Paper to be presented at the

35th DRUID Celebration Conference 2013, Barcelona, Spain, June 17-19

Uncovering the nature of the reciprocal relationship between product and process innovation: A study within the food packaging industry.

Christopher Don Simms
University of Portsmouth
Strategy, Enterprise and Innovation
chris.simms@port.ac.uk

Paul Trott
University of Portsmouth
Strategy, Enterprise and Innovation
paul.trott@port.ac.uk

Abstract

Process innovation is of critical importance to the firm. These innovations hold the potential to generate enormous wealth for the firm, and their potential to deliver benefits have been clearly demonstrated by a number of famous examples, such as Ford?s Model T production line, Pilkington?s float glass production process and SAP?s Enterprise Resource Planning (ERP) systems. In a major study of why firms engage in process innovation (Reichstein and Salter, 2006) found that product and process innovations are interdependent. Yet, virtually every book on technological change has compared innovations in products with innovations in processes (Simonetti et al., 1995). This paper explores the relationship between product and process innovations using four case studies from the food packaging industry. The findings of the paper reveal a dynamic relationship between product innovation and process innovation. The findings also uncover the significant role and influence of the capital equipment investments on product innovation. Our findings lead us to suggest that within the food packaging industry the distinction between these terms is artificial.

Jelcodes:M19,M00

Uncovering the nature of the reciprocal relationship between product and process innovation: A study within the food packaging industry.

Abstract: Process innovation is of critical importance to the firm. These innovations hold the potential to generate enormous wealth for the firm, and their potential to deliver benefits have been clearly demonstrated by a number of famous examples, such as Ford's Model T production line, Pilkington's float glass production process and SAP's Enterprise Resource Planning (ERP) systems. In a major study of why firms engage in process innovation (Reichstein and Salter, 2006) found that product and process innovations are interdependent. Yet, virtually every book on technological change has compared innovations in products with innovations in processes (Simonetti et al., 1995). This paper explores the relationship between product and process innovations using four case studies from the food packaging industry. The findings of the paper reveal a dynamic relationship between product innovation and process innovation. The findings also uncover the significant role and influence of the capital equipment investments on product innovation. Our findings lead us to suggest that within the food packaging industry the distinction between these terms is artificial.

Keywords: Process innovation; product innovation; production line; food packaging industry.

1. Introduction

Given its widely acknowledged importance, process innovation has received much less attention than product innovation in the literature on innovation management. This may be because product innovations are visible whereas process innovations are frequently invisible. Indeed, Rosenberg argued that process innovations have been subsumed into treatments of productivity and that many of the process innovations firms make are silent, requiring little strategic decision-making (Rosenberg, 1982). It is therefore not surprising that the following idiom is often quoted in the industry: "Product innovations are for show whereas process innovations are for dough". Yet, in a major review of the literature

of why firms engage in process innovation (Reichstein and Salter, 2006) found that product and process innovations are interdependent.

There can be few who doubt the importance of process innovation to the firm. Famous examples such as Ford's Model T production line, Pilkington's float glass production process and SAP's Enterprise Resource Planning (ERP) systems have shown clearly that when it comes to delivering benefits to the firm it is process innovations that can generate enormous wealth for the firm. Process innovations are an important source for increased productivity and they can help a firm gain competitive advantage. In the food industry process innovations are often associated with the introduction of new plant, equipment or machinery. The introduction of a cost-reducing process is often accompanied by changes in product design and materials, while new products frequently require the development of new equipment. In practice product and process innovation are interwoven and any distinction between them is arbitrary. Yet, virtually every book on technological change has compared innovations in products with innovations in processes (Simonetti et al., 1995). In a major study of why firms engage in process innovation (Reichstein and Salter, 2006) found that product and process innovations are interdependent.

The food packaging industry provides a unique example for any study of both product and process innovation. For example, a great deal of success has been achieved by a few packaging innovations. In the beverages sector innovations such as Tetrapak, PET bottles, and in-can systems (such as the Guinness 'in-can-system'), have achieved numerous awards, market share improvements and improved profitability for the firms involved. In all of these cases significant investment in production process technology was required and major manufacturing changes were introduced. Indeed the food packaging industry has many of the characteristics of a typical process industry such as high capital investment, high production speed, rigid process control; clear determination of capacity, one routing for all products, low product complexity; strong impact of changeover times (Franso, 1994; Wallace, 1998).

Additionally, past research in marketing and business in general, has largely failed to recognise the contribution packaging can make to a product and more widely to business (Simms & Trott, 2010). Packaging surrounds and protects products, from manufacture through to the final consumer, and in some cases the packaging can actually enhance the product itself during this lifecycle. Without packaging, handing the core product and marketing it to the consumer would be difficult, inefficient and costly. Yet, it is often viewed negatively and regarded as a necessary evil or an unnecessary cost. Indeed arguably the environmental lobby has targeted packaging as being particularly pernicious. These negative views of packaging often arise because the important roles packaging plays, particularly protecting, containing and identifying products (Fray and Albaum, 1948; Stewart, 1995; Ampuero and Vila, 2006), are often not known or not fully understood. This lack of awareness should not detract from the fact that packaging is a critical marketing tool (Rundh, 2005), which plays a key role in consumers product choices and perceptions (McDaniel and Baker, 1977; Prendergrast and Pitt, 2000; Wells

et al., 2007). Packaging is of greatest importance in the fast moving consumer goods industry, of which food products make up the vast bulk.

In this paper we extend the process innovation literature by developing a conceptual framework that provides a unique lens through which to view and explore our research question: *what are the features of the interdependence between product and process innovation*. We explore how technological and organizational contexts moderate the relationship between product-focused innovation activities and process-focused innovation activities. We argue that there is a reciprocal relationship between product and process innovation within the food packaging industry that is characterized by secondary and further relationships between key customers, the outsourcing relationship, absorptive capacity and technology trajectories.

Finally, we explore different types of relationships that seem to exist between product and process innovations in the food packaging industry and offer a simple classification of product and process innovations.

