack their purchases and have them running quickly. This led to products with pre-installed software and which consequently could be unpacked, assembled, switched-on and use in use within five minutes [Haug, 1990]. Ease-of-installation can also be an important consideration for software products, in such sectors as networking products [Taylor, 1995].

- *User Training.* The complexity of some types of equipment necessitates that manufacturers provide good training for users. For example, hospital staff need to be well-trained in the use of critical care devices [Cespedes, 1995][Goffin, 1998] and the successful implementation of process innovations, such as new manufacturing equipment, depends on extensive training being given over a long period [Athaide et al, 1996]. Many computer-based products include functions which help users learn to use them more efficiently; these can range from simple *Help* functions, to full training packages as offered by manufacturers such as IBM [Bauer et al, 1992]. However, training costs can still be very high—business users have to invest significant amounts of money in training their employees in efficient use of personal computers [Taylor, 1995]. For simpler products training may not be necessary and details of product operation are usually provided for in user documentation.

- *Documentation.* Most products have some form of documentation and in industries such as medical electronics it plays a key role [Goffin and Price, 1996]. Typical forms of documentation cover equipment operation; installation; and maintenance and repair [ibid]. Good documentation can lead to lower support costs and increased productivity [Miskie, 1989], however, documentation for many types of products is poorly written and too hard understand [ibid] [Anonymous, 1997]. New technology is being applied to documentation and, for example, CD-ROMs are making car servicing more efficient [Fisher et al, 1991].

- *Maintenance and Repair.* Historically, maintenance and repair has been an important element of product support which has required companies to invest

significant resources. For example, an estimated 500,000 car mechanics are employed in the USA [Mandel, 1995]. If equipment fails, fast and efficient repair is essential in many markets because "down-time costs run typically at anywhere from 100 to 10,000 times the price of spare parts or service" [Knecht et al, 1993]. In markets where product failure has strong implications—for example computer systems for financial institutions—companies need to adopt a strategy to offer either equipment which is very reliable (or even *never fails*), or a *rapid response* to expedite repairs [Lele and Karmarkar, 1983]. One way to achieve a fast response is to provide customers with *loaner* equipment in the event of breakdowns, where this is feasible [Loomba, 1996]. Another strategy for maintenance and repair is to design *disposable* products, the approach used by some companies for watches, torches and other products. If repair costs do not exceed a significant percentage of product replacement costs, having *repairable* products is still the best strategy for companies [Lele and Karmarkar, 1983]. It makes sense for companies to develop good *diagnostics* for repairable products—an efficient means to test for problems and identify the causes [Karmarkar, and Kubat, 1987]. In order to repair faulty equipment, companies need to have efficient management of *spares*, the parts which will be used as replacements. Some companies have focused strongly on this area, to gain an advantage over their competitors [Lele and Sheth, 1987]. However, where products are becoming cheaper and more reliable, as is the case with PCs, service is becoming less viable [Mandel, 1995].

Maintenance, also referred to as *preventive maintenance*, is undertaken to clean, refurbish or replace parts of equipment which otherwise would be liable to fail. Mechanical parts, for example, normally require regular maintenance as in the case of cars. In the computer sector, where less mechanical parts are involved, new technologies—termed *remote support*—have enabled computers to be "updated... diagnosed and repaired" by linking them to manufacturers' support centers via telephone lines [Bauer et al, 1992].

- *On-Line Support.* Telephone advice on products is a major element of customer support in many industries. Product experts give on-line consulting to customers to help them use products more efficiently or, in the case of problems, to trace the cause of a fault (*troubleshooting*). Whenever problems can be solved over the telephone, costs are much lower than an engineer having to visit the customer site. On-line support is particularly strongly utilised for software products (*software support*) [Armistead and Clark, 1992]. For example companies such as Microsoft have invested significant resources in telephone centres [Dubashi, 1992] and support costs are typically 6% of revenues in the software industry [Blaisdel, 1990]. Many software products can now be remotely configured, so that they more exactly match customer requirements—for example, Microsoft's Windows 95 product has this capability [Taylor, 1995].
- *Warranty.* Manufacturers of most products offer warranty and, in some markets such as automobiles, manufacturers may try to gain a competitive advantage by offering longer warranty periods. Warranty reduces the financial risk of owning products and warranty is an important element of customer support [Loomba, 1996] [Lele and Sheth, 1987].
- *Upgrades.* Offering customers the chance to enhance the performance of existing products by adding extra features can be an important aspect of support [Cespedes, 1995] [Davidow, 1986]. It is common practice for computer manufacturers to sell upgrades because they increase the working lifetimes of products and can be a

significant source of revenue. Manufacturers have a competitive advantage in this business because they normally have records of where equipment has been sold [Kneckt et al, 1993].

