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# Persistent Innovation Barriers, and How to Breach Them with Projects


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# Persistent Innovation Barriers, and How to Breach Them with Projects

All organisations have uncompleted ‘innovation opportunities’ that have lingered conspicuously for years without resolution. At some stage however this persistent barrier to innovation may become a greater threat to progress because of changes in the internal or external environment. Which organisational practices are effective in triggering the innovation? This paper shows that successful patterns of practice depend on the nature of the innovation barrier to be breached. A study of 28 innovation projects from widely different sectors suggests a framework of three innovation barrier types; contiguous, discontinuous and persistent. Breaking through these constraints depends on matching the barrier to the appropriate mix of routine or non routine practice. Standard search routines are generally sufficient for contiguous barriers, which are straightforward ‘next steps’. Discontinuous innovation barriers require a mix of non routine practices with standard routines that can help to introduce the new. The third type, persistent innovation barriers are the obstinate problems that have become accepted as ‘the facts of life’, and must be taken out of the organisational mainstream to be resolved. The paper is illustrated with successful innovation projects where the constraints on innovation were pushed back. It also shows how a mismatch between the barrier type and organisational response creates conflicts in priorities and can undermine innovation. Implications of the research for managers and researchers are outlined.

## Introduction

This paper is about breaking through the innovation barriers that have become the facts of life. These are the persistent problems and flaws that people have learned to "work around" or grudgingly accept: a product bug that will not go away, a functional restriction, or an inconvenient design characteristic; an unintended effect of having a more necessary feature. These types of problem present obstinate barriers to advancement and improvement. They may be irritating to the perfectionists but because they affect a localised, minor part of a product they are typically assigned to 'the back burner' and lived with.

Yet at some point these persistent innovation barriers may become a larger problem. Perhaps they prevent the firm from entering a more lucrative market, or else the existing customers' standards become more exacting through increased competition. This paper analyses empirical research on persistent innovation barriers, and shows how the organisational response to them differs from other barriers, which we call discontinuous and contiguous. The research derives from a study of 28 innovation projects in a variety of organisations. It shows how managers and practitioners have addressed persistent innovation barriers successfully, as well as unsuccessfully. It offers a diagnostic framework on innovation barriers and suggests matching organisational practices to break through them.

At core are the search activities that an organisation brings to bear in the face of an innovation barrier. This has been the subject of much debate and so the following section outlines 'what we know about search, routines and innovation'. Various studies have tried to understand how the standard operations of a firm affect the

tendency to be creative and generate innovations with arguments for and against routinised behaviour. The following section briefly summarises the present study and how the research team and partner organisations worked together. We then describe the results in the shape of an Innovation Barriers framework, illustrating successful innovation projects and how they managed to break through the different types of barriers they faced. In the discussion we focus particularly on persistent innovation barriers and how they may be breached, considering a case where there was a mismatch between the barrier type and organisational approach. Finally we conclude with some key diagnostic questions that might help managers to identify innovation barriers and the appropriate practical response to them.

## What we know about search, routines and innovation

### Search and innovation

Although the outcomes of an innovation process are by definition be uncertain, most practitioners and scholars generally agree that innovation is a process which must be managed in some way[1]. However the relationship between the stimuli for innovation and the managerial and organisational techniques to accomplish it is not straightforward. Since innovation involves the introduction of novelty, so questions are raised about the role of *routine* practice in organisations when attempting to innovate. Here we are particularly interested in the process of *search*, which is organisational activity aimed at solving a particular problem. By routines we refer to repetitive activities regularly occurring in an organisation in order for work to be done (see Exhibit 1 for definitions of concepts).

INSERT EXHIBIT 1 AROUND HERE

Thinking on the influence of standard search routines falls roughly into two camps; the first acknowledges their repetitive character but nevertheless sees routines as necessary for innovation and renewal, while the second emphasises the locally-focused and conservative tendencies of routines. This debate on the influence of routines on the generation of innovation becomes clearer when considering the circumstances that lead to successful search; the conditions that 'trigger' innovation. Typically organisations will continuously engage in *passive* search, scanning the environment for information and signals much like a radar system. Passive search will generally be directed to established locale. But when there is a lack of confidence that important information is being picked up, the organisation is propelled into *active* search and probing. An example of a strong stimulus is the threat perceived because of a successful innovation of a competitor[2].

Active search is often initiated by a particular difficulty and is "problemistic" in its direction[3]. A problem is perceived when the organisation fails to achieve its objectives or anticipates deterioration in its position. When these kinds of perceptions are formed, search processes are mobilised and directed towards resolving the problem. This type of active, problemistic search in organisations is normally quite specific in its direction. In many respects it has a lot in common with the behaviour and impulses of engineering.

Studies of technical innovation have shown that blockages, barriers and constraints are important 'focusing devices' for the advance of technology. Nathan Rosenberg[4] provides many such examples- an imbalance in the workings of the components in a

system will focus attention on its underperforming parts[5]; a cut-off source of supply of a key input or material will turn attention to producing a substitute. The advance of technical change is essentially about the detection of constraints followed by directed isolation of causes and effects; bumping-up against barriers recursively until they are understood and resolved. Many argue that this problemistic search process has been satisfactorily incorporated into the everyday routines of modern business.

**In favour of routines**

In the modern corporation the process of search has become a highly proceduralised activity. This is not restricted to the prototyping and testing of formal Research and Development, but includes the important function of scanning the environment for signals about new opportunities or the behaviour of competitors[6]. Other such search routines include business monitoring activities, networking, the preparation of feasibility studies, white papers, internal project proposals, validation by committee or the procurement of consultancy services.

In spite of their repetitive and stable nature, corporate routines of search in established and perhaps bureaucratic organisations are nevertheless intended to stimulate new directions and solutions to apparent problems[7]. Search routines have been seen to effect dramatic change and breakthroughs, especially when they involve engagement with the external environment[8]. Crossing organisational barriers through practices such as R&D collaboration agreements, guest engineers and mobility networks can have a major impact on subsequent technology development[9]. Even internal routines that involve exposure to new unfamiliar knowledge such as cross-functional teamworking can promote innovative outcomes[10].

As regards the introduction of new practices, Nelson and Winter argue that established routines may be important *components* of innovative processes. Stable procedures can support the development of innovations if they are reliable and do not complicate the process through incompatibility with the new. In this view, routines aimed at innovation are not opposed to novelty, and can help to generate it, even if they are predictable and mundane in themselves[11].

**Against routines**

The contrary position to this sanguine view on routines stresses how formal corporate search processes tend to be locally focused[12]. For technological innovations firms are disinclined to direct attention at distant and unfamiliar fields, but tend to follow trajectories that are stable and path-dependent[13]. This is partly because of the significant and costly learning that is required to enter a new technical area, but also because search processes are directed by powerful cognitive frames in people's heads that can lead to inertia not only in technical terms but also in the strategy and business model, product development and marketing functions[14].

