Interorganizational Business Process Redesign: 
Merging Technological and Process Innovation

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Abstract

Interorganizational business process reengineering is a logical extension of discussions in the 1980s of the potential for interorganizational systems to fundamentally redefine relationships between buyers and sellers and even competitors within an industry context. This paper presents a framework or model describing the relationship between technological and process innovations, and describes the interdependence of these two forces in the context of interorganizational business process redesign. This framework can be used to examine unique characteristics of reengineering within a single organization and across multiple organizations. This model is used to explain the inconsistency in the literature regarding the benefits of EDI and other interorganizational systems, which are described as providing strategic competitive advantage in some articles, and as providing little or no benefits for implementing firms in other articles. The framework describes the importance of merging technological and process innovations in order to achieve the potential to transform both organizations and interorganizational processes and relationships.

1. Introduction

Business process re-engineering or redesign (BPR) has emerged as a popular management nostrum since Hammer's seminal article appeared. Re-engineering the Corporation [24] reached the New York Times Best Seller List during its first month after release, and remained on the list for 26 weeks. Recently, theorists have argued for going beyond BPR, redesign of processes within an organization, to apply BPR concepts in an interorganizational context [16, 41, 45, 48].

In this paper, we present a framework for examining the relationship between technological and process innovations, with examples of each examined as independent and interdependent innovations supporting a complete reengineering of channel relationships within the context of the US grocery channel. The second section of the paper will present a brief review of the literature to establish the context of the research and identify the issues and questions which motivated this research. The research model will then be described at a general level in the third section, followed by a discussion of the research design and methodology used to test this model. Both quantitative and qualitative research findings will then be presented using the research model as described within the context of the US grocery channel. This presentation of research findings will be followed by a discussion of the general implications of these findings for interorganizational business process redesign, and suggestions for extending this research and model more generally.

2. Literature Review

The notion of interorganizational process redesign is a logical extension of discussions in the 1980s of the potential for interorganizational systems (IOS) to fundamentally redefine relationships among suppliers, buyers and even competitors within an industry context. The potential for IOS to improve firm performance and change industry structure has been described extensively [e.g., 2, 6, 14, 25, 31, 35, 38]. Articles proclaiming cost savings and competitive advantage through use of EDI capabilities are common [e.g., 28, 46, 50]. Even so, some studies of organizations implementing IOS capabilities, such as Electronic Data Interchange (EDI), indicate little or no effect of these systems on organizational performance. The key questions driving this research are: What is the relationship between technological innovations, such as EDI, and organizational or process changes in improving channel performance? What are the direct and indirect effects of EDI on channel performance, and how

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1 Electronic data interchange (EDI) is a form of IOS that involves direct communications links between computer systems to transmit structured data in a machine readable format using a common communications standard [20].

2 Winitz [49] found that 95% of survey respondents could not identify any advantages from the use of EDI; Carter [5] observes that most firms implementing EDI did not realize the expected savings; Eckerson [18] reports "few companies have realized significant cost savings or other benefits from implementing electronic data interchange"; Hollis [29] concluded that EDI systems were largely underutilized; Diamond [17] observes that fax and e-mail are cheaper and easier to use than EDI and provide the same benefits for most firms; and McCaskill [34] states that most EDI users complain that automating the purchase cycle has not measurably affected their bottom line.

3 Indirect effects result from enabling new processes not practical without EDI which result in productivity gains in excess of the direct improvements that would result from either EDI or process innovations implemented separately.
might this information on direct and indirect effects be used to explain the productivity paradox in the EDI literature?

Many authors have noted that EDI must involve changes in business processes to realize the savings enabled by this technological innovation [e.g., 20, 41]. However, most of the process changes recommended by these authors are internal to the organization, with the primary focus on using the data transmitted via EDI more effectively within internal systems to eliminate labor and errors related to data entry.\footnote{Emmelhainz [20] describes printing and rekeying EDI orders into systems not integrated with the EDI system as simply creating an expensive fax machine. McCusker [34] describes the need to integrate EDI with internal systems, applications, and workflows to realize the potential benefits of EDI capabilities. Riggins and Mukhopadhyay [41] describe the need to integrate EDI into existing applications within the firm to avoid “door-to-door” EDI systems that provide minimal benefits from EDI.}

Swatman, Swatman, and Fowler [47] and Clark and Stoddard [13] suggest that only through business reengineering can the benefits of EDI for improving channel performance be realized. The changes recommended by these authors extend beyond integration of EDI with existing systems to a dramatic redesign of the entire ordering process. This paper provides qualitative and quantitative data to support the proposition that technological and process innovations are interdependent and both are needed to capture the potential benefits of EDI implementation through interorganizational process redesign.