Over the last fifteen years a change in the scope of support and in the recognition of its importance can be identified from the literature. In the early 1980s, when many products had high failure rates, the most important aspect of support was fast and reliable repair [Lele and Karmarker, 1983]. However, due to the influence of new technologies, which have led to more reliable but often more complex products (with many software-based functions), the scope of support has broadened and now includes a greater emphasis on elements such as user training and on-line support. This change in scope is reflected in the greater use of the term *customer support*, as opposed to *customer service* which was the more common term used in the past [Clark, 1988]. Many companies are now responding by taking a more professional approach to customer support than they did in the past [Kneckt et al, 1993].

The choice of the distribution channel for customer support is important [Loomba, 1996]. Manufacturers need to decide whether products will be supported by their own organisation, or for instance through dealerships (for example, a common practice by car manufacturers). The choice of the distribution channel depends largely on the sales channel used for the product [Loomba, 1996], and both the complexity of products and the degree of "in-house" control that a manufacturer wants to exercise over customer support [Armistead and Clark, 1992].

The Importance of Support
There is ample evidence in the literature that product support is a key source of revenue; an essential factor in achieving customer satisfaction; and can be a means of gaining a competitive advantage.

The total world-wide market for high-tech support is estimated at $400 billion [Blumberg, 1992] and, in a range of industries from consumer electronics to textile machines, the importance to manufacturers of support revenues has been identified [Kneckt et al, 1993]. Over the lifetime of a product, support costs may be greater than the initial purchase price. In the computer sector these costs are referred to as *cost-of-ownership* and "the costs of buying and operating computer hardware for the office are rather like an iceberg - most of them are hidden" [Taylor, 1995]. Consequently, as products become more complex and support costs increase, customers are demanding more economical and effective support [Loomba, 1996].

Many authors recognise that good support is essential if high levels of customer satisfaction are to be achieved (see for example [Lele and Sheth, 1988], [Davidow, 1986], [Teresko, 1994], [Cespedes, 1995] or [Armistead and Clark, 1992]). For example, it has been recognised that the successful marketing of complex, technology-based products depends heavily on "product customization, information gathering on product performance, product education and training, ongoing product support" [Athaide, Meyers, and Wilemon, 1996].

Support can give companies a competitive advantage [Armistead and Clark, 1992], [Davidow, 1986], [Hull and Cox, 1994]. It is particularly important for high-tech products [Lawless, and Fisher, 1990][Meldrum, 1995], and gives a competitive edge in the electronics sector [Hull, and Cox, 1994]. However, it can also be important in low-tech sectors [Moriarty, and Kosnik, 1989]—for example the majority of domestic appliance dealers in the US perceive service as a key selling point [Jancsurak,

1995]. For purchasers of many types of equipment, support is one of the main criteria they consider during their purchase decisions [Holak, and Lehmann, 1990][Johne, and Snelson, 1988]. Customer support has also been identified as a key element in relationship marketing—winning and retaining customers by offering them a unique set of products and services [Christopher et al, 1991], [Athaide at al, 1996]. A number of examples of where companies have won market share by focusing on support can be found in the trade press (see for example [Goffin, 1994]).

Although the importance of customer support has been recognized, its relationship to new product development has not been widely researched.

Support and NPD

The evaluation of *all* aspects of product support at the design stage has been termed *Design for Supportability* (DFS-II) [Goffin, 1998]. Engineers with experience of customer support should be involved in product development [Hull and Cox, 1994], as "by participating in the development stage, the after-sales group can add substantial value by making the equipment more 'maintenance-friendly' - by, for example, substituting more easily replaceable subunits, building in troubleshooting systems, and so on" [Knecht et al ,1993]. However, a survey of NPD practices identified that customer support personnel were only "occasionally involved in new product work" [Page, 1993].

Previous research by one of the authors [Goffin, 1998] included a detailed review of the NPD literature related to support. It showed that a number of authors have recognised the need for support requirements to be considered at the design stage (e.g. [Berg and Loeb, 1990][Cespedes, 1995][Armistead and Clark, 1992]). In addition, many of these authors were found to have recommended that support requirements be evaluated during NPD in a similar way to Design for Manufacture (DFM) techniques—which are used to ensure that manufacturing needs are considered during NPD. However, empirical research has shown that in the past many companies did not consider support until late in the development cycle [Goffin, 1990],[Goffin, 1998]. This often lead to products which were difficult to repair and which consequently had "excessive warranty and field service costs" [Anthoney, and McKay, 1992].