Search activity may be instigated by circumstances that are exceptional, however the practices in response are quite regular and 'everyday' to the organisation, so the argument goes. In terms of process, product development teams with well-established procedures are the least likely to deviate from their pre-existing patterns of behaviour[15]. Tightly-routinised structures do not typically generate pioneering innovations as their outputs. Instead the results of search may be imitation of competitors' offerings, or else the re-hashing of the firm's current recipes[16]. Routines

that were once the organisation's core capabilities instead become core rigidities[17], indicating a failure to innovate.

Successful routines are perpetuated in the organisational life, while the less successful are dropped, but this logic means that potentially useful domains for search are discarded. For search routines to be directed towards the 'tried and tested' solutions and their vicinity means potentially important information will be missed, rather like the drunk who drops his keys, and looks for them only on the ground under the lamp-post. There is a parallel here between the individual and the organisational level in the power of cognitive schema and the routinisation of search; over time practitioners may become more narrowly focused, their skills become rusty and so innovation involves minor improvements to existing products and processes. The critics of routine argue the same is true for organisations.

New routines and practices are therefore argued by many to be keener blades for the generation of innovation. There are a great many innovation scholars that advocate the use of the non-routine in order to promote radical or discontinuous innovation[18]. In many cases this is in the form of separate venture teams or "skunk works" where isolated units are freed from the operational constraints of the organisation's mainstream. Tushman and O'Reilly's idea of ambidextrous organisations refers to managing different innovation streams and operating in multiple modes so as to support the opposing goals of stability and experimentation. In particular they give examples from Nonaka's research into Japanese organisations' mission task forces and autonomous venture teams as examples of how to promote breakthrough or

discontinuous innovations. These cases showed removal to isolated settings and freedom from the restraints of the mainstream organisation.

Within such settings *improvised* practices may emerge. With improvisation the design and execution of a task occur at the same time[19], rather than a routine practice which is first planned, and later executed. A celebrated example is the playing of jazz music, where improvisation ranges from some impromptu variation around a melody (such as Louis Armstrong) to unstructured 'free form' jazz (such as John Coltrane in the late 1960s). Improvised practice in work settings have been observed and studied and recommended as promoting creativity and lateral thinking- a useful alternative to routines.

Given this review of prior research and managerial experience we have conflicting messages over how innovation barriers may be successfully tackled. On the one hand problemistic search routines are argued to generate innovation themselves or else support the introduction of new ones. On the other hand standard routines are argued to be sources of conservatism. This suggests the following key puzzles:

- Under which circumstances (or barriers) do standard organisational routines generate search leading to innovation?
- Under which circumstances (or barriers) are standard routines insufficient to generate search leading to innovation?
- How can management diagnose the nature of an innovation barrier?

In this paper we aim to shed light on these questions concerning how and when 'bumping-up' against technical and organisational barriers propels innovators into search and the subsequent phases and routines towards an innovative solution. We show that the choice of search routines to employ depends on the nature of the innovation barrier that is being negotiated, and that this matters a great deal to a successful outcome. This is derived from a two-year study of innovation projects described in the next section.

## The cross-sectoral innovation projects study

The research team conducted a two year study with 7 organisations aimed at transferring effective innovation practice across differing industrial sectors. The organisations were drawn from the diverse backgrounds of aerospace, food packaging, public sector health services, road construction and maintenance, software and simulations, telecommunications services and equipment, and whisky distilling and distribution,. The sample were not selected to be representative of a particular industry or type of firm, but were invited to join the project because of their distinctiveness from each other.

INSERT EXHIBIT 2 AROUND HERE

The stages of the research process are presented in Exhibit 2. The method was both deductive, influenced by the concepts from the innovation literature already outlined and inductive since the organisations participating in the research contributed at key stages of the process. Details of the method followed are explained in Appendix A. The steps of the research process enabled the building of a theoretical framework

based on the innovation barriers faced by the studied firms, and the routine or non-routine nature of the practices employed to break through them. Some examples of the innovations studied are given in Exhibit 3.

INSERT EXHIBIT 3 AROUND HERE

## An innovation barriers framework

We found three types of innovation barrier when we analysed the 28 innovation projects in the study, these are the barriers to progress, the constraints and the problems that trigger search to innovation. We called these three types contiguous, discontinuous and persistent barriers. Our interest was the manner of organisational routine or practice deployed to sustain a successful search process through to implementation of an innovation. The results are represented by the diagram, Exhibit 4. The barriers are represented by the three edges of a triangle, which is imposed on a circle. One half of the circle represents the standard organisational routine, the other half the non-routine.

INSERT EXHIBIT 4 AROUND HERE

The first two barrier types, contiguous and discontinuous are quite well trodden over in the literature but we know very little on what we call *persistent* innovation barriers. These are the forgotten and unglamorous problems that people and organisations learn to live with. We have nevertheless found cases where this type of barrier was permeated and overcome through judicious organisational practice. We focus on the persistent barrier problem in the paper since it is relatively neglected; first, however

we describe the routines observed in the first two types, contiguous and discontinuous. The findings here to a large degree confirm conventional wisdom.

**Contiguous barriers**

Many of the innovation cases studied in our partner organisations were fairly predictable ‘next steps’ from previous work. These included so-called incremental innovations, that follow a trajectory established over some time: an improvement to the functionality of a product, extra features or greater performance. In terms of process innovations an example is the introduction of a new work breakdown structure to follow an established product architecture structure. The barriers for innovations such as these are proximate and adjacent to the last.

For these cases the standard search routines of the organisation were effective and sufficient to mobilise resources and people to enact the stages of the innovation process. There was generally little deviation from what would be considered as mainstream and everyday operations, in order to solve problems of a contiguous nature. The problems themselves closely resembled those solved previously, and in many cases used the same techniques to differentiate a new ‘version’ of a product or to slightly improve performance in a measurable way. For this reason the contiguous barrier represented by one edge of the triangle in Exhibit 4 occupies the ‘routine’ half of the organisational circle of possibilities.

**Discontinuous Barriers**

The second type of innovation barrier was where an organisation was attempting to enter a substantially new area for that organisation. This represents a significant

deviation from the previous path or trajectory and is often referred to in the literature as ‘discontinuous innovation’. The organisation is typically propelled towards a discontinuous barrier through some crisis or recognition that major internal adjustment is required. This is often in response to a change in the external environment that affects the organisation’s value chain and relationships. We present two examples of innovation projects engaging discontinuous barriers in Exhibit 5.

Innovation barriers of a discontinuous nature are daunting, requiring new structures and resources that are inadequately understood within the firm. They will certainly require non-routine practices and activities to enact the innovation. Yet in these cases we can observe the importance of established routines in supporting the introduction of the new. This is consistent with the Nelson and Winter argument that established routines may serve as ‘components’ of new activities and facilitate the innovation. Holding some behavioural variables constant in a transition is certainly of some value in the management of morale, and familiar structures may prove efficient at driving forward the wide range of tasks necessary for entry into a new technology or product market. For this reason the discontinuous barrier in Exhibit 4 transcends both routine and non-routine organisation practice.

