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Understanding the failure to understand New Product Development failures: Mitigating the uncertainty associated with innovating new products by combining scenario planning and forecasting

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ABSTRACT

In this paper we show that New Product Development (NPD) is subject to fundamental uncertainty that is both epistemic and ontic in nature. We argue that this uncertainty cannot be mitigated using forecasting techniques exclusively, because these are most useful in circumstances characteristic of probabilistic risk, as distinct from non-probabilistic uncertainty. We show that the mitigation of uncertainty in relation to NPD requires techniques able to take account of the socio-economic factors that can combine to cause present assumptions about future demand conditions to be incorrect. This can be achieved through an Intuitive Logics (IL) scenario planning process designed specifically to mitigate uncertainty associated with NPD by incorporating insights from both quantitative modelling alongside consideration of political, social, technological and legal factors, as-well-as stakeholder motivations that are central to successful NPD. In this paper we therefore achieve three objectives: 1) identify the aspects of the current IL process salient to mitigating the uncertainty of NPD; 2) show how advances in diffusion modelling can be used to identify the social-network and contagion effects that lead to a product's full diffusion; and 3) show how the IL process can be further enhanced to facilitate detailed consideration of the factors enabling and inhibiting initial market-acceptance, and then the forecasted full diffusion of a considered new product. We provide a step-by-step guide to the implementation of this adapted IL scenario planning process designed specifically to mitigate uncertainty in relation to NPD.

1. Introduction

Much research has sought to identify the factors associated with successful NPD. Yet, despite this, NPD success rates remain stable and there is little evidence of reduced failure (Ottum and Moore, 1997; Page, 1993). This suggests a continued failure to adequately understand NPD failure, as a result of which reducing high rates of NPD failure remains 'one of the greatest challenges of new product research' (Markovitch et al., 2015). While acknowledgement of the difficulties associated with NPD, as-well-as the high prevalence of failure, is not entirely absent from the literature (e.g. see Borgianni et al., 2013), the tendency to focus on successful NPD, thereby giving little consideration to the factors that inhibit or prevent success, is likely to be a central factor driving continued high NPD failure rates.

As consumers we are under the influence of survival bias, which makes it appear that NPD is subject to less uncertainty than high-failure rates imply it really is (Ormerod, 2005). This uncertainty is most pronounced in relation to radically new products for which no market has previously existed (Cooper, 2000); however, even incremental enhancement of already-existing products is fraught with uncertainty. In the 1980s Coca-Cola created an 'improved' version of their standard product, which they called 'New Coke' (Dubow and Childs, 1998; Schindler, 1992). Despite it being an incremental development of an already-existing product, it was a failure. In the 1990s McDonalds made a similar, expensive mistake in the form of its 'Arch Deluxe' burger (Kleijnen et al., 2009). Uncertainty, then, surrounds the development of even incrementally-improved products; the development of an entirely new product is therefore subject to uncertainty of a still more fundamental nature.

There are two sources of uncertainty associated with NPD: epistemic and ontic. The first relates to the aforementioned survival bias, whereby the many products that surround us are those which were successfully introduced to the market. But these successes represent the tip of the iceberg of all NPD; that part which we do not see represents by far the majority: the new products that fail. This unobserved failure is central to understanding the difficulty in making inferences about NPD success and failure.

The observable evidence, analysed to estimate the drivers of product diffusion, refers to new products that, being successful, are systematically different from those unobserved, that failed. Estimating the underlying

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causes and time profiles of NPD failures based on evidence from NPD successes is therefore prone to a very high risk of misidentification, leading to many potential sources of bias in the estimates. In practice, an econometric estimation of the key drivers of the stochastic diffusion process of NPD is therefore inevitably exposed to a critical *selection bias*, due to the unobservability of the counterfactual process, whereby under different values of the key explanatory variables, failed new products would have successfully diffused into the market. This represents an epistemic source of uncertainty in relation to NPD — one that is associated with our inability to observe the counterfactual of product failure, leading to inaccurate modelling. Because of this epistemic uncertainty, inferences achieved through the application of probabilistic modelling, such as in diffusion models, have limited efficacy in reducing failure rates in relation to NPD.

However, even if this epistemic uncertainty were not present, NPD would, anyway, still be subject to a more fundamental uncertainty that is ontic in nature, and which further dilutes the efficacy of probabilistic methods of inferencing in relation to NPD. By 'ontic uncertainty' we do *not* mean the uncertainty associated with natural variability (Hacking, 2006; Hoffman and Hammonds, 1994; Maier et al., 2016), rather, we use 'ontic uncertainty' to refer to the change in the nature of reality that is brought about by a successful new product. This ontic uncertainty stems from what the economist Shackle (1938, 1943, 1949a,b,c,d, 1950–1951, 1952, 1953, 1955a,b, 1958, 1961, 1970, 1972, 1979, 1980, 1983, 1984) refers to as the 'crucial' nature of some types of decision making. Decisions of these types – 'crucial decisions' (Shackle, 1955a, 1961) – change the very circumstances in which the decision is taken in the first place, such that no future decision can ever be made in the same circumstances again (Basili and Zappia, 2009, 2010; Zappia, 2014). Essentially, such decisions, because they change the nature of reality, disrupt the very forecasts that may have given rise to the decision in the first place, exacerbating uncertainty by fundamentally, and permanently, altering the strategic landscape in which the decision was taken. They lead to cascades of responding decisions, made by others, which further disrupt the strategic landscape, leading to a high level of indeterminism, and resulting in the non-stationarity that econometric models are usually only able to estimate a-posteriori, hence with no specific NPD forecasting value.

Mainstream decision theory, associated with Savage (1954) and de Finetti (1937, 1974), deals badly with this strategic landscape-changing tendency of NPD. In mainstream decision-theoretic terminology, crucial decisions introduce a new state of nature, or delete an existing one, and both these possibilities had a zero prior probability and were therefore entirely *unexpected*. From this perspective, the emergence of a new state of nature, or the unexpected disappearance of an existing one, would require the reassessment of measurable probabilities over all the elements of the, now modified, event space. Importantly, the zero prior probabilities of the newly-introduced or eliminated state of nature have a key destabilizing feature for the application of traditional decision theory: a Bayesian update of the new relevant evidence would still return a zero posterior probability, notwithstanding the new evidence about the new state of nature. For this reason, even within an orthodox decision-theoretic framework based on subjective probability (Savage, 1954), probabilistic inference remains of limited applicability in relation to NPD.

These problems affect both probabilistic inferencing methods that employ 'objective' and 'subjective' probabilities. In the first instance, our inability to observe product failure negates the possibility of creating objective probability distributions to allow for accurate estimation using econometric modelling. In the second instance, the tendency for new products, whether successful or not, to alter the nature of reality that gave rise to them in the first place limits the efficacy of subjective probabilities as a means for NPD decision making. In this paper, we show that what is therefore required are techniques designed specifically for decision making under circumstances of fundamental, non-probabilistic uncertainty which can be *informed* by forecasting.