Product design influences both the amount of support necessary and the way it can be delivered [Garvin, 1988.] [Sleeter, 1991]. Decisions taken at the design stage affect product reliability and consequently how often products require maintenance [Lele, 1986]. Similarly, modular design can reduce repair costs [Hedge, and Kubat, 1989] as can good diagnostics [Armistead, and Clark, 1992], [Karmarkar, and Kubat, 1987]. In addition to repair and maintenance, design also influences user training (easier to use products require less training) and upgradability. Therefore, suitable designs can reduce cost-of-ownership [Blanchard, 1991]. For example, Microsoft's Windows 95 product was "specifically designed to reduce total cost of ownership through increased ease of use, functionality and support" [Taylor, 1995]. Products with high supportability have a strong differentiating factor [Swink et al , 1996].

Design for Supportability Practices

Although the need to evaluate support requirements during NPD is recognized in the literature, only sparse information is available on how this should and is done. Only four main articles (see Table 1) discuss how products should be designed to meet support requirements.

In a conference paper Livingston describes how Rank-Xerox recognized that cost-of-ownership is critical to customers and this can be minimized by reducing the costs of each and every aspect of support [Livingston, 1988]. This led to the adoption of design goals for: ease-of-use; ease-of-cleaning; easier maintenance procedures (which can be conducted where possible by the customer); clear failure diagnostics and; ease-of-repair (easy disassembly and re-assembly with minimum tools). Rank-Xerox found that it was necessary to have a clear process for deciding design priorities, as different departments may have opposing objectives. For example, manufacturing's objective is to reduce assembly costs, which may lead to a product which is easy to manufacture but hard to disassemble and re-assemble for support engineers at the customer site. A limitation of Livingston's article is that specific examples of the service/support goals are not given.

Table 1: Summary of Previous Publications Giving Details of How Companies Evaluate Support During NPD.

Article	Industry(s)	Type of Article	Company(s)	Key Points
Livingston, 1988	Photo-copiers	Detailed conference presentation on design for supportability by a company representative.	Rank-Xerox	• Rank-Xerox perform a detailed evaluation of support requirements at the design stage • Total lifetime costs are determined • Clear design goals are set for all aspects of support.
Teresko, 1994	Electronics, automobiles and plant equipment	Trade journal description of software for design for serviceability developed with a consortium of companies.	Caterpillar Chrysler Ford Hewlett-Packard	• Ease-of-manufacture, ease-of-service and recycling of products are inter-related • All aspects need to be considered at the design stage • A software package for this purpose was developed with a consortium of five companies.
Hull and Cox, 1994	Electronics and computing	In-depth case studies. Purposive sample of six companies. Main focus on field support organizations but mentions design for supportability issues	Amdahl AT&T Hewlett-Packard GE IBM NCR	"Leading" companies consider support during NPD. For example: • At IBM "field service personnel also maintain close relationships with manufacturing and perform an important role as serviceability advocates" • At NCR "maintainability and serviceability of products are a prime consideration in the design and manufacturing processes"
Goffin, 1998	Medical electronics	Survey of design for supportability at high-tech companies / Single case study	Trade association / Hewlett-Packard	• At many companies support is not considered until well into NPD • Importance of understanding the support costs over the whole working lifetime of a product.

Teresko [1994] discusses *serviceability* (ease of product maintenance and repair) and product design, suggesting that "a new design idea is surfacing in the market battle for product supremacy: serviceability". A computer-aided design (CAD)

tool is described which calculates field disassembly and re-assembly times and identifies service costs [Parker, 1993][Teresko, 1994]. This package is based on earlier software used to ensure that products are easy to manufacture. The apparent drawback to the software is that it focuses maintenance and repair and apparently ignores other elements of customer support such as user training, documentation, etc.

Hull and Cox [1994] conducted case study research at six electronics manufacturers. They focused mainly on field service issues but also identified that these leading companies assigned field service personnel to give inputs during new product development. For example at National Cash Register (NCR), a leading business information processing company, "maintainability and serviceability of products are a prime consideration in the design and manufacturing processes". Similar approaches were found at International Business Machines (IBM); Hewlett-Packard; and General Electric (GE) and Amdahl (data processing systems). Up until 1989 at American Telephone and Telegraph (AT&T) "little attention was given to product serviceability and field service. Now products are designed for serviceability and after-sales support is acknowledged as a prerequisite for product sales". Although they clearly identified that leading electronics companies consider support at the design stage by involving field engineers, Hull and Cox do not explain in detail the approaches or techniques used for the evaluation of support requirements during NPD.