2. Exploring the relationship between product and process innovation: Literature review

In order to explore the relationship between product and process innovation it is necessary to review some of the seminal studies that have contributed to our understanding and have shaped our views. In addition, when exploring relationships between constructs, clarity of terminology and shared understanding of the language being used is essential if any meaningful dialogue is to be achieved. With this in mind we also initially briefly review terminology. In a major review of the constructs of product and process innovations Simonetti et al., (1995) considered the alternative meanings attributed to the terms product and process innovation, and on the basis of the SPRU database on innovations in the UK demonstrate how the total number of product and process innovations varies according to the definition adopted. They conclude that 97% of innovations incorporate product and process innovation attributes.

Process innovation can be defined as new activities introduced into a firm's production or service operations to achieve lower costs and/or produce higher quality product (Reichstein and Salter, 2006; Utterback and Abernathy, 1975). This then may be why it is often regarded as the Cinderella activity compared to the more glamorous product innovation. It is true that many of its activities and improvements may go unnoticed. Changes in the production process of a cereal box that reduces costs by 10% would not be noticed by end consumers; but it would certainly be noticed by the firm. In a major study examining the sources of process innovation, Reichstein and Salter (2006) found that 'the presence of R&D activities is associated with process innovation' (Reichstein

and Salter, 2006: 677). Further, in industrial economics, a number of studies have attempted to theoretically model the factors that shape the propensity of firms to undertake product and process innovations. Some recent models suggest that firms will favor product innovation where there is a high level of product differentiation and competition is intense (Weiss, 2003). In contrast, process innovation will be undertaken where products are less differentiated and there is less competition in the industry. Clearly the industrial context will shape decision making and Porter's taxonomy of technology strategies illustrates this. In this framework, process innovation is often associated with the attempts of firms to achieve cost leadership in their market segment or to focus on cost reductions in the production of existing products.

Technology change

The widely and commonly held view of technological change begins with an initial technological discontinuity (Tushman and Anderson, 1986). This is typically a product innovation incorporating new technology. The launch of an innovative new product into the market is usually only the beginning of technology progress. Product innovation, process innovation, competitive environment and organisational structure all interact and are closely linked together. Abernathy and Utterback (1978) attempted to illustrate this dynamic; they argued there were three phases in an innovation's life cycle: fluid, transitional and specific. Briefly these can be characterized as technological and market uncertainty where a large experimental game occurs in the market place. During this phase competitors and suppliers compete and maneovere to try to establish a dominant design. The passage of time sees further technological development as producers start to learn more about the technology application and about customer's needs, some standardisation will emerge. Usually by this time the acceptance of the innovation starts to increase and the market starts growing rapidly; these are signals that according to Abbernathy and Utterback mark the transitional phase. The third *specific* phase is where competition now shifts from differentiation to product performance and costs. Companies now have a clear picture of market segments and will therefore concentrate on serving specific customers. Manufacturing will use highly specialised equipment with the ability to produce the product on a large scale. The Abbernathy and Utterback model, which attempts to delineate between product and process innovation, has dominated thinking within the innovation literature. Indeed, much research has built upon this understanding.

A strength of the Abbernathy and Utterback study was its incorporation of firm competition and firm strategy rather than viewing the innovation in isolation. It is the reaction to the innovation and the role played by competitors that seems to be central to our understanding of technological change. The initial technological discontinuity will prompt competitors and others into technological development and innovation. Indeed, incumbent firms are forced to develop new technology and possibly learn and adopt new capabilities in order to keep pace and possibly move to a new technological trajectory. Nonetheless, considerable technology management challenges exist for firms during periods of significant change such as a shift from one technology (S1) to another (S2) on technology S-Curve development cycles. Organisations need to be able to exploit current capabilities while simultaneously developing new ones. Process management techniques

such as TQM, ISO 9000 have shown to help firms through strong adherence to documented organizational processes (Harry & Schroeder, 2000). As the organizations adapts along the technology development cycle so it requires both process innovation skills and process management skills at the appropriate stages. Tushman and O'Reily's, (1997) technology change cycle offers an explanation of how a technology moves through stages of radical change and ferment. Yet, there have been few studies that explore the co-existence of process management and process innovation (O'Neil and Sohal, 1999; Chang and Luo, 2010). Hence, specific details of when, where and how much process innovation and process management remains underexplored area.

Management and change of structure, culture, people and process is required to sustain existing product innovation and stimulate innovation beyond existing competencies. For example, Rosenbloom (2000) showed how the NCR corporation was able to adjust to the introduction of electronics into the field of business equipment. And Tripsas and Gavetti (2000) in an in-depth case study, showed how Polaroid was unable to respond to the changing business environment due to internal management battles and differences over how the business should compete. Verona and Ravasi (2003) termed this core rigidities and argued that these can prevent a firm developing new capabilities. Nonetheless, managing the balance of activities between exploration and discovery is difficult. All too often firms tend toward exploitation where positive local feedback in the form of customer demand and profits produce path dependence (Benner and Tushman, 2002; Gupta, Smith and Shalley, 2006; Henderson and Clark, 1990; Levinthal and March, 1993). Firms tend to focus their activities on short–term returns. Such firms become more efficient in using what they already know, but risk losing out to more radical ideas and becoming obsolete. In contrast the benefits to firms utilizing discovery are potentially greater but the benefits are longer term and often upset existing organizational structures and routines. Firms thus become vunerable to technological and market changes.