2.1 IOS Importance Driven by Technology Advances

Recent interest in interorganizational connectivity has been fueled by the opportunities created as a result of the dramatic reduction in communications costs, particularly for computer-to-computer linkages and interorganizational connectivity [43, 30]. Transaction cost economics predicts that significant reductions in transaction costs can enable new organizational and channel structures [51]. The digital connectivity applications now being implemented were all technically feasible in 1980, but prohibitively expensive [44]. Organizational boundaries in the grocery industry evolved over a period of several decades to minimize the sum of transaction and production costs. Badaracco [1] suggests reductions in transaction costs enable firms to join in information alliances, reducing the need for integrated ownership structures.

Although network-organizational structures have always been technically feasible, the associated connectivity costs were too high (relative to hierarchical modes) to make the networked-organization practical [33]. Declining connectivity costs have enabled networked-organization structures to become a viable design for many complex environments [37].

2.2 IOS and Product Replenishment

Reducing channel logistics costs is essential for grocery retailers to compete with mass merchandise (e.g., K-Mart) and club store (e.g., Sam’s Club) retailers which have captured significant market share of products traditionally provided by grocery stores. These “alternative formats” for grocery product distribution used replenishment systems which provided significantly lower channel costs than traditional grocery practices [21, 32]. Changes at both suppliers and retailers in systems, structure, and policies enabled the grocery industry to overcome the logistics cost advantages held by these alternative distribution channels in the early 1990s.

The adoption of a new product supply process known as Continuous Replenishment (CRP) was one of the changes in channel processes which dramatically improved channel performance [32]. CRP is the term used in the grocery industry to describe a vendor-managed inventory process for product replenishment. With CRP, retailers transmit data on warehouse shipments or store sales to vendors, and vendors determine order quantities to ship based on this information. Retailers do not place orders with CRP, and vendors are responsible for maintaining adequate inventory levels to manage stockouts. Vendor performance is managed by the retailer by establishing targets or objectives for inventory and stockout levels to be achieved at the retailer’s warehouse.

CRP is one element of the US grocery industry’s Efficient Consumer Response (ECR) vision, and represents more than half of the projected savings resulting from implementing ECR. The ECR vision includes many programs and concepts, some of which are still evolving, but CRP is a relatively well defined approach to product replenishment which has already been implemented by many retailers and manufacturers.

CRP is similar in some ways to Quick Response (QR) for apparel retailers [25, 31] or Just-in-Time (JIT) supply in manufacturing [7, 11]. However, QR and JIT are sometimes used to describe traditional ordering processes combined with increased requirements for supplier responsiveness. As a vendor-managed inventory process, CRP is similar to the more advanced examples of QR or JIT, and represents a substantial innovation in channel processes and policies for product replenishment. CRP combines EDI with channel process and policy changes to reduce inventories, transportation costs, and stockouts in the channel. It essentially represents a new form of channel structure and relationships enabled by lower transaction costs and increased information sharing.

Although CRP is a potentially useful tool for reducing channel uncertainty and inventory levels, CRP and other forms of vendor-managed inventory processes are not appropriate for all products. For continuous or vendor-managed replenishment\footnote{Replenishment refers to ordering replacement inventory for existing products. Ordering for new products is not replenishment. Changes in existing products could be considered replenishment if the changes are minor.} to work effectively, demand must be either stable or predictable. Products that change frequently, such as fashion apparel or seasonal foods, may not be appropriate for CRP [7]. Many grocery products are relatively stable or...
3. Research Model and Framework

Two dimensions of change in channel replenishment ordering are shown in Figure 1, with process innovation and technological innovation described as separate dimensions which should be considered individually. BPR is described as the combination of technological innovation and process innovation, either within an organization, or within the channel. The relative benefits from re-engineering can be compared to the benefits possible from both technological and process innovation implemented independently to determine if these dimensions are independent or interdependent.

This paper argues that the benefits of simultaneous innovation on both dimensions are much greater than the sum of the benefits achievable from innovation on each dimension separately, and that reengineering, which represents the merger of these two forms of innovation, is more than the sum of these two types of innovation implemented independently.

