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CONJECTURES ABOUT FUTURE WANTS: SOME INSIGHTS FROM EVOLUTIONARY ECONOMICS WITH REFERENCE TO DIGITAL PHOTOGRAPHY

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ABSTRACT

The essence of strategic management lies in making decisions which commit the organisation to future activities, but by its very nature the future is unknowable with any degree of certainty so managers have to formulate conjectures about the likely future state of the world. As George Shackle (1992: xii) observed 'The word enterprise points directly to the nature of business as a venture into the unknown. Businessmen are explorers, sometimes suffering shipwreck by their over bold conceptions…' In this paper we take a look at the decision problem from the perspective of evolutionary economics broadly defined. We focus attention on how consumers may choose to buy products on the basis of a hierarchy of preferences for the characteristics embedded in a product and how this may be at odds with the firms' understanding of the drivers of demand for their products (which may be informed by a the view that consumers are happy to substitute between different quantities of characteristics). We also focus on the problem of strategic myopia which may well arise because managers are blinkered in their understanding of the broader issues faced by consumers and the contexts in which they make choices. This is a problem which is particularly prevalent when a firm is required to move from a product based on one technology to a product based on a new one. Our analysis is

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illustrated throughout with examples, with special attention paid to the case of Kodak and the development of digital photography.

1. INTRODUCTION

The essence of strategic management lies in making decisions that commit the organisation to future activities, but by its very nature the future is unknowable with any degree of certainty, so managers have to formulate conjectures about the likely future state of the world. As George Shackle (1992: xii) observed 'The word enterprise points directly to the nature of business as a venture into the unknown. Businessmen are explorers, sometimes suffering shipwreck by their over bold conceptions…'

We discuss the case of digital photography as an exemplar of new technology introduction and examine it through the lens of evolutionary economics (Boulding, 1981; Nelson & Winter, 1982; Potts, 2001). Evolutionary economics borrows heavily from behavioural economics (founded by Simon, 1955) which is based on a more sophisticated view of the psychology of the consumer than the well informed rational economic actor often referred to as *homo economicus*. Evolutionary economics also takes a systemic perspective so it encourages decision makers to better see the 'problem whole' (Teece & Winter, 1984) and as such it offers insights beyond the traditional textbook economics with which managers may be more familiar. Since it is consumers who determine the success or failure of products the underlying aim of this paper is to shed light on the problems faced by consumers in their attempts to make sensible buying decisions in the face of uncertainty. If managers can understand these issues better they can make more informed decisions when strategizing about the firm's scarce resources. We focus on two main issues: (i) the implications of non-compensatory (hierarchical) decision rules and their associated dynamics for consumer choice, and (ii) the interplay between standards, consumer adoption rates and consumers' decision contexts.

2. NON-COMPENSATORY DECISION RULES AS A DRIVER OF CONSUMER CHOICE

Orthodox economic theory offers business decision-makers a view of how buyers reach their choices that is potentially highly misleading in markets where products are complicated and technological change is rapid. In essence it says that consumers are prepared to trade product characteristics off against each other, though at a decreasing rate. If we imagine the case of a consumer buying a digital camera for the first time what this might mean is

that the consumer may be prepared to forego some of image capturing capability (e.g. accept a 4-megapixel camera rather than a 5-megapixel one) in exchange for a better optical zoom capability (e.g. 5x rather than 3x) but if they are to sacrifice even more image capturing capability (e.g. from 4 to 3.2-megapixels) then they will only do so in exchange for a proportionately greater gain in optical zoom (e.g., 8x rather than 5x). To put it another way, the consumer is assumed to have a given set of preferences and experience diminishing marginal utility in terms of product characteristics and products themselves beyond a certain point.

Seen thus, the process of choice implies a pretty straightforward solution to the problem that a firm faces when it is trying to work out what combinations of features to offer in a new product: do market research and discover consumers' willingness to pay for additional features or more of particular features and then see what these answers imply in terms of revenue, compared with the costs of offering more in one area relative to offering more elsewhere. The only complication seems to be processing the data, for the diminishing willingness to substitute rather conflicts with the use of linear modelling tools.

Unfortunately, this approach fails to address the question of how consumers acquire information about the features that products have to offer and how they deal with the information that they manage to obtain or cope with absent information. If information has to be gathered, consumers need first to have an idea of what kind of information they should be trying to gather and this requires they have knowledge about what they ought to be trying to achieve in terms of end results and about means-ends relationships. If information is costly to acquire, the consumer needs a means of limiting search to avoid wasting time and effort on possibilities that are either poor means to the ends being pursued or needlessly expensive.

