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Aim Fire Aim - Project Management in Dynamic Environments – Planning Styles

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Abstract

Rapidly changing environments are a newly recognized and increasing challenge in the field of project management. Traditional prescriptive approaches, orientated around process control, are considered sub-optimal in meeting this challenge. In this article, the authors present an exploratory theory-building study aiming to identify the project management approaches used by experienced practitioners to respond to rapidly changing environments. The results of thirty-seven semi-structured interviews with thirty-one participants across ten industries (i.e. construction, aerospace, international community development, pharmaceutical, defense, film production, startups, venture capital, research, and information technology) were analyzed according to the planning styles used. Results are discussed in the light of previous research and a model for better management in rapidly changing environments proposed.

Introduction

Dynamism in the project environment is an increasing threat to projects across all industries providing challenges even where complex technology is not an element of the core business (CSIRO, 2007; Dodgson, 2004; Gareth R Jones, 2004; Perrino & Tipping, 1991; Rothwell & Zegveld, 1985; Sugden, 2001). Traditional prescriptive approaches, orientated around process control, are considered sub-optimal in meeting this challenge (Ashton, Johnson, & Cook, 1990; Koskela & Howell, 2002; Sachs & Meditz, 1979, p. 1081; Sugden, 2001; Williams, 2004). In this article, the term 'dynamism' is used to refer to rapid change in the project management context. It is acknowledged that dynamism is a linear dimension, and just one of many project dimensions that may be taken into account when selecting the project management approach for a project. The needs of other dimensions may outweigh those of dynamism. Previous research suggested that the causes of change can be organized into three broad categories (Collyer & Warren, 2009)

- Change in materials, resources, tools and techniques
- Changing relationships with other related projects, services or products
- Changing goals due to changes in what is possible, changes in competition, or changes in the general business environment, such as government policy

Examples of problems caused by project dynamism include: (a) difficulty planning, (b) short timeframes, (c) high levels of interdependence between projects, (d) high levels of customization, (e) planning for uncertain outcomes, (f) balancing flexibility with reliability and accountability, (g) balancing decision quality against decision speed, and (h) timing scope freeze during rapid change (Collyer & Warren, 2009).

To date, the challenge faced by projects conducted in dynamic and uncertain environments is a key unresolved project management issue (Collyer & Warren, 2009; Gray & Larson, 2003). In recognition of this, Collyer and Warren (2009) reviewed the literature on project dynamism and approaches for managing it, and provided a fuller explanation of change causes and approaches for managing rapid change (see Collyer and Warren, 2009 for a full revision of the research surrounding each approach):

- Environmental manipulation (Make Static) is about resisting change in the project and the industry generally to better allow traditional waterfall style detailed planning (Collyer & Warren, 2009). This involves active efforts to reduce the amount of dynamism in the general project environment.

- Emergent planning informed with feedback. This may also be known as rolling wave or iterative (Collyer & Warren, 2009). This approach involves starting with a high level framework plan and then filling the details in as they are made available. The details can be obtained through the use of testing, prototyping, pilots and parallel experiments. The *PMBOK® Guide*—Fourth Edition does recognize the need for emergent planning in its description of "What Is Project Management" (PMI, 2008, p. 7). It cautions that many of the processes are iterative and make used of progressive elaboration. The more that is learnt about a project the greater the level of detail with which it can be managed. The fourth edition (PMI, 2008) uses the word 'iterative' thirteen times, 'prototype' twelve times, but 'emergent, 'pilot', 'experiment', 'staged', 'freeze' are not defined or explained. The use of 'prototype' is up from five mentions in the third edition (PMI, 2004).

  In a non-participant example, the head of Intel, Andy Grove, advised that "the biggest failures that you may encounter is not that your plan fails but you fail to depart from that plan" (Grove & Ellis, 2001). While useful as a guide, excessive detail in the early stages of a project may be problematic and misleading in a dynamic environment (Collyer & Warren, 2009) and counter-productive to maintain. Grove & Ellis (2001) had previously advised that "plans are highly overrated" and that "plans are a baseline, in my opinion; a model of a life that you depart from as you go on" (Grove & Ellis, 2001).
- Staged releases with the smallest possible scope in Stage One to reduce risk and allow proof of concept (Collyer & Warren, 2009). This approach involves releasing smaller pilot and production versions to the market to test and secure feedback before adding functionality or more capable versions. This scope reduction approach makes the first stage as small as possible in order to quickly obtain feedback that will allow the work to be brought in line with reality more rapidly.

Insert figure 3 about here

- Competing experiments to more quickly identify the optimal approach (Collyer & Warren, 2009). This is controlled experimentation.

Insert Figure 1 about here

- Alternate controls to detailed process controls that assume a predictable environment. Greater focus on input and output controls such as team selection and clear goals and reward (Collyer & Warren, 2009). In this article c*ontrol* refers to how resources are managed to achieve objectives (Ouchi, 1979, p. 833), as opposed to the technique discussed in the *PMBOK® Guide—Fourth*

Edition (PMI, 2008, p. 430). There is increasing evidence to suggest that shifting the control approach from process control to other approaches could be of benefit in dynamic environments (Collyer & Warren, 2009). Traditional project management has focused on formal process control, making used of detailed plans, but dynamic environments may benefit more from complementing formal with informal forms of control (Collyer & Warren, 2009; Kirsch, 1997; Susilo, Heales, & Rohde, 2007; Williams, 2005).

A project illustrative of those challenged by rapid change, was the Australian submarine project which in the 1990's grappled with advances in weapons system technology over its lifespan (McIntosh & Prescott, 1999). Similarly, the Iridium satellite project's goals were made redundant by rapid developments in terrestrial cell phone networks, despite its success from a time/cost/quality point of view (Highsmith, 2004). The same challenges apply to the smallest businesses projects conducted in rapidly changing environments.

The Project Management Body of Knowledge (PMI, 2004) focuses on process control as opposed to other forms of control, and does not specifically deal with the challenge of dynamism (Williams, 2005). Change control as described by the PMBOK® Guide—Fourth Edition (PMI, 2008) is a detailed and bureaucratic process that does not include strategies specifically for keeping pace with rapid change.