Tushman and Rosenkopf's (1992) model of co-evolution of technology, clearly illustrates and distinguishes the role played by the market (that is consumers and businesses) in shaping a technology. It also shows that the selection of a dominant design demarks the transition between two fundamentally different roles of evolution: social construction of technology during the era of ferment, and technological determinism during the era of incremental change. As competition becomes more intense the market moves towards an oligopoly. As a consequence incumbents are able to secure their position through supplier relations, distribution channels and other complementary assets that will create entry barriers to new entrants. Tushman and Rosenkopf argued that the more complex the technology the more intrusion from sociopolitical factors during the evolution of the technology. This is clearly evidenced in the current development of electric powered automobiles where legislation and political decision making are influencing the shape and size of the future market. With the emergence of a dominant technology, the nature of technical change shifts from product innovation to a relatively long period of incremental refinements and process innovations. This forms the first principle for the development of our conceptual framework:

i. The relationship between product and process technology trajectories;

Technology capabilities

Significantly, Henderson and Clark (1990) contributed to our understanding of the linkages between product and process innovation. They argued that it is necessary to distinguish between the components of a product and the ways they are integrated into the system, which they termed the "product architecture". Henderson and Clark examined product innovations and demonstrate that product innovations are complex entities and are embedded in organizational capabilities, which are difficult to create and costly to adjust (Nelson and Winter, 1982; Hannan and Freeman, 1984). Henderson and Clark (1990) divide technological knowledge along two new dimensions: *knowledge of the components* and knowledge of the linkage between them, which they called *architectural knowledge*. In this framework technology development could be a radical innovation only if it revolutionises both component and architectural knowledge.

The strategic management literature has addressed the issue of how to manage critical organizational capabilities and competencies (Winter, 2003; Wernerfelt, 1995; Teece et al., 1997; Newbert, 2007; Barney and Clark, 2007). There appears to be a general consensus that at least complementary skills or organisational competences can be handled and developed by alliances and opened up to collaboration and that goods and services of little strategic value can be purchased on the open market (Brandes et al, 1997). A number of researchers, however, believe that the core competences and most special skills related to competitive advantage need to be kept in-house (Reve, 1990; Quinn, 1999). Hamel (1991) maintains that core skills can be learnt form the other party and absorbed into one's own company just as much as one's own skills can be absorbed by a partner and one's unique competitive advantage lost in the process. Bower et al (1997) observed the behaviour of technology leaders in the close-knit North Sea upstream offshore oil and gas industry and found that participating in networks sharing leading edge technology was exposing firms to the risk of their competitive edge being lost to competitors. This dilemma, of the need to share and exchange information yet at the same time protect oneself from knowledge appropriation, was discussed with respect to collaboration agreements in the aerospace sector (Jordan and Lowe, 2004).

Outsourcing has become very widespread in the last decade and has moved on from limited applications where peripheral business functions are "outsourced" to much more vital business functions being outsourced today (Jennings, 1997, Quelin and Duhamel, 2003). The food packaging industry is characterized by a strong market orientation simply because of the nature of the consumer product. Furthermore, very few food brands own the entire manufacturing process from beginning to end. The outsourcing of activities over the past ten years has led to a complex network of suppliers, manufacturers, packaging suppliers and food science regulators all with important contributions to make in the innovation process. Given the web of collaboration and the volume and extent of negotiations required it is sometimes surprising that change occurs

at all. Further, given the level of outsourcing of the packaging activity it seems an unintentional consequence may be the outsourcing of component knowledge has inadvertently led to the outsourcing of architectural knowledge. This forms the second principle for the development of our conceptual framework:

ii. The extent and nature of the outsourcing of product and process technology development;

Radical and incremental Technology change

Product and process innovations have been classified by many writers. For the purpose of this paper we need to recognise that radical and incremental innovations have very different competitive consequences because they require quite different organizational capabilities and environments. Organizational capabilities are difficult to create and costly to adjust (Nelson and Winter, 1982; Hannan and Freeman, 1984). Incremental innovation reinforces the capabilities of established organisations, while radical innovation forces them to ask a new set of questions, to draw on new technical and commercial skills, and to employ new problem-solving approaches (Burns and Stalker, 1966; Hage, 1980; Ettlie, Bridges, and O'Keefe, 1984; Tushman and Anderson, 1986). The impact of this on the nature of innovation activities is that as the organisation learns and increases its efficiency subsequent innovation is increasingly incremental (Levinthal and March, 1993; Benner and Tushman, 2003). Another constraint on innovation which arises as a result of an organisational focus on process innovation is the shift to meeting existing customer needs (Christensen and Bower, 1996). The impact on the innovation activities within the firm is that radical product innovations can be overlooked in favour of incremental process innovations that deliver benefits for existing customer groups. In the food industry this situation is exacerbated by powerful retailers. This forms the third principle for the development of our conceptual framework:

iii. The nature of the relationship a firm has with its customers;

In the longer term, if this selection of easy-to-measure efficiency improvement innovations continues over time it can have a more profound impact on an organisation's innovation capability. For example, if novel R&D projects are continually overlooked it can reduce exploratory activity and can hinder an organisation's ability to develop knowledge outside of the existing technological trajectory. This will affect its absorptive capacity and a firm's likelihood of subsequent innovations that incorporate new technologies (Benner and Tushman, 2003). Indeed, this situation is exacerbated if there is also outsourcing of research and development activities as potentially the firm and even the industry loses its ability to signal for and identify radical new technologies. This forms the fourth principle for the development of our conceptual framework:

iv. Level of Absorptive capacity within process activities and product activities

Development of conceptual framework

Given the above discussions we summarise and bring together these arguments in our conceptual framework, which is based upon the following key arguments. The features of the interdependence between product and process innovation is determined by the following interrelated relationships:

i. The firm and its customers;