These knowledge- and information-related issues have led behavioural/evolutionary economists to see choices as being made not on the basis of given underlying preferences but via the application of decision rules that simplify the process of choice and which are modified as time passes and experience is acquired. Firms that engage in extensive market research programmes and act as if the story from orthodox economics applies run the risk of (a) failing to understand the significance of the rules that consumers presently have at their disposal, and/or (b) failing to appreciate that consumers may be desperately looking for workable decision rules—in other words, far from having 'given preferences', they are open to being supplied with means for reaching decisions by third parties such as friends, retailers and manufacturers.

The crucial thing here is whether the rules that third parties supply fit into consumers' higher-level rules for choosing rules for choice: some suggested rules they may simply rule 'out of court' because the rules are at

odds with the core principles around which they build their lives (for example, about getting into debt) or otherwise present a challenge to their ways of seeing themselves (for example, regarding the kind of photographer they see themselves as being, or their private perceptions of their ability to cope with new technology). Thus some consumers, who saw themselves as serious photographers, might find it unthinkable that they should delay purchase of a digital SLR camera even though they could make substantial savings by doing so, whereas other consumers, fearful of any new technologies and without home computers, might be reluctant to consider a camera that could not be connected directly to a stand-alone printer, even if they initially planned to get their photos printed in a photographic store.

From the behavioural/evolutionary standpoint decision-makers are seen as often dealing with complicated information environments and poor knowledge by setting targets or *aspiration levels* for product characteristics. Taken together, these targets imply a checklist of requirements (Earl, 1986) and if several products have all the required features a tie-break rule will also be deployed, whereas if nothing that is available meets all requirements then the buyer may apply a priority ranking to the items on the checklist. In other words, such a consumer is essentially specifying a *template* that products are expect to fit. If a consumer is asked to rank product features in order of importance, the answers may thus imply not relative weights, in line with the orthodox adding-up view of choice, but *non-compensatory priority rankings*. The important implication for a firm here is that if it fails to offer adequate performance in one area it could be mistaken if it presumes its product's shortcomings can be offset by above par performance in other areas.

For example, suppose a digital camera buyer has a template that looks like the one illustrated in figure 1. This buyer is prepared to pay $300 for a camera that meets the following criteria: it must have at least 4-megapixel image resolution, at least 3x zoom, and be slim enough to fit into her handbag. She may know nothing about megapixels but may have formed an aspiration in respect of image resolution because this is what a salesperson advises as giving sharp enough pictures for A4-size prints, or because she has a rule of adopting for her targets something slightly better than the bottom-end performance level and at the time in question that seems to be 3-megapixels. If she sees a camera, such as one from the Fuji Finepix range (we will call this 'model A'), that achieves much more zoom than she requires and meets her zoom target optically rather than digitally but which has a bulky lens system as result, she may reject it because its chunkier shape conflicts with her requirement that it must fit in her handbag (have a size index of 4) and this feature is ranked more highly than the zoom requirement. If Fuji wants to sell this consumer a camera, it must attend to the dimensions of its cameras, even if its rivals are unable to match its zoom performance in this price zone. Offering greater image resolution (more

megapixels), more zoom capability for the money, or even reducing the price, will not win this consumer over, though it might make the product appeal to other consumers, who are using different decision rules. Indeed, there is scope here for making 'parts-bin' combinations of the technologies in order to appeal to a wide variety of customer templates just as Sony did when it offered 150 varieties of its famous Walkman (but it does not appear to be doing the same thing with its digital cameras).