- Suitable culture, communication and leadership styles such as collaborative leadership with a greater focus on informal communication and rapid decision making (Collyer & Warren, 2009).

Despite support for a range of project management approaches most suited to dynamic environments in the literature, to date there is little information available as to how practitioners implement these approaches in practice. Dynamic capability is a term discussed in organisational literature and is generally agreed to mean an organisation's ability to adapt resources or activities to match environmental change (Ambrosini & Bowman, 2009). The actual capabilities presented are so far in this field are largely illustrative examples unsupported by empirical studies or applied to project management specifically (Govind Menon, 2008; Pablo, Reay, Dewald, & Casebeer, 2007) . Capabilities are argued by various researchers to include R&D acquisitions, alliances and product innovation, absorptive capacity , organizational structure reconfiguration and resource divestment (Ambrosini & Bowman, 2009). While there is certainly overlap with that area of research this study focuses primarily on project management.

The aims of this research were to (a) determine what project managers perceive to cause dynamism in their projects,(b) identify whether, how, and why experienced managers across a range of industries encountering dynamic environments use five of the approaches proposed by Collyer and Warren (Collyer & Warren, 2009) (c) determine in which contexts project managers perceive five previously proposed project management planning approaches to be effective in practice when dealing with dynamic projects, and (d) identify new practical coping strategies employed in dynamic environments specifically to achieve management optimization in those environments.

This study is part of a larger research project aiming to develop theory on how to better manage the dimension of dynamism in project management. This study focuses only on the five planning approaches (resisting change, scope reduction, emergent planning, competing experiments, and alternate controls) while the larger study includes an analysis of culture, communication, and leadership style and new strategies suggested by participants, to build a grounded theory on the subject. Findings from the larger study are reported elsewhere (Authors-de-identified, 2009).

Method

Research Design

A qualitative research design based upon grounded theory methodology was selected as most suitable for addressing the aims of this research for three primary reasons: (1) dynamism in project management is an area about which little is known, (2) the researchers were seeking an in-depth understanding on the perspectives of project managers in actual environments, and qualitative research methods are most suited to understanding the complexity of human behavior and perceptions in naturalistic environments (Denzin & Lincoln, 1995) and (3) it was important that the findings contributed to an emerging theory that was built from within the data rather than reflect previously held positions or theories that historically have not considered the impact of change.

Participants

The researchers used purposive and theoretical sampling to recruit 31 project managers to participate in the study. In total, 37 interviews were conducted with practitioners in organizations from ten different industries. Purposeful sampling was employed to identify participants who were senior practitioners or process designers with at least ten years experience from organizations that had been operating for at least ten years, with the exception of the two start-up companies targeted for their particular exposure to rapid change. This criteria was employed as a means to minimize collection of

novice or less proven strategies. Only participants who perceived they were significantly challenged by the dimension of dynamism were included in the study. Participants' label, description, and role are presented in Table 1. One participant, Const1, was identified through theoretical sampling to inform the study because the participant reported that the company was using essentially the same techniques on their projects over the last 100 years. The spread of participants across diverse industries ensured that a broad range of approaches to managing dynamic environments were explored, and commonalities identified.

Insert Table 1 about here

Data Collection Procedure

In keeping with grounded theory methodology, information was gathered from a variety of sources to triangulate findings and to inform the developing theory on project dynamism (Singleton & Straights, 2005). This study involved in-depth interviews (face to face, telephone and email exchange included), and a document review (of publicly available documents on companies represented by participants). The first author also made field notes on the data throughout the entire period of data collection that were included in the analysis and synthesis of results.

Interviews. The first author conducted in-depth, semi-structured interviews to explore, clarify, and confirm participants' views on challenges and strategies (Creswell, 2003; Flick, 2006). This interview type allowed the participants to elaborate on their understanding of the issues and explore their understanding of the problem and the relevance of strategies used in addressing change in project management environments. Each interview began with an open question "what do you think are the causes of dynamism in your industry, and the project management challenges created in managing this dynamism?." Participants were asked to illustrate their responses with indicative, pertinent examples. In the interviews, participants were asked to discuss ways their experiences of previously document causes of change, and theoretical methods for managing change. Participants were also asked about forms of management control they used to align work with an objective, and to identify other approaches that they believe have been useful for dealing with rapid change in their project environments.

Twenty-two of the semi-structured interviews were conducted face-to-face with participants, allowing for immediate clarification and exploration by the researcher; a further fourteen interviews were conducted in written form by email exchange of the researcher with the participant. One

interview was done via telephone. This enabled researchers to include project managers who were geographically distant or time poor and otherwise unable to attend for a face-to-face interview. Following analysis of the interviews, six of the participants were interviewed a second, to verify and expand upon their responses and to confirm or clarify the researcher's interpretations of the data. The face to face interviews generally allowed more in depth exploration of the issues.

Document Search

A background document search was conducted on each participant's company to investigate project management approaches described in publicly available documents.

Field Notes

Field notes were made during and after interviews and interpretations were used to guide subsequent interviews and formed the basis of discussions between researchers.

Transcription of the Interviews

All digitally recorded interviews were transcribed verbatim and all written responses were transferred into Word documents and de-identified. In all interview transcripts participant names and company names and any information that might potentially identify participants was deleted or replaced with general descriptors (e.g. city, company, director).

Data Analysis

Interview transcripts and field notes were analyzed as data collection progressed. This constant comparison involved continuously drawing interpretations and refining concepts from one participant to the next (Creswell, 2003; Taylor & Bogdan, 1998; Yin, 2003). The constant comparative thematic analysis of interview data facilitated the analysis across multiple participants and enabled comparison across industries. Transcripts were read and re-read for content themes according to the research questions. Researchers discussed the data to identify content themes, explore any possible alternative interpretations of the data, to arrive at a consensus on the findings (Flick, 2006). Interview transcripts were coded according to the content themes that were then organized into broader categories of meaning as they emerged (Creswell, 2003). The unit of analysis is the project management approach used by organizations conducting project management in dynamic environments.