A case study [Goffin, 1998] of hospital equipment identified a number of key points. Support may have to "compete" for resources with issues such as product features during NPD. Therefore, a clear understanding of the cost implications of support is essential and a change in financial reporting may be necessary to highlight these. For example, an analysis of all aspects of support over the working lifetime of a product is required to ensure a full understanding of support costs. If aspects of support, such as training, are ignored at the design stage it may be difficult to improve them at a later date due to design constraints. Although the points identified in Goffin [1998] are interesting, a serious limitation of the paper is that it only describes the approach taken at one company.

The need for evaluating customer support during NPD is clear from the literature but previous research (Table 1) has either not directly focused on this issue or has only provided single case study information. These limitations of the extant literature were the motivation for the investigation described in this paper.

THE RESEARCH

Case studies investigating the importance of support were conducted in three industries using an exploratory approach. The study investigated the following research questions in each case:

1) What are characteristics of typical products?
2) What is the importance of post-sales support in these industries?
   - in influencing potential customers
   - in contribution to revenue and profit
   - in achieving customer satisfaction
3) What are the key elements of customer support in this industry?
4) What support delivery channel is used?
5) How do companies evaluate support requirements during new product development?
   - the stage at which support requirements are considered
   - the involvement of various departments in planning support

- the use of quantitative design goals for support requirements

Case Study Design

The case studies were conducted in the second half of 1997 by holding on-site interviews with personnel from a range of departments—typically development, quality, customer support and marketing. The interviews followed a structured approach, based on a questionnaire which covered:-

- Company background
- Product characteristics
- The role of support in the organisation
- Support life cycle
- New product development

Interviews were recorded (and later transcribed) and at the same time detailed notes were taken. In addition to the direct interviews, a number of telephone interviews were held with personnel who had not been available at the time of on-site visits but interviewees had recommended the researcher to contact. Interview transcripts were prepared and footnotes added to explain any specific terms used by the respondents. A number of company documents were inspected, most of which were confidential. In some cases the sample companies were willing to give the researchers copies of these documents, in a few cases they only allowed document inspection. In addition, the researchers collected promotional materials describing the products and services offered by the companies. Detailed case files were prepared containing the transcripts, interview notes and copies of company documents.

Case analysis involved two stages. Each case was reviewed separately and the data analysed to give a complete picture of the company's approach to evaluating support at the design stage. Following this, it was possible to make cross-comparisons, to determine where similarities and differences existed and to identify a number of "best practices" [Yin, 1989].

Questionnaire Design

The questionnaire used in the interviews was very detailed (11 pages). It was designed as follows:-

- The starting point was a questionnaire developed previously by one of the authors for a survey of high-technology companies' approaches to evaluating support during NPD [Goffin, 1990]. This focused particularly on the design goals used to ensure products are easy to support.
- Modifications were made to the above questionnaire to account for findings from case studies on customer support [Hull and Cox, 1994][Goffin, 1998]. Therefore, questions were incorporated on the key elements of support over the working lifetime of products.
- Extra questions were added on the role and organization of support —these were largely based on Knecht et al [1993]; Loomba [1996]; and Hull and Cox [1994].

Sample

Three industries were selected as an exploratory sample for the research. As the computer industry had been focused by previous research (see Table 1) this was ignored; instead the car industry, telecommunications and vending machines were chosen—a purposive choice of industries. Once the industries had been identified,

"leading" companies were chosen—companies having a significant market share in their industry. In the three industries selected, actual companies were selected at random. As a motivation to the companies approached, an informal "benchmarking report", contrasting their approach evaluating customer support during NPD to that of other companies was offered. This offer was well-received and only one company declined to co-operate with the research (forcing the random selection of another company).

RESULTS: THREE CASE STUDIES

The importance of product support and how it is evaluated during NPD will be described separately for each company, before a cross-case analysis is given. As the companies were promised anonymity, they will be referred to as *TelecommA*, *AutoB* and *VendorC* respectively. Table 2 summarizes the company background and key findings on customer support and NPD. It also specifies the job titles of each of the interviewees; for instance three managers from R&D, operations and quality were interviewed at *TelecommA*.