3.1 Technological Innovation

Most literature on IOS describes the technological innovations involved and the impact of these innovations on channel performance or structure [e.g. 40, 50, 52]. Technological innovations are important to understand in examining alternatives for replenishment ordering in the grocery channel. The most important aspect of technological innovation in the context of replenishment ordering is the emergence of EDI as an affordable alternative to traditional forms of information transmission. This capability represents a merger of computing and telecommunications, and is cited in many trade and academic publications as a key factor enabling dramatic improvements in channel performance.

3.2 Process Innovations

Many articles regarding the use of IOS, such as EDI, ignore or minimize the organizational or process changes required to take advantage of the technological capabilities. Some note the changes, but assume that technological innovations automatically result in new processes that effectively use the new capabilities [e.g. 22, 36, 46, 52]. In contrast, Davenport [15] describes technological innovation as an enabler of process innovation, with process innovation defined as including technological innovation. Both the technological paradigm, which assumes that process innovation will follow automatically, and the Davenport paradigm, which views process innovation as another term for BPR, fail to capture the complexity of the relationship between process and technological innovation. Although process and technological innovation are often interdependent, innovations on each dimension can be adopted independently.

Process innovations often are associated with policy changes in the organization or organizations involved; changes in organizational structure and strategy frequently are required as well. Therefore, this framework dimension might be more accurately described as policy, structure, and process change, but since the only policy and structural changes considered are those associated with process changes, the term process innovation will be used to describe this dimension.

3.3 Channel Replenishment Alternatives

Five alternatives for channel replenishment ordering are examined in this research, and are shown using the basic research model framework in Figure 2. These five modes of replenishment are: traditional, EDLC (everyday low-cost), EDI, and CRM.

Figure 1. Technological and process innovation framework

EDI is a pricing policy that elimination all (or most) promotional incentives from the manufacturer to the retailer. It is similar to EDLP (everyday low-price) retailer pricing strategies which eliminate promotional pricing to customers at the retail store, but EDLC is the term used in the grocery channel to describe constant pricing policies between manufacturers and retailers or wholesalers. Use of EDLP by retailers did not require EDLC retail pricing, but the two pricing policies were often implemented together as this was easier for retailers to manage using their internal systems and processes.

4EDLC is a pricing policy that elimination all (or most) promotional incentives from the manufacturer to the retailer. It is similar to EDLP (everyday low-price) retailer pricing strategies which eliminate promotional pricing to customers at the retail store, but EDLC is the term used in the grocery channel to describe constant pricing policies between manufacturers and retailers or wholesalers. Use of EDLP by retailers did not require EDLC pricing from manufacturers, nor did EDLC require EDLP retail pricing, but the two pricing policies were often implemented together as this was easier for retailers to manage using their internal systems and processes.
EDI, CRP, and manual CRP. The traditional process is based on promotional pricing and retailer determined order quantities. Orders are delivered to the manufacturer via phone, fax, or mail, and are generally determined on a weekly basis. Quantities vary dramatically based on manufacturer promotional pricing incentives. EDLC ordering also uses orders determined by the retailer and delivered to the manufacturer via fax, phone, or mail. However, manufacturer pricing is consistent over time, removing retailers' forward-buying incentives. Order quantities vary with consumer demand without artificial forward-buying spikes.

Using EDI ordering, the retailer retains responsibility for determining order quantity, but orders are sent to the manufacturer electronically in machine readable format. Some manufacturers are able to automatically accept these electronic orders in their shipping and invoicing systems, but others simply print out the EDI information. EDI ordering can take place in either a promotional pricing or an EDLC environment.

CRP is the combination of EDLC, EDI, and manufacturer-determined order-quantities. This re-presents a high level of both technological and process innovation. As strictly defined in practice within the industry, CRP does not require EDI or EDLC; it simply represents a shift from retailer to manufacturer determination of order quantities. CRP could be viewed as outsourcing responsibility for determining replenishment order volumes. Several early implementations of CRP did not use EDI and are labelled *manual CRP* in the framework. Manual CRP is uncommon, but the tradeoffs for implementing CRP without EDI are relatively easy to understand and provide a useful perspective for examining synergies between process and technological innovation.

Each of these replenishment alternatives is illustrated in this paper. Performance implications of each alternative are described from both retailer and manufacturer perspectives.