Verifying and Confirming Interpretations from the Data.

Participants were sent written summaries of their interview with an invitation to amend or add to the information. This procedure enabled the researchers to verify that their identification of themes was an accurate representation of the participants intended meaning (Creswell, 2003).

Results and Discussion

This article investigates the first five approaches listed above. Of the five, four were supported and clarified. The resist-change approach was considered more appropriate for static environments. Most participants reported that their organization needed to embrace dynamism in order to remain viable. Each of the approaches along with the clarifications are presented and discussed herein. Change drivers identified by the participants included competition, the market including customer requirements, and technology with its effect on tools and materials.

Change Causes

Changing materials, resources, tools and techniques

Research1 reported a complete environmental turnover every 6-10 years and how the unpredictability of their materials or resources made planning extremely difficult. Start-up1 reported "we have no option but to change the material, and we are inventing techniques as we go." The information technology participants highlighted how popular software products are updated and change characteristics on an almost weekly basis. By comparison concrete has been in use for hundreds of years, and its properties are well understood and predictable.

Traditional approaches to project management planning use progressive elaboration to break complex goals into smaller components. If the properties of the materials change on a weekly basis the process can become counter productive (Collyer & Warren, 2009). ITSVC2 described how "the size of the learning curve is not predictable; expertise is 'lumpy' which creates resourcing/scheduling issues; Testing of all aspects of new technology is difficult and time consuming." Start-up2 reported "we are leading the way in a new industry. There are many unknowns. Essentially we don't know what's down there until we get in and do it*."*

Changing relationships with other related projects, services or products

Managing multiple interdependent dynamic projects could amplify the planning problem for each project significantly. A change in one project can create a change in another. Rapid changes in all projects make prediction difficult. ITSVC2 cited high levels of system interdependence. The interrelationships were so complicated that representations were considered to be almost as complex

as the product systems, and just as time consuming to maintain. The construction counter-example related how a construction project may relate to others in terms of basic utility connections, access, shade, height etc but once the connections are planned they remain relatively static. The ITSVC participants highlighted how they have to run IT project to replace a running service with ones still being written by a vendor, interacting with several other services that are also changing. Detailed planning in these circumstances seemed to be a significant challenge.

Changing goals

An example of changing goals was given by Film2 who reported that "film making is such a fickle business, because it's partly determined by the whim of the broadcasters and what they might have determined they need for a particular year." Film3 lamented significant changes in government policy that affected investment. DefSvc1 summarized the impact of competition on goals by saying "the enemy is constantly trying to figure out what your intent is and seeking to undermine it." ITSVC3 reported how "in volatile environments such as the current global economic crisis, business strategies often change quickly in order to meet the market conditions at the time."

These results provide insight into how practitioners perceive the causes of change and believe it is necessary for projects to respond and adapt to these causes and embrace rapid change in some project environments (CSIRO, 2007; Dodgson, 2004; Gareth R. Jones, 2004; Perrino & Tipping, 1991, p. 87; Rothwell & Zegveld, 1985; Sugden, 2001).

Strategies to Optimize Planning in Dynamic Environments

In the following section, results related to planning approaches for managing the dimension of dynamism (Collyer & Warren, 2009) are presented. Approaches included: make static; emergent planning; staged releases – scope reduction; competing experiments; alternate controls.

1. Make Static Approach

One approach to dealing with rapid change in the project environment is to attempt to make it static and shield the project from environmental impacts(Collyer & Warren, 2009). Study participants were asked to comment on and provide examples of this approach. Two participants provided support for this strategy as being effective in their environment. Const1 described why they resisted change vigorously and said "change leads to chaos. There should be order and discipline." Similarly, Aid1 indicated this approach, although suboptimal, was entrenched in the organization, as "the large

bureaucratic structure tends to view enacting process as the way to mitigate risk on projects as opposed to relying on people to mitigate risk (i.e. recruitment of expert managers)."

All other participants did not support the 'make static' approach and indicated a preference for strategies that actively embraced changes more rapidly in the project in response to changes in the project environment. These participants generally argued the 'make static approach' would be counter productive, and that embracing change was necessary for the survival of the organization and for the success of the project. Participants argued some forces could not be contained by the 'make static' approach. For example Defsvc1 illustrated the impact of competition in mitigating any efforts to maintain a static environment. The participant described how despite high levels of planning, in the battlefield environment "plans only survive the first shot." Pharm2, Const2 and ITsvc3 all argued that the organization's very existence was dependent on them adjusting projects to suit a dynamic market. Film3 reported that production would not work if they did not make many changes due to the sheer number of factors that can not be determined until filming commences. The venture capital participant reported "we have to be responsive to the external environment at all times. This includes both the technology environment and the investment environment."

Both defense service participants related how their organizations had been forced over decades to change strategy from resisting change to embracing it. They offered examples of how the resistance to changing materials had been used in the past to maximize the reliability and predictability on its endeavors. For example, the main battle rifle remained static for two decades thereby helping achieve reliable storage, maintenance, distribution, and training processes. Since then, the services have been forced to embrace higher rates of change in order to stay competitive, and the average soldier now carries $20,000 worth of high technology into campaigns (including night vision and laser targeting scopes). The loss of precise control, reliability and predictability that came from embracing rapid change was considered a more fruitful strategy than the loss of the competitive edge that came from resisting it. Adaptability is regarded to be the key capability in a dynamic environment.

In summary, all but two of the participants reported they must embrace the rapid change for survival in the industry. For these participants it was more effective to employ strategies that quickly and efficiently embrace change in the project environment rather than resist or precisely controlling the changes. This conclusion is consistent with previous discourse that changes can occur at rates

that make traditional change management a disadvantage (Ashton, et al., 1990; Sachs & Meditz, 1979, p. 1081; Sugden, 2001; Williams, 2004).