To deal with the fundamental uncertainty of 'crucial decisions' of the sort NPD generates, Shackle (1955a, 1961) set out Potential Surprise Theory (PST). PST has been shown to be in 'essential unity' with scenario planning (Derbyshire, 2017; Jefferson, 2014), as originated by RAND and popularised by Royal Dutch Shell (Bradfield et al., 2005). The currently most commonly-applied format for scenario planning is that known as Intuitive Logics (IL) (Wright and Cairns, 2011; Wright et al., 2013). IL is a narrative-based approach to decision making which allows for consideration of the effect of political, economic, social, technological, environmental and legal factors on the decision to be made. Importantly for our argument, while it is a qualitative technique, it allows for input from formal, quantitative modelling. However, because scenario planning recognises probabilistic approaches to be of limited efficacy in the face of fundamental uncertainty, IL in its standard format is a plausibility-based approach, designed to overcome the problems related to uncertainty that we have outlined above (Derbyshire, 2016a). Moreover, IL recognises that humans have a degree of agency in shaping a desirable future which is as yet undetermined (Cantamessa, 2016; Derbyshire, 2016a). In this paper, we set out an adapted Intuitive Logics scenario planning approach designed specifically to mitigate the uncertainty of NPD by combining insights from the qualitative analysis of driving forces with those from model-based forecasting.

The plan for this paper is as follows. In Section 2 we show why decisions related to NPD are subject to fundamental, non-probabilistic uncertainty. In Section 3 we show why scenario planning and forecasting should be viewed as complementary, rather than the alternatives they have come to be seen as. In Section 4 we show how scenario planning in its 'standard' IL format already includes many aspects useful to mitigating the uncertainty of NPD. In Section 5 we firstly highlight the usefulness of simple forecasting techniques for identifying the 'predetermined elements' in a standard IL scenario planning process focused on NPD, before going on to outline the role of more advanced forecasting techniques, capable of identifying network and other social effects, in an enhanced NPD scenario process. In Section 6 we propose a new scenario process specifically designed to mitigate uncertainty in relation to NPD by listing the adaptations to standard IL that would be required to further enhance its efficacy for this purpose. We conclude by arguing for the suitability of this augmented scenario-planning approach for mitigating uncertainty specifically in relation to NPD.

2. NPD as a 'crucial decision'

2.1. The nature of probabilistic risk

The economist Shackle (1955a, 1961) distinguished between 'crucial decisions' subject to fundamental uncertainty, and more mundane decisions subject to risk, by firstly identifying the nature of the latter. Then, having clearly set out its opposite, Shackle was able to accurately characterise a number of important problems with crucial decisions, central among which is the lack of efficacy of probabilistic methods when facing them (Derbyshire, 2016a).

Shackle's (1955a) simple, but revealing, example of coin-tossing provides us with useful information about the future (i.e. about future coin-tosses), but this can only be accrued by dividing the problem into a series of experiments (i.e. individual tosses) and then aggregating across different categories of outcome, which is possible since the problem is a 'divisible' one, and all possible outcomes (i.e. either heads or tails) are known in advance. Obviously, if we toss a fair coin one thousand times the resulting probability distribution shows the coin to land with heads facing upwards about 50% of the time, and tails about 50% of the time. We know, then, that if we were to conduct a similar experiment of another thousand tosses, we would get approximately the same result and, furthermore, we know the probability of each possible outcome (i.e. heads or tails) for the next individual instance (i.e. the next toss). Knowledge achieved by aggregating across instances of the same type in this way is therefore useful in relation to the future — it provides us with knowledge of the probability of future outcomes of particular types. Situations such as this one are characteristic of probabilistic risk since knowledge useful to a decision can be garnered by examining aggregated past outcomes in the form of a probability distribution. This is possible because the problem is a divisible, seriable one (Shackle, 1955a).

Extremely complex problems can be successfully analysed through probabilistic reasoning of this sort, as long as they can be formalised using sigma-algebra as complex combinations of simpler elements, referring to a known set of states of nature, or of elementary events over which a probability measure can be attributed. Once their probabilities are known, the logic of objective probability (Kolmogorov, 1956), or the logic based on the alternative set of subjective probability axioms (de Finetti, 1974), allow for the calculation of the probabilities of extremely complex events through the recombination of their basic elements. Under the right circumstances, in which the focal events are sufficiently similar to other events of the same type to form a class of outcomes, and where divisibility and serialisation is therefore present, probabilistic reasoning is a powerful tool for mitigating uncertainty of the type that is akin to risk.

2.2. The crucial nature of NPD decision making

In a situation that is characteristic of risk, asymptotic probability theory allows us to derive the properties for the estimators of the population parameters which are used in econometric models. This is possible only because the context is one of known and bounded *risk*, in which all possible outcomes are known, such that it is possible to form an exact distribution of them from observation. Indeed, the requirement that all possible outcomes be completely known from the start is a fundamental assumption at the heart of the Kolmogorov axioms that underpin probability theory (Derbyshire, 2016a; Kolmogorov, 1956). Under these axioms, if the event space cannot be fully specified in advance, then the probability of any one outcome, or of any subset of outcomes, cannot be defined. These conditions, condensed in the idea that no true surprise may arise due to the appearance of an ex ante inexistent state of nature, form the basis of decision theory and of game theory under incomplete information, within the so-called Harsanyi doctrine (Harsanyi, 1967, 1968a,b), based on the idea of a closed universe (Morris, 1995).

While the possible outcomes of a NPD decision could be deemed fully specifiable in advance if interpreted in terms of the two starkly contrasting outcomes of either market-acceptance or non-acceptance – as it is in our subsequently-described, augmented NPD scenario procedure – NPD, nevertheless, does *not* fulfil the criteria of a divisible and seriable experiment required to form valid, objective probabilities. As implied by Bass (2004, p. 1838), the most important decision related to new products is that taken prior to the product's launch when no sales data are available — at which point there is no 'objective' basis on which to create a distribution of diffusion outcomes. To the individual firm doing the innovating, then, NPD is a one-off, major decision that is not amenable to experimentation (i.e. division and serialisation) and which has major consequences — a 'crucial decision' (Shackle, 1955a, 1961). An aggregated, objective reference class of past examples cannot be created to guide this decision making probabilistically, since these past examples are not products of the same type. A *new* product, as in NPD, is exactly that: new, and therefore different from previous products.

The technological trajectory of analogous products, even those which are from quite different domains, can be used to consider the trajectory of a new product (Loebmann, 2002), implying that analogous past products might be used to consider the diffusion of a potential new product for which there is currently little data (Meade and Islam, 2003, 2006). However, the tendency for new products to alter the strategic landscape leading to non-stationarity means that this past diffusion may be misleading. In addition, a new product's technological solutions are not the only factor affecting its potential diffusion (or non-diffusion); social, cultural and other 'soft' factors can also be highly influential, meaning that superior technology is no guarantee of diffusion. Detailed consideration must therefore be given to the validity of any analogy that is drawn, and the factors that might lead to it proving invalid. As noted in the introduction, the uncertainty associated with newness is even present in the case of products that are only partly 'new' because they are incremental innovations — the failure (i.e. market non-acceptance) of which is also not uncommon.