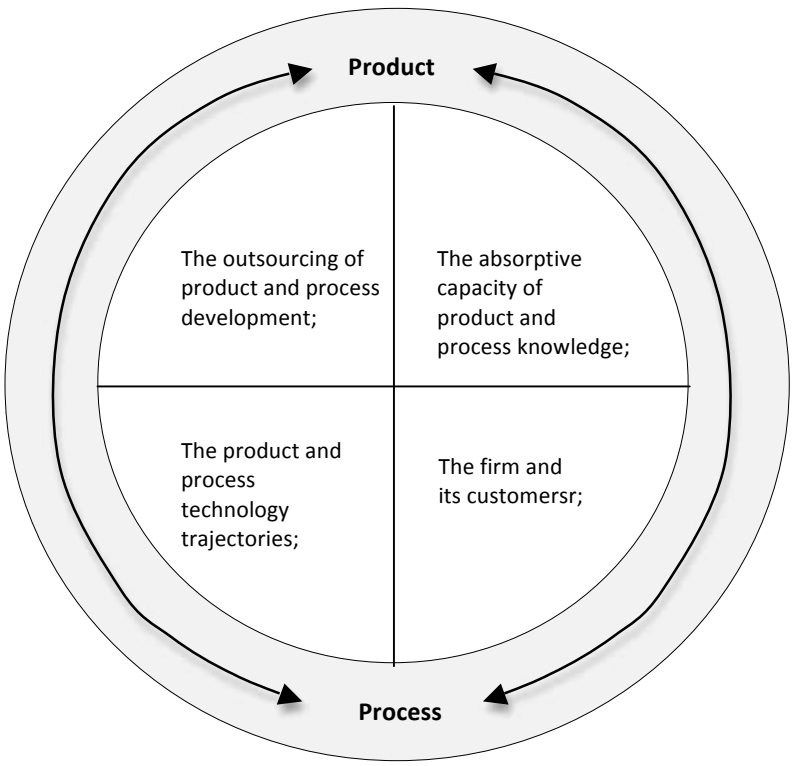
ii. The product and process technology trajectories;

iii. The outsourcing of product and process development;

iv. The absorptive capacity of product and process knowledge.

These four key principles form the basis of our conceptual thinking. We bring these together diagrammatically to help illustrate the dynamic nature of the inter-relationships between these constructs. Firstly, we begin by making clear that there is a strong interdependence between product and process innovation within the food packaging industry. We show this on the perimeter of the circle. Secondly, we try to underscore that the nature of this relationship is dependent on four key elements hence we put these at the centre of the framework. This framework is intended to act as a unique lens through which to view the product-process innovation relationship.

Figure 1: The interdependence between product and process innovation



Business relationships and team relationships have been studied by many disciplines related to business performance. Social interdependence theory argues that it is the way that goals are structured determines how individuals interact, which in turn creates outcomes. Researchers have conducted hundreds of research studies over the past 50 years on the relative merits of cooperative, competitive, and individualistic efforts and the conditions under which each is appropriate. Social interdependence theory has been widely applied, especially in education and business (Thompson, 1967). These applications have resulted in revisions of the theory and the generation of considerable new research (Johnson and Johnson, 2005). Furthermore, social interdependence theory has helped provide insight into business project success and successful business teams Aziz et al., (2010). Drawing on social interdependence theory we use the conceptual framework as a lens through which to view the different types of interdependence and develop a classification (see Table 1).

Table 1: A classification of interdependence between product and process innovation

Classification of interdependence between product and process innovation	
Reciprocal	Both and either product or process developments lead to improvements in the other.
Pooled	Where developments in product and process activities are pooled and then a selection is made. Similar to reciprocal except that internal decision making may prevent improvements in either product or process.
Process sequential	Where innovation is dependent on process developments. In this scenario process dominates.
Product sequential	Where innovation is dependent on product developments. In this scenario the product dominates.
Amensalism	Is a type of symbiosis between two species where one limits the success of the other without being affected, positively or negatively, by the presence of the other. Plants are a good example. In the case of product and process innovation a situation could exist where the presence of a dominant process or product technology could hinder developments in the other.
Unilateral	Where no relationship exists (difficult in practice) where product or process innovations take place irrespective of the other.

3. Research methodology

A qualitative method of enquiry was chosen to explore the research question of this study. The basis of this qualitative enquiry was informed by twenty interviews with senior managers, technologists, consultants, suppliers and directors, within both the packaging and FMCG industries in 2008/10. The participants that were interviewed for the study were selected as 'key informants' (Churchill and lacobucci, 2005; Seidler, 1974) based on having expert knowledge of the relevant product/packaging development within the FMCG sector or the packaging industry. Therefore although the sample size may seem to be small, it was not intended that the research should provide results to be generalised, rather it was the aim to provide preliminary insights based on the expertise of the participants (Denzin and Lincoln, 1994) on the issues being considered. Using these key informants it was also possible to gain higher levels of reliability and validity to the findings of this research.

The research design employed a multiple case study approach because it allows both an in-depth examination of each case and the identification of contingency variables that distinguish each case from the other. Furthermore, Eisenhardt (1989) found that multiple case studies are appropriate when attempting to externally validate the findings from a single case study, through cross-case comparisons. Drawing on the literature about case study research and qualitative methods (Glaser and Strauss, 1967; Miles and Huberman, 1984; Yin, 1981, 1984), we built our research strategy to provide descriptions (Gersick, 1988) of innovation activities within the food packaging industry. A case study approach was chosen to allow an empirical inquiry that investigates a phenomenon within its real-life context. This was necessary given that we wish to explore the nature of the relationship between product and process innovation to try to offer explanations. Four case studies from the food packaging industry were selected and a cross-case analysis enabled the search for patterns amongst the multiple sources of evidence.

Research Instrument

The data collection was undertaken using a semi-structured interview guide. The interview questions were drafted for the analysis of the development of packaging in general, and for understanding the management perceptions towards its role within NPD in particular. The interviews also examined the balance between consumer and technical input, during the development of new packaging, where the responsibility of the new packaging development lies, and finally the role of external parties in the process.

Because of the exploratory nature of the research, this initial investigation used a semi-structured in-depth interviewing technique. The aim was to get the participants to talk as freely as possible and to discuss the area in their own terms. This technique aims to gain the perspectives of informants so that the research topics could be explored (Daymon and Holloway 2004), and this would allow the interviewees to express their perceptions and feelings at length in their own words, leading the dialogue, thereby obtaining insight and

understanding. The interview guide was developed with the aim of ensuring interviews lasted no more than one hour, although in a few cases this was exceeded.

In-depth interviews were the primary data-collection method of this study since they provide richness and depth of information, particularly about the development of NPD within FMCG sector and managerial viewpoints with respect to the issues. Interviews were conducted either face-to-face or by telephone. In addition, it should be noted that a few interviews were undertaken with more than one interviewee, where appropriate or where the circumstances made this necessary. Analysis was through coding and attributing content to identified dimensions, thus recognising any commonalities or trends (Schilling, 2006; Miles and Huberman, 1994).