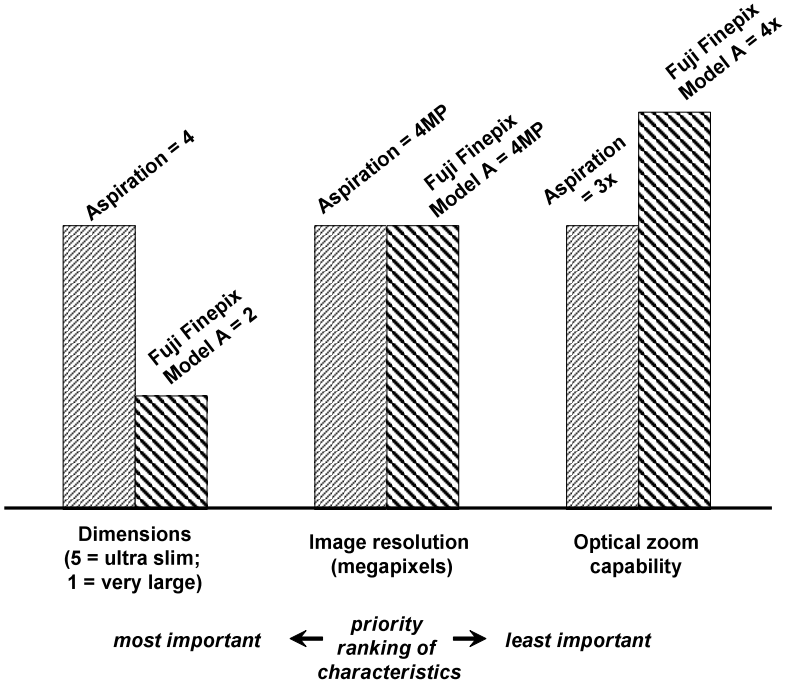

Figure 1: A customer's aspiration template compared to a given product's actual attainment

A further complicating factor in this analysis is that consumers' aspiration levels for the performance of different characteristics are unlikely to remain constant as time passes. This is because customers learn what is possible with a technology as it becomes more established through experience in use and observation of third parties. Indeed there are a large number of influences on aspiration levels, not least of which are the performance standards achieved (or claimed) by rival firms' products. The upshot of this aspiration adjustment is that customers are likely to become more demanding in terms of the performance they expect from each characteristic. For example, TV sets became a mass-market product in the

1950s and at that time consumers accepted that they offered a black and white picture and it was necessary to get up off the couch to change channels. In the third millennium the demand for what would have been highly advanced features in the 1950s, such as remote channel changers and a colour picture, is taken for granted.

An alternative to the consumer specifying the product template herself is to simplify the choice problem drastically by, in effect, delegating the selection of product specification to the manufacturer of a trusted brand and, for example, buying that brand's best product within the budget the consumer is prepared to spend. However, this simplification strategy can be difficult to implement in the case of emerging technologies. For example, in the case of digital cameras the choice of which brand to trust was complicated by the presence of a curious mixture of players in the market: established camera manufacturers such as Canon, Nikon and Olympus; established consumer electronics firms such as Sony and Panasonic with reputations in the movie camera area but not for still cameras; established firms from other sectors, such as computer maker Hewlett-Packard; and Kodak and Fuji, both known mainly as film suppliers. Which of these companies would both know what it was appropriate to offer the consumer and, crucially, have the necessary capabilities to offer it? Consumers' choices of brands in these kinds of scenario will be affected significantly by the knowledge that they have (or think they have) about a company's capabilities and this itself may be a reflection of advertising strategies and/or familiarity with how the company has marketed itself in the past. For example, the market leader in US digital camera sales in the US in 2003 was Sony followed by Kodak. Both have very different images and have employed different strategies. Sony built up its reputation in the digital camera market by entering into a strategic alliance with Zeiss lenses to complement its widely-respected expertise in microelectronics. While the reason for Sony's success is relatively easy to identify as rooted in its well known capabilities, in the case of Kodak it is less obvious. This is because Kodak is known primarily for its film manufacture and processing business rather than for camera manufacture (it outsourced camera making to Chinon in the 1980s), and it has also failed prominently to advertise the fact that it actually invented the digital camera! In the minds of many consumers, however, it is associated with making photography accessible and easy through its 'you point and shoot, we'll do the rest' philosophy that it has been pursuing for a century now. It has been able to continue this philosophy with its EasyShare range of digital cameras allied with its easy-to-use web-based image storage and sharing facilities although this by no

means guarantees it a secure footing in a market that is flooded with entrants.[1]

3. THE STANDARDS PROBLEM REVISITED

The consumer's decision problem changes through the course of a product lifecycle. Not merely are there changes in the performance levels and performance dimensions that products can be expected to offer with the associated feedback to aspiration levels, as we have discussed above, but the variety of formats the product takes may change. In mature markets, choice is often made easier for late adopters by the presence of product standards for sizes, interfaces, and modes of operation. Where there are a number of standards, experienced consumers will tend to get locked into the one that is most familiar to them (for example, a Nokia mobile phone, rather than a Motorola one, or a Windows PC rather than an Apple one, in both cases because of user interface standards), or which enables them to be 'futureproof' by promising connectivity of new items to existing ones. (Such a claim was made in 2003 by Nokia for its original digital TV set top box with respect to its compatibility with as yet underdeveloped expansion cards required to watch pay-to-view channels. In fact the claim was overbold; in the UK in 2005 it became apparent that it was necessary to purchase an adapter before one could use the most common card type with this model. In the event it was cheaper for owners to buy a new and different set top box rather than adapt their original Nokia box.)