Exhibit 5 shows cases of discontinuous innovation barriers and the mix of routine and non-routine practices brought to bear on them. SimCo is a provider of customised simulators and training solutions to military and civilian markets and needed to respond to an important technological shift in its industry. Previously in the 1990s civil aviation companies ceased the practice of flying actual aeroplanes in the training of their pilots.  At that stage there was a considerable cost advantage in the use of

flight simulators when compared with real flight training. The next stage on from simulators was the development of microcomputer-based training (CBT), which was proving to be an effective and low-cost alternative to high-end customised simulators.

The trend towards PC-based solutions has lowered barriers to entry in the simulation and training industry, meaning that SimCo faced competition from new entrants exploiting the relatively small investments needed for PC-based CBT. Increasingly, the lower cost solutions were proving attractive to major customers. Key individuals argued that the firm needed to change its view of the product it offered. Many people in the firm thought they were in the business of providing simulators- pieces of kit. While what was required was an understanding that the firm offered solutions to training needs. These solutions would draw from a range of technologies from large units of equipment in the form of conventional simulators to microcomputer based training at the 'low end'.

This entailed a major deviation in thinking as well as the news skills and capabilities required to deliver courseware suitable for CBT. In such a scenario persuasion and advocacy is needed. The internal champions used familiar and 'everyday' routines to raise awareness of the need to change among their colleagues, such as working papers, conferences and presentations. These 'comfortable' routines helped to disseminate the unsettling message of what was needed to break through the barrier. Non-routine practices mainly involved the building of a CBT team within the organisation, recruiting specialists in unfamiliar fields like educational psychology and courseware design, as well as external search routines like participating in standardisation committee work.

Interestingly, a new Training Needs Analysis routine was introduced for all new SimCo contracts, which is an example of how regular routines may emerge from the novel and improvised practices. This is a typical example of the combination of routine and non-routine in an approach to a discontinuous barrier. A similar pattern can be observed in the second discontinuous barrier; ScreenCo's entry into a radical new Liquid Crystal Display technology. We now turn to the third type of innovation barrier, which shows a rather different profile.

**Persistent Barriers**

There has been much written on practices to trigger discontinuous innovation and contiguous barriers are more or less the starting point for conventional product development, which is well-understood. However the third edge of the triangle of innovation barriers in Exhibit 4 is much more neglected. Persistent innovation barriers, almost by definition receive less attention, since these are the long-standing problems that people have learned not to see. They might have received some attention years ago, but required more work to really crack the problem than seemed justified. The problem then took on the qualities of a natural constraint; one of the facts of life. Search was ended as the organisation was more or less satisfied and more pressing priorities were addressed.

At some stage however the persistent barrier to innovation may become a bigger threat to progress because of changes elsewhere in the internal or external environment. This represents a quandary for the organisation, since the routine practices have not been capable of resolving the snag. It is this type of scenario that

was perhaps most interesting of the innovation projects in the study. Exhibit 6 and 7 show two cases where persistent barriers were tackled. The organisational routines that were successful were quite different to the solutions to those of a contiguous and discontinuous nature.

**Persistent innovation case 1: Absorbent polystyrene meat tray**

The innovating organisation, FoodPack[20] always aims to be lead the industry with new products, yet the stream of new concepts does not always flow easily. This innovation project began with the recognition by senior managers that there were no new product ideas coming through. The roots of the problem stemmed from a prior experience when the company had been "kicked" by an instance of launching a new product prematurely. The product was not ready for distribution and consequently an important customer- a major supermarket chain - had no product to fill its shelves for a day. As a result of this corporate embarrassment the organisation had stopped innovation and had "moved back into a comfort zone"; inertia set in.

To break out of this constraint of gun-shy conservatism, managers reached for an unexploited opportunity in the form of a patent purchased by FoodPack some years before. The patent contained the potential to develop a polystyrene tray for meat, which could absorb the product's blood and juices. A pad-less tray would mean major cost reduction, extended shelf-life so granting extra time for distribution, as well as design advantages to appeal to the final consumer

**Search to solution**

The FoodPack Operations Manager had been reading about 'Skunk Works'[21] style product development and suggested this model as a way of energising and avoiding the large firm bureaucracy that tended to slow down development. They identified a cross-functional team of individuals known to be capable of the "wild and wacky". They were set a 1 year deadline before the product launch when it should be fully tried, tested and approved. The team were released from standard organisational constraints operationally and psychologically. They were collocated and encouraged to chat, scribble ideas on the wall, create, clarify and challenge their emerging ideas in a non-threatening environment. Yet this was described as a "controlled freedom" since a project manager provided structure and focus, together with bi-weekly executive briefings and reviews with the Board, including a demanding technical director. These arrangements were all quite non-routine for the firm.

Following the initial "crazy idea" stage, the team were told to go away for a week and think about what resources they needed. The Operations Manager told them they could have anything they wanted, which forced him into a predicament:

> It was the worst thing I ever said, but in essence it was the best thing I ever said… They wanted me to give them a machine for a year. Under a normal concept you wouldn't have actually ever done that. You wouldn't have said yes, 'you can have your way'. My first answer was 'No you can't have a machine, because I need to service the market. And I remember the meeting, the first answer they came back to me was 'but you said we could have anything', and I said 'well, I didn't expect you to ask for one of my

machines'…, I had to go and find a way around it in the end they did [get the machine].

Despite the reservations, the 'skunk works' approach paid off. The project succeeded on its terms, its additional cost was an estimated £200,000, which made it one of the cheapest projects that operations had ever conducted. But there were other benefits; the appetite for innovation had been aroused again with an idea for a next generation product. Another benefit was an organisational change; FoodPack's centralised technical centre was closed, with the engineers moved into the sites where products were made in order to bring a commercial focus to research, and innovation to the manufacturing sites. This decision was partly based on the success of the meat tray project and its combination of technical experimentation and commercial focus.

The project's success in breaking through a persistent barrier was largely attributed to its non-routine nature and the relaxation of standard procedure and thought. On documentation requirements for example, the Project Leader insisted "the worst thing we could do would be to put things in tablets of stone." This is an example of a removed organisational constraint that enabled the team to break through the formidable constraints of current technical knowledge and the inertia within the firm to generate a radical innovation.

These non-routine practices were counterpoised to the standard routines of the mainstream. Exhibit 6 shows the standard routines followed in FoodPack as contrasted with those that emerged on the innovation project. We argue that it was

though these emergent working practices that the trigger to innovate was effected. A similar pattern can be seen in the second case.

**Persistent innovation case 2: Distorted screen display reducer**

The ScreenCo case is an incremental improvement to an established product. Similarly to FoodPack, ScreenCo faced a technical constraint and an organisational constraint. This was another challenge of stretching the technical properties of the product. However there were also organisational constraints in the form of severely limited resources to develop innovations. ScreenCo had no resource or organisational slack, which is typical of small, project-based firms[22].