However, these difficulties relate to the use of objective probabilities in the form of frequencies based on empirical observation. It is important to take into consideration Savage's (1954) and de Finetti's (1937, 1974) alternative approach to defining probability, not based on divisible and seriable experiments as in 'objective probabilities', but as subjective judgment based on beliefs, expressed as the amount a person is willing to bet on the outcome of an uncertain event. Indeed, it is based on de Finetti's (1937, 1974) definition of probability, which expresses the subjective ignorance about relevant future events, that this paper later integrates insights from the different traditions of scenario planning and forecasting so as to mitigate the uncertainty associated with NPD.

Yet, as NPD is representative of a 'crucial decision' even the use of subjective probabilities is problematic, since the changed landscape that ensues from a new product's creation requires new factors to be taken into consideration (such as a responding product innovated by a competitor), which in turn requires additional outcomes to be incrementally considered over time, which is not possible within the traditional means of applying subjective expected utility (Derbyshire, 2016a; Savage, 1954). Ultimately, subjective expected utility remains a probabilistic approach for which all outcomes must be known in advance, as when creating probabilities based on frequency (Morris, 1995).

Nevertheless, it remains true that once a new product has appeared, unexpectedly and unforeseen to rivals, de Finetti's (1937, 1974) notion of subjective probability is applicable within the changed strategic landscape — albeit, the newly-innovated product is likely to result in a cascade of changes to this landscape, as rivals respond in currently-unknown ways, leading to a strong form of indeterminism. In this setting, the Harsanyi doctrine (Harsanyi, 1967, 1968a,b) provides the conditions under which an innovator would be able to anticipate the newly revised expectations of her rivals, and consequently their rational responses, based on the notion of a 'Bayesian Nash Sequential equilibrium' (Mamer and McCardle, 1987). However, apart from the heroic rationality assumptions this requires about the innovators and their rational learning processes, the presence of a multiplicity of these equilibria, or their refinements, would still leave the analyst in a situation of crucial uncertainty, whereby even the most sophisticated sequential equilibrium concepts, would not be able to reduce the true uncertainty to measurable risk (Giovannetti, 1993).

2.3. Taking account of both probabilistic risk and non-probabilistic uncertainty in NPD

The tendency for NPD 'crucial decisions' to change the strategic landscape in which the decision is originally taken is evident in the example of mobile-phone NPD. Apple successfully innovated touchscreen and internet-enabled mobile technology, introducing their highly-innovative iPhone product in the mid-2000s (Mazzucato, 2015). As a result, the previously-dominant market-leader, Nokia, never fully recovered its market position, resulting in its decline and eventual sale to Microsoft. The correct decisions leading to the creation of a product with strong capabilities in relation to touchscreen and internet-enabled technology, made by Apple, and the incorrect decisions, or failure to make similar decisions in time, by Nokia, forever changed the strategic landscape of the mobile-phone market, such that no future decision could be made under similar circumstances again. While Apple and Nokia both made subsequent NPD decisions, they both did so from a radically different strategic position, with Apple being dominant and Nokia attempting to catch up — the reverse of the previous situation.

Apple's decision to innovate a mobile phone with what were then innovative capabilities was a very expensive (and in this case, successful) gamble – a 'crucial decision' (Shackle, 1955a, 1961) – with irreversible implications associated with failure, but also with success, as both Nokia and Apple discovered. While this initial decision was subject to irreducible, non-probabilistic uncertainty at the point of its making, once the diffusion of the newly-innovated iPhone product overcame a critical-acceptance threshold, drivers amenable to probabilistic estimation started to accompany the process of diffusion and market-substitution of the previously-dominant Nokia-style of handset. This implies that forecasting based on estimating the role of the drivers of diffusion – particularly the immaterial ones, such as direct and indirect network externalities (Goldenberg et al., 2001) and covariates, including cultural effects (Meade and Islam, 2006) – while lacking capability in relation to the fundamental uncertainty of the initial decision to innovate because of its 'crucial' nature, is nevertheless useful once the NPD process has overcome the first critical steps and new 'priors' have been generated, the old ones having been dismantled rather than revised. At this point, empirical observation again becomes useful in estimating the, usually highly-nonlinear, features of the new diffusion curves.

2.4. The double uncertainty of NPD

As a result of this double-edged uncertainty, epistemic and ontic, the exclusive use of traditional forecasting techniques for NPD decision making is likely to be misleading. However, once a new product's diffusion has reached a certain threshold, its further diffusion may be more amenable to estimation using probabilistic methods, because the disturbance to the strategic landscape resulting from the introduction of the new product has taken effect, with the new strategic environment then fully emergent and stable — at least for a time. Crucial NPD decisions tend to invoke responses from rivals, which are highly unpredictable, leading to cascading changes that can take a long time to fully play out, and which are subject to high levels of indeterminism. Nevertheless, because of the relative stability that ensues for a time once a new product's diffusion has reached a critical threshold, after which its further diffusion is subject to positive-feedback, insights from diffusion forecasting can be useful. We later discuss how to identify this critical threshold as part of a combined scenario planning and forecasting approach to mitigating the uncertainty of NPD.

In light of the double-edged uncertainty of NPD, what is needed is an approach capable of dealing with both probabilistic risk, and, prior to this, the non-probabilistic and more fundamental uncertainty associated with whether the product even reaches this critical threshold in the first place. The adapted IL procedure we subsequently outline is designed to be just such an approach.

3. Scenario planning and forecasting: alternatives or complements?

3.1. The importance of both continuing and non-continuing aspects of the future

Scenario planning is nowadays viewed as an alternative to forecasting (Derbyshire and Wright, 2016), the central distinction between the two being scenario planning's emphasis on unexpected and extreme (but plausible) outcomes that represent a break from the past, in contrast to forecasting's emphasis on continuing trends, representing change along the same trajectory, as in the recent past. The early adopters of scenario planning, such as Wack (1985a,b), placed emphasis on identifying and separating out of trends into those expected to continue to develop along stable, known trajectories, and those expected to change leading to discontinuity and uncertainty. This was a central part of the process of scenario planning as applied by these early practitioners (Selin, 2008; Sharpe, 2008; Sharpe and van der Heijden, 2008). Over time however, diminishing attention has been given to consideration of continuing aspects of the future as scenario planning has become increasingly viewed as a tool for exploring discontinuity, resulting in emphasis on those aspects of the future expected to change (Derbyshire and Wright, 2016). It is this that has led to the view that scenario planning is an alternative to forecasting — a view that overlooks the fact that IL contains specific steps for uncovering continuing trends and for considering these alongside drivers of change.