Clearly, with new products, the absence of a single standard can prove a barrier to the product taking off, due to consumers adopting a 'wait and see' strategy (as happened in the late 1970s with quadraphonic vinyl LPs). This strategy enables them to eliminate the risk of making a commitment to durable goods and associated operating capabilities that it will later be necessary to abandon (as in the Nokia set top box example above) because they fail to win the standards battle and hence enjoy less development than the winning technology. In such a situation, any early signal as to which standard is winning may tip the market into rapid growth by overcoming both investor and customer uncertainty. If the market explodes really rapidly, it may leave enough room for a minority standard if that dominates on some dimensions even despite being more costly, so long as it is compatible with the dominant one (as in the case of Apple computers).

Clearly, uncertainty about what form the most successful product will take poses a corresponding challenge for producers. The firm that places its bets on what turns out to be the dominant product form can enjoy

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1 See www.kodakgallery.com.

spectacular growth and years of profits; so, with everything to play for, competition tends to be very aggressive until a standard form emerges (Klein, 1977). For example, in the early days of the motor car it was not clear whether cars were going to be powered by petrol, diesel, steam or electricity, whether they would have steering wheels or tillers, and so on. Likewise, in the early days of home video, Sony's Betamax system battled with VHS, backed by Matsushita, JVC and others, whilst early personal computers ran a variety of operating systems, and digital audio recording could be done using Sony Minidisks, DAT or Phillips' Digital Compact Cassette, or via computer hard disks in conjunction with recordable CDs. Sometimes, the technology that comes to dominate is not even the initial victor: the recordable CD's reign as dominant mode is currently being challenged by a new genre that itself comes in a variety of formats, namely, mini-hard drives (iPods) and flash drives (MP3 players).

Given that firms that back the less favoured technologies can run up large losses, the temptation is to try to engineer things to ensure that their particular standard wins. The success of Windows PCs and VHS versus the shrunken market share of Apple and the failure of Betamax video are now legendary examples of how an open access technology can prove a bigger money spinner than a proprietary system because it results in a standard: there is not much to be said for capturing all the rents from a technology if few end up adopting it.

We raise these cases here not because we are about to run over familiar territory once again but because we believe that the familiarity of these examples is something that could itself be just as much a problem as an Apple/Sony-style strategy. Whilst we accept that economies of scale may come from establishing a standard and may bring profits far greater than a niche player might be able to achieve, success stories such as Microsoft should not divert managers from thinking carefully about whether there is actually a role for a standard in the market in question. In this section, we use the digital photography revolution as a case study to show that a new technology may actually destroy the need for a standard rather than creating a role for a new standard to serve in the same role as the old one. The case study ends with a lesson about alternatives to thinking about standards rivalry in dog-eat-dog terms.

Prior to the introduction of digital photography, the dominant standard was 35mm colour print film. Black and white and slide film were minority products for serious photographers and a few of the latter would sometimes use larger format film rolls. But the 35mm standard had emerged quite late in the day. For many years there were two main kinds of rival standards in the market for photographic film: (i) roll-based film that had an unattached end that needed to be wound onto a roller system in the camera, and (ii) films that were much easier to load without error, mainly developed

by Kodak as part of its century-long strategy of trying to make photography simple for everyone. Kodak tried in the 1960s, initially with some success, to simplify the loading of film via its cassette-based 'Instamatic' cameras and in the early 1980s the 110-film standard involving much smaller film cassettes was tried. Despite being heavily involved in trying to develop digital photography from the early 1970s onwards, Kodak also experimented in the 1980s with disk-film, a revolving flat sheet of film, for which it also supplied cameras, but few bought them. These systems appealed only to those who were not looking for high-quality photos, as an inherent design problem with them was that the film could not be tensioned against a flat back-plate in the way that it can be in film-roll-based camera so, even with good optics, a cassette-based camera would not deliver really sharp pictures. In any case, in the 1980s advances in camera technology, most particularly self-loading of film and automatic ASA selection made it much easier even for inexperienced/incompetent camera users to get their films loaded properly.