Working within the resource constraints a prototype model was put together "using MDF, chewing gum, sticky tape and string". Since there was no slack in the production schedule the team worked outside of normal hours. Nor did ScreenCo have the finances to manufacture a sphere for development purposes, so the team leader decided to "hijack" a customer's system under assembly over a weekend. He sent an email to his engineers asking for volunteers to work over the weekend: "We're going to pinch a customer's mirror for a weekend, who's in?" They quickly fitted the solution and got it to work, and then de-rigged it for Monday morning. This shows the slightly shadowy, after-hours nature of the project and the improvisation that occurred. The respective standard routines and 'non-routines' are shown in Exhibit 7.

Similarly to FoodPack, loose documentation requirements were reported to be important in maintaining a momentum as well as morale, according to the program manager:

> The whole process took about 8 months and the first prototype was up and running in 1 month. [I]f we'd have laden it with excessive documentation up front, then I think the process would have slowed and stalled. And the other bonus is that the people working on it, if they see bits arriving, and they see their drawings going out the door, and they see their test data being generated, their involvement is much heavier and they're much more excited and they're much more interested in getting it finished and done. Whereas if they come into work thinking, 'I've got to spec today, catalogue and report on what I've done for the last 3 weeks, generating a justification for the next stage' interest dwindles.

The 'Distort Reducer' innovation was successful and welcomed by the customer. It has been patented by ScreenCo and licensing is seen as a potential revenue stream. It is being retrofitted to other customers' existing products for a fee and ScreenCo is looking to implement the Distort Reducer on the range of smaller products to maintain a competitive edge across the portfolio. A Mark 2 improvement is on the drawing board. The original distortion problem had been an irritating eyesore for years but had become a threat to competitiveness when the company was aiming to diversify into a new market. It was this urgency that propelled the firm to break this persistent innovation barrier. It needed some ingenuity and taking the problem out of the constrained standard operations to force the breakthrough.

**Mismatching practices with barriers**

We have argued that taking a persistent barrier to innovation out of 'normal' organisational routines helps to make progress where the mainstream routines have failed. We show in Exhibit 8 what can happen if this is *not* done. This is a case where the innovation barrier had all the hallmarks of persistence, a reconfigurable core software architecture that had long made sense for a project-based firm like SimCo. When the firm took the decision to make resources available to develop the idea it was tied to a live standard project, in order to share funding and engineering resources. This led to conflicting priorities and the everyday routine gradually took precedence over the innovation work.

The project went over budget as eventually engineers satisfied both masters; the contract and the innovation development. With hindsight the project manager responsible concluded that the core architecture should have been separated from routine work. With a choice between pressures of project deadlines and the cracking of persistent innovation barriers, most people will reach for the lower-hanging fruit of the live project. This is precisely why trickier innovation barriers become persistent, and why it often requires dedicated attention away from standard routines and mindsets to resolve them.

As well as the conflicting priorities, another interesting difference with the two cases where non-routine practices were applied was that documentation was seen to be *too* loose. The project manager claimed "…that's the major lesson that came out of this. Much more detail in specification and documentation. We left too much open. That was the approach I was looking for; without the design reviews, but it doesn't work. Too many reviews, too tight, doesn't work, too much freedom, doesn't work. It's

balance, finding the balance is the hard part". We discuss this dilemma in the next section.

## Discussion

### Loosen constraints to break constraints?

We have seen that in some cases non routine practices are a relaxation of standard procedure and have been successful. Do we then conclude that merely relaxing managerial controls will help break persistent barriers? This would be an elegant message: loosen some constraints to break through others. However the experience of the previous project illustrates how looseness can be excessive. While we counterpoise standard routines and the non routine, this is not a tight/loose dichotomy in the same way as the ambidextrous architectures concept. Tushman and O'Reilly recommend loose practice for periods of technological ferment and tight control for stable stages of a life cycle. Our focus is the type of innovation barrier being faced in a search problem, rather than stages in the product life cycle *per se,* and we do not suggest loose routines for persistent barriers as a general rule for persistent barriers.

Both of the two successful innovation cases showed that relaxation of organisation routine and procedure certainly appeared to facilitate the process. However there were also pressures and constraints that were applied to the teams beyond the original technical difficulties. For FoodPack these were the project deadline pressures and high level review meetings with the Board and Technical Director, while for ScreenCo the intensity of working around the resource constraints meant that in some respects management practice was tighter than the standard routines.

Some constraints appear to be search *enhancing* such as focused timelines, the technical challenge, and the resource constraints that enforce improvisation and creativity. Other constraints block search and innovation, one example in these two cases was documentation. This was identified as being a block by the project managers because it slows progress and de-motivates. Non routines can be constraining but they do need to be dynamic and revitalising, not boring activities. The practices that developed in the two cases show a mix of technical and organisational constraints as well as 'loose' practices, like brainstorming for solutions and writing on the walls.

Yet the 'non routines' do not just emerge within a vacuum of control. While *the usual* stringent documentation requirements were not observed in the FoodPack and ScreenCo cases there were other forms of recording the key work tasks. Some functions, like accounting for time, were relaxed but for important tasks rigorous documentation was crucial, such as recording the data produced when testing the prototype products.

A large part of the effectiveness of the non routine is precisely because it is different from the everyday and the mundane. This promotes the lateral thinking and fresh perspectives that can crack a persistent problem. In some instances this might mean a loosening of process or in others a tightening that has the effect of focusing search and opening new ways of thinking that triggers the innovation. The FoodPack barrier

meat tray was a latent opportunity and the product of years of external *passive search*, but it was not until the nonroutine was tried that the active search to solution occurred. It required a fresh mix of practices to induce the change.

**Where does the non routine come from?**

Non routine practices may be used irregularly in the organisation or manager's toolkit and kept in reserve for special occasions. Alternatives to the standard practice may be have been tried and abandoned in the past, or in other settings. They may also have been read about, like the FoodPack manager reading about Skunk Works, or heard about on the grapevine. The most extreme non routine is the case of improvised practice, for example the ScreenCo engineers pulling together plumbing pipe, MDF, string and whatever resources they could muster to build a prototype of the contraption they had envisaged in a brainstorming session.

However even improvised practices are drawing on memory of actions and skills learned previously. Closer examination of jazz music reveals a fair amount of repetition, whereby musicians will fall back on favoured 'licks' and phrases committed to memory for the moments when inspiration fails. Similarly when improvising in work settings practitioners are not only experimenting with genuinely new ideas. Instead they might suggest and employ practices they had previously experienced, or had heard or read about vicariously.

Moorman and Miner have argued that at an individual and collective level people draw on two types of memory during improvisation: *procedural memory*- the skills

and repertoire of “things we can do”, and *declarative memory*- ‘facts’ and theories. While declarative memory tends to encourage novelty and the ‘trying-out’ of new ideas, procedural memory works against unfamiliar actions, reverting to the tried and tested.

The problem with declarative memory is that since it is more theoretical and not dependent on personal experience and know-how, there is such a vast range of possibilities that this presents a search problem: how to select tasks and actions judiciously. Procedural memory moderates the excesses of declarative memory by providing coherence and structure of practices that are known to work. The implication of this is that even within improvised practices there may be an element of established structure: new innovative practices do not fall from the sky. Yet the greater the influence of procedural memory: the lower the chance of novelty and innovation.

