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► **To cite this version:**

Helen Wagner, Susan C Morton, a R J Dainty, N D Burns. Path Dependent Constraints on Innovation Programmes in Production and Operations Management. *International Journal of Production Research*, 2010, pp.1. 10.1080/00207543.2010.482569 . hal-00596294

HAL Id: hal-00596294

<https://hal.science/hal-00596294v1>

Submitted on 27 May 2011

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|-------------------------------|---|
| Journal: | <i>International Journal of Production Research</i> |
| Manuscript ID: | TPRS-2010-IJPR-0287 |
| Manuscript Type: | Original Manuscript |
| Date Submitted by the Author: | 22-Mar-2010 |
| Complete List of Authors: | Wagner, Helen; Loughborough University, Wolson School of Mechanical and Manufacturing Engineering Morton, Susan; Loughborough University, Wolson School of Mechanical and Manufacturing Engineering Dainty, A R J; Loughborough University, Civil and Building Engineering Burns, N D; Loughborough University, Wolfson School of Mech and Man Engineering |
| Keywords: | INNOVATION MANAGEMENT, CONTINUOUS IMPROVEMENT |
| Keywords (user): | Force Field Analysis, Path Dependency |
| | |



Path Dependent Constraints on Innovation Programmes in Production and Operations Management

Helen T. Wagner^{a*}, Susan C. Morton^a, Andrew R. J. Dainty^b,
Neil D. Burns^a

^{a.} *Manufacturing Organisation Group, Wolfson School of Mechanical &
Manufacturing Engineering, Loughborough University, LE11 3TU. UK*

^{b.} *Department of Civil and Building Engineering, Loughborough University,
LE11 3TU. UK*

(Received October 2009; final version received)

Innovation has been categorised into levels, ranging from incremental to radical, each of which has the potential to impact on the workforce and the organisation of a company, influenced by contextual factors. This paper investigates the barriers to innovation diffusion in companies working at these two ends of the innovation scale, in order to identify similarities and differences in how levels of innovation affect an organisation and how culture affects success. It also considers these factors in light of the Path Dependency concept. Investigations were conducted on a case study basis, using semi-structured interviews. This led to the creation of Force Field Analysis diagrams to portray the findings, which show the radical innovation implementation has experienced greater resistance than the incremental program. Conclusions show that there were many similarities between the radical and incremental innovation projects. Differences were primarily based on project specific forces and those that occur as a result of path dependant forces that have shaped the current working environment. Organisational culture was found to be a significant influence, as all innovation programmes require the involvement of people. Findings of this study will contribute to theory on the differential and similar forces which shape incremental and radical innovations.

Keywords: innovation levels; Force Field Analysis; path dependency

1. Introduction

Baumol states that “Under capitalism, innovative activity – which in other types of economy is fortuitous and optional – becomes mandatory, a life-and-death matter” (Baumol, 2002). This makes it essential for all organisations (Arias-Aranda et.al., 2001) wishing to survive the capitalist economy that prevails in western society to embrace innovation, especially at this time of global financial uncertainty. Innovation itself can come in several forms, as “an idea, practice or object that is perceived as new by an individual or other unit of adoption” (Rogers, 1995), all of which have the potential to impact on the culture and status quo of an organisation and the individuals within it during Innovation Diffusion. Innovation has been categorised by Henderson and Clark (1990) into four levels, dependent on the effects they have within an organisation: Radical, Architectural, Modular and Incremental (Henderson and Clark, 1990; Afuah and Bahram, 1995), each of which have different effects on an organisation, ranging from the minor incremental to the disruptive radical.

The process of transferring new ideas, known as innovation diffusion, causes a degree of social change, and what may appear to be a simple process is driven by the

* Corresponding author. Email: h.t.wagner@lboro.ac.uk

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3 individuals involved and, therefore, gives rise to potential barriers to success (Steele
4 and Murray, 2004) as individuals project their uncertainties over the loss of stability
5 (Topf, 2000) of a situation they have often had a stake in creating (Christensen, 2000).
6 The level of resistance and barriers experienced during this process comes from a
7 variety of reasons, many of which can be linked to company specific decisions,
8 unrelated to the current initiative (Mazzoleni, 1997). For example, the process of
9 innovation diffusion is affected by past events in the history of organisations, which
10 can inhibit the ability of an organization to adopt new ideas, a concept known as 'path
11 dependency' (Liebowitz and Margolis, 1995; Coombs and Hull, 1998; David, 1985).

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14 Having found a lack of business level implementation cases, a finding supported
15 by Yu and Tao (2009), who noted that "*Literature on business-level technology*
16 *adoption is scarce compared to general literature on examining individual-level*
17 *technology adoption"* and Armbruster et.al (2008) who stated that "*the existing*
18 *literature on organizational innovation is diverse and scattered"*; this paper will
19 investigate the barriers to both the uptake and generation of innovation in
20 organisations working at the two ends of the innovation scale; one in radical
21 innovation, the other incremental. Offering information on how the level of
22 innovation affects the barriers created and how culture affects success. It sets out to
23 inform practitioners of the potential issues faced when attempting to propagate a
24 culture more accepting of innovation and the change which this necessitates.
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29 **2. Literature Review**