Though it is easy to explain why the alternatives to film-roll cameras had faded away by the end of the 1980s, this still leaves the question of why one film size dominated. To some extent, we might try to explain this in terms of economies of scale in production of just one type but the issue appears to have been driven more by economies on the distribution side that relate to the way that film was typically purchased. Buyers of film essentially could choose between getting it from specialist photographic stores or buying from retailers that did not specialize in photographic products, such as pharmacies, filling stations, convenience stores, supermarkets and tourism venues. Their purchases could either be forward-looking, where they had no need for film at that moment but expected to need it in future, or done 'on-the-run', where they had an urgent need to get more film because they were, say, on holiday and wanted a new film right now, having run out of spare film. If the consumer is in a hurry and/or is in unfamiliar territory, it is important to be able to find the right kind of film without engaging in major search activity. The 'right kind of film' refers both to film of guaranteed quality, since photographs are often taken in significant, non-replicable situations (holidays, family occasions, etc.) and to film of a size that fits the camera. Though our focus is on the second issue, it is important to keep the first one in mind.

Film is an 'experience good' (Nelson, 1970), and the consumer often has a major incentive—the loss of images that will not be repeated—to avoid a bad experience. Hence we can make sense of the dominance of the film market by just a few trusted brands that are internationally immediately recognizable (Kodak and Fuji, with Agfa and Konica as rather smaller players) purely in terms of the trust issue and the marketing economies that are associated with this, though economies of scale in production may be likely to have a role, too (given that film is likely to be produced in a

continuous process form of manufacture, one complicated by the need to ensure it is not exposed to light along the way). Being able to find the trusted film brand logo readily is vital for the consumer who is in a hurry (exactly the same issue as with finding fast food, where the issue is not only fast delivery but delivery of food of acceptable quality, a problem that many people solve by looking for the conspicuous McDonald's golden arches logo), but this still leaves the issue of finding the right type of film. If the store is not a photography specialist, it will have to limit the range of film products that it stocks, which will mean one or both of two things: it must limit the brands of film it stocks and/or the types of film (and note here that film varies not just in terms of size but also slide versus prints and ASA exposure type). The other thing of relevance is the turnover rate of stock, since film carries an expiry date and film past its expiry date will only be saleable at a discount, if at all, and stock that turns over slowly may not generate an adequate return on shelf space that could have been used for other goods (i.e. the opportunity cost issue).

These considerations provide incentives for convenience retailers of film only to stock film types that are commonly demanded; for consumers to choose cameras that use film that is commonly supplied (for otherwise they will find it hard to get film when they need it in a hurry); and for camera manufacturers to concentrate on offering products that take popularly demanded film types so that they can spread their fixed costs of development and manufacture over larger volumes of output. Once the pattern of supply and demand tilted somewhat in favour of 35mm cameras *for whatever reason*, the process would be self-reinforcing. (Perhaps, in the case of 35mm film, the crucial feature was more convenient size of the 35mm camera compared with other, large width formats, coupled with picture quality that was adequate for most purposes.) The convenience issue probably would have had a further angle via the rise of the one-hour photo printing shops whose equipment might have been specific to the dominant film, with other films having to be sent away to a specialist lab. For film-based photography, then, the story looks very similar to what happened with PCs and VCRs, where the relatively abundant availability of complementary software products soon came to be the main driver.

With digital photography, the digital storage card or memory stick is the equivalent to film, but no standard has emerged. The economics here suggests that it is unlikely that one will do so, as things are quite different in a number of ways:

- The existence of a standard for memory media for digital cameras is much less important for consumers since the various types of memory media normally have storage capacity that is vastly in excess of a 36-print 35mm film roll.

- Storage capacity within many formats is growing rapidly, too, as is the tendency for over-kill in terms of picture quality offered by a camera. Consumers with high quality cameras who think they are going to run short of memory capacity can economize on it by lowering picture quality without this being discernible unless they need to print off their photographs in a very large size.
- Consumers who run short of camera memory can download their photos to CD in many locations, not just in photography shops but also at home, whilst visiting friends or using Internet cafes whilst on the move, or to devices such as iPods.
- Unlike film, digital storage media for cameras are more in the nature of investment goods rather than consumables, because they are used over and over again. They are not purchased 'on the run' to nearly the same degree and hence they are not tending to be stocked by the convenience retailers who had tended to supply film. Rather, they are purchased from specialist photography stores that can carry a wider range without it being uneconomic (especially given their higher value relative to storage space).
- If the digital media are reliable and can be overwritten time after time, and if photographers tend to have a couple or more memory cards for their cameras, then there is no need to worry about a particular type of memory card failing to become the industry standard and vanishing from the photography shops. Consumers' memory cards may serve them well for many years, despite their cameras falling behind in terms of specification as technology moves on. Moreover, since newer generations of cameras may have different memory systems, there is less incentive to try to choose one's present camera with a view to being able to continue to use its type of memory media when one upgrades to a new design, so there is less incentive for manufacturers of cameras to opt for the memory system that is currently most popular.