4. Research Design and Methodology

The research design integrates both case-research and statistical analysis methodologies to examine the technological and process innovation alternatives described. The case studies included two manufacturers, P&G [12] and Campbell [10], and two retailers, H. E. Butt Grocery Company (HEB) [8] and Hannaford Brothers (Hannaford) [42]. Data used for statistical analysis were obtained from a survey of integrated grocery retailers (e.g., retailers providing their own warehouse functions). The research focused on the channel processes and relationships between large retailers and large manufacturers, intentionally excluding the more complex channel relationships involving wholesale distributors as channel intermediaries. By focusing on large retailers and manufacturers, issues of channel power in implementing IOS could be largely ignored, as both partners in the relationship were highly dependent on each other and neither could force compliance for new innovations.

4.1 Case studies

The manufacturer case sites were selected to provide data on the innovation leader, P&G, during the evolution and expansion of the CRP innovation, and on a later adopter of the CRP innovation, Campbell, to examine generalizability of the experiences of the innovation leader. Campbell also provided an interesting variation on the P&G experience, as the firm has taken a different approach to process innovation and CRP implementation than has P&G. The differences in approach between the two firms provide useful insights for evaluating the effectiveness of channel replenishment alternatives.

The retailer case sites include HEB, the leading retailer implementing CRP, and Hannaford, a CRP-innovation follower which has taken a different approach to processes and technological innovation. The combined experiences of these two retailers are useful in providing insights regarding the effectiveness of the replenishment alternatives described in the research framework in reducing inventories and improving channel efficiency and effectiveness.

The use of case-studies in the research design allows us to gain important insights into the causal processes involved in a complex environment [4, 53], and has been recommended by several authors as essential for understanding the complex interactions between technology and organizations that are an
important aspect of research in the MIS field [3]. This type of research can be especially powerful when the research design involves multiple case studies examining a single issue from different perspectives [19, 53].

Each of the four case studies used in this research design involved several days of visits to the company offices, with interviews conducted with at least 8 managers from each company. The interviewees included executives from marketing, logistics, operations, and information systems, as well as senior general managers (i.e., President or VP level) for each company. Following these initial interviews, followup phone calls and interviews were conducted with other managers recommended by these initial contacts, especially when additional data was required to complete a case study describing each of these companies in detail. The interview findings were summarized in Harvard Business School (HBS) case studies for each company, reviewed by the managers involved in the visits to the company, and then approved by a officer from each company for publication [8, 10, 12, 42].

4.2 Retailer Survey

A survey of grocery retailers was mailed to all self-distributing retailers listed in the Progressive Grocery Marketing Guidebook [39]. Of 109 surveys sent out, 26 were completed and 19 retailers agreed to participate in a one-hour phone interview to supplement the written data collection. Nearly 20% of the chains receiving the survey declined to participate because their firms had experienced a major change of ownership (e.g., acquisition, merger, or divestiture) during the prior year. Another 8% of survey recipients declined to participate because their firms were in the process of "reengineering", and they could not spare any management time for nonessential activities.

The survey was designed with the assistance of several industry experts, including academics with experience in survey design for retailers in the grocery and apparel industries [25, 27]. The survey instrument was then tested and validated with the case study sites for consistency, feasibility, and completeness. The final survey instrument was mailed to either the president or COO (Chief Operating Officer) of each grocery company, with a request that it be completed by the senior executive responsible for product replenishment ordering. The survey gathered data on the percent of product ordering using EDI and CRP and on the level of inventory turns and stockouts for the company overall. Executives were also asked to estimate the level of improvement in inventory turns and stockouts that resulted from switching from traditional processes to EDI and from EDI to CRP.

5. Discussion Of Research Findings

The four case sites provided important insights regarding the relative benefits of each of the replenishment alternatives (Figure 2). The survey data provided evidence that these case study data were not isolated to a few companies, and provided estimates of the magnitude of performance improvements that have been realized by retailers from implementing EDI and CRP. In this discussion of research findings, we will examine the manufacturer case-study findings, then the retailer case-study findings, and then the retailer survey results. These three perspectives will then be integrated in a discussion of the overall channel benefits resulting from each of the replenishment alternatives identified previously.

5.1 Research Findings from Manufacturer Cases

Proctor & Gamble (P&G) provides insights regarding the challenges and potential benefits of EDI and CRP ordering, as well as demonstrating the potential for improving channel performance through process innovation without any innovation in technology (e.g., EDLC). Campbell highlights the weaknesses and challenges of using process changes alone, and provides further support for the importance of merging technological and process innovations. Both P&G and Campbell provide data to suggest that both manufacturers and retailers benefit from CRP innovations, although the benefits for retailers appear to be larger, at least during the 1990s period of initial adoption of the CRP innovation.