While it is arguably unexpected changes and discontinuities that can be most impactful, most of the time the predominant 'default' future outcome is for the future to look similar to the past (Bradfield et al., 2016). This is not least because of path-dependence, which is very widely present in many systems of interest to scenario planning, and in which the trajectory from the past to the present goes on to influence the future, rendering it similar in important ways to the past (Derbyshire, 2016). Path-dependence makes it essential to give due consideration to which aspects of the future may continue along the same trajectory as presently, reinforcing the existing direction of change, and their relative strength compared to the strength of factors that may instead bring about disruption, leading to an alternative future.

In relation to NPD, path dependence could come in the form of 'consumer resistance' (Kleijnen et al., 2009), whereby individuals behave conservatively in choosing products, such that a new product, even with superior features, does not diffuse in expected ways. In the UK, attempts to increase competition in the energy-supply market have been affected by only 14% of consumers switching to a new supplier, even when they could receive exactly the same quality of supply at a lower cost (Ofgem, 2014). Similarly, lock-in to existing products can occur because of network effects that reinforce through positive-feedback small, initial advantages in a product's diffusion, creating insurmountable barriers to the diffusion of a new, alternative product, even if it appears to have superior features. Arthur (1994) used the example of Betamax vis-a-vis VHS in the market for video-recorders in the 1980s to describe this. Initially small, random advantages in the diffusion of one or the other would become self-reinforcing because they affect video-rental stores' decision making regarding which format of video to stock. The resulting additional prevalence in terms of videos of one format then feeds back on consumers' choice of which video-recorder to purchase, leading to a process of self-reinforcing diffusion. It is factors such as these which can render it difficult to model the potential diffusion of an as yet unlaunched new product, for which no diffusion data currently exists. Scenario planning can assist in considering the factors that may influence these values.

Indeed, an effect similar to that described by Arthur (1994) may have taken place in relation to Microsoft's Windows product, the diffusion of which may have become self-reinforcing because of the need for compatibility between computers. Such network effects are arguably increasingly prevalent, given the network-related nature of many modern products, plus the increasingly social aspect of diffusion based on recommendation and word-of-mouth (Bass, 1969, 2004; Goldenberg et al., 2001). The result is that past, even highly nonlinear, trajectories (such as the logistic diffusion of a particular product) can be highly informative of the continued future diffusion of the same product, rendering it important to consider both the past cumulative adoptions of existing rival products, so as to understand the plausibility of disrupting their further diffusion, and the actions that may be initiated to achieve this disruption, if this is seen as desirable for the considered alternative new product to succeed.

To summarise, there is therefore a need to consider existing trends and trajectories which impinge upon the initial market-acceptance and then (if accepted) diffusion of a potential product, including generic trends such as the growth of market segments and of disposable income in these segments — but also trends related to specific rival products such as their growth of market-share over time, and any associated network effects. These 'continuing aspects' need to be considered alongside the factors that cause them to continue through positive feedback, alongside consideration of factors that could enable their disruption, should this be desirable to facilitate a considered new product's diffusion. Scenario planning can facilitate this when seen in light of the approach adopted by early practitioners in which emphasis was placed equally on both continuing and discontinuing aspects of the future. Furthermore, as we show subsequently, augmenting the scenario planning procedure to incorporate insights from recent developments in diffusion modelling related to network and social effects can enhance its capability still further in this regard.

3.2. Taking account of the socio-economic enablers and inhibitors of market-acceptance

Nowotny (2016) has recently shown how the emergence and acceptance of new products by the market is a social process. New products emerge within particular pre-existing socio-economic and technological regimes, rather than in isolation (Breschi et al., 2000; Briggs et al., 2015; Nelson and Winter, 1982). These 'regimes' represent a combination of technological opportunities, appropriability conditions, and cumulativeness of technical advances and knowledge, usually related to a particular set of key-enabling technologies, and the associated social practices and behaviours that they give manifest to, but which also act to sustain the dominant regime (Dosi et al., 1995). An obvious example is the dominant socio-economic and technological regime associated with internal-combustion engine transportation, which creates new product niches that fit within the logic of the regime. The result is to reinforce the currently-dominant regime over time, thereby inhibiting the emergence of alternative products that do not fit easily within it.

For an alternative technological regime to emerge, such as one based on electrically-driven transportation, what is required is a broad set of changes across customer practices, legal infrastructure, as-well-as the development of large-scale supporting infrastructure, so as to allow for a coordinated 'transition' to an alternative technological and socio-economic regime. This can only occur if relevant stakeholders from government, business and customers act together to bring about the necessary changes in a coordinated fashion (Turnheim et al., 2015). This requires consideration of the political, infrastructural, social, legal, and motivational (stakeholder motivations) factors that might bring about such coordinated action. It also requires the consideration of the effect of power – such as the power of currently-dominant producers – on enabling or inhibiting change (Hughes, 2013).

Cultural factors can also be a key determinant of whether a new product is accepted by the market, such that a process of full diffusion is initiated. This is evident in the current case of driverless vehicles. A survey by the American Automobile Association recently suggested that 75% of drivers in the USA fear driverless cars. As reported in the Financial Times, the majority of UK motorists also consider them unsafe (Campbell, 2016). This evidences the need to take into consideration behavioural, social and cultural factors that might impinge upon market-acceptance. By employing a scenario planning process that allows for consideration of the political, infrastructural, social, legal, and motivational aspects of the future, NPD decision making can take account of these 'softer', yet critical factors that play such an important role in market-success. The key is to anticipate how future demand conditions may change depending on these combined factors, and to correctly assess potential new products in terms of the anticipated future needs of customers based on these changes, and scenario planning can be highly useful for this purpose (von der Gracht and Stillings, 2013).

4. The usefulness of the existing IL scenario planning process and its recent augmentations for mitigating uncertainty in relation to NPD

4.1. The 'standard' Intuitive Logics scenario planning process

The 'standard' approach to scenario planning is that known as 'Intuitive Logics' (IL). It is extensively used by business, governments and the military for considering the future and decision making (Bowman, 2015, p. 79). However, it is *not* currently widely used for consideration of NPD, even though, as will be shown in this section, it contains many elements that are useful in this regard.

As described by Wright et al. (2013, p. 634), the standard IL scenario-development process follows a sequence of eight stages:

Stage 1: Setting the agenda — defining the issue of concern and process, and setting the scenario timescale.
Stage 2: Determining the driving forces — working, first, individually, and then as a group.
Stage 3: Clustering the driving forces — group discussion to develop, test and name the clusters.
Stage 4: Defining the cluster outcomes — defining two extreme, but yet highly plausible – and hence, possible – outcomes for each of the clusters over the scenario timescale.
Stage 5: Impact/uncertainty matrix — determining the key scenario factors, A and B — i.e., those which have both the most impact on the issue of concern and also the highest degree of uncertainty as to their resolution as outcomes.
Stage 6: Framing the scenarios — defining the extreme outcomes of the key factors, A1/A2 and B1/B2.
Stage 7: Scoping the scenarios — building the set of broad descriptors for four scenarios.
Stage 8: Developing the scenarios — working in sub-groups to develop scenario storylines, including key events, their chronological structure, and the 'who and why' of what happens.