In short, in this case the lack of a standard digital media product is not a problem for consumers and this, in turn, makes it unlikely that such a standard will develop. Because those who practice digital photography will be less likely to see other photographers changing the memory cards of their camera than they would have been to see people brandishing packets of film, *copycat behaviour* is less likely to promote a dominant variety of memory card. Insofar as there is any prospect of a memory card standard emerging for cameras it lies in an entirely different reason from that which underpinned the 35mm film standard, namely that cameras may use similar types of memory cards to other electronic devices. If so, we may expect consumers to tend to standardize where possible amongst their own collections of devices. Related to this is the extent to which home video

devices incorporate memory card readers: some DVD recorders and LCD televisions incorporate card readers that will read several format, but some will only read a particular kind. Though photos may still be viewed on-screen by connecting the camera to a 'AV video-in' socket, regardless of memory medium type, we might perhaps envisage some consumers having their choices of camera affected by choices they have already made in terms of home video devices: after all, if face with a tie in terms of cameras that pass all checklist requirements, the consumer will be looking for something extra as a tie-break. Thus although the memory card type is not on the initial list of core requirements, such ways of making decisions could tilt the market towards a standard.

None of this is to say that digital photographic technology has eliminated consumers' needs for standardization; on the contrary, a different kind of standard is now needed, rather equivalent to the industry-wide MIDI (Musical Instrument Digital Interface) standard that emerged in music technology in the early 1980s. Because of the need for cameras to connect to computers, the need for image files to be compressed to reduce memory demands, and the possibility that people would wish to exchange photographs with each other in electronic form, it was important that a standard for compressed electronic image files emerged at an early stage. The name of the system that did so—JPEG—is an acronym for Joint Photographic Experts Group, which reflects this standard's emergence not via a battle for competitive supremacy but through cooperation by major players through market institutions. This was similar to what happened with the emergence of MIDI in 1981-3, where synthesiser manufacturers such as Roland, Yamaha and Oberheim abandoned their proprietary interface systems and collaborated on a universal one, in the process setting up the MIDI Manufacturers Association to develop and maintain the standard. Note that while orthodox economics sees collaboration between firms as a bad thing via its focus on cartels in existing markets, these cases should serve as reminders that collaboration between firms can be beneficial both for firms and consumers by facilitating the development of a new market and may indeed prevent the emergence of an unduly dominant player in the Microsoft mould (see further, Richardson, 1998).[2]

2 See: http://www.dsi.unive.it/~smm/2001/docs/wallace91.pdf on the JPEG standard. See: http://www.rbjones.com/rbjpub/music/mus007.htm#what on the MIDI standard.

4. THE ECONOMICS UNDERLYING ADOPTION RATES

Established ways of thinking can result in firms underestimating the pace at which consumers may adopt their new technologies. Just as in the mid-1980s the spectacular takeoff of CDs presented a challenge in terms of both CD pressing capacity and the run-down rate of vinyl LP pressing plants, so in the past five years the switch from film-based photography to digital has taken many suppliers by surprise. In both cases, consumers had to make a substantial investment in new hardware to enjoy the benefits of digital technology and they did so even though the price of this hardware was falling and they could have saved money by waiting a year or two.

For firms to anticipate adoption rates more accurately, they need to understand the economics of adopting new technologies that consist of new systems for meeting goals that consumers were previously trying to meet via a less effective vintage of technology. Economists have not written much about this in terms of the consumer's predicament but the work of Salter (1960) on the adoption of new technologies by firms is readily adaptable to the consumer context. Salter points out that for an existing investment to continue to be operated it need only cover its average *variable* costs, whereas for it to make sense to adopt a new technology it must be expected to cover both its average variable costs and its average *fixed* costs over the planning period. In this section we show that this use of conventional economic concepts provides a useful starting point for dealing with this issue but that is can lead to myopic strategizing if not buttressed with a more evolutionary, systems-based perspective.