Analytical Procedure

Due to the sensitive nature of business interviews (involving customers, suppliers and internal departments) it was decided that interviews would not be tape recorded in order to provide an environment that encouraged and facilitated open discussion. The interviewee took detailed notes throughout the interviews, and these notes were expanded on and transcribed shortly after each interview was conducted. The analysis then followed the subsequent steps described by Miles and Huberman (1994). Further analysis was undertaken both within and across each of the cases, thus providing insights into each firm, as well as a comparison of these insights across each of the interviews/cases, thus providing insights into the differences between firms. Thus significant time was spent analysing and interpreting the data, and a rigorous approach was adopted into order to ensure "credible, dependable, and replicable" methods in qualitative terms (Miles and Huberman, 1994: p2).

4. Findings and analysis

Case 1 - Guinness in can system

Guinness PLC is one of the world's leading drinks companies, currently producing and managing a wide-range of successful international brands including Johnny Walker, Bells, Smirnoff, and what is both the world's most distinctive beer and the focus of this case study, Guinness.

With a history stretching over 230 years, Guinness enjoyed long-term growth and continued success through much of the twentieth century. However, since the 1980s the UK beer industry came under severe attack from various international brands including Castlemaine XXXX, Fosters and Miller Lite. Further to this increased competition Guinness was, and still is, facing the challenge of a growing take-home market, in which lager producers were gaining increased success relative to their beer producing

competitors. This was because lager from a can or bottle tasted much the same as lager on draught. The same could not be said for beer. It was this problem that lead to the development of Guinness's 'in-can system', or what is now known as 'widget technology'.

First developed by Guinness in 1984, the widget is a device inserted into a can in order to produce a firm head similar to draught beer when it is poured.

"The widget works by adding liquid nitrogen to the beer during filling. When the can is sealed the liquid nitrogen vaporises forcing beer and gas into the widget via a tiny hole. When the can is opened the pressure equalises forcing beer and nitrogen out through the main body of liquid and releases the nitrogen dissolved in the beer resulting in the classic Guinness surge and creamy head." R&D Manager A.

"The development of the widget technology took 5 years, with costs totaling upwardly of £40million. Much of these costs came from the acquisition of machinery and equipment, as well as R&D and the purchase of technology necessary to design and create the widget that was beyond the absorptive capacity of the company." Marketing Manager A .

Further to these high costs, Guinness had concerns regarding issues such as the capital costs for each can produced, potential delays and 'down time' during the development process, potential opportunity costs incurred, and the speed of producing the new cans.

"For the inclusion of the widget to be a viable option for us financially, canning speeds in the production process had to at least match the current rate, if not better it". Marketing Manager A.

These such concerns and issues demonstrate both the magnitude of the decision to invest in the development of the widget, and also how developing product innovations can in turn facilitate significant and costly process innovations. In order to develop the product innovation they needed to deliver their customers a better quality product and to better compete in the take-home market, Guinness was required to develop significant process innovations.

Despite the concerns of Guinness regarding production costs, once the necessary machinery and technology had been acquired and new production processes had been implemented, that costs per can for production actually decreased.

"Through our continuous R&D into the creation of the widget and how it would be incorporated into cans and bottles, we were able to not only develop and innovation new product but to also identify areas for improvement within our production processes". R&D Manager B.

This improvement in production efficiency demonstrates how in this case a reciprocal relationship exists between the product and process innovations. Further to the improvements in production efficiency experienced by Guinness in developing their innovative product, the company was also able to charge a premium price for the product based on the improvements made in taste and appearance. However, issues regarding the anonymity of both the product and process innovations caused problems.

"Although the widget required huge investment and successfully delivered our customers a superior product, the changes in the appearance of a can or bottle of Guinness on the shelf of a supermarket were subtle. If customers were unaware of the changes to production and could not see the widget within the product, how were we to communicate and justify the increase in our pricing". Marketing Manager A.

This case therefore demonstrates that although the development of an innovative product can in turn facilitate process innovations, these changes to processes and production can be expensive and time-consuming, with assurance of financial recuperation. Furthermore, this case demonstrates that even if a reciprocal relationship develops between product and process innovations, this does not eliminate the possibility of experiencing difficulty marketing a new product.

Case 2 – Ring Pull Cans with easy lift lids

With a history spanning nearly 120 years, Crown Cork is a leading innovative packaging company, producing packaging for a variety of products ranging from drinks cans and containers to aerosols and biscuit tins.

"One of our main aims at Crown Cork is to develop packaging that is easy to use and provides customers with the greatest level of convenience possible. By doing so we feel this will enhance the level of interaction between customer and company by relieving the frustration often experienced when opening and consuming various products." Marketing Manager A.

The focus on ease-of-use and customer convenience is highly apparent in Crown Cork's ring pull can lid system, the Crown Cork Easy Lift System.

"The ring pull system for opening can lids has long been in use for many companies. However, adoption of this packaging type has been slow for products in the food market. We feel this lack of adoption is down to several issues. Firstly, many organisations within the food industry are averse to the change in production processes and the associated costs of changing their packaging. Secondly, many organisations express concern at the costs likely to be accrued by including the extra metal needed for the ring pull function. Finally, organisations feel that the ring pull system is difficult for many customers to operate, with a lack of accessibility restricting the functionality of the packaging." R&D Manager A.

It was based on this final issue that Crown Cork developed their Easy Lift System for ring pull openings. By utilising their existing technology of the Eole vacuum 'pop-up' technology developed for tamper evidence/protection on jars, Crown Cork were able to create an indent in the lid of canned goods that allowed for greater access to the ring pull function.

"Through various research efforts we were able to discover that one of the commonest problems suffered by customers when engaging with ring pull openings was being able to physically grip and lift the ring pull in order to utilise the packaging's functionality. To alleviate this problem we used our Eole vacuum technology to create an indented concave shape to our can lids that allowed for significantly greater access to the ring pull. This indentation was made possible through the use of a thinner grade metal in the lids of cans that featured a moulded pattern that made the material malleable yet robust". R&D Manager A.