Case 1: TelecommA

TelecommA is a leading European company in the field of telecommunications equipment and has approximately 150 employees. They design, integrate and support complex systems used in logistics applications, such as radio contact and control of fleets of vehicles. Key aspects of customer support and NPD are:-

- *Product Characteristics*. TelecommA develop what they call "base systems", using hardware from computer manufacturers. The central computer is linked to many devices such as PCs, sensing and radio equipment, with specialised software monitoring and controlling the resulting network. Base systems have a product life cycle of typically 5 years. Every system sold has a unique configuration achieved by the selection of appropriate hardware and further development of specific software to meet customer needs. Systems cost in the region of $1M and customers— normally large companies or organizations—use their systems for anything up to 20 years.

- *Key Elements of Customer Support*. Systems are complex and are installed by TelecommA engineers, although sub-contractors are used for simple work such as installing cables. A typical installation (with system testing) takes 9 working days. Systems are designed to be intuitively easy to use but users still require training— this typically takes one day and is performed at the time of installation. Once the equipment is in use, TelecommA "spend very little time on training, we do try to pass that on to the customer. We might train the trainers, if anything. We often try to do that during installation" [TelecommA—Development Manager]. All systems are sold with a 12 months hardware warranty and 3 months software warranty, which is standard in this industry. Hardware is very reliable and failure rates are typically only 1%. However, due to the complexity of networks, problems may occur with the running of the software and require investigation. A typical system under service contract consequently has an allowance of 8 engineer days reserved for problem investigation. "If they [customers] do not use it [the allowance] in maintenance they can, at their discretion, request enhancements or training courses" [Development Manager]. System documentation is produced by R&D engineers and has, in the past, mainly been written for internal use. However, some customers are now requesting comprehensive documentation for their own use in first-line

maintenance. Upgrades, which enhance system capability, are a significant business for TelecommA as customers require "flexibility for integration with other platforms and expansion" [Development Manager]. Systems typically have a major upgrade every 2 years.

- *Importance of Customer Support.* Support is "becoming more and more important, particularly to... non-technical owners of systems" [Development Manager]. Customers cannot afford their systems to be out of order and to minimise the possibility of this, TelecommA build a certain amount of redundant (parallel) processing power into their systems. In addition, they offer a quick response in the event of problems. From a business perspective, support is important because of its influence on customer satisfaction. However, it also generates about 4 percent of revenues (at margins of typically 60 percent). Although TelecommA mention support in their brochures, they acknowledge that their marketing is weak; saying "we don't sell our support well enough" [Operations Manager]. For instance, low cost-of-ownership is not promoted to customers; "we don't discuss that, unless made to. We don't actually use cost-of-ownership as a selling feature" [Development Manager]. On support issues they tend to react to the market rather than anticipate it and consequently customers "are looking for packages of support that we've never previously needed to do" [Development Manager]. "

- *Support Delivery Channel.* TelecommA have no formal field support organization and installation; hardware and software maintenance; and upgrades are organized by the Operations Manager utilizing R&D engineers. It is acknowledged that this can lead to resources being stretched: "it's a balancing act" [Operations Manager] but existing customers have, if need be, the priority over development work. As a consequence, TelecommA think they have "built up a reputation [for good support] very quickly by going in and only sending people who were able to fix the problems" [Quality Manager], compared to competitors who have a dedicated field organization but are less effective at system problem-solving.

- *Customer Support and NPD.* NPD entails taking a base system and developing it to match specific customer needs, by selecting the right set of hardware and developing suitable software. The design of a system typically takes a team of four people 6 months and a prototype system is normally running after four months. Support and testability issues are considered from the design stage but in an informal way: "our whole design ethos is to make it as simple to maintain and support as possible. There's no formal documentation" [Quality Manager]. TelecommA have no *product support plan* (a document which summarises how product support, which is common in the computer industry [Goffin, 1998]). However, as many of the development engineers have experience of supporting previous systems in the field, they are aware of customer support issues. No formal goals are set at the design stage on any issues of supportability. Therefore, for example, there are currently no formal goals to reduce installation, training or upgrade times.

Although management at TelecommA is generally satisfied with the quality of support they have offered in the past, they are now looking to improve their offering and also become more proficient at marketing, in order to gain a competitive advantage from support.

Table 2: Summary of Customer Support and NPD at the Three Case Companies.