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31 Morton and Burns (2008) define innovation as threefold: "*the process of bringing*
32 *new and improved products and processes to market; developing, adopting and*
33 *adapting manufacturing processes to enhance productivity and product quality; and*
34 *developing, adopting and adapting business practices to enhance the performance of*
35 *the firm."* All of these have the same goal: to improve efficiency and ensure the
36 organisation remains competitive in its market. In this study, it is the organisation's
37 innovativeness that is important, considering the propensity a firm has to adopt
38 innovations (Garcia and Calantone; 2002, Damanpour, 1991; Rogers, 1995), both in
39 terms of new technology and process improvements.
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42 Recent publications on innovation diffusion into organisations have focused on
43 topics from training (Sharma & Yetton, 2007), patterns of adoption (Freitas, 2008;
44 Xue et.al, 2008) and effects of firm size (Freitas, 2008; Battisti and Iona, 2009), to
45 monitoring and measuring diffusion (Armbruster et.al 2008) and recognising its
46 differing stages (Freitas, 2008; Yu and Tao, 2009; Carayannis and Turner 2006;
47 Larsen, 2005; Lapointe and Rivard, 2005). However, the majority have explored the
48 effects of management involvement in the process (Panuwatwanich et.al, 2009;
49 Peansupap and Walker, 2006; Lapointe and Rivard, 2005; Dong, 2008; Lyytinen and
50 Rose, 2003).
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52
53 In their study, Sharma & Yetton (2007), established that although training is
54 generally seen as an essential component in the innovation diffusion process, it is
55 really only critical where technical complexity and task interdependence are high;
56 which has the potential to impact on many planning innovation adoption. Freitas,
57 (2008) and Battisti and Iona, (2009), found that firm size had an impact on innovation
58 diffusion; showing that larger firms were more likely to adopt organisational
59 innovations (Freitas, 2008) and use them more intensively, than small, independent
60 firms (Xue et.al, 2008). Armbruster et.al (2008) categorised innovations into
structural – those which change responsibilities, information flow, hierarchical levels

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3 and divisional functions – and procedural – those that affect routines, processes and
4 implement new procedures. This allows for a structure in a monitoring system that is
5 clear what it is measuring, which is further broken down to identify four areas for
6 consideration: i.e. complexity, lifecycle and quality of innovation, along with extent
7 of use.
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10 There are many different stages in the diffusion process, that begin before the
11 decision to adopt, at which point information begins to become available and opinions
12 begin to be shaped (Yu and Tao, 2009); views which change as the stages progress
13 (Larsen, 2005). Observations made by Carayannis and Turner (2006) showed that
14 many of the most successful firms have undertaken what have often been lengthy and
15 expensive pilot studies as the first stage in their diffusion process. The work of
16 Lapointe and Rivard (2005), explored resistance behaviour through diffusion stages;
17 identifying behaviour that escalated from passive individual to actively resistance
18 coalition groups. This has led them, Lapointe and Rivard (2005), and others (Yu and
19 Tao, 2009;) to advise that, at least in the initial stages, that resistance should be looked
20 at on an individual level and their interactions (Wagner et.al) rather than considering
21 the group as a ‘unified entity’ and management responses modified accordingly. The
22 general consensus amongst authors (Panuwatwanich et.al, 2009; Peansupap and
23 Walker, 2006; Lapointe and Rivard, 2005; Dong, 2008; Lyytinen and Rose, 2003), is
24 that top level management visibility is critical to the success of an innovation
25 initiative. Peansupap and Walker (2006) noted how this should manifest at the
26 different stages of diffusion; demonstrating commitment in the early adoptive phase
27 by making resources available, followed by encouraging users through adaptation and
28 routinisation of the innovation into normal working practices and supporting with
29 the appropriate technology and training to develop the necessary skills. Dong (2008)
30 conformed to this view, adding that senior management should be visibly supportive
31 throughout the stages of diffusion and should not assume that staff will be aware of
32 their support, by paying attention to change management and satisfaction of users.
33 This will also include (Lyytinen and Rose, 2003) that management recognise the
34 demands and implications involved the change. Inspiring creativity and challenging
35 staff to promote the development of new ideas was also considered a role of a leader
36 in the diffusion process; a strategy that should lead to a greater propensity for
37 supporting and facilitating the innovation initiative (Panuwatwanich et.al, 2009).
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41 Innovation typology is a widely discussed topic, with many different scales being
42 offered by authors (Garcia and Calantone, 2002). Henderson and Clark’s (1990) four
43 level typology, developed from Abernathy and Clark (1985), was considered to be the
44 appropriate structure in the analysis of the two case studies, which fall at either end of
45 the scale, when related to organisation based innovation. It is considered that the
46 culture for radical innovation differs greatly from that of incremental innovation
47 (Greenwood and Hinings, 1993), and must be considered by managers undertaking
48 innovation projects (Garcia and Calantone, 2002; Oke, 2007). Management style also
49 differs and a thorough understanding of the process must exist in order to make sense
50 of complex and uncertain conditions (Tidd, 2006). With success resting on
51 management creating sufficient level of enabling influence to support the process
52 (Sharma & Yetton, 2003), they must obtain feedback from staff and modify their
53 supportive actions correspondingly (Dong, 2008).
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57 Radical innovation, as seen in Case 1, is disruptive in nature, rendering current
58 equipment and the connected competencies obsolete (Garcia and Calantone, 2002). It
59 is defined as “*change that sweeps away much of a firm’s existing investment in
60 technical skills and knowledge, designs, production technique, plant and equipment*”

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3 (Utterback, 1996) and is characterised by a greater level of risk (Garcia and
4 Calantone, 2002). Although innovation is often associated with radical change (Oke,
5 2007), it was suggested by Morton and Burns (2008) that most successful innovations
6 come from a programme of incremental changes, emanating from efforts of
7 individuals in many areas not confined to research and development. Incremental
8 innovation is based on “*doing what we do, but better*” (Tidd, 2006), refining existing
9 technology and processes, leading to standardisation and a position of status quo in an
10 improved organisation (Garcia and Calantone, 2002).
11