2. Emergent Planning Approach

The strategy 'emergent planning' was strongly supported across the interviews with all but one participant giving detailed examples of its use. Indeed, when considering all of the strategies discussed, emergent planning attracted the greatest consensus across participants in the group who claimed to be challenged by dynamism. For example, ITSVC1 reported: "I like to lay out the major phases / deliverables / milestones at the outset, but only plan the detail for the phase I'm about to start." Ventcap1 related how "while an overall plan was in place to start with, the individual stages are often revised." Contrasting one of the construction participants with the defense participants regarding safety may illuminate a key factor in deciding whether to embrace or resist. For each one the embrace-change strategy carried very high risks, but for the defense case the risks of resisting change were even higher. The defense participants reported that embracing and adapting to change on a battlefield reduced overall risk. They therefore employed rapid adaptation principles such as delegated control, and management by objective. For the construction participants, embracing change increased financial and physical security risk while providing little advantage of any kind. This led them to adopt principles that resisted change, such as strict centralized control implemented against detailed static plans. In the construction example, the planner described how they strongly resisted change unless it was necessary to bring work back in line with the plan. The construction planning engineer said: "If an order is wrong it's better to follow that order to avoid chaos." It may be that the construction industry achieves its safety and financial imperatives adequately through strict management of and resistance to change. Indeed, this may also be possible in an industry where there are relatively slow rates of change in tools and techniques, offering little advantage to those who embrace them in the course of a project. Where the benefits of embracing change do not outweigh the benefits of making static the preference in some industries may be to maintain order and make static in order to obtain other benefits such as financial predictability and safety.

In emergent planning time is of the essence. DefSvc1 paraphrased a WW2 General Patton saying "a reasonable plan executed quickly is better than a perfect plan hatched in a prison camp." The participant also referred to Prussian General Karl von Clausewitz, who said "the greatest enemy of a good plan is the dream of a perfect plan" (Clausewitz, 1873) to illustrate

how in a dynamic environment excessive expenditure attempting a flawless/riskless plan overlooks the much larger risk of failing to capitalize on limited windows of opportunity.

Given the high levels of support for emergent planning in this study, a useful approach for project management in these environments may include (a) planning detail should be proportional to the accuracy of the information and (b) planning to gather the missing information more quickly than the environment will change. A detailed up-front plan in a dynamic environment may mislead the sponsor, while a high level framework plan (Turner & Cochrane, 1993) with detail completed in rolling waves will be more realistic and easier to adapt and manipulate. In summary, emergent planning seems to be the most fundamental approach for dynamic environments and this has implications for predictability in terms of budgeting, resource planning and strategy.

The green power generation start-up participant revealed some of the challenges with emergent planning when a participant said:

> Earlier stages do inform later stages but in more of an informal, unplanned way …Running a pilot is fundamental to the business plan. It's a proof of concept. The business plan is set up to deal with this uncertainty. Some people would like to reduce overlap between stages and do things more sequentially to reduce the variability in the planning. For instance its hard to finalize the design of the power station without well outputs, which depend on the results of the subsurface work. The solution we are trying to work with is to design scalability/adjustability in subsequent stages (e.g. power generator) to allow them to adapt to the results of the early stages as they become known [Start-up1].

Start-up1 went on to describe how they used this approach by defining the major deliverables and then tackling one milestone after another using a rolling wave. ITSVC3 described how they use this approach and how there was no alternative:

> I have experienced this during a global rollout of a new DHCP and DNS infrastructure for a major global investment bank. Essentially, it involved replacing a legacy non dynamic DHCP global infrastructure with a new dynamic infrastructure. The impact of this was replacing approximately 700,000 IP addresses globally. Prior to deployment a significant amount of testing was completed and it was believed that a full understanding of the full impact on equipment and applications was obtained. However during implementation it became clear that there were many regional based applications and environments that were impacted differently.

> As a result the rollout was completed country by country and data was gathered after every implementation in order to prepare for the next. It is not an ideal way to complete a project, however in some environments it is not practical to complete in other ways. [ITSVC3]

Every participant was able to give an example of emergent planning techniques including prototypes, pilots and experiments. For example Film3 described how the developers of "Who Wants To Be A Millionaire", is syndicated in 100 countries and was piloted seven times before being released. Even Const1 even provided examples of how the results of the first tunnel construction project significantly altered plans for subsequent tunnels.

The ITsvc2 approach of a framework plan followed by rolling wave is an example of the approach advocated by Turner and Cochrane (1993). Similarly, Boehm and Seewaldt (1984) compared the effectiveness of specifying and prototyping and found that prototyping was nearly twice as efficient although less robust. A conceptual framework for emergent planning in a dynamic environment was formulated:

- Start with a high level framework plan
- Gather details for components that are likely to remain static and independent of dynamic components.
- Start resolving details for dynamic items early with late design freeze, using:
  - Recursive design cycles, for example film scripts.
  - Tests or experiments
  - Prototypes, if affordable, for example story boards.
  - Pilot of prototype, to gather data from real users

A synthesis of these approaches is contained in Table 3. A military metaphor proposed by one of the participants is used to help illustrate (Carpenter, 2008).

3. Staged Releases Approach – Scope Reduction

Pharm2 reported how they initially brought drugs to market with only their 'lead indicators' developed, and later developed the drug to its full potential. Start-up1 reported how they were initially developing their hydrogen storage technology only for the industrial market, with a view to expanding applications if that was proven. Const1, ITSvc1, Start-up1, and Start-up2 also gave good examples of this approach. Start-up2 tested its new power generation process on a very small scale initially to provide power for a small town, before exploring the potential to power an entire state. An anecdotal

example provided by Pharm1 was how Rituximab, (developed by Biogen Idec and Genentech) was initially developed to treat one type of cancer patient group and when that proved successful it was expanded to treat others and later arthritis.