Background			
Company	TelecommA	AutoB	VendorC
No. of Employees	approx. 150	Many 1000s	several 1000s
Main Interviewees	• Development Manager • Quality manager • Operations Manager	• Advanced Service Manager • 4 Product Support (Factory) Specialists • Financial Analyst	• Quality Manager • R&D • Quality Assurance Engineer • Product Support Specialist • Field Service Engineer
Main Products (cost of typical product)	Telecommunications systems (cost: $1M)	All types of passenger cars (cost: $15,000)	Vending systems for high-value products (cost: $15,000)
Product Working Lifetime	20 years	10-12 years	10 years (slightly shorter in US)
Key Elements of Customer Support	- Installation - Fast problem resolution - Upgrades	- Warranty - Documentation - Maintenance - Repair - Spare parts - Dealer training	- Full installation services - Documentation - Maintenance - Repair - Training staff - Goods management / consultancy - Refurbishment
Importance of Support	"becoming more and more important"	Cost-of-ownership is key and "makes a difference to repeat sales"	Support is key to "dramatically improve.. [customers'] business performance"
Revenues	4% of sales (at 60% margins)	15% of sales (25% of profits)	35% of sales (at 25% margins)
Support Delivery Channel	R&D engineers managed by the Operations Manager	Word-wide accredited dealer network for sales, service and parts	70% own service organization; third parties; customers
Customer Support and NPD	Importance of easy support is recognised but evaluation at the design stage is not formalized. No documentation.	Dedicated group with charter to ensure products have high serviceability. Formalized processes and documentation.	Strong emphasis from top management on good and economical support. Formalized processes and full documentation.
Use of Quantitative Design Goals	None.	Extensive use of goals on many aspects of supportability.	*RASUI* goals set at the design stage for all aspects of support (see text).

Case 2: AutoB

This company is a major international manufacturer of a wide range of passenger cars and has thousands of employees in its various organizations world-wide. They design, market, manufacture and (indirectly) service cars in many countries and their products are produced in very high volumes.

• *Product Characteristics.* A typical vehicle produced by AutoB costs $15,000 and has a product life cycle of 10 years (although major re-designs will take place over

this cycle). Cars are sold to not only private users but also to fleets, and this is a major segment of the business. Car design is changing fast and typical models now have a large amount of new technology in engine management, airbag control, security systems and optional navigational aids. The addition of new equipment to cars is making designs more complex and "the days have gone where you could open the bonnet [hood] and look down and see the engine. You're only going to see part of it" [Advanced Service Manager] and this has major implications for serviceability. A passenger car has a 10-12 year working lifetime, during which it will have a number of owners, with later owners typically doing much of the maintenance themselves. Currently, the average working lifetime of passenger cars is dropping in terms of years (emissions legislation is pressuring older cars to be scrapped) but the typical mileage per vehicle is increasing.

- *Key Elements of Customer Support.* In the automotive industry product support is generally referred to as service. The most important elements of customer support are warranty; maintenance and repair including parts; documentation (workshop and owner manuals); and training. Warranty is normally 12 months, although competitive pressure is changing this to 3 years in some countries. Due to their mechanical parts, cars require a significant amount of maintenance and repair and this increases cost-of-ownership. Stocking and distributing spare parts is a major part of the business for AutoB and other car companies. Although accessories—such as mudflaps and roof racks—may be sold after the initial sale, currently the automotive industry does not have an upgrade business as such.

- *Importance of Customer Support.* Customers expect cars to be reliable and reliability has doubled over the last 10 years. In addition, the level of maintenance required has improved—service intervals are now every 10,000 miles. The cost-of-ownership is a key factor, particularly for sales to car fleets. Fleet managers are very aware of the costs of running vehicles as they are published in the trade journals. Therefore "reducing cost-of-ownership sells cars" [Advanced Service Manager]. "Loyalty is what we're actually after. When I say we want lower cost [of-ownership] to sell more cars, to be more specific, it's unlikely to sell the first car but often it makes a difference to repeat purchases" [Advanced Service Manager]. Internally support is viewed as a important area; parts generate about 15% of revenues and 24% of profits.

- *Support Delivery Channel.* AutoB have a large organization responsible for managing spare parts, as it is a major part of their business. Actual maintenance for all of their products is however provided through an accredited chain of dealers all of whom must provide sales, service and parts management. To ensure that customers receive a good quality service, dealers' technicians must attend AutoB's maintenance and repair training courses—there are three levels of training and dealers must have a minimum number of staff trained to each level. AutoB "publish labour times and the dealers are required to work to those" [Advanced Service Manager]. As the service delivery channel is not directly under the control of AutoB, they experience difficulty in obtaining comprehensive and accurate data on reliability and repairs over the typical working lifetime of a car.