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13 Within any organisational undertaking, there are potential barriers and enablers
14 that come from both the program being pursued and the individuals involved in the
15 process, which is potentially different in every organisation as “*innovation is a*
16 *process which is intrinsically firm specific*” (Coombs and Hull, 1998). Context has
17 been shown to be an important factor in the understanding of innovation and its
18 challenges, as set out by Afuah and Bahram (1995), as the ‘*hypercube of innovation*’.
19 This argues that what is seen as incremental in one context may cause radical
20 consequences in another (Harty, 2008). Issues surrounding fit with the organisational
21 structure and top management level support exist, along with work patterns and
22 availability of resources (Morton and Burns, 2008). Many of these issues can be
23 resolved by the formulation of an innovation strategy (Babbar and Rai, 1990), which
24 should then be communicated throughout the organisation to elicit buy-in (Oke,
25 2007). This has been shown to be important in the field of radical, technology
26 innovation implementations, where more failures result from organisational issues
27 than technical ones (Voss, 1986; Babbar and Rai, 1990; Machuca et.al, 2004).
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30 Human factors play a part in achieving success; barriers to which have been
31 identified at all levels from the individual, and the team, to the organisation as a
32 whole (King, 1990; Kratzer et al., 2005). Organisational culture may have an affect on
33 potential for success. Hill and Jones (2004) explain culture as “*the specific collection*
34 *of values and norms that are shared by people and groups in an organisation and that*
35 *control the way they interact with each other and with stakeholders outside the*
36 *organization*”. In mature organisations these can be deeply embedded and, although
37 they initially brought about success, they can inhibit the capability to embrace new
38 ideas (Dougherty and Cohen, 1995; Leifer et al., 2000). Working within rigid
39 structures potentially has a negative effect on innovation (Amabile et al., 1996), and a
40 lean organisation may not allow for much ‘idea time’ (Anderson and West, 1998).
41 However, innovation can be nurtured by a more caring atmosphere (Kratzer et al.,
42 2005; Zarraga and Bonache, 2005). Initiatives to manage resistance and promote
43 involvement may include a human resource policy (Oke, 2007) and the designation of
44 innovation champions (Rogers, 1995), especially in cases of radical innovation
45 (Garcia and Calantone, 2002). A further, important issue in motivating individuals to
46 engage with the innovation programme is that of the perception of trust, both in
47 management and in their colleagues, the establishment of which will allow the sharing
48 of knowledge and ideas (Morton and Burns, 2008).
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51 As each organisation faces the challenges of new technology, the process they go
52 through is different every time. One potential explanation for this difference is known
53 as Path Dependency (PD). One term that is often associated with PD is ‘*history*
54 *matters*’. Simplistically, this explains that the decisions made, or acts of ‘fate’ that
55 happen at the beginning of a venture have consequences further down the road, which
56 may not be anticipated, and can constrain future activities (Greener, 2005). If the
57 notion of history means that “*What we have today is in part a consequence of what*
58 *we had and what we did yesterday*” (Liebowitz and Margolis, 1995), it also brings to
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3 any new venture the associated '*inherited*' culture and technological skills. In many
4 cases it can be the things that the organisation had little control over that have had an
5 impact, such as external events; these cannot be underestimated in their influence over
6 the process, as it is considered to be dynamic and takes on characteristics of its history
7 (David, 1985), and can remain affected by these events long term (Liebowitz and
8 Margolis, 1990). The concept of path dependency has been related to many areas of
9 study in addition to technical innovation (Patel and Pavitt, 1997; Dobusch, 2007);
10 including economics (Coombs and Hull, 1998; Boas, 2008), finance (Deeg, 2001),
11 social sciences (Greener, 2005), and biology (David, 2001). In searching for a
12 definition of PD, authors have made several observations of the concept; that it is
13 dynamic (Liebowitz and Margolis, 1990), non-reversible and evolutionary (David,
14 2001).

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17 When considering work published on innovation and PD, Coombs and Hull
18 identified three domains in which PD is observed within an organisation, these being
19 '*technology-as-hardware*', '*knowledge base*' or '*shared mental framework of*
20 '*fundamental design concepts*' which can be seen to be connected to the technologies
21 employed, and the '*routines*' that exist to allow workers to perform effectively
22 (Coombs and Hull, 1998). Whilst it is true that often small events are averaged out by
23 history (Schwarz, 2004) this does not always happen (David, 2001), resulting in PD
24 where small, seeming inconsequential or random events at a critical juncture can play
25 a part; in some cases creating disproportionately large and long-lived consequences
26 further down the path (Liebowitz and Margolis, 1995; Deeg, 2001; Schwarz, 2004).
27 Arthur offers examples of these types of events as "*unexpected orders, chance*
28 '*meetings with buyers, managerial whims*" (Arthur, 1989).

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31 The term '*lock-in*' (Greener, 2005; Liebowitz and Margolis, 1995; Deeg, 2001;
32 David, 2001; Arthur, 1989) is often used to describe the process of moving into the
33 reproduction phase of the path (David, 2001), after change has taken place. Within
34 this process the organisation must find ways of sustaining the equilibrium in order to
35 'lock out' competing ideas (Greener, 2005); these mechanisms are central in the
36 concept of PD (Deeg, 2001). This locked-in state can be a positive or negative
37 situation, as firms can also become locked-in to a situation, which is no longer the
38 most efficient solution for them, by factors such as financing, when it is still more
39 cost effective to continue to use inferior equipment than invest in new (Liebowitz and
40 Margolis, 1995).