P&G [12]. P&G was one of the largest manufacturers supplying grocery retailers and wholesalers and was a leader in the transformation of grocery distribution channels. Process innovations at P&G were driven by the company's focus on improving value to consumers by eliminating non-value-added processes in the channel. Unilateral action by P&G during the early 1990s to change the nature of pricing and promotion for branded products (e.g., adoption of EDLC for all products) was initially resisted by some retailers and many wholesalers, but P&G's commitment to EDLC significantly accelerated the adoption of more efficient systems, policies, and practices in the grocery channel. This decision cost P&G some sales initially, but helped retailers and manufacturers understand the potential savings that could be realized with changes in channel processes and policies.

There was considerable internal resistance to the change to EDLC from some P&G managers, in spite of the obvious advantages, since this was the complete opposite of the promotional pricing strategies many executives had used to create new brands and strengthen product market throughout their careers. Many retail and wholesale customers also resisted the change, which was initially perceived as being forced onto the channel by "typical P&G strong-arm tactics".

In spite of this internal and external resistance, senior executives at P&G viewed the shift to EDLC as necessary to maintain the value of P&G's brands with consumers, and shift the consumer and channel purchasing decision from promotional deals to purchase of products that provided consumers with the best overall value on a long-term basis. EDLC enabled both P&G and retailers to reduce inventory
levels, and provided P&G with production cost savings from eliminating artificial demand spikes within the channel. Although the benefits of value pricing were difficult to determine, senior management believed that market-share losses due to the change in policies and ordering processes were more than offset by savings realized using the new pricing structure.

EDI was also important in facilitating the expansion of CRP at P&G. The primary incremental cost savings from CRP adoption were in reduction of retailer warehouse inventories, but the process was an important marketing tool for P&G. By assisting retailers in reducing inventories and costs, P&G was able to expand sales with CRP customers. Increased retailer satisfaction and sales were the primary benefits of CRP, in contrast to EDLC, which decreased satisfaction and sales for many retailers, but was essential to reduce P&G's costs and increase consumer brand loyalty.

Campbell [10]. Campbell's management recognized the benefits that could be realized from an EDLC pricing approach, but were unwilling to force this new policy onto their customers. For Campbell, CRP was partly a means to encourage retailers to shift to demand based ordering using either EDLC pricing or a modified pricing structure that allowed retail promotions but eliminated forward-buying by retailers. Campbell's retailers benefited from CRP by reducing their inventory levels and stockouts simultaneously, and Campbell benefited from eliminating demand uncertainty related to forward-buying for their CRP customers.

Although Campbell offered an EDLC pricing alternative for all retailers which would allow them to reduce inventories and costs without CRP, the only retailers adopting the new EDLC pricing plan were those which also chose to implement CRP. Even if EDLC pricing was lower on average than traditional promotional (i.e., high-low) pricing, virtually all buyers at retail chains and wholesalers believed that they were significantly better than average in buying and, thus, had lower costs than average. Only when the additional benefits from CRP for reducing inventories and stockouts were offered to retailers were they willing to abandon the traditional promotional pricing structure and shift to EDLC.

Summary of Manufacturer Cases. While EDI represented one approach to improve the efficiency of the ordering process and was essential for CRP implementation, EDI alone was not viewed as particularly important in the effort to improve efficiency and order quality. One P&G manager described EDI as "an enabling technology" which, if implemented without changes in interorganizational processes and policies, represented little more than "a fancy electronic fax". Another manager explained:

EDI is simply an electronic envelope, not a system. It does not fix anything and, by itself, is not a solution. However, when implemented in parallel with process and systems re-engineering, it can become a powerful tool.

Both P&G and Campbell viewed EDI as offering savings more than sufficient to justify the cost of investing in the technology, with reduction of data entry error cited as one of the most important benefits of EDI. However, the level of savings offered by either CRP or EDLC pricing was estimated to be at least an order of magnitude greater than the net benefits realized from implementing EDI ordering by managers at both firms. Several opportunities for substantial savings through use of EDI in invoicing and payment were also identified, but these involve substantial changes in channel processes and policies, similar to the magnitude of policy changes required to implement CRP in the ordering process. In summary, technological innovation alone, represented by EDI, was not perceived as offering significant opportunities for improving manufacturer or retailer performance relative to the benefits realized through either process innovation or the merger of technological and process innovations.