- *Customer Support and NPD.* For the last three years AutoB has had a specific organization of over 30 people worldwide responsible for ensuring that customer support issues are adequately considered in new designs. Their charter "is to participate early and proactively in new model development process and to represent customer services division in design decisions". Consequently, the

evaluation of support requirements during NPD has become formalized, with detailed documents produced on the way products will be supported. Goals are set at the design stage for service-related issues: *Cost-of-ownership; Serviceability;* and *Maintenance*. Documents also give analysis of how new models solve *Prior Model Concerns* and meet *Damageability* requirements. The latter is an assessment of the cost of repairing the inevitable damage that will occur in common accidents. The product *Cost of Ownership/Serviceability/Damageability Plan* comprehensively assesses the five issues mentioned, for each and every major component in a car. Design goals are defined for each part of AutoB's organization developing components and also suppliers. To convince other departments to give priority to service issues financial arguments are also used "to demonstrate the wisdom of reducing cost-of-ownership and look at the effect of poor repair capability on customer satisfaction, based on historical data and transferring that into customer loyalty and trying to put a dollar figure on it" [Advanced Service Manager].

For the future, AutoB believe that they have much to do in further reducing the cost-of-ownership on their products. They are looking closely at the work of some of their competitors in this area.

Case 3: VendorC

This company designs, manufactures, sells and supports complex vending machines—it is a significant business and, as a market leader, they employ several thousand employees based at one main development and manufacturing plant and in their field organizations all over the world.

- *Product Characteristics*. Vending companies buy large numbers of machines to provide self-service sales of a wide range of goods, some of high value. Modern vending machines—now often referred to as *Vending Terminals*—are a complex mix of mechanical, electronic, security and display technologies and a top range model can cost in the region of $15,000. The product life cycle for a design is typically 5-6 years and the machines themselves have a working lifetime of about 10 years, although this may be slightly less in the US. Due to the large amount of mechanical components in machines and their high levels of usage, regular maintenance and repair is required. Product functionality has recently been extended so that individual terminals can be linked via modems to a central computer, which remotely monitors the function, sales activity and stock levels of strings of machines.

- *Key Elements of Customer Support*. VendorC offer a *total installation service* and "manage all aspects of installation, from site surveying, architectural design and planning, to building, wiring and fitting" [Quality Manager]. Warranties are 90 days—standard in this industry and, to date, not an area where companies compete. Timely maintenance and repair is very important; equipment downtime leads to lost sales. Consequently VendorC has invested heavily in establishing an effective, largely direct, support organization. Terminals have full technical documentation for maintenance purposes and some of this is being made available over the internet. Training plays a key role; the staff of vending companies who are responsible for first-line maintenance and replenishing machines need training. (There tends to be a high turnover of this type of staff.) Using the modem links already mentioned, VendorC have the capability to offer full *goods management* to their customers—ensuring that machines are working and are replenished in a timely fashion. This incremental service is a new and important source of revenue for VendorC. It arose

from ideas generated by customer feedback to the field service function. In addition, VendorC sell upgrades; they "will carefully examine the benefits of refurbishing... used terminals to extend the usable equipment life" [VendorC brochure].

- *Importance of Customer Support.* From an internal perspective, product support is an essential part of VendorC's business; it generates 35% of sales at margins of typically 25%. These revenues are increasing as, although the equipment is more reliable and requires less service than in the past, goods management creates new business opportunities. Top management at VendorC has focused more resources on product support over the last decade due to the recognition that good support can "dramatically improve... [customers'] business performance" [Quality Manager].

- *Support Delivery Channel.* VendorC have a large field organization and 70% of all service-related activities world-wide are conducted by them directly. In some countries support is organized via third party maintenance companies and some of VendorC's larger customers use their own staff to carry out simple maintenance procedures. The performance of both the field organizations and the installed base of vending machines is very closely monitored by an elaborate internet-based system which collates data on all aspects of field service. Product reliability (e.g. downtime by product; by location; by cause; etc.) and service engineer efficiency (installation times; percentage first-time-fixes; etc.) are just two of the metrics which are reported daily by the field organization. Over 18 months work was required to create this system but "I want to point out that a huge step forward was getting data that was just about instantaneous" [Product Support Specialist]. Comprehensive data has been found crucial for early recognition of product problems and in "charging customers where their misuse / abuse led to service costs" [Product Support Specialist]. "Quality Assurance have [subsequently] worked in partnership with several key customers to perform an overall analysis of their 'system' availability" [Quality Assurance Engineer].