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43 This paper aims to bring together many areas of innovation research, comparing
44 the barriers to innovation diffusion in companies working on radical and incremental
45 programs, in order to identify where similarities and differences occur and how levels
46 of innovation affect an organisation. It also considers how culture affects success in
47 innovation programs and contemplates these factors in light of the Path Dependency
48 construct.
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51 52 **3. Methodology**

53 For this work to address the issues identified, the case study methodology was chosen.
54 In an era where Open Innovation (Perkmann and Walsh, 2007; Morton and Burns,
55 2008) is encouraged, conducting case studies in collaboration with organisations was
56 the most appropriate research methodology. This approach allowed for the use of
57 multiple data collection methods that created the richest picture possible. It also
58 provides a useful example to others of practical research findings from organisations
59 attempting change over an extended time, something that Yu and Tao (2009) and
60 Armbruster et.al (2008) also found lacking in extant literature; and which forms an

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3 important part of explaining the nature of resistant attitudes and behaviours (Lapointe
4 and Rivard, 2005) and are especially interesting and under reported (Perkmann and
5 Walsh, 2007)

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7 Case studies are used to study complex social phenomena (Yin, 2003) and are a
8 useful tool in studying behaviour in organisations and new or emerging behaviours.
9 They involve research of a real situation (Ritchie and Lewis, 2006), with the
10 behaviour viewed in the context of all the interactions going on around it rather than
11 in isolation (Cassell and Symon, 2004; Rowley, 2002). Qualitative cases seek to find
12 the underlying factors, coming from perceptions and feelings of people as they
13 undergo experiences related to the process, uncovering what lays beneath the
14 objective evidence (Gillham, 2005). Their ability to achieve this comes from the
15 richness of data collected using the various sources of evidence (Rowley, 2002),
16 which can be used to provide description, and generate new, or test existing theory
17 (Eisenhardt, 1989). Based around a set of research questions or hypotheses, a case
18 study is conducted over time (Cassell and Symon, 2004), using varied methods of
19 data collection (Yin, 1981), such as interviews, focus groups and observations, in
20 order to create as full a picture of the situation as possible (Ritchie and Lewis, 2006).
21 This may be enhanced by the use of quantitative methods (Bryman, 1989) in some
22 cases.
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26 The cases introduced in this paper were investigated as part of two larger research
27 projects, but were brought together to show the differences and similarities
28 experienced by organisations innovating in different ways and at different levels. Case
29 1: a large automotive manufacturer that has implemented highly innovative and
30 complex technology and is encouraging staff to embrace it and be innovative in how it
31 can be utilised. Case 2: a large automotive supplier that has undertaken a lengthy
32 program of improvement, and wishes to promote innovative thinking and the
33 acceptance of innovative improvements, put forward by the workforce. During the
34 investigations, semi-structured interviews were conducted giving rise to substantial
35 sources of qualitative data. This data was then coded into themes for further analysis.
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38 Barriers and enablers to the innovation identified within the process at each of the
39 case organisations were represented in visual form using the Force Field Analysis
40 method. Force Field Analysis is a technique that was developed by Kurt Lewin in the
41 1940's (Dezieck, 2003; Dhillon, 2006) and was published in 1951 in the work *Field*
42 *Theory in Social Science* (Lewin, 1951). It is a 'time honoured' qualitative analysis
43 tool (Schwering, 2003), included in many organisational behaviour (Thomas, 1985)
44 and strategic management texts (Elliott et.al., 2001). Primarily utilised to inform the
45 strategy when an organisation wishes to undertake change (Mersha, 1997; Thomas,
46 1985), it is used to identify and evaluate the forces at work (Thakkar et.al., 2006;
47 Schwering, 2003); where a force refers to any factor that has the potential to impact
48 on an organisation, capable of changing its state (Schwering, 2003). Working on the
49 premise that an organisation is in a state of balance (Londeix, 1995) or, as illustrated
50 in, "*quasi-stationary equilibrium between driving (promoting) forces and restraining*
51 *(hindering) forces*" (Oliver and Harrison, 1996), the technique is used to assess how
52 great an affect the forces will have on the change process. The forces that resist
53 change attempt to maintain the status quo (Salaheldin, 2003; Thomas, 1985), but
54 change cannot be enacted without creating this temporary imbalance in the
55 equilibrium (Mersha, 1997).
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59 Strengths of this technique are its ability to create an overall picture of the
60 situation, identifying assets as well as inhibitors (Thakkar et.al., 2006); it clearly
identifies all variables, which allows for an objective evaluation of all aspects of the

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4 planned process (Thomas, 1985). Such an approach offers the potential to ‘*unearth*
5 *fresh options*’ (Jones and Sims, 1993) and not only provides a list of forces for and
6 against, but also can identify individuals and groups that will affect, or be affected by
7 the change, including those not part of the subsystem directly related to the change
8 (Thomas, 1985). Using this technique allows the perception of forces to be quantified
9 in a formalised way, which gives rigour to the decision making process making it
10 transparent and explainable (Swinton, 2007). There are though, identified criticisms
11 of the technique, based primarily on its ability to withstand bias. It can be affected by
12 the experience, personality and style of the analyst (Schwering, 2003). However, this
13 individual bias can be mitigated by performing the technique in a group (Thomas,
14 1985), often in a brainstorming activity (Jones and Sims, 1993).