As is suggested by the aforementioned concerns of many FMCG organisations, product innovations can often facilitate a need for expensive process innovations. Such changes can inhibit the development and adoption of such product innovations for many companies. However, as Crown Cork has demonstrated, these issues can stimulate research into product innovations that are developed using existing technologies and capabilities. By utilising the trajectory of an existing technology, Crown Cork were able to avoid making large investments in new production lines, and in turn to avoid the associated complications that come with making such changes.

Case 3 – Paperboard Blister Packs

Chesapeake is a leading supplier of cartons, labels and leaflets, and specialist plastic packaging. The company currently produces packaging for a range of FMCG brands, as well as for many pharmaceutical products.

"*At Chesapeake* we consistently supply the majority of the world's leading pharmaceutical companies as well as many more specialist niche businesses."
Marketing Manager A.

Currently, the packaging of almost all tablets/pills consists of blister packs made from plastics and foil. This method of packaging has become well established in the pharmaceuticals industry due to the assurance of the integrity provided to each tablet/pill by these materials, as well as the allowance for the printing of dates on the foil seal. However, with growing customer concerns regarding environmental issues, reliance upon non-recyclable plastics is less than desirable. It was this issue that formed the basis for the development of Chesapeake's Paperboard Blister Pack.

Of the many innovative materials and resources available to Chesapeake is that of a formable paper.

"Having successfully patented our formable paperboard material, we were able to pursue development for the product in a variety of different industries where plastic is commonly used for packaging purposes. Through several months of experimentation we discovered that we were able to utilise this new material with existing production lines for products such as blister packs for tablets and pills." R&D Manager A.

This material was made from 100% paper and therefore eliminated the need for plastics. Furthermore, the mouldable/formable quality of the material meant that for products such as blister packs to be produced, existing techniques and machinery would be suitable, and in turn would eliminate the need for pharmaceutical firms to invest in new production lines. However, although the technology transfer of existing production processes would allow pharmaceutical firms to avoid making investments in new machinery and equipment, it also created issues regarding patent protection.

"For several of the pharmaceutical firms we are in contact with, one of the main issues with utilising the material was regarding patent protection. By utilising existing technologies and production processes, many firms felt that the technology would be open to imitation by competitors and therefore approached considerations of investment in the material with trepidation". R&D Manager A.

Further to this issue, Chesapeake were also aware that the rate of adoption for the new material may be negatively affected by the need for pharmaceutical firms to gain FDA approval for any drugs contained in new materials. The costs involved in gaining this approval, combined with concerns regarding customer reaction to a new type of packaging, has lead to slow progress and a lack of adoption for this innovation within the pharmaceuticals industry.

"There has always been the question from our already satisfied clients within the pharmaceuticals industry of whether the benefits that may be gained from the adoption of this new packaging would outweigh the risks involved in changing the product so considerably." R&D Manager B.

These such risks and issues demonstrate the difficulty often experienced when making investment decisions in process industries. This is particularly true for commodity industries such as packaging where emphasis is placed heavily on costs and efficiency of production. This emphasis can often leave innovation and issues such as that of environmental concerns gaining minimal attention and consideration from many organisations.

The experimentation involved in the development of the paperboard blister pack demonstrates how innovative products can often be formed from process lead innovations. By developing and experimenting with a unique process innovation, Chesapeake was able to realise various potential product innovations. However, the lack of adoption from pharmaceutical firms goes to demonstrate that although an interdependent relationship may exist between product and process innovations, this relationship does not necessarily always create successful products.

Case 4 – McVities Biscuit tube

During the 1990s, in an effort seeking to offer their customers a wider range of products, the McVities Biscuits brand began communicating with a number of packaging companies. These communications focussed on the development a new and innovative form of packaging for biscuits. By developing this packaging, McVities was hoping to allow customers the opportunity to carry and consume biscuits in different environments, to provide the product with greater protection and robustness, and to allow for a price premium compared to biscuits housed in traditional flow-wrap packaging. One of the companies McVities were in contact with was Chesapeake.

"The traditional form of packaging for biscuits is a simple thin plastic wrapper that provides manufacturers with a low-cost method of packaging that kept biscuits fresh until opening and allow for precise graphics to be printed and displayed. However, this form of packaging leaves biscuits open to damage due to thinness of the material used, and also fails to provide customers with a method to re-seal their biscuits. These two issues mean that the types of environment in which biscuits can be consumed is often very limited. It was with this problem in mind that we aimed to develop a form of packaging that would allow customers the ability to consume and re-seal biscuits in a variety of locations without fear of damaging the product, and in turn, to allow McVities the

opportunity to provide a superior product and obtain a price premium." R&D Manager A.

With this rationale in mind, Chesapeake began developing concepts for the new packaging based on their expertise with paper and board. Amongst the concepts developed was a round paperboard tube made from a single piece of board sealed at both ends. By utilising a single piece of board, Chesapeake was able to avoid the costs incurred by similar packaging such as the expensive spiral wound tubes used to package Pringles Crisps. The concept was presented to McVities who then chose the tube for further development.

"Upon receiving approval for further development from McVities, we were provided with extensive guidelines and specifications from the company from which to create the packaging and a method for re-sealing. Based on these guidelines and specifications we developed a double corrugated tube based on a suitable grade of material, and chose a suitable glue, alongside ultrasonic welding and plastic caps for the packaging." R&D Manager B.

Chesapeake then went on to develop a proof of concept production machine, costing around £10,000 to set up. Using this machine, Chesapeake produced 2000 examples of the packaging for presentation to McVities for Marketing assessment. Eventually, following positive response from the tests, the concept was fully developed and selected to be the chosen method of packaging. McVities then asked the firm to make investments into a pilot plant, at the cost of about £100,000, for the production line for this type of packaging, offering to share the cost with the packaging firm.

"Despite the offer from McVities to share the costs with us, we felt the level of investment required from us for this project was still too high. Because of this, we came to the decision to decline the opportunity to pursue the venture further." Marketing Manager A.