Participants usually work in teams to come up with alternative scenarios, with a comparison (i.e. a reading) of created scenarios being the outcome of the process, possibly feeding into subsequent discussions as to how the imagined futures might affect the organisation's strategy — such as, in this case, whether to develop a particular considered new product or not. The scenario teams would tend to be comprised of the organisation's executive management committee. However, as discussed below, there is increasing emphasis in the scenario literature on involving a range of stakeholders from throughout the organisation, and possibly external to the firm, so as to ensure that a range of views about the future are incorporated in the created scenarios, thus reducing potential for blind-siding by factors left unconsidered but which subsequently turn out to be important. Von der Gracht and Stillings (2013) note this diversity to be particularly important when scenario planning is used for the consideration of innovation.

4.2. Aspects of 'standard' IL already able to assist in mitigating the uncertainty of NPD

4.2.1. Use of plausibility rather than probability

Importantly in relation to the previous discussion of 'crucial decisions' and the lack of efficacy of probabilistic means for their consideration, scenario planning in the IL format employs plausibility, not probability (Jefferson, 2012). The use of plausibility allows for consideration of extreme outcomes – such as the complete market-acceptance (e.g. iPhone) or non-acceptance (e.g. New Coke) of a new product – which in turn facilitates consideration of actions designed to facilitate or avoid these extreme outcomes, and factors inhibiting or enabling them, including the self-reinforcing market-dominance of incumbents. This focus on extreme outcomes differs markedly from probabilistic-modelling approaches to consideration of future outcomes, in which the emphasis is on variation within known bounds examined through ‘sensitivity analysis’; it can facilitate consideration of whether a new product will be sufficiently accepted by the market, such that it reaches the ‘critical point’ at which its diffusion becomes self-reinforcing, or instead never reaches this point, such that it is rejected by the market.

4.2.2. Consideration of socio-economic factors

At Stage 2 of the standard IL approach there is a decomposition of the scenario teams' perceptions into the ‘forces’ expected to drive the unfolding of the future. Identification of these forces is initiated by asking the scenario team to consider, in turn, each of the six PESTEL dimensions (Political, Economic, Social, Technological, Environmental, and Legal). As discussed earlier, such ‘socio-economic’ factors play a central role in the success or failure of a new product (Nowotny, 2016). For example, Mazzucato (2015), in a highly detailed analysis of the development of the iPhone provides in-depth evidence of the role of political, legal, social and technological factors in that product's development and successful diffusion, and scenario planning places such factors at the heart of the analysis through its use of PESTEL. The ‘Legal’ dimension is a prime example of the importance of these factors: the many and increasing regulations related to climate change and a clean environment affect demand for, and customer preferences in relation to cars, heating systems, televisions, public transportation, energy generation, packaging, communication services and aviation, travel and tourism, to name just a few obvious product categories.

4.2.3. Consideration of regime-related lock-ins and the combination of factors that might disrupt them

Because IL allows for consideration of the interaction between the PESTEL dimensions in the clustering of driving forces that takes place in stage 3, standard IL facilitates consideration of the complex web of changes that would be required in order for a current socio-economic or technological regime – such as that related to the current, so-called ‘fossil-fuel lock in’ – to transition to a new regime, based on a new set of technologies, supporting infrastructures, rules, social relations and behaviours.

The early parts of the IL process (stages 2 and 3), in which driving forces – sometimes more than 200 in number – are identified, listed and then clustered, allows for consideration of the multiple and layered interactions between customers, suppliers, government and technology (von der Gracht and Stillings, 2013) required for a transition of this sort to take place, leading to the emergence of new-product niches and curtailing of demand for some current types of product.

4.2.4. Identifying key stakeholder motivations

Cairns et al. (2010) have recently presented an augmentation to IL – the ‘Critical Scenario Method (CSM)’ – to evaluate both the interest and power of particular stakeholders to take self-interested actions within an unfolding future. Powerful distributors, such as the major supermarkets in the UK, may not distribute a new product if they consider it against their interests, or that it compromises advantageous relationships they have with existing suppliers. CSM makes explicit the instrumental role of stakeholders in determining why one scenario – such as market-acceptance or non-acceptance of a considered new product – may unfold rather than another. It can assist in identifying the power-related factors that could act to inhibit or enable successful diffusion. It examines how ‘winners’ achieve their outcomes by exercise of power so as to maintain or enhance their interests, which is a critical factor in relation to NPD.

Wright et al. (2013, p. 637) suggest this stakeholder analysis can be usefully implemented either as a new stage near the beginning of the standard scenario development process, or as an additional stage towards the end of the process, or it can be incorporated at both stages if desired. CSM can be used as a tool for interrogating the logic of developed scenarios, using questions such as:

- Who has high levels of power and interest in each scenario?
- What concerns them?
- How do their concerns relate to those of other stakeholders?
- How would they exercise their power?
- How would they react to the unfolding of events within a particular scenario?

Those with high levels of power might include competitors, who could potentially innovate their own new product in response to that innovated by a focal organisation considering NPD. It might also include lead users, or early adopters, who might play a key role in ensuring that the product reaches the critical threshold point at which its diffusion becomes self-reinforcing, occurring from then on through a social process akin to contagion (Young, 2009). This in turn relates to the question ‘How do their concerns relate to those of other stakeholders?’ which is useful for uncovering the social and network-related aspects of diffusion which we earlier suggested are becoming more prevalent.

The question ‘What concerns them?’ might be interpreted as referring to key design features and capabilities desirable to consumers in important market segments. Recall, for example, the role of touchscreen and internet-enabled technology in bringing about the diffusion of Apple's iPhone technology (Mazzucato, 2015). Anticipating such changes in customer demands is crucial to NPD success (von der Gracht and Stillings, 2013) and this makes it imperative to consider what emergent ‘concerns’ (i.e. requirements) customers, as stakeholders, might have, and how a considered new product may assist with these.

The question ‘How would they exercise this power?’ and ‘How would they react to the unfolding events within a particular scenario?’ are highly salient to a consideration of how rivals may seek to block market-acceptance of a considered new product, such that it never reaches the critical threshold at which its diffusion becomes self-reinforcing (see Section 5.2). The former question might be used to consider how a competitor might act to block the initial market-acceptance of a considered new product; how a competitor might lobby for a change in regulation to block the product; how rivals may form coalitions to ensure the innovative new product does not diffuse; how a competitor might persuade large distributors not to distribute the new product. The latter question can also be used to consider how the process of diffusion may be disrupted by the actions of competitors who seek to halt it so as to maintain the dominance of their own products. In particular, it can be used to consider the rival new products, perhaps containing similar features, which may be innovated to challenge the successful diffusion of the considered new product, leading to the cascading changes to the strategic environment that we earlier showed to be a result of ‘crucial’ NPD decisions, as evidenced by the cascading changes to the mobile-phone manufacturing industry resulting from Apple's innovation of the iPhone.

