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Project management approaches for dynamic environments

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Abstract

This paper investigates the properties of projects conducted in rapidly changing environments. These projects are challenged by the rapid introduction of new unknowns as they progress. One might say they are more akin to stacking worms than stacking bricks. The difficulties posed by these projects are identified and the literature is reviewed for suitable approaches.

Keywords: Project management; Dynamic

1. Introduction

This paper sets out to investigate the nature of projects conducted in fast changing environments. Examples and theory are used to illustrate the nature and challenges of this category. Suitable management approaches are identified under the following headings: Planning, Experimentation, Lifecycle, Controls, Culture, Communication, and Leadership style.

2. The dynamic project category

The paper closes with recommendations for further research. In this paper, *control* is taken to mean the mechanisms through which resources are managed to achieve objectives [1], and is different to the PMBOK 'technique' [2] which is strictly focused on bringing activities in line with a plan [3]. The term dynamic is taken to mean characterised by constant change [4]. In the project management context dynamism is taken to be a dimension of a project that represents the extent to which a project is influenced by changes in the environment in which it is conducted. This paper argues that this is a non-binary dimension that applies in varying degrees to all projects, so strictly any given project is neither 'dynamic' nor 'not dynamic'. All projects have some degree of dynamism, so the dimension is not dichotomic. Therefore, the ideas in this paper may be applied in varying degrees to any project as deemed appropriate. For the sake of simplicity though, for the remainder of this paper, a dynamic project is taken to be one that is necessarily subject to higher than normal levels of change due to the environment in which it is conducted.

The business environment is changing at an increasing pace [5–7]. Rothwell and Zegveld [8] went so far as to say we are in the midst of a technology explosion. They argued that 90% of our technical knowledge has been generated in the last 55 years, and that technical knowledge will continue to increase exponentially. Perrino and Tipping [9] reported "the pace of technology is accelerating, raising the stakes and risks for managing innovation, and requiring early warning and shorter response time". Change, in all forms of technology and business processes, can be regarded as increasingly pervasive and providing challenges even where high technology is not a core business, such as in mining [10]. Consider how the Australian Submarine project was challenged by developments in the IT industry between the 1980s design phase, and sea trials decades later [7].

This paper will now investigate dynamic projects from a theoretical point of view. Gray and Larson [11] argued that

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projects conducted in highly uncertain environments are a key unresolved project management issue and present the following challenges:

- planning for uncertain outcomes;
- balancing flexibility with reliability and accountability;
- balancing decision quality against decision speed;
- timing scope freeze during rapid change.

Pich, Loch and De Meyer [12] describe a type of project that encounters unknown unknowns and how it is best suited to what they called a 'learning' strategy which involves scanning, problem solving and flexibility. They argue that this is distinct from projects conducted in well understood environments which are suited to 'instructionism', and distinct from 'selectionism' where the most fruitful initiative is chosen after a pool of trials. Turner and Cochran [13] espouse the 'goals and methods matrix' that describes four different types of project according to how well defined the methods and goals are. Projects can have poorly defined goals ('fire') or poorly defined methods ('water'), or both ('air').

Shenhar and Wideman [14] describe a type of project that involves high levels of uncertainty, using technologies together for the first time. They call these 'high tech' [14]. They also describe a type of project that actually creates new technologies, called 'super high tech'. Shenhar [15] describes how 'low technology' projects are typically performed in construction, production and utilities, and high technology projects in the computer, aerospace and electronics industries. He offers building and bridge construction as examples of low technology projects. The key difference to Shenhar is the level of development work involved, in that low technology projects have little, and high technology projects have considerable levels and usually require prototyping. Shenhar and Wideman [14] argue that another key difference is the number of design cycles. In low technology projects they say there is typically only one cycle with a freeze before development, and with high technology there are at least two, typically three cycles.

Cioffi [16] suggests that 'projects' be placed on a spectrum of 'newness' from operational to project. The idea has been adapted in Fig. 1 to illustrate the sliding scale of unknowns that applies to projects. Unknowns in this sense refer to any aspect of the project, including the methods to achieve it, the objective, and the environment it has to operate in.