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16 The process is carried out in a series of steps which begin with identifying the
17 current position of the organisation and the required position after a change would
18 take place (Dezieck, 2003); this information is then used to analyse the forces at play.

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21 Step 1: identify the driving and restraining forces that may affect the change, taking
22 care to look at all aspects including “*intangible or emotional factors*” (Oliver
23 and Harrison, 1996).

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25 Step 2: score each force based on its level of effect, using a rating scale, for example:
26 1 (weak) to 5 (strong), taking account of their limitations and constraints
27 (Thakkar et.al., 2006). Create a Force Field diagram to depict the forces
28 (Schwering, 2003) on either side of a central divide (Dhillon, 2006),
29 assigning representatively sized arrows to driving and restraining in opposing
30 directions (Londeix, 1995; Oliver and Harrison, 1996; Swinton, 2007;
31 Mersha, 1997; Thomas, 1985).

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33 Step 3: total the forces driving and restraining the change to assess the potential
34 success of the planned implementation.

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37 This gives a picture of the current balance and offers the potential to drive the
38 process forward by addressing and prioritising the forces working for and against the
39 change. Where the restraining forces outweigh the drivers making change difficult,
40 the forces should be examined to find ways to lessen their effect.

41
42 During this study factors that influenced the innovation programmes at the case
43 study organisations became clear, from the observations and interviews carried out.
44 Analysis was carried out in brainstorming sessions of involved researchers and results
45 were assessed using the Force Field Analysis technique to gauge the current situation
46 and the potential for success of the enterprise. Scored arrows were allocated based on
47 the frequency issues were raised and the importance that the respondents placed on
48 that factor.

51 52 **4. Results**

53 Case 1 explored an organisation implementing a new advanced manufacturing
54 technology (AMT); known as Rapid manufacturing (RM). An undertaking such as
55 this has been shown in the past to create significant disruption within an organisation
56 and on its individual workers, meaning they must be on-board with the decision to
57 innovate the production process. The implementation had been under way for some
58 time at the point of study but with limited success, making progress slow. Results are
59 shown in Figure 1.
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[insert Figure 1 about here]

As the diagram shows, the barriers significantly outweigh the enablers, going some way to explain the lack of progress. It also illustrates just how much of the innovation depends on the attitudes of the individuals involved. In this case, however, the immaturity of the technology must also be seen as a major obstacle to exploitation.

For the organisation in Case 2, the innovation being considered was based on incremental improvements to the working practices, processes and production facilities; having previously undergone a lengthy period of business improvement to achieve Lean working conditions. In order to be successful, the program relied on the ideas of staff working in the areas of improvement, requiring them to be creative and challenge accepted practices. The results of Case 2 are shown in Figure 2.

[insert Figure 2 about here]

It can be deduced from Figure 2, that the innovation initiative has shown a degree of success, with the support for the process outweighing the resistance. However, in order to optimise the full potential there are still many areas for the organisation to address.

5. Barriers and enablers

Assessing the forces that exist within the two innovation initiatives, it can be seen that there are three types of forces: those that could be generally associated with innovation programmes; ones that are innovation specific; and others that relate directly to the individual organisation and are therefore path dependant.

Comparing the generic forces, it can be seen that there are some that make a significant impact on the success of the venture. It is important that the programme of innovation fits with the existing direction and objectives of the organisation. This can be seen as less aligned in Case 1 than in Case 2, as in recent years the majority of production has been outsourced, thereby building a network of external suppliers rather than increasing capabilities in-house, as would be the expected situation with radical technology implementation. Case 2 has undertaken major reorganisation in order to create a Lean working environment and as such a programme of incremental innovation fits perfectly as an ongoing direction. Strategy is an important factor and for Case 1 the innovation implementation was not planned in advance as an innovation programme. Rather, it was allowed to evolve; resulting in a lack of direction and slow, sporadic progress.

In direct contrast, the programme at Case 2 was carefully considered and planned and has shown a far greater level of success to date. This is also connected to the level of top management support shown, with Case 2 management being firmly committed to a predetermined effort rather than the unstructured, somewhat experimental approach of Case 1. In addition to this support, the nomination of change champions has had an impact on both programmes, a step more usually associated with radical innovation. Proving a significant ally in Case 1, the effects of the change champion may have actually been more fruitful in Case 2, as the individuals not only serve to influence others but in an incremental innovation programme, can begin to make initial changes that can show real results.

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Organisational philosophy plays a big part in the innovation process, especially in long established firms with deeply embedded routines. It also affects individuals who become invested in the status quo and, if not sufficiently convinced of its merits, can see potential innovation as change for change's sake. This is the situation at both of the organisations. At Case 1, where not all individuals can see the point of replacing equipment and processes that work perfectly well in their eyes with a new, unknown system. At Case 2 a similar, if less pronounced situation exists. Having gone through a widespread Lean Manufacturing initiative, some think the processes have already been improved and do not set out to innovate further. In both cases, this situation also links to a phenomenon that can be experienced in any type of change, especially in long established firms with little staff turnover; the legacy of initiatives past.

Both the radical and incremental programmes have come after many past innovations - some successful, some not - which causes individuals to view any new initiative with scepticism. It taints their perception and puts up barriers that have no relation to the current programme and are therefore, difficult to address. In order to counteract this, widespread acceptance of the initiative being pursued is needed. Efforts to create this level of acceptance at Case 1 have included internal 'road-show' events where key members of staff have gained access to information provided by experts in the field. Case 2 has harnessed Visual Management techniques to highlight successes in order to win-over those who are negative or disinterested. It must be recognised that, from both a technical and human resource perspective, that any new innovation initiative will take time to develop and this time must be allocated by management before measures of success are taken.