4.2.5. Incorporating positive-feedback within influence diagrams

The identification and clustering of driving forces in stages 2 and 3 of IL is usually accompanied by the creation of an ‘influence diagram’ — a causal chain representing how individual scenario elements affect each other, leading to a particular outcome. Recently, Derbyshire and Wright (2016) have shown that this process results in a bias towards identifying ‘efficient’ causes at the expense of other types of cause that can lead to positive-feedback and transformation over time. In their augmented IL process, they recommend that causal loops are explicitly included in influence diagrams to emphasise that future changes can occur in a nonlinear fashion as a result of self-reinforcing processes. This augmentation is highly salient to an NPD scenario process as it allows for consideration of the factors that may enable a new product's diffusion to overcome the critical threshold at which it becomes self-reinforcing, and the factors that may then cause the process of diffusion to fully play-out, possibly leading to the new product's market-dominance at the expense of currently-dominant products.

4.2.6. The usefulness of the existing IL scenario process and its augmentations in relation to NPD

As shown in this section, the widely-used IL scenario process and its recent augmentations already contain many aspects able to facilitate a sophisticated consideration of uncertainty in relation to NPD. However, by making further adaptions, this capability can be still further enhanced. In the next section we consider how forecasting and formal modelling can be combined within IL so as to allow a comprehensive analysis of both the probabilistic and non-probabilistic aspects of uncertainty associated with NPD.

5. The role of forecasting

5.1. Modelling the pre-determined elements of the future using simple forecasting techniques

In stage 2 of the current IL process, future trends expected to continue on the same trajectory are identified, alongside those expected to be affected by the identified PESTEL driving forces, such that they are disrupted. Simple, projection-based forecasting techniques can be used to understand the potential future implications of these continued trends, such as the *potential* future size of markets for new products of particular types (von der Gracht and Stillings, 2013), or levels of disposable income in relevant market segments. The forecasting analysis here might be of a type such as conducted as part of a standard market evaluation, employing relatively simple projection-based forecasting techniques, or it may make use of more sophisticated techniques, such as that recently demonstrated by Schaer et al. (2016) when employing data from Google Trends to estimate market size, achieving greater accuracy than benchmark models using information from past product generations only. This is an example of a forecasting technique that could be usefully drawn on within an NPD scenario process, at an early stage of the process, to understand the size and nature of potential markets; however, it is most relevant for a product that is anticipated by the market such that it is searched for online, perhaps because it is an incremental development (i.e. next generation) of an existing product, or because the product has been widely publicised, such as through previews, as is particularly prevalent in the video games market.

While perhaps employing relatively simple forecasting methods, such analyses can provide insights crucial to NPD decision making. For example, if the products or services of a particular business cater to the market for assisted-living for the elderly population, simple forecasts showing an increase in the size of this population, should current demographic trends continue, and showing its growing share of income – alongside, perhaps, projections of the type of chronic ailments and disabilities from which this population is expected to suffer based on current trends – are all likely to be useful contributors to the decision making of a firm considering NPD in this market. Forecasts of this type can guide the process of NPD by indicating possible emergent sources of demand, and the prevalence of possible customer requirements of particular types. However, consideration must also be given to potential changes that could disrupt these trends, leading to the assumptions about demand on which the NPD decision might be taken proving false.

For example, a firm considering innovation in the assisted-living market in the UK must consider whether the disproportionate size of the elderly population compared to the working-age population in the future will result in the curtailing of government expenditure related to health, which future governments may simply consider unaffordable. This might in turn result in present demand assumptions (i.e. potential size of market) proving inaccurate. For this reason, an NPD scenario planning process should consider both continued trends and the factors that might disrupt them, alongside each other. The process of separating out those trends expected to continue from those expected to discontinue, which was a central part of scenario planning as it was originally conceived (Selin, 2008; Sharpe, 2008), allows for this.

5.2. New forecasting methods for identifying the 'critical threshold' point from which diffusion becomes self-reinforcing

The application of sophisticated forecasting techniques, applied at the end of the IL procedure, and based on estimating the role of the drivers of diffusion – particularly the immaterial ones, such as direct and indirect network externalities (Scaglione et al., 2015) and covariates, including cultural effects (Meade and Islam, 2006) – can further enhance the IL procedure as a means for mitigating uncertainty in relation to NPD. By augmenting IL in this way, it then becomes a procedure for both considering the factors that may inhibit or enable a new product's initial market-acceptance, such that it reaches the critical threshold at which its diffusion becomes self-reinforcing (Valente, 1996) — and also for considering what this critical point is, how it can be reached, and how diffusion may occur (i.e. the shape of the diffusion curve) from then on.

Young (2009), for example, examines three different classes of diffusion model – contagion, social influence, and social learning – and shows that each leaves a characteristic 'footprint' on the shape of the resulting diffusion curve. Since each results in a distinct diffusion curve, consideration as to which type of diffusion might ensue as part of a given scenario then allows for the association of a particular type of diffusion curve with that scenario. Scaglione et al. (2015) estimate the impact of direct network externalities in diffusion by comparing different nonlinear diffusion functional forms, identifying the critical threshold after which direct network externalities become self-reinforcing, resulting in the diffusion process proceeding automatically. Goldenberg et al. (2010), in contrast, study the 'chilling effect' that network externalities have on the diffusion of a new product, showing how waiting for network externalities to take effect can be a key factor holding back diffusion, leading to the failure of new products. Indirect network externalities have been usefully introduced into forecasting and diffusion models by the employment of additional complementary covariates within a – usually logistic – diffusion process (see, for example, Meade and Islam, 2006). Giovannetti and Hamoudia (2016) study how these indirect effects might significantly impact diffusion depending on whether they take place before or after the critical diffusion threshold has been met, with these thresholds endogenously derived as the inflection points of logistic diffusion processes driven by direct network externalities and originating in herding behaviour, or word-of-mouth effects.

These approaches place emphasis on social-network, herding and word-of-mouth effects, and the effect of these on the momentum of diffusion (i.e. either contributing to its positive momentum, or having a 'chilling effect').

6. Summary of a scenario process designed to mitigate the uncertainty associated with NPD

Based on the previous discussion of aspects of the currently standard IL process useful in relation to NPD, alongside the discussion of the role for forecasting above, we below set out an augmented IL procedure designed to mitigate the uncertainty of NPD by combining scenario planning and forecasting. We describe only those stages which differ from standard IL, summarising the differences between the two in Table 1. IL scenario planning is usually conducted in a workshop setting, over the duration of several days, and commonly involves an organisation's executive team, plus other stakeholders deemed to be relevant (e.g. in this case, perhaps, individuals from engineering, design and marketing departments). For a full description of the procedure the reader is referred to Wright et al. (2013). Each of the component aspects of this augmented IL procedure have been used previously — not least the IL procedure itself, which is very widely used across many domains (Derbyshire, 2016a), but also the forecasting procedures designed to identify critical diffusion thresholds. However, they have not previously been used in combination in the way we describe here, which represents a new – and, as yet, untested – approach.