The non routine also appeals to the darker side of personalities. Task forces and Skunk Works are often described as feeling exclusive and secretive. The FoodPack and ScreenCo teams worked for long hours on these projects, and their morale and motivation was linked with the covert, authorised rule breaking. The secret may be precisely because the process *is* nonroutine that enables out-of-the-ordinary results. To break routine to innovate, you must also have routines to break with; this may have the feeling of a counter culture: ‘Punk Works’ rather than Skunk Works.

The role of management requires a stepping back to allow the non routine to develop. Peter Augsdörfer[23] has shown the prevalence of 'bootlegging' innovations, where management turns a 'blind eye' to unauthorised innovation activity. But the role of management in the context of persistent barriers is not so much turning a blind eye, as giving a nudge and a wink.

**Innovating in the Last Chance Saloon**

That non routine practice can help to generate innovation has long been known by practitioners and innovation scholars. The practices employed by the firms in our study are not especially remarkable and will probably feature in the toolkit of most innovative firms. However what is new is our focus on the pattern of matching organisational practice with the type of innovation barrier, and in particular the thus far neglected case of persistent innovation barriers. We found non routine practices to be effective for persistent barriers, standard routines for contiguous barriers and a mix of both for discontinuous barriers.

We identified these organisational responses to the three categories of innovation barrier when analysing our data. However our study of 28 innovation projects is of course a limited sample. In other circumstances it may be that a different pattern could be observed which also led to successful innovations. Our findings however are consistent with the innovation theory and provide a starting point for thinking about the reasons why routines are considered innovation friendly in some instances and innovation hostile in others.

One finding which may be counter intuitive is the mixture of the routine and non routine for discontinuous innovations. It could be argued that entirely non routine practices ought to be used for discontinuous barriers to break through these formidable constraints. This is often the logic behind setting up New Venture Divisions; separating a new innovative unit from an established parent and thereby protecting it from the forces of conservatism. This is an entirely valid organisational strategy but there are hazards, particularly around how the innovative unit is integrated back into the mainstream organisation.

Tushman and O'Reilly's work on ambidexterity is concerned with how the innovation streams and their differing systems of operation are to be integrated in the organisation. They warn of the dangers of allowing newer units to be starved or trampled to death by established divisions. Gary Hamel's *Leading the Revolution*[24] also insists on incorporating innovative thinking throughout the business. Without this, independent skunk works type ventures may become isolated and never integrate with the parent organisation and its resources, and so are often unrealised.

The diffusion of innovation into the mainstream can be observed in the FoodPack case, where the success of the meat tray project in taking product development closer to the production line was instrumental in a relocation of the engineering function within the operating divisions. In this way the engineers could have better access to working machinery and test out concepts and prototypes just as in the innovation project. What was seen as unthinkable at the start of the project became non routine

within a task force setting, and later became assimilated as standard routines in the mainstream organisation.

This sequence of events is quite common. A well-known example is the IBM Personal Computer task force that was given autonomy and delivered the PC in less than one year. The PC task force later became a division (and many would argue lost its buzz because of it). In fact other important IBM products, the System 360 mainframe and the ThinkPad portable PC were initiated through the nonroutine, but were eventually assimilated.[25]

So in addition to an innovative solution to a particular problem, an unexpected outcome of employing non routine practices may be further effects on the organisation. The non routines could become assimilated into the mainstream, by forcing a review of the innovative potential of standard routines. But this is by no means an objective of the original decision, and we would envisage in most cases the 'non routines' to be dropped and placed back in reserve. It is in the temporary application that they may be most potent. They should not be relied upon to rejuvenate an inert business, which is a longer term and wider ranging endeavour[26]. They might however suggest directions on the path to broader transformation.

Non routine practices should be seen as 'the last chance saloon' for particularly thorny problems where the mainstream organisation has failed. It may be that some

useful practices emerging from an innovation project will be integrated into the standard routines, or simply added to the 'special menu' of non routines. Exhibit 9 illustrates this with an algorithm diagram showing the high level flow of decisions to diagnose innovation barriers and match appropriate organisational practices with them. We discuss some diagnostic questions in the conclusions.

## Conclusions

We considered the problem of when to employ routine practices and when to encourage non routine practices in order to promote innovation. We found that the effectiveness of the approach depended on the nature of the innovation barrier to be tackled. When the proposed innovation is an obvious progression from a familiar path we found standard routines were effective and sufficient. When the proposition was a major deviation from previous activity within the organisation we found a mixture of routines and non routine practices was effective to mobilise the energy and control needed. Finally we found a third type of innovation barrier, which we called persistent, where only a conscious removal from standard routine was effective in breaking through the constraint. This suggests that when attempting to innovate managers may be able to diagnose the nature of the barrier and to assess what organisational arrangements may be brought to bear on it.

### Contiguous innovation barriers

For contiguous innovation barriers, the 'decision' is in effect a non-event since cracking this type of problem is essentially what standard routines are for and do all the time. Questions to diagnose a contiguous barrier may include the following:

- Is the proposed innovation a new ‘version’ of an existing product?
- Does it involve the extension of the ‘range’ of existing offerings?
- Does it add new features to a component or subsystem product?
- Is the product being sold to a familiar customer base?
- Is the suggested improvement a measurable but not radical performance increase?
- Does the innovation draw on the organisation’s existing skills base?
- If a process innovation, does the proposed change add to existing structures, rather than replacing them?

**Discontinuous innovation barriers**

Having thought through such questions as those above a manager may conclude that the innovation barrier is a logical ‘next step’ from prior innovations and that the standard routines will suffice. However if the organisation faces a change in path from the ‘bread and butter’ and wants to enter into a new area, this will require the introduction of the non routine, but standard routines may also be helpful to support the introduction of the new. In particular the *persuasion* aspect that is crucial to mobilising an assault on a discontinuous barrier may be done through familiar styles of communication. In a sense enlisting support is as important as building the new skills and structures and a radical message may be better received through less radical means. In addition the established routines might form ‘components’ of discontinuous practice provided that they are not incompatible with them. This has the effect of reducing risks in introducing the very new, and increases the possibility survival through integration with the mainstream organisation. Diagnostic questions might include the following:

- Does the innovation require new and different skills from those already in the organisation?
- Would the innovation be aimed at a new and different customer base?
- Is the innovation a reaction to the organisation being challenged because of some change in its competitive environment?
- Does the innovation involve a radical (great than 30%) performance increase?
- Is there resistance to the ideas underlying the need to enter the new area?
- Would the necessary resources and capabilities to deliver the innovation involve new relationships with external actors?

**Persistent innovation barriers**

Persistent innovation barriers may well have some characteristics of the two other types. Perhaps they were discontinuous opportunities that were left on the rack, since the firm's existing wardrobe could last another few years. They have been considered contiguous barriers once, but after some digging away at the problem it was realised that this was not the next simple step, but something more challenging. The organisation learned to 'work around it' and the constraint was accepted as one of life's imperfections. However a change in the environment may have brought the persistent problem back into the foreground. Like an abandoned and neglected house, it appears more conspicuous as its neighbouring buildings are refurbished. The troublesome component may become a bottleneck to overall progress. Questions to diagnose a persistent innovation barrier might include these:

- Is this a problem that has been tackled before and abandoned?