In dynamic environments projects can be challenged by short material lifecycles, changing goals. Not only are larger projects more likely to fail (Jones, 2003; Standish-Group, 1994) but the longer a project takes the more likely the end result will not match a changing environment (goals) and changing materials (inputs). In dynamic environments this can be mitigated by reducing project delivery. It is proposed that it be achieved in the following way:

a) A minimal scope Stage One is delivered to obtain real world feedback as quickly as possible. The objective is to minimize effort on unsuitable approaches and to reduce the amount of time the environment has to diverge from the plan. Advantage may also be gained from using a project delivery timeframe that is compatible with component and product lifecycles. In dynamic environments this can be achieved by scope reduction, fast tracking, staging etc.
b) Real world feedback is obtained on the performance of the product. This is particularly useful when the tools and techniques might be poorly understood at the start of the project (Collyer & Warren, 2009). For example a budding author might be advised to try their hand at magazine articles before investing years writing a novel, only to find their style needed major improvement.
c) Subsequent stages are customized to better suit the actual environment at the time the each stage is delivered, adapting to the likely changes along the way (Collyer & Warren, 2009). To use a military analogy “aim fire aim” not “aim fire.”

4. Competing Experiments Approach

The participants reported examples of this approach in use. Film2 reported:

I’ve got at least five projects out and about in the market place, with different producers and different people, at different stages of consideration and its exactly that multi layered approach that’s enabled me to survive. On average, for instance, a documentary maker estimated that one in twenty experiments turn out, and I would say, from my own experience, that that figure is accurate…..in the film business it is an essential survival mechanism as the industry is both fickle and intensely competitive.

Film3 reported “We have got at the moment about 21 film scripts in development, and we are aiming to make two or three a year.” The venture capitalist, VentCap1, reported how they initiate multiple endeavors accepting higher risk in the early stages, expecting that some will be “killed off”, and their resources redirected. Space1 reported that parallel experiments were “fairly common” and believed that “cancellations are good and healthy” because it was better to cancel during concept phase when projects are competing against other projects.

Const2 related how during the construction of an airport runway they actually built several different experimental designs to see which would work best. As a result they won the bid and saved 9 months on the schedule.” The Pharm1 participant reported how scientific process taught them how unsuccessful experiments can teach as much as successful ones.” Conversely Const1 reported they were not using experiments for reasons of cost. Start-up2 said they were collecting data through staging independent self sustaining pilots. Each version of the pilot justified itself based on revenue generated by that pilot.

To give some examples from outside the participant group:

- When IBM discovered that it was falling behind in the microcomputer market it launched secret research teams who competed against each other” (Lambert, 2009). The most successful approach was taken to fruition and changed the computer industry forever.
- When NASA was developing the decent engine for the lunar module on the Apollo program it was unsure of the design of the lunar module itself, and so it initiated two competing endeavors for the motor. After some years it decided on the one that proved most appropriate for the final module design (Pich, Loch, & De Meyer, 2002).
- Sobek (Sobek II, Ward, & Liker, 1999, p. 75) related how car manufacturers develop a number of prototypes in parallel, choosing the ones that give the best market reaction.
- Film directors shoot multiple endings choosing the one that receives the best reaction from the test audience.
- While making the movie *Star Wars Episode I: The Phantom Menace*, director George Lucas discovered that one of the robot characters was malfunctioning. To mitigate the high production costs of a delay he commissioned competing teams on the other side of the world to develop a more reliable design and fly in for a decision before recommencing shooting only a few days later (Lucas, 1999).

While there may be an additional cost to duplicate effort in parallel experiments, the results of this study indicate that the approach offers a number of advantages in environments with significant unknowns and variability:

- *Potential quality improvements*: Where the correct approach is unclear, it can be used to discover the approach most likely to achieve the project's objectives.
- *Potential time savings*: In a dynamic environment it is important to deliver value relevant to the environment before it significantly changes, so by testing approaches in parallel the project may be more likely to come up with something that delivers relevant value before too much change or expenditure occurs. It also allows direct comparison between mutually exclusive options.
- *Potential cost savings*: In a dynamic environment parallel experiments may help identify the most effective approach before too much money is committed. The other advantage may be in resource management, as a means to maximize resource usage by keeping the pipeline full. For instance as Film2 advised "if you have two or three things on, and one is pushed back to next year, you take another project and work out what you can do to accelerate it to this year."

In a dynamic environment, parallel experiments allows direct comparison of alternative approaches. Each approach may be adequate for the task, but parallel experiments allow the most advantageous one to be identified quickly and dead- ends removed before too much effort is expended. It can take courage to cancel endeavors before they are complete but this does allow resources to be redirected in a way that maximizes overall productivity. This would suggest an organization with a reasonable project cancellation rate may be healthier than one with no cancellations, or at least claims to have none. Ventcap1 gives an extreme example of this saying "venture capital comes with an understanding that there will be an acceptable failure and attrition rate; the flipside being that the less common successes are usually higher reward." This may therefore require a redefinition of what constitutes a project failure. If a project is cancelled when it becomes irrevocably incompatible with a changed environment, as will often happen, it should be considered a success. Additionally when a project investigates the potential of a first-of-breed concept and rules it out, that also should be considered a success. The guiding rule would be that the anticipated benefits from the successes should outweigh the efforts required to test and select. This is essentially the

same principle applied to organizations that expend effort on bids for work. Experimentation is not a dirty word, but rather it's the denial of experimentation or mismanagement of it that causes problems in increasingly dynamic environments.

5. Alternate Controls Approach

Two examples of control approaches used in project management are input control which seeks to regulate resources made available to the project, and output control which regulates project deliverables. An example of input control is provided by one of the start-ups which was having trouble controlling the technology development process and decided to recruit from around the world the best subject matter expert they could find. It was difficult however as it was relatively new territory with an almost non existent pool of people to recruit from. DefSvc2 reported how they "pre-empted the battle with lots of research and training", another example of leaning more on input control to make up for the impracticalities of process control in dynamic environments.