Table 1
Contrasting the ‘standard’ and augmented NPD Intuitive Logics approach to scenario development.

Stage	‘Standard’ IL approach	Augmented NPD IL approach
Stage 1: setting the scenario agenda	Defining the issue of concern and process, and setting the scenario timescale.	Defining the type of new product under consideration and its potential target market. Consideration of present assumptions as to why the innovation of the considered new product might be a good idea. Application of simple forecasting techniques to understand implications, if unchanged, for trends related to the potential market's future development. Descriptive statistics to describe e.g. present market share.
Stage 2: determining the driving forces	Eliciting a multiplicity of wide-ranging forces.	No change.
Stage 3: clustering the driving forces	Clustering causally-related driving forces, testing and naming the clusters.	Explicit use of causal loops in Influence Diagram, so as to consider effect of positive feedback and self-reinforcing processes on diffusion of considered new product.
Stage 4: defining the cluster outcomes	Defining two extreme, but plausible and hence possible, outcomes for each of the clusters over the scenario timescale.	No change.
Stage 5: impact/uncertainty matrix	Ranking each of the clusters to determine the critical uncertainties i.e. those clusters which have both the most impact on the issue of concern and also the highest degree of uncertainty as to their resolution as outcomes.	No change.
Stage 6: framing the scenarios	Selecting two initial critical uncertainties to create a scenario matrix, framing the scenarios by defining the extreme outcomes of the uncertainties.	The critical uncertainty should always represent ‘market-acceptance/non-acceptance’ of the considered new product.
Stage 7: scoping the scenarios	Building a broad set of descriptors for each of the four scenarios.	No change.
Stage 8: developing the scenarios	Developing scenario storylines, including key events, their chronological structure, and the ‘who and why’ of what happens.	Use of Critical Scenario Method to identify important stakeholder and power-related issues, such as the potential behavior of powerful dominant producers and distributors. Consideration of how actions of these powerful actors may prevent initial market-acceptance, and then enable or inhibit full diffusion of considered new product.
Stage 9: identifying the ‘critical threshold’ for diffusion	N/A (standard IL does not have such a stage)	Use of advanced diffusion-modelling techniques, which focus on social-network and contagion effects, to identify the ‘critical threshold’ point at which the new product's diffusion would be self-reinforcing, based on the social, power-related, cultural and other factors considered in the prior eight stages. Consideration of the specific p and q parameters to be used in the diffusion model. Consideration of diffusion of analogous products, but also consideration of how and why the diffusion of the considered new product may play out differently from that of these analogous products. Creation through modelling of a specific, expected diffusion curve for the particular considered scenario. Comparison can then occur across the four created scenarios in terms of the nature, extent and speed of the diffusion of the considered product.

6.1. Stage 1 — setting the scenario agenda

Bradfield et al. (2016) and Derbyshire and Wright (2016) argue that scenario planning originally placed emphasis on detailed analyses of the development, through time of the focal issue of concern, which could include analysis of important trends from the past to the present. Only recently has this important historical analysis received less attention in scenario planning (Selin, 2008; Sharpe, 2008), leading to the present situation in which scenario exercises sometimes give the impression of futures branching off from a present disconnected from the past from which the present emerges (Bradfield et al., 2016; Derbyshire and Wright, 2016). Such a-historicism would be particularly detrimental in the case of a scenario exercise to consider NPD for the reasons outlined earlier: path-dependence, demand inertia and lock-in to existing products are all prevalent in NPD. To understand the implications of these for the success of a considered new product therefore requires an explicit historical perspective, such as an examination of how lock-in to a currently dominant product came about in the first place, which can provide clues as to how the lock-in might be disrupted so as to facilitate the diffusion of the considered new product.

An NPD scenario planning procedure not only needs to take into consideration the past trajectory of development of the focal industry of concern, of targeted market segments, and in relation to the demand for existing, rival products. It should devote a significant part of the scenario process to this initial assessment, which should occur as part of an extended 'stage 1', which then becomes a 'setting the scene' exercise in which the nature of the considered new product is set out, the initial motivations towards innovating it are made clear and in which past developments, such as growth of demand in potential target-market segments, is projected forwards as if they were assumed to continue, so as to understand their implications for future demand conditions, under circumstances in which these trends go undisrupted. This can be done through the use of simple, projection-based forecasting techniques, and descriptive analyses of, for example, current market share.

6.2. Stages 2 and 3 — identifying and clustering the driving forces, and creation of influence diagram

It is recommended that influence diagrams contain a range of causes and explicit causal loops, not just efficient, precipitative causes set out in a linear 'cause-and-effect' manner, as is often the case in scenario planning exercises (Derbyshire and Wright, 2016). This acknowledges the importance of positive-feedback, nonlinearity, and self-reinforcing, social-contagion type processes in the market-acceptance and diffusion of the considered new product.

6.3. Stage 6: framing the scenarios — defining the extreme outcomes of the key factors, A1/A2 and B1/B2

Under standard IL a 2×2 matrix is commonly used to represent uncertainty and impact — one on each axis of the matrix. In a NPD scenario process it is proposed that the uncertainty axis always represents, at one end, market-acceptance, and at the other, market non-acceptance of the considered new product. This would ensure that the scenario process focuses on factors that may enable or inhibit the initial market-acceptance of the new product, such that it reaches/does not reach a point at which its further diffusion becomes self-reinforcing. The factors affecting full diffusion are then considered in additional stages below.

6.4. Stage 8: developing the scenarios

We recommend that the Critical Scenario Method (Cairns et al., 2010) becomes a central part of the scenario process to allow full consideration of the important power-related factors that may prevent the new product's successful diffusion. In particular, we recommend detailed consideration is given to the questions Wright et al. (2013) suggest in relation to the CSM, as outlined earlier. These should be used to consider how a competitor might act to block the initial market-acceptance of a considered new product; how a competitor might lobby for a change in regulation to block the product; how rivals may form coalitions to ensure the innovative new product does not diffuse; how a competitor might persuade large distributors not to distribute the new product; and the rival new products, perhaps containing similar features, which may be innovated to challenge the successful diffusion of the considered new product. In terms of successful market-acceptance of the considered new product, the converse of these questions can be considered, such as how an important distributor might be persuaded to distribute the new product, or how a rival might be prevented from blocking diffusion.