Consider, from Salter's standpoint, the economics of photography. If you have a traditional camera that you expect to continue working perfectly well for the next, say, three years, you should compare the cost of taking three years' worth of photographs on this camera in terms of film and developing/printing charges with the cost of a digital camera and memory card(s) and the cost of getting prints made. The new technology has lower variable costs but entails fixed costs that can be avoided by continuing to buy film and using the old camera. Those who do not take many photos will be late adopters of digital technology, since it would have high average fixed costs. Serious photographers, who insisted on having an SLR camera with the capacity to change lenses, might also be predicted to delay adoption given that prices of digital SLR cameras with high resolution capacities were initially proportionately far higher relative to fixed lens digital cameras (or simply not available at the desired picture quality level) and switching to them might also require heavy investment in new sets of lenses (as in the case of those who had stuck with manual focus lenses that would not fit on autofocus cameras of the same brand). However, market research might well find that serious photographers were inclined to invest in a less-than-ideal

digital camera as an interim measure to use on some occasions and for learning how to use the technology.

Now, it should be possible via market research to discover how the market is segmented in terms of annual rates of taking photographs and ages of cameras and make predictions about probabilities of adoption of the new technology as time passes, with existing cameras becoming more likely to fail and digital ones falling in price. However the analysis has a problem: it compares, so to speak, apples with apples, whereas digital photography is not simply an alternative means to the end of obtaining photographic prints. According to the *Economist* Kodak missed this point and found itself surprised by the rapid adoption of digital cameras:

> As prices fall and performance improves, even many professional photographers are going digital. This rapid uptake surprised the Rochester, New York, company. When photography was a matter of exposing rolls of film, Kodak was primarily in the chemicals business: making films, darkroom agents and light-sensitive papers. Now this part of its business is shrinking more quickly than expected. (The Economist, 2003)

The potential for the rapid take-off of digital photography looks far less surprising than Kodak anticipated if one sees its cost advantages in relation to a more thorough analysis of what Earl and Wakeley (2005) call the 'context of choice':

- For computer-literate photographers, variable costs of using digital cameras as a means of getting photographic prints are further reduced insofar as the printing of photographs is done at home via personal computers. In the mid 1980s, when Kodak was developing the world's first one-megapixel image sensor, the home computer was only just beginning to emerge, so the risk that image downloading might not end up being handled by Kodak Shops may not have been perceived.
- The variable cost of digital photography is reduced yet further if consumers do not even bother to make prints of their photographs and instead view them on computers or on their televisions via JPEG-compatible DVD players or the ability of new-generation LCD and plasma TVs to provide memory card readers or to be hooked up to computers via VGA input sockets and to iPods and other portable file storage devices. For such consumers, the digital photograph is a substitute for the slide film, or a means to switch to slides without all the costs associated with slide projectors, screens, and storage magazines. A corporate mind-set that focuses on digital photography as

a rival to the mass-market product of print film incorrectly frames the *opportunity costs* of many consumers and under-estimates the case for adopting digital photography. Digital photography had to be seen in the context of other digital technologies that were emerging at the same time. Kodak's CEO, Dan Carp (2005), however, remains convinced that the firm's future lies in making it easy to get Kodak prints. His vision is for wireless links between Kodak cameras and printers and one-touch printing. He sees computers as problematic and seems oblivious of the significance of changing television technology, not mentioning it, or the coming together of computers and television, at all.

Kodak initially had been rather more open-minded about the significance of computers for their business and developed the Kodak Photo CD product enabling users of traditional photographs to collect digital copies with their traditional prints (thereby helping more serious photographers to keep using their SLR cameras until digital ones of comparable quality became available and cheaper). Kodak Photo CDs also provided a means whereby, say, older generation consumers could have their digital photographs downloaded for them on to a form playable on DVD players rather than having to get to grips with doing it themselves on home computers. However, for the mass of those who wanted to see their photos as slide shows on large screens, it was unnecessary to get Kodak involved: they soon acquired the appropriate expertise for making their own photo CDs and although initially the growth in DVD player capabilities included only Kodak Photo CDs, soon a typical DVD player enabled any JPEG format photo to be viewed. By 2006, it was increasingly possible to avoid the computer and CD burner altogether and download photographs direct from camera to iPod-style devices or to view and edit them directly via multi-format card readers included in the latest televisions or in DVD players and recorders, and storage cards themselves had fallen spectacularly in price. Any vision Kodak may have had of establishing an ongoing role for the Kodak Shop via Kodak Photo CDs must lie in tatters because of this failure to establish a standard.

- Even for those who wish merely to get photographic prints, digital photography changes the way that photography is done by enabling consumers to take photographs at zero marginal cost except in terms of their time. Multiple shots of a particular subject can be attempted and those that are not later required can simply be deleted with no cost in terms of consumables. Furthermore, the quality of a shot can be checked immediately after it has been taken. To ignore this advantage will result in demand being under-estimated. The same may be said for

the enhanced scope for editing photographs, such as the production of panoramic wide-angle shots by cropping and 'stitching' digital images.