- *Customer Support and NPD.* New products typically require 18 months development and after 12 months a full prototype is used as the basis for a major development review. The team working on NPD is cross-functional and includes R&D, product management, manufacturing, suppliers and product support specialists. Their work is co-ordinated by a seven stage *Phase Review* plan, which specifies the key responsibilities of each department at each stage of NPD. Over the last five years, a strong focus on product support by management has led to the consideration of service issues being "pushed further back into the design" [Field Service Engineer] and the *Product & Solutions Services Planning* document is an integral part of NPD. At the design stage product support specialists analyze the *RASUI* of products—the *reliability; availability; serviceability; usability;* and *installability,* compared to typical workloads and environments. For each of these five categories a detailed analysis is performed, and design recommendations are made. Modular design, for quick replacement of faulty or worn components, is standard practice and "diagnostic capability is designed into each individual element of terminals" [Quality Assurance Engineer]. The Quality Department has the overall responsibility to take a particularly critical look at whether *RASUI* goals are met during NPD. Several of the benefits to customers of the *RASUI* evaluation are clearly identified in product brochures.

VendorC's strong focus on customer support has enabled them to use it to gain a significant competitive advantage. They offer a unique combination of reliable, highly-

functional products and a responsive field organization offering a wide range of incremental services has given them market leadership position. To maintain this position, they now intend to focus on reducing NPD cycle times.

CROSS-CASE ANALYSIS
The cases cover three very different markets but it can be seen that customer support plays an important role in each of them—managers identified that good and economical product support is an essential component of their business.

The nature and reliability of equipment obviously has a large influence over the key elements of product support. In the two companies where products have a large number of mechanical components, products require higher levels of maintenance. In the telecommunications industry hardware maintenance is less of an issue but, in all three markets customers expect reliable products and quick response in the event of failure. From the three cases, it can be seen that VendorC has been most successful at using product support, in particular incremental services, to gain a competitive advantage. Equipment retrofits or upgrades are an important element of customer support in two industries; telecommunications and vending machines. Currently they are not important in the car industry but it remains to be seen whether this will change as a an even greater amount of electronics—technology which lends itself to comparatively easy upgrades—is used in cars.

The degree with which customer support issues are evaluated at the design stage varied across the three companies. TelecommA, probably because of its small size, has the most informal approach to evaluating customer support requirements during NPD. Although R&D engineers are used as a resource for field service and therefore often have first-hand knowledge of the problems, it appears that TelecommA could benefit from a more structured approach. Both AutoB and VendorC have more formal design goals for the key aspects of customer support and use these as benchmarks for comparing the performance of different generations of products. The VendorC company appears particularly effective at ensuring product design is fully integrated with the needs of customer support—and the strong support of top management on this issue is acknowledged as being instrumental in this success

Although the sample size was small, certain best practices can be identified. These are:-
- Sufficient top management assistance in gaining cross-functional recognition of the importance of considering customer support at the design stage.
- Performing a comprehensive evaluation of support needs at the design stage and using financial models to decide whether these are design priorities.
- Closely involving customer and field support experts in NPD.
- Using data management systems to obtain timely and comprehensive data on all aspects of field support.
- Using the field service function to obtain ideas on incremental services which can give a competitive advantage and increase revenues.
- A strong focus in product documentation to identify the benefits of good customer support to customers.

CONCLUSIONS

The contribution of this research is that it provided the first empirical evidence on how support is evaluated during NPD in different industries. It showed that leading companies invest significant resources to ensure that products are easy and economical to support. Previous research [Goffin, 1990] had showed that many companies do not evaluate customer support until well into the NPD cycle and so these new findings give an idea of the commitment required to evaluate customer support needs effectively during NPD.

For researchers active in the area of new product development, there are a number of areas which require further investigation. Research is necessary to identify whether the case companies manage customer support at the design stage in a way that is typical for their industry or whether, in addition to having large market shares, the sample can be considered as being "best-in-class" in this area. To establish this, a wide survey of companies' practices is required, ideally covering several industries. The case on VendorC clearly demonstrates the competitive advantage that can be obtained from well planned support and functionality in products which supports incremental services. This requires further investigation—are a high percentage of manufacturing companies using support to gain a competitive advantage?

The research has important implications for all managers involved with new product development and, in particular top management who can exercise the greatest influence. It has clearly shown that customer support needs to be given adequate priority during NPD. If they are not already doing so, companies in other industries need to identify the best practices which are relevant to them. Customer support needs to become a fully-integrated part of product development.

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