6.5. Stage 9: identifying the 'critical threshold' for diffusion and further consideration of self-reinforcing factors causing full market-diffusion

We propose a new, final stage in which recent advances in diffusion-modelling techniques, which focus on social-network, cultural and contagion effects, are incorporated into the scenario process to identify the 'critical threshold' point at which the new product's diffusion would be self-reinforcing, based on the social, power-related, cultural and other factors considered in the prior eight stages. This will lead to consideration of how driving forces may combine to produce a self-reinforcing diffusion process, once the product has achieved a 'critical' level of market-acceptance as considered in stage 6, and how factors such as the stakeholder motivations and power considered in stage 8 might act to 'chill' the diffusion process such that the product's diffusion is started but curtailed (Goldenberg et al., 2010), leading to market non-acceptance. The earlier stages of the scenario process, and the adaptations to them we have outlined, allow for consideration of the social aspects that influence diffusion modelling, setting its pace and nature. Explicit consideration should be given in this final stage to the diffusion of analogous past new products which are now fully diffused. Such 'forecasting by analogy' is a standard way in which diffusion modellers overcome the problem of a lack of 'objective' data for a considered new product (Meade and Islam, 2003, 2006). Indeed, in the engineering-design domain there are specific methodologies – such as the TRIZ methodology – by which to make use of analogous products, even those in very different application fields, to anticipate the features of the next generation of a considered new product, even where that next generation is quite distinct from the previous (Loebmann, 2002).

However, as part of this adapted NPD scenario process, in this final stage, full consideration must also be given to the complex web of *unique* factors associated with the considered new product that may render these analogies misleading. This would draw, in particular, on the driving forces identified in stage 2 and the discussion and stakeholder analysis related to power conducted through a CSM analysis as part of stage 8. An important question to consider as part of this process is 'How have things (i.e. the strategic landscape in the industry, the nature of demand, customer tastes etc.) changed such that the diffusion of this new product may play out differently from these seemingly analogous products?' The analogous diffusion curves therefore serve to initiate a conversation on the possible diffusion of the considered new product, rather than acting as a rigid model to be imitated. Along these lines, Goodwin (2016) argues that management judgment has a particularly crucial role in new product and services forecasting because of the absence of historical data specific to the product or service being forecasted. Such judgment would play a central role in the consideration of how analogous the diffusion of seemingly analogous past new products really is in relation to a considered new product.

We envisage this would then lead to the creation through modelling of a specific diffusion curve for the particular considered scenario. Comparison can then occur across the four created scenarios in terms of the nature, extent and speed of the diffusion of the considered product under each scenario. We earlier noted that Young (2009) shows that contagion, social influence, and social learning effects each lead to distinct diffusion curves, with specific implications for the way the diffusion process plays out. We suggest consideration is therefore given to the type of contagion and learning effect that might occur as part of each scenario, including both its potentially positive and negative (i.e. 'chilling') effect on the probabilistic diffusion process. In particular, this can provide valuable insights useful to the marketing of any resulting new product, since it provides an indication of the type of diffusion most likely to be successful within the context in which the new product is innovated.

7. Summary

Markovitch et al. (2015) have recently stated that reducing high rates of NPD failure remains 'one of the greatest challenges of new product research'. Yet, that NPD is subject to high rates of failure may not be obvious to the casual observer, because NPD failure is largely unobservable. The unobservability of NPD failure is, then, a first, epistemic source of uncertainty in relation to NPD, rendering it highly difficult to accurately estimate the factors associated with success. To produce accurate models of the factors determining success as opposed to failure, an unbiased sample incorporating both would be required. The nature of NPD renders the creation of such a sample highly problematic.

However, the uncertainty of NPD, and the complications associated with modelling it, is further compounded by a second, even more fundamental ontic source of uncertainty: the 'crucial' nature of NPD decisions. This crucial nature acts to disrupt the very stability needed for any forecasting model used to make the NPD decision in the first place to prove accurate. This leads to a high level of indeterminism, and results in the non-stationarity that complicates modelling efforts still further.

Moreover, these two sources of uncertainty, which act to complicate NPD modelling, are still further compounded by the fact that NPD is affected by prevailing conditions that already exist within the targeted market, including the currently-dominant socio-economic and technological regime, which act to enable products that fit within the dominant regime's logic and to inhibit those that do not, and the motivations and requirements of important stakeholders, not least the currently-dominant producers and distributors. For these reasons and others, social, political, legal, power-related, cultural and other 'softer' factors (in contrast to the 'hard' factors associated with the new product's inherent capabilities and price vis-à-vis rival products) influence whether a new product is successfully accepted by the market, such that its diffusion is initiated. Yet, forecasting techniques, when used exclusively, would have great difficulty in adequately taking account of such factors.

In light of this manifold, compounded uncertainty we have shown that to mitigate the uncertainty of NPD what is required is a broad, pluralistic approach which combines scenario planning and forecasting. We have shown that the 'standard' approach to scenario planning, known as Intuitive Logics, already contains many aspects of use for this purpose. Furthermore, viewing it as a hybrid approach that places equal emphasis on continuing trends and trajectories, and separating these out from those expected to discontinue, and giving consideration to the factors that might lead to their discontinuation, as is important in relation to NPD, is very much in-keeping with scenario planning as it was originally conceived by its early adopters. The nature of NPD renders it important to place equal emphasis on both continuing and non-continuing aspects of the future; especially because, in relation to the continuing aspects, of the prevalence of path-dependence in the form of customer inertia, and the tendency for small initial advantages in a product's diffusion to be compounded and reinforced over time, leading to market lock-in to existing products. To understand these requires a historical perspective that is not always present in standard IL exercises.

We have set out a new, augmented IL scenario planning approach specifically designed to allow consideration of the factors that would enable or inhibit a considered new product's initial acceptance by the market such that it reaches a 'critical threshold' at which its further diffusion becomes self-reinforcing. It then allows for consideration of the factors that may affect the nature, extent and speed of diffusion, for which probabilistic-based modelling techniques can be of use, especially those recently developed to examine the enabling or dampening effect of network externalities on diffusion, and those which distinguish between contagion, social influence and social learning diffusion effects.

In conclusion, it is perhaps worth speculating that the reason there continues to be little progress made in reducing NPD failure is because of an associated failure — the failure to acknowledge the fundamental uncertainty of NPD, leading to the continued attempt to apply probabilistic-based modelling techniques in isolation, which have only limited efficacy for dealing with uncertainty. This approach to mitigating the uncertainty of NPD represents a refusal to accept the full extent of uncertainty to which NPD is subject. A more promising approach, as indicated in this paper, might be not only to acknowledge the full extent of the fundamental uncertainty of NPD, but to embrace it as the very source of the new opportunities, and emergence of new product niches, which innovators prepared to test an idea with little a priori knowledge of its likely success or failure benefit from. If innovators had complete probabilistic foreknowledge, as in a closed universe, no such opportunities would exist, because they would all have already been identified, and probabilistically (i.e. those with the greatest chance of success) exploited out of existence. It is the uncertainty of NPD that makes it worthwhile, because it is this uncertainty which is the source of large potential rewards for those that succeed.

However, while embracing this uncertainty, we should not fail to make use of the limited possibilities we have for considering what are, essentially, highly non-deterministic and difficult-to-predict outcomes in terms of market-acceptance. Furthermore, once a new product's market-acceptance has reached a critical threshold, uncertainty begins to diminish, and greater confidence can be had in probabilistic approaches for considering the nature, extent and speed of further diffusion. While highly uncertain then, let us at least make use of whatever small gains we can achieve in considering the possible future outcomes of considered new products. We recommend our combined scenario planning and forecasting procedure for this purpose.

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