Some practical examples of output control were identified by four participants. Const1 related how project staff were rewarded with a significant bonus when the project was ahead of schedule. Start-up1 reported that staff performance measurement was a big challenge since they could not check off steps they need to complete as they were working out what the steps were as they went along. They decided instead to measure performance by milestone achievement as opposed to checklist/plan/task achievement. This gave their experts the freedom to be creative and to optimize application of their expertise within those goals. Start-up1 described how they motivate staff with "an employee option plan, where everyone in the company is a participant where they get granted options linked to a future liquidity event." They hoped this provided motivation for staff to apply themselves in the way they see best fits this goal as they are subject matter experts beyond what our managers can be." Pharm1 reported that it was difficult to use incentives in the drug development world because the process requires a large number of people over a number of years, and parts of the process were quite formal and structured due to regulation. Pharm2 related how they used teamed output and boundary control to great effect: 'if you are delivering it did not matter how you did it, as long as you adhered to regulatory framework from the government."

DefSvc2 reported how they took advantage of one of the most powerful forms of output control, that of survival, to motivate soldiers to come up with the right tactics. They reported that in training there was a greater emphasis on on-the-spot problem solving, in order to deal with

unpredictability's on campaigns, rather than just doing what you are told. In fact they "promote belief in gut feeling and intuition, as long as they understand at a high level what the commander wants to do, then they get about their task." So they provide clear success indicators to measure goal achievement:

> "in the orders they specifically say what constitutes success, for example, at the end of this operation I will have destroyed 30% of the armored force, so everyone is clear whether its been successful or not, and work out alternate methods to achieve that." Interestingly Pharm2 they believed the appointment of a CEO who was an advocate of tight process control, eventually caused their slide in stock prices.

A synthesized theory for control approaches in dynamic environments is therefore proposed as follows:

- For process control rely more on a framework plan with milestones and goals than fine detail. Add detail for high risk or predictable components.
- Place greater reliance on input control, interactive control, boundary control, and output control (Vroom, 1964).

Implications of the Results for Developing Theory on Project Dynamism

Some project management practitioners focus on embracing change as rapidly as possible. It is proposed that a project manager's willingness to embrace change is proportional to the advantage/risk trade off of doing so. This trade-off may for example be proportional to the maturity of the technologies used. This may be why construction gains relatively smaller advantages from change, compared to the information technology sector which gains large advantages for a lower risk. For instance in construction the risk of public harm has driven a highly regulated environment that may stifle innovation and change. The slower pace of the market and the smaller rewards for innovation may be why the construction participants considered resisting change to be a lower risk strategy than embracing it.

As traditionally stable industries increasingly embrace high technology they may benefit from management approaches that more rapidly adapt to change. For instance in the defense forces the risk of harm from change is probably even higher than in construction, but risk from not adapting to change is considered to be even higher. In technology the risk of public harm is small, and the advantage gained great. When deciding to what extent to embrace or resist

dynamism a practitioner can consider the advantages from leveraging the changes in terms of functionality, competitive position, and future compatibility versus the disadvantageous impacts on management predictability, safety, financial risk, flow on impacts and additional management required. As outlined in table 2, ultimately it is the risk of embracing change that must be balanced against the risk of resisting it, and as high technology spreads to traditionally static industries, the risk of resisting change may appears to be increasing.

The results in this article are synthesized into a theoretical framework describing approaches used by practitioners to manage the dimension of dynamism on their projects.

The framework outlined in Table 3 consists of the following principles:

- Consider the project type and the relative strengths of each dimension before deciding the project management approach. Project environment dynamism is just one of many dimensions and may not be the most important.
- Consider whether it is possible to achieve a greater net benefit from a make-static approach wherever possible. Consider the Table 2 model.

Insert Table 2 about here

- To manage the dimension of dynamism:
  - Commence with clearly stated objectives, expanded into a basic high level framework plan made of milestones and phases.
  - Make the project delivery timeframe compatible with component product lifecycles. Identify and plan for the minimum possible scope that can be delivered initially as an independent product/service for phase one, thereby allowing real world feedback early enough to facilitate adaption to environmental changes as per figure 2.

Insert Figure 2 about here

  - Treat the planning for static and dynamic components differently:
    - Gather details for static components in more detail expecting fewer design cycles.
    - Start resolving details for dynamic items early with a late design freeze, using:
      - Recursive design cycles e.g. Film scripts
      - Tests or experiments
      - Prototypes, if affordable. E.g. story boards.
      - Pilot of prototype, to gather data from end users

    - Parallel experiments where the cost of delay may exceed the cost of effort duplication.

- For project control rely more on a framework plan with milestones and clear goals than fine detailed planning. Add detail for high risk or static components.
- Exchange some level of 'predictability' for greater adaptability. Maintain levels of control with increased emphasis on input control, interactive control and output control (Simons, 1995). Examples include greater emphasis on hiring of experienced practitioners, induction, training, performance measurement (achievement of milestones) and reward and recognition.

Insert Table 3 about here

Limitations and Directions for Future Research

Only six of the participants were interviewed a second time. It is possible that if all participants had been interviewed a second time further insights would have been gained. Some participants (n = 14) only provided written information in email as opposed to face to face interviews. Using maximum variation sampling the researchers deliberately sought the views of participants from diverse industries. While meeting the aims of this study, the sampling means that results cannot be generalized to all project managers within each of the participants' industries. These perceptions might not be shared across all project managers and that further research is needed to test these results in larger populations and in longitudinal studies.

Conclusion

Practitioners in dynamic environments may encounter the following causes of rapid change: Materials; Resources; Tools; Techniques; Interdependence; Objectives; or a combination of these causes. Results indicated that emergent planning, staged releases with the least possible in early stages, competing experiments and alternate control approaches were preferred in these dynamic environments. The make-static approach may be applied where safety and risk minimization is an imperative or change adaption offers little advantage. Further analysis of the interview data will inform theory making for strategies relating to culture, communication, and leadership style.

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Table 1. Participant profiles.