- Does solving this problem seem self-evident “in an ideal world”?
- Do customers repeatedly complain about this problem?
- In a time management matrix, would the problem be placed in the ‘not urgent’ quadrant?
- In a time management matrix, would the problem have moved from ‘not important’ to ‘important’?

If there is a broadly positive answer to these types of questions, this would appear to be a persistent innovation barrier. The organisation will have tried in the past to push through this constraint without success, and so it has become accepted as given. However our study has suggested that taking this type of problem outside the standard search routines aids the lateral thinking and fresh perspectives that might produce the breakthrough. This might entail a Skunk Works type task force, an informal ‘virtual’ team releasing people from their everyday jobs, or simply of series of extracurricular meetings that can generate a ‘buzz’ and thoughtful conversation. In each case management’s role is a careful balance of license as well as unobtrusive focus. There is a role for experimentation in this respect as well.

There is scope for further research on the durable nature and weaknesses of persistent innovation barriers, which, almost by definition are a neglected phenomenon. It may also be that there the three barriers suggested by our data may be joined by others, that each have distinct organisational implications. We might expect refinements and further insights from looking at the routine/non-routine debate in terms of innovation barriers. This provides food for thought for researchers, as well as heartening evidence for innovating (and constrained) practitioners.

## Appendix A: The research method

Working with practitioners in the organisations the researchers identified four types of innovation project in each organisation. These were *product* innovations of both radical and incremental nature and innovations in *organisational process* of both radical and incremental types. The research team then collected data on an example of each innovation type in each of the seven organisations. The primary data source was in-depth, semi structured interviews with key managers, engineers and other professionals involved in the innovation projects asking them to relate the triggers, motivations and development phases for the new products and practices. This was supplemented by archival data such as documentation, procedures, working papers and observation of operations.

In all, data was collected from 123 interviews from all levels in the organisation. Interviews were of variable length but with a mean of approximately 1.5 hours. Where possible interviews were tape recorded and transcribed for analysis. Where this was not possible or inappropriate, extensive field notes were made immediately after the interview. These were also transcribed and validated by respondents in order to become part of the final data set.

The researchers then coded the interviews and other data, building categories on the sources and triggers for the innovations, the subsequent stages of implementation, the practices employed at each stage and the factors enabling and inhibiting the innovation project. All individual project cases were then shared and compared with

those compiled by colleague researchers to ensure agreement over their interpretations. The final stage of validation was a series of workshops where the researchers presented the emerging results to practitioners and elicited any comments and corrections.

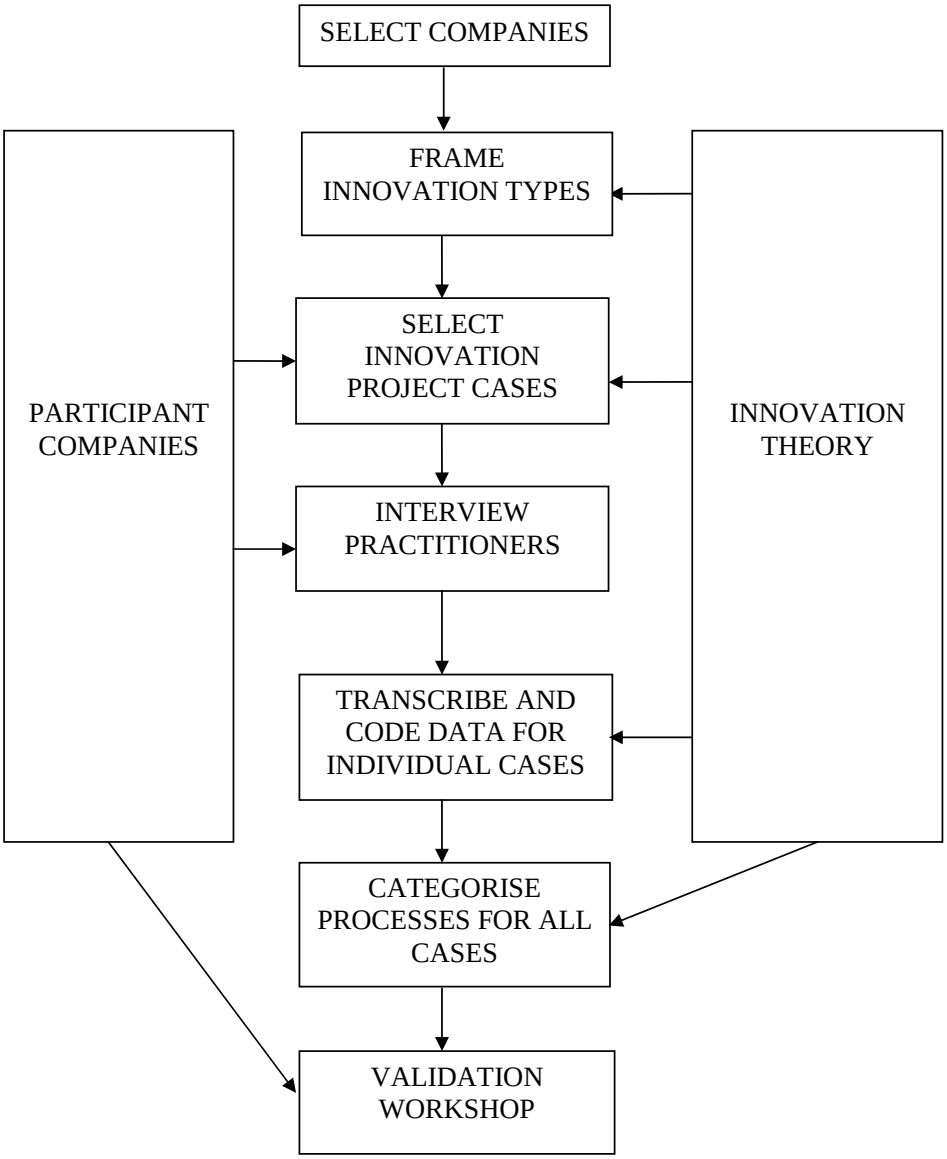
**Exhibit 1: CONCEPTS**

**SEARCH:** In this article we use the term search as shorthand for 'problemistic search', that is organisational activity that is stimulated by a problem and directed toward its solution. Problemistic search is therefore oriented around a specific goal and is distinguished from random curiosity or general scanning in order to collect information or advance knowledge. A high profile example was the year-long re-engineering effort to correct the "wobbly" Millennium Bridge built over the River Thames in London.

**STANDARD ROUTINES:** Standard routines are the repetitive practices and operating procedures that are employed within an organisation so that work is accomplished. In this article we are particularly interested in the routines directed towards search. Examples include the practice of hiring 'head-hunters' when planning an executive succession, or performing known testing procedures to diagnose why a piece of production equipment is not working properly. Although standard search routines are repetitive and predictable, the outcome of the process may be quite new and unexpected.