Although both manufacturers noted that it was process change, not technology change, which provided the real benefits for the channel, the technology was perceived as a key enabling force that enabled the process changes to be implemented. In some early CRP implementations, P&G had used fax transmission of data until EDI connectivity could be established. This manual-CRP process was both expensive and risky, with any data entry error potential resulting in stockouts. Campbell's managers did not view manual-CRP as a viable option and refused to implement CRP with any retailer that had not demonstrated acceptable EDI capabilities. Although P&G had once used manual-CRP, they no longer considered this a viable option, as the costs and risks of manual data-entry more than offset the benefits realized from CRP.

5.2 Research Findings from Retailer Cases

HEB was one of the first grocery retailers to adopt CRP with P&G, and was the pilot test company for CRP with Campbell. Hannaford adopted CRP in early 1993, several years after HEB, but has become a strong advocate of the benefits of CRP for retailers and manufacturers and has dramatically expanded their CRP program over the past two years. Both Hannaford and HEB had invested in developing EDI capabilities in the 1980s, but had terminated their usage of EDI at the end of these trials as the benefits offered by using EDI were insufficient to offset the costs involved. With the declining costs of using EDI, both firms perceived EDI as offering benefits in excess of costs in the mid-1990s. Even so, the reason for both firms redeploying EDI capabilities was initially to support the adoption of CRP with manufacturers.

Both HEB and Hannaford experienced dramatic improvements in inventory turns through using CRP. Both firms had also adopted EDLP retail pricing policies, which enabled them to simplify product replenishment processes both within their own operations and with vendors. However, the timing of adoption of CRP and EDLP varied for the two firms, and the relative benefits realized from these two innovations...
provides some interesting insights regarding the relative performance impacts of EDLC and EDLP pricing relative to the potential benefits realized from CRP.

**HEB** [8]. As one of the first retailers implementing CRP, HEB was a pioneer in the industry. The initial CRP implementations resulted in inventory turns roughly doubling, on average. One HEB manager explained that they never realized that they had so much opportunity for improvement. Following these initial CRP trials, HEB embarked on a simultaneous effort to expand the use of CRP with all vendors who could effectively manage the new process and to improve the traditional ordering process with all vendors not on CRP. Expansion of EDI usage was also encouraged for all vendors, not because it resulted in dramatic savings in inventories or operations, but because it reduced barriers to CRP adoption while providing modest operational benefits for both firms.

By 1994, 96% of HEB’s grocery product orders were transmitted using EDI (including CRP shipments), and more than 50% of all grocery-product replenishment used CRP. Inventory turns for all vendors had increased, including those products not using CRP. The conversion of most HEB vendors to EDLC pricing during the early 1990s (at HEB’s request) assisted in this effort to reduce inventories and costs. Even so, conversion to CRP still provided substantial incremental savings in inventories and costs, but the relative gains from CRP adoption versus the improved traditional process using EDLC pricing were about half the level that had been realized in the early CRP conversions. The incremental gains from CRP were about equal to improvements realized from process changes alone, with process changes and CRP each resulting in a 50% improvement in inventory turns.

**Hannaford** [42]. Hannaford adopted CRP three years after HEB, but had implemented EDLP retail pricing and encouraged EDLC manufacturer pricing before HEB had committed to this new approach. Rather than focusing on the potential for technology-based innovations, such as EDI and CRP, to reduce costs, Hannaford management focused on improving processes and developing activity-based costing (i.e., a form of direct product profitability) tools to reduce costs. Inventory turns improved during the early 1990s for the chain overall, with the level of improvement estimated to be about a 50% increase in inventory turns over a five-year period as vendors were converted from promotional pricing to EDLC and warehouse management and control systems improved.

The adoption of CRP in 1993 provided significant additional improvements in inventory levels, with the level of overall improvement from CRP estimated to be about 50% higher than had been possible using the traditional ordering processes and EDLC pricing. This estimate of improved performance was consistent for both HEB and Hannaford for CRP adoption with vendors already using EDLC pricing. These estimates were verified by examining historical inventory turns tracked for multiple products in each firm. Although the level of improvement varied widely, turns for all products improved following implementation of CRP, although turns for some products actually decreased temporarily during the first four to eight weeks following the conversion to CRP.