Abbreviation	*Industry*	*Organization Description*	*Role Description*	*Interview Type*
Const1	Construction	Joint venture building road tunnels.	Planning engineer	1 face to face 1 via email
Const2	Construction	Green power station construction company.	Project office manager	1 face to face
Space1	Aerospace	Government space agency.	Project management leader	1 face to face
Aid1	International Community Development	Aid agency.	Post conflict project and program management specialist	1 by email
Aid2	International Community Development	Aid agency.	Project manager	1 by email
Aid3	International Community Development	Aid service provider.	Program manager	2 by email
Pharm1	Pharmaceutical	Drug development company.	Program manager	2 by email
Pharm2	Pharmaceutical	Drug development company.	Project manager	1 face to face
DefSvc1	Defense	Defense forces – army.	Military commander	2 face to face
DefSvc2	Defense	Defense forces – army.	Military commander	1 face to face
DefSvc3	Defense	Defense supplier.	Program manager	1 via Telephone
Film1	Film Production	Documentary production	Producer	1 face to face

		company.		
Film2	Film Production	Documentary production company.	Director	1 face to face
Film3	Film Production	Feature film production company.	Director/producer	1 face to face
Start-up1	Startup in Science/Technology	Start-up developing new power storage technologies.	Project manager	1 face to face
Start-up2	Startup in Construction	Start-up developing new power generation technologies.	Project manager	1 face to face
VentCap1	Venture Capital	Venture capital provider.	Portfolio manager	1 via email
Research1	Research	Government research organization.	Program manager	1 via email
Research2	Research	University	Research fellow	1 via email 1 face to face
ITSvc1	Information Technology	Information technology service provider.	Project manager	1 via email
ITSvc2	Information Technology	Information technology service provider.	Software development project manager	2 via email
ITSvc3	Information Technology	Data-centre design/construction company.	Project manager	1 via email

ITSvc4	Information Technology	Information technology service provider.	IT manager	1 face to face
ITScvc5	Information Technology	Information technology service provider.	IT manager	1 face to face
ITSvc6	Information Technology	Information technology service provider.	IT manager	1 face to face
ITSvc7	Information Technology	Information technology service provider.	IT manager	1 face to face
ITSvc8	Information Technology	Information technology service provider.	IT manager	1 face to face
ITSvc9	Information Technology	Information technology service provider.	IT manager	1 face to face
ITSvc10	Information Technology	Information technology service provider.	IT manager	1 face to face
ITSvc11	Information Technology	Information technology service provider.	IT manager	1 face to face
ITSvc12	Information Technology	Software vendor.	Program manager	1 face to face

Participants n=31; Interviews n=37; Face to Face n=22; Via Email n=14; Via Telephone n=1; Second Interviews n=6

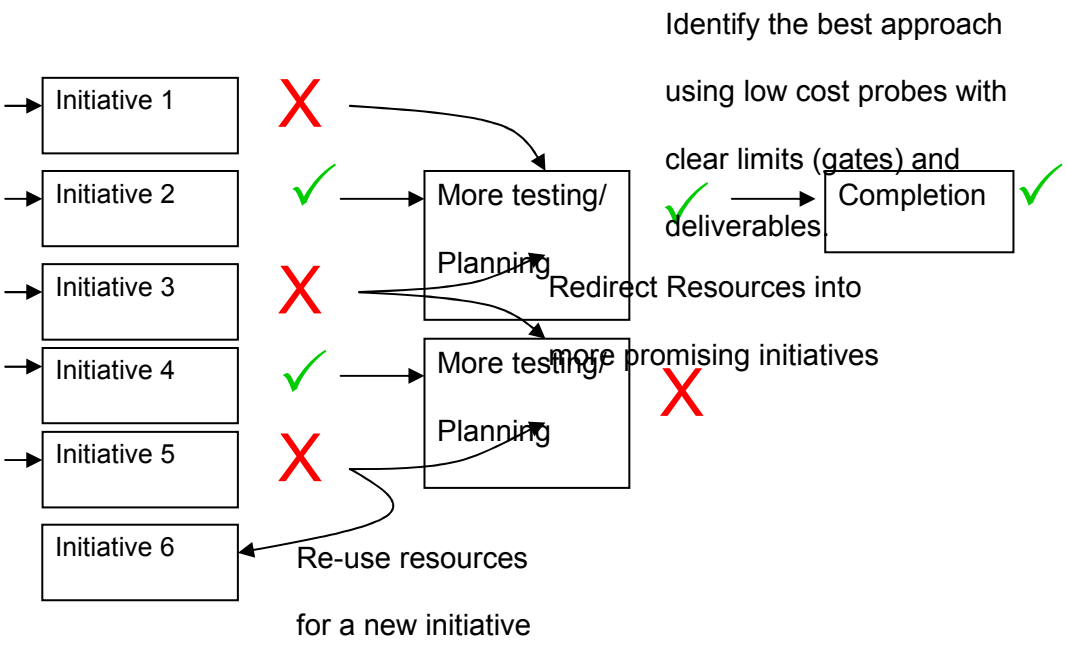

Figure 1. Competing experiments (Collyer & Warren, 2009).

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Table 2. Embrace or resist dynamism - decision matrix.

	Impact of Embracing Change	
Impact of Resisting Change	Negative	Positive
Negative	High Intensity Balanced Approach (Defense, Aerospace)	Embrace change using emergent approaches (High Technology)
Positive	Resist change (Construction)	Low Intensity Balanced Approach (Low technology)

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Table 3. Management in static and dynamic environments – Planning Styles

STATIC ENVIRONMENTS Stability is the Norm	DYNAMIC ENVIRONMENTS Rapid Change is the Norm
• The world is largely predictable. • Targets are stationary • Concrete/Steel/Glass: Same for decades.	• The world is difficult to predict. • Targets are moving. • High Technology: Enhances weekly
• Change brings more harm than good. • Allowing change is mostly damaging.	• Change brings more good than harm. • Resisting change is mostly damaging.
• Work is directable like a bullet. Think factory production line.	• Work is guidable like a missile. Think cars in traffic guided by drivers, rules and signs.
• Business cases stay valid.	• Business cases change constantly
• Strategic input required at start	• Strategic input required throughout
GOAL ACHIEVEMENT TARGETING SYSTEM COMPATIBLE WITH STABILITY OF TARGET	
• Aimed bullet: • Aim-aim-fire • Detailed plan hits a stationery target • Initial plan focuses on maximum accuracy • An accurate plan saves repetition • Goal: Time/cost/quality	• Guided Missile: • Aim-fire-aim • Rapid feedback hits a moving target. • Initial plan focus on expedient adequacy • An adjustable plan achieves expedience • Goal: Optimized business benefit.