**NON-ROUTINE PRACTICES:** We use the term non routine for those practices that are employed to conduct search but are not frequently and regularly used in the organisation. They may be experimental and new to the organisation or even new to the world, but they may also be proven techniques and "kept in the back pocket" for occasional use. Innovative routines might include brainstorming techniques, strategic retreats or else improvised practices that are not planned or structured before they are performed.

**Exhibit 2: The Research Process**



## Exhibit 3:

## Examples of innovation projects in the partner organisations

***Radical Product Innovations***

- Absorbent polystyrene meat tray
- Simulation screen using Liquid Crystal Display technology
- Service for dementia sufferers in under 65 age group
- Microcomputer-based training solutions

***Incremental Product Innovations***

- Enhanced functionality upgrade to telephone exchanges
- New whisky blend distilled in wine barrels for light, sweeter finish
- Screen display distortion reducer
- Multi-application software architecture

***Radical Organisational Process Innovations***

- Re-organisation from functional to cross-functional teams
- In-line reduction and filtration of whisky
- Satellite positioning and messaging system for road maintenance vehicles
- Introducing outsourcing of design

***Incremental Organisational Process Innovations***

- Projects 'lessons-learned' database
- Introducing telephone sales for packaging
- Training needs assessment procedure
- Work breakdown structure

**Exhibit 4: The Innovation barriers framework**

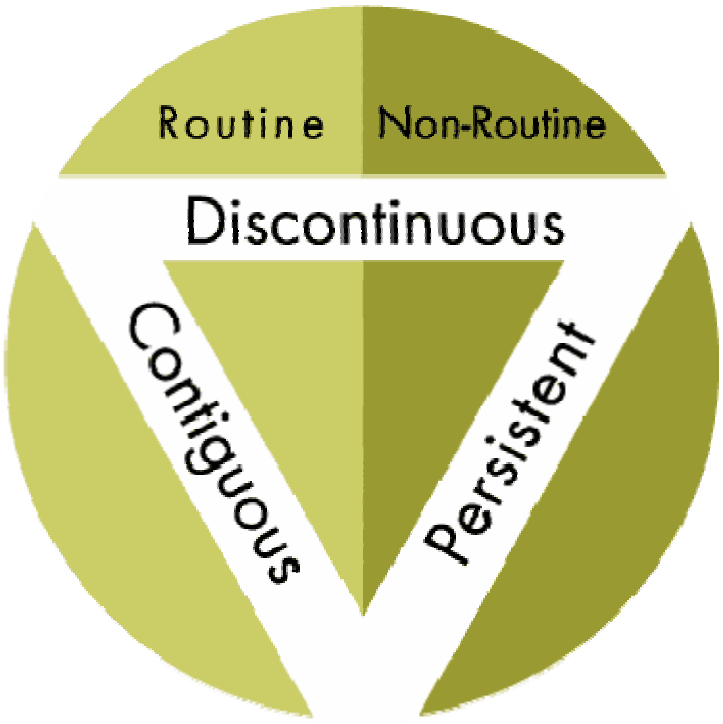


**Exhibit 5**

**DISCONTINOUS INNOVATION PROJECT: CBT SOLUTIONS**

**INNOVATION BARRIER:** (Micro)Computer Based Training was lowering barriers to entry in the flight simulation industry. SimCo needed to move from being a provider of simulators which were large, high-cost pieces of equipment, to a position of providing solutions to training needs, involving whatever technologies were appropriate. This entailed building a capability in computer based training, including the subtleties of courseware design, assessment as well as the technicalities of software and hardware.

**ROUTINES DEPLOYED:** Standard routines and non-routine practices were deployed. Standard routines included the drafting of a working paper arguing the urgent need for rethinking product strategy, a series of presentations also were important in persuading and advocating the move into CBT. External routines included attending academic and commercial conferences and promoting the firm's developing capability at them. These were all regular and mundane occurrences to the organisation.

Non routine practices included the recruitment of specialist professionals that were unfamiliar to the firm, such as an educational psychologist, as well as the introduction of a training needs analysis routine to be undertaken with every new contract. A useful external search non-routine was participating in IEEE technical standards bodies relating to CBT development.

**DISCONTINUOUS INNOVATION BARRIER: LCD SIMULATORS**

**INNOVATION BARRIER:** ScreenCo had never entered the fast jet training market since the current portfolio of technologies could not fulfil the demand. One prospective solution was Liquid Crystal Display technology, which always promised to simulate fast jets but was not quite ready. The level of detail was not adequate for a believable simulated environment. A change came as the US Air Force developed a prototype using a rival solution to LCD demonstrating the demand. An LCD based sphere would provide a superior experience but would be a much more complex product than conventional offerings, requiring a far greater number of projector channels than the industry had seen before.

**ROUTINES DEPLOYED**: This break from a prior technological path was managed through a mix of standard procedure and unorthodox practices. The project was funded in response to a standard internal proposal, but this had been developed through a brainstorm in a hotel room and with schematic diagrams and specifications added on a transatlantic flight. The project was straightforward in its internal execution, accomplishing intermediate target routines along the way such as building a concept demonstrator which was exhibited at the big annual industry show. Outputs were standard, such as publications in industry magazines and some patents of the leading edge work. Yet a non-routine aspect to the project was a co-operative R&D agreement with an end user organisation which brought in human factors expertise to the developing product.

**Exhibit 6: FoodPack innovation project:**

**FOODPACK COMPANY BACKGROUND**: FoodPack is a multinational plastics producer that supplies packaging for food retailers including large supermarket chains and global brand fast food vendors. The firm generally is first-to-market with innovations in the product categories in which it competes and actively tries to refresh product lines to sustain its advantage over competitors. The strategy is that 50% of revenues derive from products developed within the previous 5 years, with a step- change innovation every 2 years.

**INNOVATION BARRIER:** This persistent innovation barrier relates to the development of a polystyrene tray for meat, which could absorb the product's blood and juices. Conventional meat trays needed an absorbent pad between the meat and the tray surface, which added a 30% cost to each unit produced. Also by removing the pad the shelf-life of meat products could be extended to 12-14 days. Making an absorbent, pad-less tray had become a holy grail to the food packaging industry and in spite of some tests and promising techniques a technical solution had never been achieved.

**Standard Routines and 'Non-Routines' in the FoodPack innovation project**

| Standard Routines | Non-Routine Practices |
|---|---|
| Product concept and prototype developed in Technical Centre then received by operating divisions | Cross-functional team co-located in same space for three months to brain storm concept and work towards a prototype |
| Dedicated product development engineers | Operators, technicians, experts and sales personnel seconded from functions |
| Well defined requirements and specification | General 'solution' needed to problem of pad-less tray |
| Resourcing specified by technical management | Project team promised "anything they wanted" |
| Formal Stage Gate process of development | 1 year deadline for completed product, with regular progress reviews with Board |
| Full documentation on systems required | Documentation as team desired- "writing on the walls" |
| Equipment drawn from product development pool | Equipment from active operations used for project |

**Exhibit 7: ScreenCo innovation project:**

**SCREENCO COMPANY BACKGROUND**: ScreenCo is a supplier of high-end screen displays and structures for a wide range of visualisation applications. These include flight and military simulation training, corporate presentation and broadcasting, and a growing range of applications in virtual reality for engineering, education and entertainment. ScreenCo was created in 1984 and has been growing at a steady rate of around 20% for 10 years to170 employees.