- The social context of photography affects the growth of demand for digital cameras. First there is the conspicuous consumption aspect of photography: the belief that one's camera says something about oneself to others. Those who are taking photographs with traditional cameras increasingly stand out as behind the times compared with those who can be readily seen, via the different shapes of their cameras' bodies and their LCD screens, to be using digital cameras. Secondly, and echoing our initial point about the technological context of consumption, digital photography enables images to be shared much more readily between friends and family via the Internet. Mobile phones with in-built cameras are another aspect of this.
- While home computers enable the time-rich consumer to internalise part of the photographic image production service rather than having it carried out by Kodak Shops, so, too, digital photography enabled time-poor business users of photographs to obtain images in electronic form without first having to wait for them to be developed (or incur the costs of buying Polaroid cameras and film) and then scanning them). The *co-evolutionary* progress of the digital photography market and eCommerce should be reflected on here: websites for real estate agents and car dealers would be much more difficult to operate without digital photography; so, too, would eBay and Internet dating sites, some of whom claim to have hundreds of thousands (or millions) of members. This, too, was a decade away when Kodak was making its first one-megapixel image sensor work. Once again the lesson is in terms of the need for innovating firms to gather intelligence about potential/emerging complementary innovations when thinking about the potential markets for their own innovations, rather than focusing on their innovations as substitutes for existing technologies.

These lines of thinking lead us to take very seriously the suggestion in *The Economist* (2003) that Kodak could be unwise to pin its hopes of funding its restructuring towards becoming a more digital-focused business on funds generated from selling traditional film and film developing services in emerging markets:

> Managing the traditional film business for cash is how Kodak plans to fund much of its strategy. It has described emerging markets as its "reservoir of growth". In China, for instance, it expects film sales to grow by 7-9% a year until 2006. In India, an annual growth rate of 6-8% is expected. In China, it has purchased

> a 20% stake in Lucky Film, the country's biggest maker of camera film, for $100m. (The Economist, 2003)

Newly prosperous Asian consumers may simply go straight from no camera to digital camera, rather as many went straight to mobile phones (including camera-phones!). The entry costs of running a photographic print shop are far lower than for a traditional Kodak store, even one that uses a Kodak mini-lab shipped in from a high-income economy rather than being scrapped. Worse still, the ability to find a family member or friend who has a computer may be far higher in a country such as China than per capita income figures would suggest. As Tom Friedman (1999, p. 168) points out 'Even birth control works for Microsoft', since the one-child policy means that the capacity of parents and grandparents to invest in their children is not diluted and it is increasingly possible for a family to scrape together the money for at least one computer. From this standpoint, Kodak's purchase of a 20% stake in China's Lucky Film sounds questionable.

5. CONCLUSION

For an executive or an entrepreneur faced with the challenge of changing markets there is a high degree of uncertainty. In these situations executives are just like consumers in that they use simplifying heuristics (Bazerman, 2002) to streamline their decision-making processes and construct conjectures about future wants. Here we have shown that avoidable errors of judgement can result from reliance on simple models of given preferences and choice-as-substitution, as found in traditional economics, and blinkered (non-systemic) thinking. What is needed is a deeper understanding of how consumers make sense of the complex world they live in and how they might form their decision rules, coupled with an appreciation of the context in which they make choices, since only then can executives and entrepreneurs formulate their strategies. The other side of this perspective is the need for a firm to examine its capabilities in order to assess whether it is able to meet the wants of customers. If it cannot then it needs to formulate a strategy that will allow it to either develop capabilities internally or acquire suitable capabilities through some form of strategic alliance or other co-operative mode of business (see Kay, 1997). The literature on resources and capabilities (for an overview see Barney, 2001) implies that a firm's capabilities should determine the goods/services it produces and the markets it operates in. Implicit in this thinking is the notion that markets for goods and services are somehow given. The perspective advocated here urges executives not to see markets as 'given' but as territories occupied by consumers whose own problems of choice need to be better understood

prior to offering them goods and services for which they have a need, and for which the balance of characteristics is appropriate in the context of their lifestyles, complementary technologies and their possibly non-compensatory decision rules. In other words a critical capability for the firm to develop is the insight to see things from the perspective of the consumer who is struggling with her own problems of information and knowledge in a complex and dynamic context.

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