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CONTROL CONTROL APPROACHES COMPATIBLE WITH PREDICTABILITY OF ENVIRONMENT	
• Control with detailed plans, processes and checklists.	• Guide with a framework plan, boundaries, inputs, goals, discussions.
• Higher Emphasis on Control to achieve goals (reduce Change)	• Higher Emphasis on Adaption to achieve goals (relinquish some control)
DURATION PROJECT DURATION COMPATIBLE WITH COMPONENT PRODUCT LIFECYCLES	
▪ Gain economies of scale with size.	▪ Achieve relevance with quick iterative releases

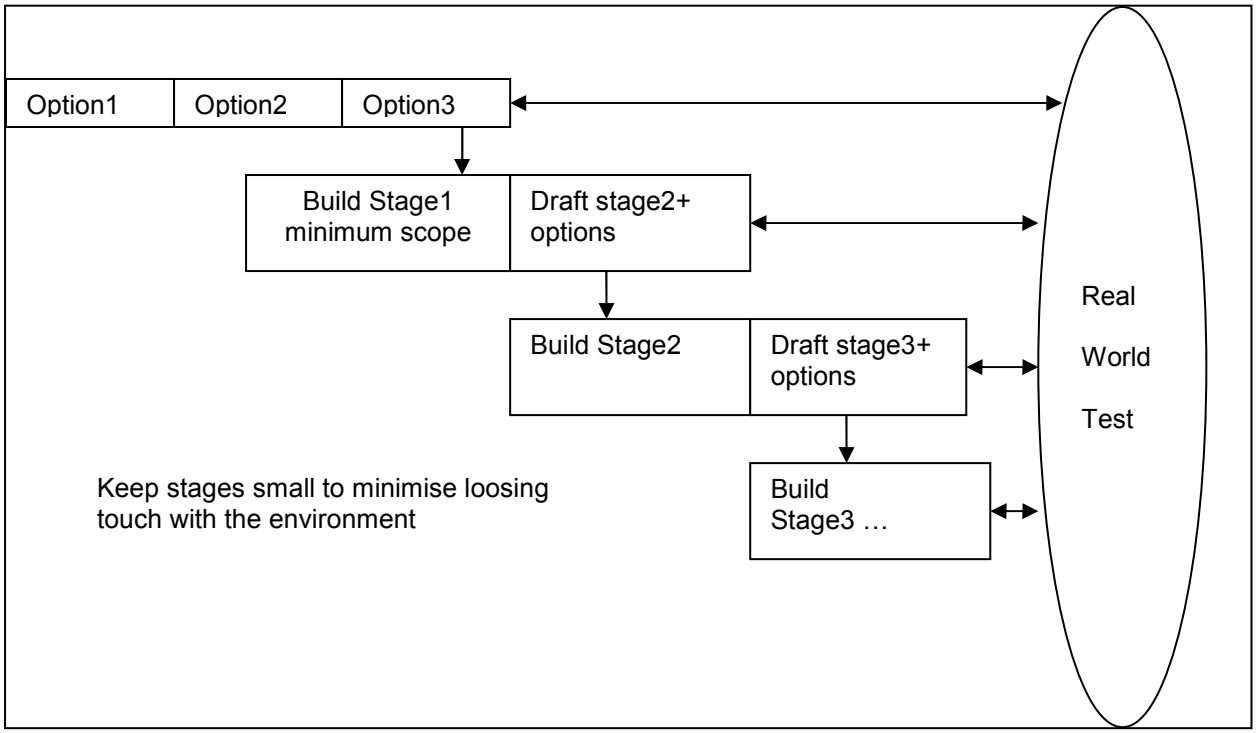

Figure 2. Experiments, staged release and emergent planning.

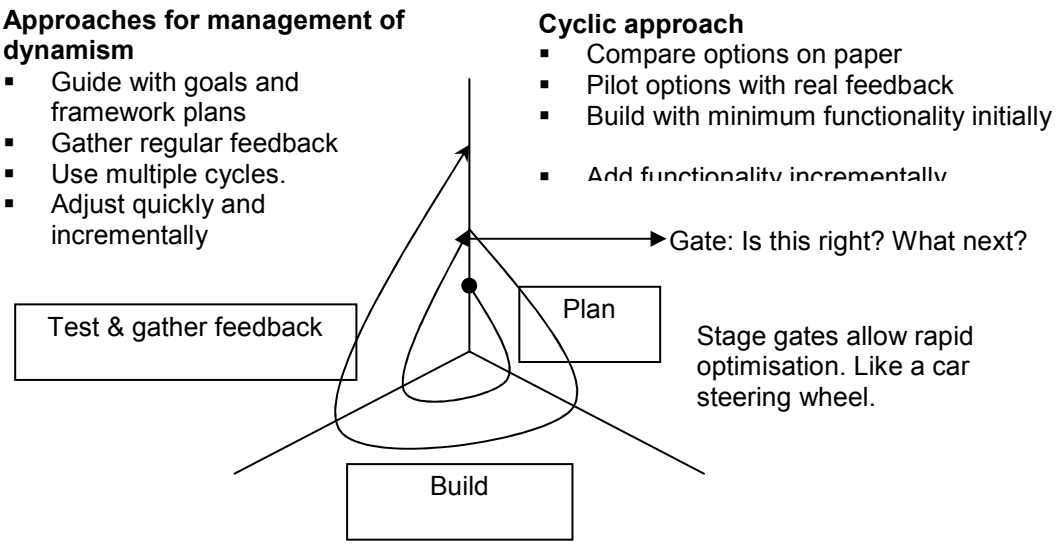

Figure 3. Iterative approach in a dynamic environment.