Following Chesapeake's decision to decline the offer from McVities, the idea was then taken up by another packaging firm that was willing to make such a large investment. The £100,000 investment required to develop the packaging, as well as the various costs and potential opportunity costs incurred up to that point, demonstrate the level of expenditure often required for process innovations. The need to develop the basic packaging materials as well as the vast machinery and technology demonstrates how products innovations and often facilitate process innovations on both a small and large scale. Furthermore, the decision from Chesapeake to decline further investment and development of their concept packaging exemplifies how difficult investment decisions can often be for firms operating in process industries.

5. Discussion

This research provides empirical evidence from four case studies within the food packaging industry that different types of relationship exists between product innovation and process innovation. It also finds that within the food industry the distinction between these terms is artificial. The case studies provide insight into the cycle of product innovation to the innovation cycle of the packaging manufacturing process and illustrates different consequences of different actions. Significantly, within the Guinness case the relationship is revealed to be reciprocal in nature. The findings from this case suggest that product innovations requiring large process changes hinder adoption among food production firms. However, where investments are made to change a product and the associated process, these firms can in the long-run benefit from further product related opportunities that come from these process innovations.

This research characterizes the interdependence of product and process innovations. It contributes to the research of Reichstein and Salter (2006) and the wider process innovation literature. This interdependence can be seen from the findings in the cases to differ depending on a few key relationships. The conceptual framework provided a lens for us to view four particular relationships:

i. The firm and its customers;
ii. The product and process technology trajectories;
iii. The outsourcing of product and process development;
iv. The absorptive capacity of product and process knowledge.

If we combine these with the classification developed in Table 1 we are able to construct a table to help us identify different types of interdependence. Table 2 represents a first attempt at such a table.

Table 2: Interdependencies based on the relationships between product and process innovations

	Relationships between product and process innovation				
	The firm and its customers;	The product and process technology trajectories;	The outsourcing of product and process development;	The absorptive capacity of product and process knowledge.	Type of interdependence
Guinness in-can-system					Reciprocal
Paper board Blister Packs					Process sequential
Mcvities tube					Product Amensalism
Ring pull with easy-lift lid					Process sequential

The evidence from this study has significant implications for senior management, and the dynamics of the underlying product-process interactions and the resulting constraints when implementing different types of innovation. Significantly, it illustrates and characterises the productivity and flexibility trade-off. In so doing it extends the work of Eisenhardt and Martin (2000). For a firm to successfully exploit product and process innovations it may require it to possess dynamic capabilities. That is, those rare attributes within a firm that enable it to be simultaneously explorative and exploitative. The ability of the firm to seize opportunities through organizing and integrating both new and existing assets to overcome inertia and path dependencies is at the heart of dynamic capabilities. These capabilities have been called routines or processes to learn new routines (Winter, 2003; Zott, 2003, Eisenhardt and Martin, 2000) and are seen within the strategic management literature as fundamental to long-term competitive advantage. It remains true, nonetheless, as Eisenhardt and Martin (2000) note that dynamic capabilities remain vague. This paper contributes to this body of literature by offering insight into what these dynamic capabilities may look like.

References

Aziz A, A Hamzah A Rahman and Z Harun (2010) Literature mapping: A bird's eye view on classification of factors influencing project success, African Journal of Business Management Vol. 4(19), pp. 4174-4182.

Abernathy, W. and J. Utterback (1978), 'Patterns of industrial innovation,' *Technology Review*, 80(7), 40–47.

Ampuero, O. & Vila, N. (2006) *"Consumer perceptions of product packaging", Journal of Consumer Marketing*, Vol. 23, No. 2, pp.100-112.

Anselmsson, J. and Johansson, U. (2009) Retailer brands and the impact on innovativeness in the grocery market, Journal of Marketing Management, vol 25, no 1, 75-95.

Baldwin, J., P. Hanel and D. Sabourin (2002), 'Determinants of innovative activity in Canadian manufacturing firms,' in A. Kleinknecht and P. Mohnen (eds), *Innovation and Firm Performance*. Palgrave: London, pp. 86–111.

Barney, J. B., and Clark, D. N. (2007). *Resource-based theory: Creating and sustaining competitive advantage*. Oxford: Oxford University Press.

Benner, Mary J., and Michael L. Tushman (2003) Exploitation, Exploration, and Process Management: The Productivity Dilemma Revisited. *The Academy of Management Review* 28, no. 2: 238-256.

Chesapeake Ltd (2009) Discussions with Production Manager and R&D Manager at Chesapeak Ltd., Manufacturing Plant, Nottinghamshire, UK.

Chang H and Luo C (2010) Analyze innovation strategy of technical-intensive industries: scenario analysis viewpoint", Business Strategy Series, Vol. 11 Iss: 5, pp.302 – 307.

Coles R C and Beharrell (2007) Packaging innovation in the Food Industry, The British Foof Journal, 92, 2, 21-32.

Dosi, G. (1982), 'Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change,' *Research Policy*, 11, 147–162.

Eisenhardt and Martin (2000)

Eisenhardt K M (1989) Building Theories from Case Study Research, *The Academy of Management Review,* Vol. 14, No. 4, 532-550.

Financial Times (1995) "Not so much choice, please" 30th Nov, p 26., as cited in Nancarrow, C., Wright, L.T., Brace, I. 1998. "Gaining competitive advantage from packaging and labelling in marketing communications", *British Food Journal,* Vol. 100, No. 2, pp. 110-118.

Francis, M. (2004) "New Product Development and IT in food supply chain management: The case of Tesco." As cited in *Food Supply Chain Management*, Bourlakis, M. and Weightman, (eds.): pp. 153-164, London: Blackwell.

Francis, M., Dorrington, P. and Hines, P. (2008) "Supplier led new product development process improvement in the UK fast moving consumer goods industry", *International Journal of Innovation Management*, Vol 12, No. 2: 195-222.

Fransoo, J C (1994) A Typology of Production Control Situations in Process Industries, International Journal of Operations & Production Management, Vol 14, 12, 47-57.