One issue that affects both the radical and incremental change is the observed changes to the job roles and the level of tasks within them. The forces termed 'blurring of job roles' and 'lack of empowerment' are connected, as one leads to the other. Perhaps by not anticipating the changes to job roles, those in authority have not allowed employees in lower level positions to become empowered to take the lead and, in some ways, to take on tasks from those above. These higher level individuals also feel the change and resist the loss of what they perceive as part of their role, which was previously above those now taking on the tasks.

For radical technology innovation there are several forces that come directly from the nature of the innovation, its potential benefits and the knowledge needed to optimise it. Advantages that come from the technology, helping to drive it forward, include the flexibility of the technology that allows for many different parts to be processed simultaneously without tooling, and leads to the potential for customisation of goods. In-house manufacturing allows for a much shortened supply chain and removes issues of confidentiality that may exist when utilising external suppliers. RM is currently immature when compared to established processing techniques and this brings with it many problems. Not only does it lead to unrepeatability and therefore unreliability, but to resolve these issues requires a level of knowledge that does not currently exist within the organisation and industry as a whole, thus holding back the technology and not just on an individual organisational basis.

The incremental innovation programme at Case 2 has brought about forces that come from the organisation itself, its culture and approach. As a well established firm with low staff turnover and high years of service, staff have become invested in the organisation and care that it is working at its best, both for their pride in the organisation and job security. There is a tremendous feeling of loyalty which is amplified by the work the union representatives do with management to ensure success and a good working environment. One element of the strategy that is proving

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successful is the provision in the working week for idea generation, an idea not common in Lean organisations, with a designated meeting time every week. This shows staff just how important management see the initiative and gives them a forum to put forward their innovations in a supported way. However, in the past, poor communication of the response of management to innovative suggestions has led to individuals becoming disillusioned and, where credit has not been correctly attributed, some have felt aggrieved. The issue of reward has also been discussed, with some feeling the current system inadequate or inappropriate when related to effort; this must be addressed.

6. Radical v incremental innovation

It can be seen that many of the same forces exist in both the radical and incremental innovation programmes. Potential explanation for this relates to the size of the organisation and the ambition of the programme. As both are large and the programmes affect many staff in areas not always directly related to manufacturing, the effects of the initiative are widespread and amplified by the number of staff involved. This is not unexpected with radical innovation as it is anticipated that this will cause technology, knowledge and job roles to change. However, it is less obvious that these effects would be as widespread with incremental change. In light of the similarities experienced, it is thought that a similar management approach would be needed, contrary to suggestions in the literature. Although it can be seen that the management at Case 2 have approached the innovation with much more understanding of what will be required and what can be achieved than Case 1, who appear to have underestimated the extent to which a radical innovation can affect their organisation. In these cases it could be considered that Case 1, as a radical change in a fairly limited context, was a deep change that concentrated a narrow focus on the business, whereas Case 2, was seeking incremental change in a way that affected the whole business and so was a shallow change that had a wide effect on all of the plant, perhaps explaining why many similarities were found.

It has been said that incremental innovations tend to show more successes than radical; which at a similar stage in the two programmes has been shown to be the case. This may, however, be due to the nature of incremental innovation being broken down into stages, each of which in itself can be a success. Whereas, in order for radical innovation to achieve success, all of its elements must come together, meaning that reaching a specific stage in development does not ensure that the overall initiative will not eventually fail.

7. Organisational culture

Extant theory has shown that organisational culture affects the potential for innovation in organisations (Amabile et al., 1996) and that has been seen to be the situation in these cases. Case 1 is a highly bureaucratic structure where staff know their roles and the tasks involved within them, leading to a situation where challenging the status quo has great affect on the individual, leading to resistance. The routines and work practices that are embedded are firmly set and hard to change, especially without the necessary support and influence of committed management. Case 2 has been seen to be a procedural organisation, but one that is open to change, especially having undergone a fundamental program to achieve Lean status. The overall environment is populated by staff who value their job and the role they have in

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3 keeping the organisation successful; they see improving things as part of the norm.
4 Supportive management with a positive industrial relations climate creates an
5 atmosphere that fosters innovation and aims to make every individual feel involved
6 and valued. Although both organisations have seen a level of success, which in part is
7 limited by the type of innovation, it is felt that the differences in organisational culture
8 and attitudes play a significant part.
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11 12 13 **8. Path Dependency**