**Summary of Retailer Cases.** Determining the exact level of improvements resulting from CRP implementation was difficult for both HEB and Hannaford, due to the multitude of individual products and sources of external uncertainty that complicated this analysis. However, managers in both firms were confident that the level of improvement realized from CRP adoption with vendors already using EDL was an increase in turns of approximately 50% given similar stockout levels. The level of improvement in inventory turns with EDI was estimated to be less than a 5% increase in turns, if any.

### 5.3 Research Findings from the Retailer Survey

The relationship between EDI and CRP and retailer performance was examined extensively in the retailer survey to determine if the experiences of HEB and Hannaford were representative of the industry overall. The survey examined this impact of EDI and CRP on retailer performance in two ways. First, retailers were asked to estimate the level of improvement in inventory turns and stockout levels which they had experienced for products that had switched from traditional ordering to EDI and then from EDI ordering to CRP. Almost half of the survey respondents had implemented EDI to be able to use CRP, and did not have experience in switching from EDI to CRP, so these respondents indicated the level of benefit realized from switching from traditional ordering to CRP.

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The second approach used to analyze the effect of EDI and CRP adoption on retailer performance was to collect data over a five-year period for each firm on the percentage of EDI and CRP usage and on the level of inventory turns and stockouts. Using multivariate regression, the impact of CPR, EDI, and stockouts on inventory turns was examined. The results are described in detail in [7] and are summarized in Figure 3.

The firms participating in the survey averaged 16.3 inventory turns per year over the five-year period examined, so
the coefficient for improvement resulting from CRP adoption of 0.16 for each increase in percent of volume using CRP represents approximately 100% improvement in inventory turns for a specific product volume that switches to CRP [9]. This is significantly higher than the estimated improvements at the case study retailers, however, the survey did not examine the percent of retailer volume on EDLC. However, Campbell’s experience suggest that EDLC and CRP adoption are highly correlated, since no retailer voluntarily adopted EDLC with Campbell's without also adopting CRP. Assuming EDLC and CRP are highly correlated, then this regression estimate of the impact of CRP on inventory turns is consistent with the early HEB experience with the impact of moving from traditional pricing and ordering to CRP ordering using EDLC.

Interestingly, the retailer reported estimates of the improvements realized from EDI and CRP adoption were quite consistent with the estimates provided by HEB and Hannaford. Retailers estimated that EDI adoption improved inventory turns by about 3% and CRP adoption improved turns by about 52% on average [9]. Since the retailers also reported that stockouts had improved with adoption of CRP, and stockouts and inventory turns are operational tradeoffs [7], the estimate for improvement in inventory turns given a constant level of stockouts would be higher than without controlling for stockout level improvements. The regression analysis controlled for stockouts, but retailer’s were asked about both inventory turns and stockouts separately. Since both stockouts and turns improved simultaneously, the effect of CRP on turns for a constant level of stockouts would have been even higher than the reported estimate for turns alone. Thus, the estimates provided by the retailers directly (52% improvement with CRP) and using the regression analysis (100% improvement with CRP) may be closer than they initially appear.

5.4 Summary of Research Findings

Process innovation alone offers significant improvements for channel performance in grocery product replenishment, but technological innovation alone offers only slight improvements in performance (Figure 4). Investments in EDI can be cost justified, but the largest payoffs for retailers and manufacturers result from the combination of process and technological innovation, as represented by CRP in this example.

Examples of both process and technological IOS innovations are provided in the context of the grocery channel and suggest that the incremental gains from innovation on either dimension independently are much less than the gains possible from innovations that merge both technological and process innovations. Process innovations without changes in technology, such as the shift to EDI, improved channel performance by reducing cost and inventory in the channel. With process innovation alone, HEB and Hannaford were able to reduce inventory level by about 50%. However, several retailers in the survey noted that this improvement was not without a cost, as the loss in forward-buying profits may more than offset the savings from reduced inventories. This research did not examine the net benefits of EDLC, but focused only on the cost saving that resulted from the adoption of this new approach. Even though some of the retailers in the survey were unwilling to adopt EDLC pricing alone, almost all of the retailers believed that they would need to implement CRP to remain competitive in the industry, including the majority of the retailers responding who were not yet using CRP.

The manual CRP example demonstrates that a high level of process innovation is possible without any significant change in technology. While this manual-CRP process innovation did reduce inventory levels compared with EDLC and traditional ordering, the net benefits to the channel were not significantly greater than the cost of implementation. Both manufacturers and retailers agreed that CRP is not economically viable without EDI. This supports the hypothesis that process innovation without technological innovation is limited for providing dramatic performance improvements in comparison with the combined effect of innovations on both dimensions.