**INNOVATION BARRIER**: This persistent innovation barrier was an imperfection in one of the firm's core products: a 'panorama' wraparound style screen. The projected image became distorted at the edge of the screen, which was tolerated for some years and although it had had some attention, was not a priority to correct. It became a more urgent problem when ScreenCo wanted to enter the pickier military market. Military flight training needed a clear image at the edge of the screen since this was where a pilot would visualise reloading artillery. The successful innovation was a technique called the 'Distort Reducer' which was later patented. It was developed through the non routine practices listed below

**Standard Routines and 'Non- Routines' in the ScreenCo innovation project**

| Standard Routines | Non Routine Practices |
|---|---|
| R&D team research and produce feasibility study of concept | Cross-functional team meet to brainstorm nature of problem and solution. |
| R&D team develop prototype and pass on to product teams | Product team technical members develop prototype and final product |
| Resourcing formally applied for in stages; decided and provided by R&D Director | Resources 'begged, borrowed and stolen'- team worked in over time; materials improvised |
| Presentation of concept to potential customers | Borrowed customer's products for testing |
| Prototype production allotted in the factory schedule | Team produced prototype over weekend |
| Full documentation | Loose documentation at team's own discretion |
| Design reviews with standard checklists | Occasional 'Sanity checks' with directors and engineers |

**Exhibit 8:**

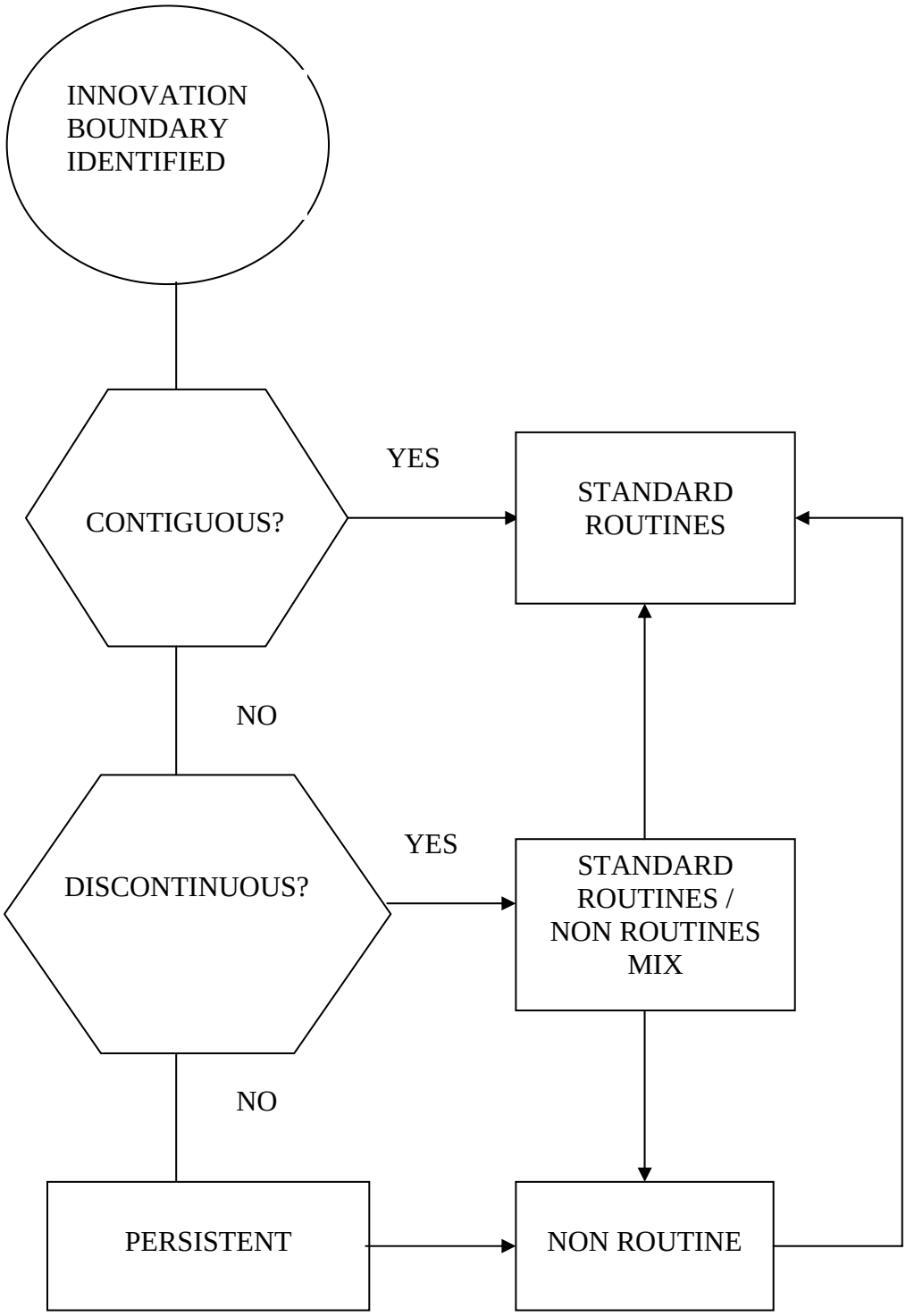
**MISMATCH OF ROUTINES WITH PERSISTENT BARRIER**

SimCo faced a persistent innovation barrier in the shape of core software architecture (CSA). Engineers had long argued for a central development environment which would form a core structure. Different applications could be developed around this core but it would avoid duplication of effort and reduce risks of individual projects. This had been discussed and some experimentation had been done, but the diversified nature of software projects in the firm had shown that this would need to be a major project.

A champion of the CSA had got agreement from the company directors and project managers to develop it, but the wrong choice of organisational practice was made. Instead of taking the problem out of standard routine operations the innovation development was attached to a live contract so as to partly fund the work. This sounded like good financial sense at the time, but it had the effect of creating conflicting priorities. The project manager tried to mix non-routine practices and improvisation with the less-exotic demands of the contracted work tasks. The live project gradually dominated priorities while the CSA work floundered. The CSA eventually was successfully completed and is now being used as a firm-wide resource, but the project had gone £300K over its budget, 65% over the projection.

The project manager concluded the CSA would have been better developed as a separate endeavour from a live contract “We shouldn’t have done a development of this nature on a live project, with project timescales and deadlines.” Persistent innovation barriers of this type tend to be undermined when competing with the clearer demands of everyday business.

**Exhibit 9: Algorithm diagram**

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