14 Coombs and Hull (1998) believe that the process of implementing an innovation is
15 firm specific and as such path dependant. This has been shown to the case in each of
16 the case companies of this study, as the trajectory has been different based on the
17 initial conditions found within the organisations.
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19 Path dependency, in its most traditional form, relies on the assumption that small,
20 somewhat insignificant events lead to the large consequences, which shape the
21 direction of an organisation (Schwartz, 2004). Others, such as Deeg (2001) and
22 Liebowitz and Margolis (1995), accept that larger events and purposeful decisions
23 also cause path dependent results and constrain future choices (Teece, et.al, 1997),
24 which is a major constraint on companies' dynamic capabilities. For the case
25 companies this is more likely the situation as, rather than the result of chance, many
26 of the current conditions have come from decisions taken in the past. Case 1 is a long
27 established company that has made its reputation on providing not only luxury but
28 personalisation of their products. The technology is used primarily to tap into the
29 market for customisation and the decision to focus on this marketing strategy makes it
30 an appropriate technology. Other past decisions, such as the choice to outsource the
31 majority of components and establish a tiered supplier network, have set a situation
32 that makes RM implementation more difficult than in other organisations. At Case 2,
33 the culture of long service means that many have been at the organisation through
34 previous failed change initiatives that have affected their perceptions of any potential
35 venture, causing some to be sceptical and detach from the programme.
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38 One area that has proven to be path dependent at the companies is that of routines;
39 the importance of these routines and the role they play in an organisation was noted
40 by Coombs and Hull (1998). These established routines go on to inhibit change as
41 they become ingrained and become the norm after what potentially could be years of
42 optimisation to the current situation (Andreua and Ciborab, 1996). This has been
43 shown to be true at the case organisations, especially Case 1, a highly procedural
44 company, which in itself inhibits change and where even the most basic of updates
45 must go through a formal process that takes weeks and so deters engineers from
46 making changes in all but necessary situations. Engineers and designers have become
47 accustomed to using techniques and materials that they know will work in a certain
48 situation, rather than expanding their options to include new possibilities that may, in
49 fact, meet their needs better. Routines of this kind actually form a barrier to the
50 potential benefits of the innovations being implemented. Case 2, although procedural,
51 has learned through previous initiatives to adapt to change and challenge procedures
52 and set-ups that are not optimal, supported by a union established long ago; these past
53 decisions and events actually aid in the innovation process. However, the formalised
54 structure established at both organisations inhibits change, as staff see their roles as
55 clearly defined and the changes begin to blur those roles, often without sufficient
56 empowerment for them to embrace the added levels of responsibility.
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3 The process of radical innovation at Case 1, when compared to the conditions set
4 out in the theory is undoubtedly path dependant, with many factors that are company
5 specific working against the acceptance of the technology. Case 2 is less pronounced,
6 but still subject to path dependant issues in many parts of the incremental innovation
7 process.
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10 11 **9. Conclusions**

12 This paper provides a contribution to extant literature on the barriers and enablers of
13 innovation at different levels, highlighting the similarities and differences that exist
14 and the effects of company size. It shows that initial perceptions of the terms radical
15 and incremental may not be sufficient to determine the level and types of resistance
16 that may be encountered.
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19 Supporting the work of Coombs and Hull (1998), findings show that much of the
20 implementations have been firm specific; however, there were also generic barriers
21 found that could affect any implementation. The barriers identified within the two
22 case study organisations can be split into; 1) those common to both and therefore may
23 have the potential to affect many organisations; 2) innovation specific forces, that
24 occur as a direct result of the innovation being undertaken, especially prevalent with
25 new technology; and 3) those that are organisation specific, derived from the
26 individual situation and set-up that the organisation is in when it begins the innovation
27 initiative. These organisation specific forces are highly path dependant, based on past
28 events and decisions made, as suggested in the work of Liebowitz and Margolis
29 (1995) and David (1985), who recognised the effects history has on an organisation
30 and its characteristics.
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33 Measuring the success and failure of innovation is difficult (Armbruster et.al
34 2008), especially when comparing radical and incremental programmes. For a radical
35 innovation to be a success, it is essential that all stages are achieved, whereas for
36 incremental innovation every step is a success in itself, which may explain why
37 Morton and Burns (2008) found that incremental innovations are more often
38 successful. Culture also plays a huge part in innovation, as human factors are vital in
39 achieving success (King, 1990; Kratzer et.al., 2005). It has been shown that the more
40 open and supportive an organisation is to innovation and change in general, the
41 greater it's potential for success; in line with the findings of Amabile et.al. (1996) and
42 Zarrage and Bonache (2005). Results also show that those experiencing deeply
43 entrenched routines and attitudes struggle to overcome them and encourage the level
44 of involvement needed, corroborating the outcome of studies from Dougherty and
45 Cohen, (1995) and Liefer et.al. (2000).
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48 Finally, as Garcia and Calantone (2002) and Oke (2007) highlight, it is essential
49 that an organisation understands the type of innovation it is embarking upon and what
50 that potentially may involve, in order that it can plan and manage the initiative
51 successfully. It is possible, however, that the steps involved and management style
52 needed may not actually vary as much between the levels of innovation as would be
53 expected, especially in large firms undertaking company-wide programmes, which
54 forms a significant finding of this work.
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59 **10. Limitations and further work**

60 Case study research has distinct advantages in the depth of knowledge that can be
gained on a specific issue within an organisation; however, the findings are case

specific. Although these findings have been discussed across the cases and certain commonalities found, it does not allow for automatic generalisation across the types of organisation or industries studied. This can only really be assessed with further comparison studies of organisations undertaking innovation at different levels and would benefit from the inclusion of those working at the mid levels of architectural and modular innovations.

Acknowledgements

The support of the Engineering and Physical Sciences Research Council under grant EP/C534239/1 and the Economic and Social Research Council under grant RES331270005 for this work is gratefully acknowledged.