Technological innovation without process innovation is illustrated by product volume that is shipped via EDI without using CRP. The retailers and manufacturers examined agreed that the potential savings from EDI used for issuing purchase orders are an order of magnitude less than the savings from use of CRP. The ECR committee estimates of the potential savings from CRP ordering are also an order of magnitude greater than the savings projected from EDI ordering. Savings from EDI are attractive enough for a large percentage of grocery retailers and manufacturers to implement EDI ordering without making the commitment to the process changes required to adopt CRP, suggesting that technological innovation alone does offer performance improvements. However, the performance improvements enable by combining technological and process innovations via CRP are much greater than the benefits from ordering using EDI alone.

Interorganizational BPR combines process and technological innovation with CRP. As noted, CRP provides
benefits far in excess of process or technological innovations alone. The net cost savings potential of CRP is an order of magnitude greater than the savings achievable from technological innovation alone (i.e., EDI). Since the relative benefit of manual CRP is not significantly greater than the benefits of EDLC ordering alone, the benefits of BPR through CRP appear to be much greater than the sum of the benefits of the technological and process innovations which combine to form the interorganizational re-engineering innovation.

The experience of these companies in the US grocery channel clearly demonstrates that EDI combined with process innovations can reduce inventory for both manufacturers and retailers simultaneously, refuting Hendry’s [26] argument that EDI must increase manufacturer inventory as it reduces retailer inventory. Most authors have viewed EDI as a technological innovation, and have ignored the process innovations required to achieve the potential benefits enabled by this technology. Understanding the importance of process innovation in combination with technological capabilities provides a useful framework for explaining the inconsistency in the literature which states that EDI provides dramatic channel performance improvements as well as providing little or no benefit for many firms adopting the technology. EDI, combined with process innovations, can provide dramatic performance improvements and can even enable new channel structures to emerge; EDI without process innovation provides little or no benefit for firms investing in the capabilities.

6. Conclusions

The evidence from the case studies provides support for the framework and model presented, which describes BPR as a combination of process and technological innovations. This model suggests that a merger of technological and process change is needed to achieve dramatic performance improvements, both within the organization and with channel "partners". Performance gains from EDI use alone were limited, and the incremental benefits of implementing CRP without EDI were also limited. Interorganizational business process design, in the form of CRP using EDI, represented a dramatic performance improvement for the channel overall, with both retailers and manufacturers benefiting. EDLC did provide significant improvements, suggesting that process innovation alone can provide significant performance improvements. Even so, few retailers voluntarily adopted EDLC with manufacturers that offered both promotional pricing and EDLC as alternatives, which suggests that EDLC was not necessarily viewed as an improvement in channel performance by many retailers. Overall, the experience of these case study companies using alternative approaches for grocery product replenishment and the survey of grocery retailers validates the proposition that process innovation and technological innovation can do occur independently, but that combined, they enable much greater performance benefits for the channel.

This case study approach to examining the relationship between technological innovation and process innovation is limited to a single industry, so broad generalization based on this study may be inappropriate. Even so, the findings were strongly supportive of the research model, and the framework can be easily extended to other industry contexts and processes to examine the interactions between technology, process change, and firm or channel performance. Both case study approaches and more quantitative analysis would be valuable to support the findings from this exploratory work.

This framework provides a model for exploring the BPR concepts that have been popular among both academics and managers today. One concern sometimes raised about BPR as an academic research topic is the lack of formal models for what is meant by BPR. In this paper, we have suggested a model for examining the fundamental assumptions underlying BPR, which states that technological and process changes are both required to achieve dramatic gains in productivity.

Additional research would be valuable in extending this work for both the grocery industry and in other industry contexts. The basic framework can be used for examining both BPR within the firm and for interorganizational BPR. Within the grocery channel, the role of intermediaries and the challenges and benefits for CRP adoption should be examined for wholesalers. The characteristics of products that can benefit from vendor-managed-inventory processes (e.g., CRP) should also be examined in more detailed research on retailing and distribution industries more broadly.

Additional research would also be valuable that addressed the relative importance of technological innovation, process innovation, and mutual innovation on both dimensions in other industries. This research suggests that process innovation provides greater benefits than technological innovation, with the benefits of both process and technological innovation combined significantly greater than the sum of the benefits of each type of innovation independently implemented. Testing this finding using firms in other industries would be useful for validating the applicability of this finding more generally.

REFERENCES.