Frey A W Albaum, (ed.) (1948) packaging, Section 6, *The Marketing Handbook*, New York, The Ronald Press Company.

Grunert, K.G., Hanne, H., Meulenberg, M., Kuiper, E., Ottowitz, T., Declerck, F., Traill, B. and Goransson, G. (1997) "A framework for analysing innovation in the food sector". In *Product and Process Innovation in the Food Industry,* Traill, B. and Grunert, K. (eds.), London: Blackie Academic and Professional, pp. 1–37.

Henderson R., Clark K. (1990) Architectural innovation: the reconfiguration of existing product and the failure of established firms. *Administrative Science Quarterly*, Vol. 35, p. 9.

Johnson, David W. and Johnson, Roger T.(2005) 'New Developments in Social Interdependence Theory', Genetic, Social, and General Psychology Monographs, 131: 4, 285 — 358.

Johnsson, M. (1998) "Packaging logistics – a value added approach", doctoral dissertation, Department of Engineering Logistics, Lund Institute of Technology, Lund University.

Kraft, K. (1990), 'Are product- and process-innovations independent of each other?' *Applied Economics*, 22, 1029–1038.

Martinez-Ros, E. (2000), 'Explaining the decisions to carry out product and process innovations: the Spanish case,' *Journal of High Technology Management Research*, 10(2), 223–242

McDaniel & Baker, 1977, as cited in Ampuero, O. & Vila, N. (2006) *'Consumer perceptions of product packaging'*, *Journal of Consumer Marketing*, Vol. 23, No. 2, pp.100-112.

Newbert, S. L. (2007). Empirical research on the resource-based view of the firm: An assessment and suggestions for future research. *Strategic Management Journal, 28*(2), 121-146.

Paine, F. A. and Paine, H. Y. (1992) "The Economics of primary packaging" in 357- 389. In *A Handbook of Food Packaging*, 2nd edn. fa Paine and hy Paine. Blackie Academic and Professional, London.

Phillips, H. and Bradshaw, R. (1993) "How customers actually shop: customer interaction the point of sale", *Journal of the Market Research Society*, 35, no. 1: 51-62.

Pisano, G. (1997), *The Development Factory: Unlocking the Potential of Process Innovation*. Harvard Business School Press: Boston.

Porter, M. E. (1985), *Competitive Strategy*. Free Press: New York.

Prendergrast, G & Pitt, L (1996) “Packaging, marketing, logistics & the environment: are there trade-offs?” *International Journal of Physical Distribution & Logistics Management*, Vol. 26, No. 6, 1996.

Reichstein *T,* Salter *A,* Investigating the sources of process innovation among UK manufacturing firms, *Industrial and Corporate Change*, *2006*, Vol:15, Pages:653-682.

Rudder, A., Ainsworth, P., Holgate, D. (2001) “New food product development: strategies for success?”, *British Food Journal*, Vol. 103, No. 9: 657-671.

Rudolph, M.J. (1995), "The food product development process", *British Food Journal*, Vol. 97 No.3, pp.657-71.

Rundh, B. (2005) “The multi-faceted dimension of packaging”. *British Food Journal*, 107 (9), 670-684.

Saghir, M. (2002) *“Packaging logistics evaluation in the Swedish retail supply chain”* licentiate thesis, Department of Design Sciences, Division of Packaging Logistics, Lund University, Lund.

Sara R (1990) “Packaging as a retail marketing Tool”, *International Journal of Physical Distribution& Logistics Management*, , Vol. 20 No. 8, pp. 10-21.

Silayoi, P & Speece, M (2004) “Packaging & Purchasing Decisions: an exploratory study of the impact of involvement level & time pressure”, *British Food Journal*, Vol. 106, No. 8, pp. 607-628.

Simms C and Trott P (2010) Using packaging to create new product ideas, *Marketing Theory*. Vol. 10, No. 3.

Simonetti R, Archibugi D and Evangelista E (1995) Product and process innovations: how are they defined? How are they quantified?, Scientometrics, vol 32, No 1, 77-89.

Stewart, B. (1995) *“Packaging as an Effective Marketing Tool”,* Pira International, Surrey.

Teece, D. J., Pisano, G., and Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*, 509-533.

Thompson J. D. (1967) *Organizations in Action: Social Science Bases of Administrative Theory.* McGraw-Hill, New York.

Tushman, M. L. and L. Rosenkopf (1992), ‘Organizational determinants of technological change: toward a sociology of technological evolution,’ *Research in Organizational Behavior*, 14, 311–347.

Tushman, M. L. and P. Anderson (1990), ‘Technological discontinuities and dominant design: a cyclical model of technical change,’ *Administrative Science Quarterly*, 35, 604–633.

Utterback, J. M. and W. J. Abernathy (1975), ‘A dynamic model of process and product design,’ *Omega*, 3(6), 639–656.

Wallace, T.F. 1998) (Eds),*APICS Dictionary*, 5th, American Production and Inventory Control Society, Falls Church, VA.

Wansink, B., Huffman, C. (2001) "Revitalizing mature packaged goods", *Journal of Product & Brand Management*, Vol. 10 No.4, pp.228-42

Weiss, P. (2003), 'Adoption of product and process innovations in differentiated markets: the impact of competition,' *Review of Industrial Organization*, 23, 301–314.

Wells, L.E., Farley, H. & Armstrong, G.A (2007) "The importance of packaging design for own-label food brands*", International Journal of Retail & Distribution Management,* Vol. 35, No. 8, pp.677-690.

Wells, L.E., Farley, H. & Armstrong, G.A (2007) "The importance of packaging design for own-label food brands*", International Journal of Retail & Distribution Management,* Vol. 35, No. 8, pp.677-690.

Wernerfelt, B. (1995). The resource-based view of the firm: Ten years after. *Strategic Management Journal, 16*(3), 171-174.

Winter, S. G. (2003). Understanding dynamic capabilities. *Strategic Management Journal, 24*(10), 991-995.

Zott, C (2003) Dynamic capabilities and the emergence of intra-industry differential firm performance: Insights from a simulation study. *Strategic Management J.* 24 97-125.