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6 Figure 1. Force Field Analysis diagram of the innovation process at Case 1
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10 Figure 2. Force Field Analysis diagram of the innovation process at Case 2
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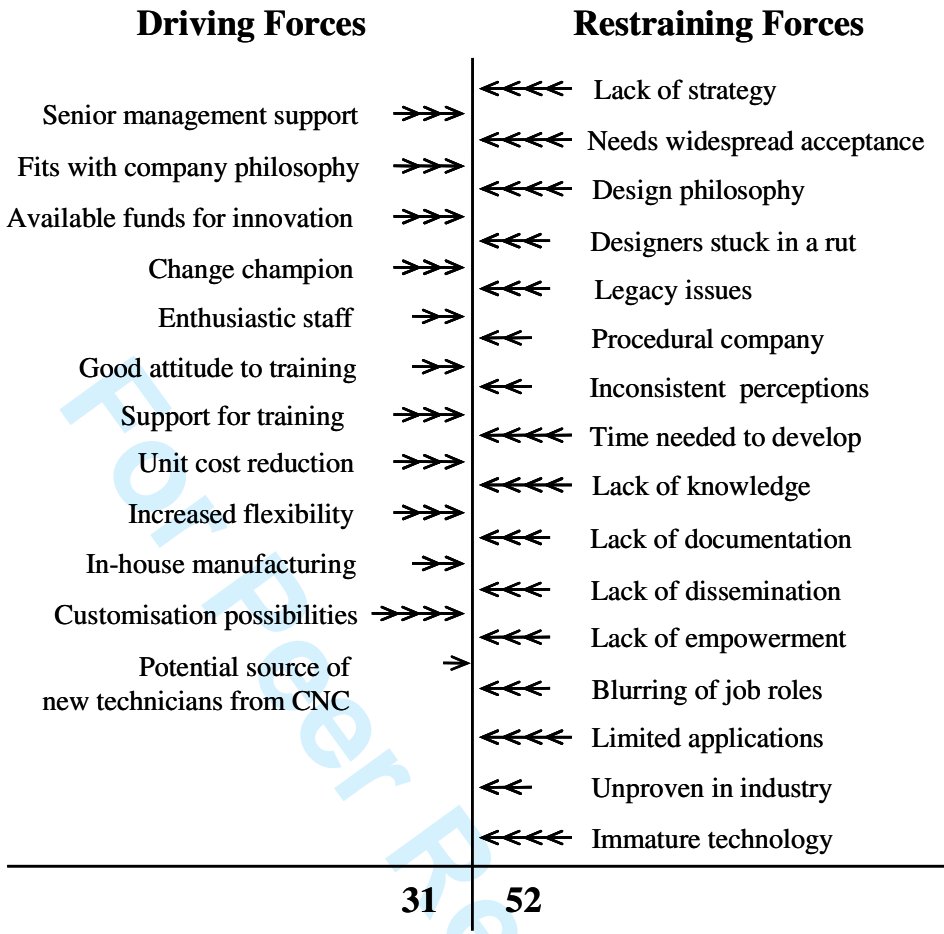


Figure 1

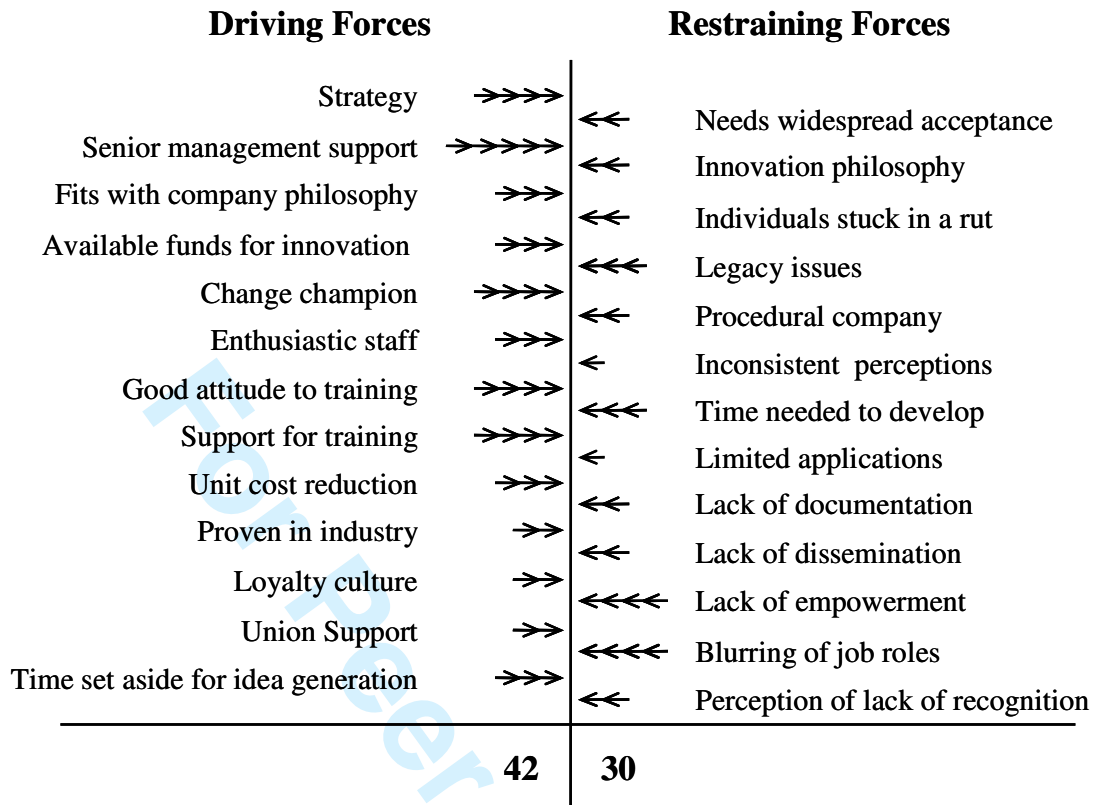


Figure 2