The guide to the project management body of knowledge (PMBOK) [2] describes 'progressive elaboration', where planning is developed in greater detail as the project progresses. Using progressive elaboration to fill knowledge gaps, it might be possible to move a project to the left in Fig. 1, thereby achieving the objective in a more predictable fashion. However, rapid changes in the environment, including tools and methods, and attempts to innovate, act to push the project to the right, increasing unknowns. The two forces of exploration and change act against each other continuously throughout the project. The challenge is to conduct exploration at a greater rate than the emergence of environmental change. It is also important to ensure that the amount of change created by the exploration and implementation is not counterproductive overall. An example of Project A in Fig. 1 might be a production line where there only variable is the colour required. Project B might be a house construction where there are more unknowns at the start but most are resolved in the early stages. Project C might be a software development project for a new business. The client's business processes, and the technologies used in the project, change during the course of execution, thereby affecting the methods used and goals.

Projects conducted in environments with higher levels of dynamism may be more likely to pose some of the attributes of Shenhar's [15] high technology or super high technology categories with uncertainty at the start, but also include even more challenging high levels of change along the way. In dynamic project environments, significant proportions of the methods and goals are changed by external forces out of the project's control. The effort to resolve unknowns at the start of the project is severely challenged by the introduction of additional unknowns along the way, because what is learned can become obsolete in less time

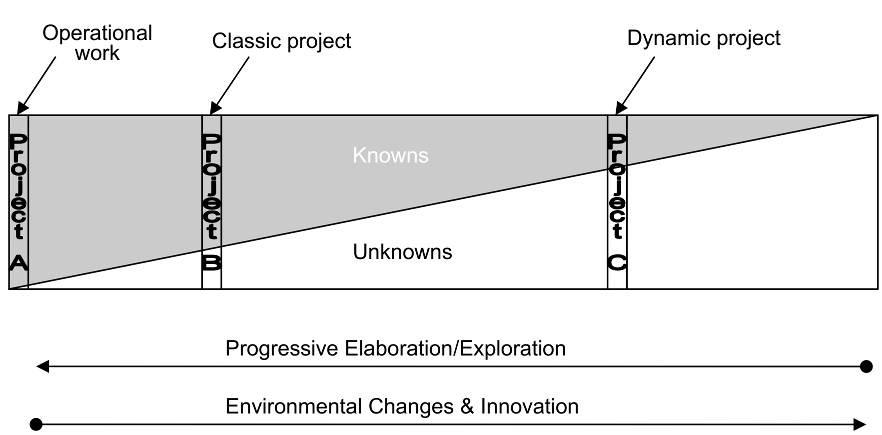

Fig. 1. The race to resolve project unknowns.

Table 1
The dynamic project category

Work type	Description
Operational	Established controls. 'Operational' processes. Lower levels of unknowns
Classic project	Requires the creation of new controls, usually a project plan, for a significantly new body of work, usually only carried out once. May have high levels of unknowns at the start but most resolved early, and few new unknowns arise during execution
Dynamic project	Requires the creation of new controls that are changed regularly during execution. Has high levels of unknowns at the start and a high rate of new unknowns throughout. Must resolve the unknowns at a faster rate than they appear, and in time for completion

than it takes to learn. Materials, methods and goals are always moving, making projects more akin to stacking worms than stacking bricks. Table 1 attempts to describe the difference between operational work, classic project work, and projects with a strong dynamic dimension.

The rate of resolving unknowns is especially critical on these projects. As soon as one engages in adjustment of scope to suit an uncontrollable environment one runs the risk of 'resolution lag'. The rate at which unknowns are resolved must not only be sufficient to deal with those that existed at the start, but also those that appear during execution. For instance, assuming linear production and resolution of unknowns, the resolution rate must at least be equal to the appearance rate, plus enough to resolve unknowns that existed at the start (i.e. number at start divided by the duration). The appearance rate will be quite high in a highly dynamic environment. Furthermore, unknowns may appear in inconvenient bursts, and certainly after planning is 'complete'. Therefore, the rate of unknown resolution is a particular hazard for projects conducted in dynamic environments.

3. Illustration

Two examples are provided to help illustrate the challenges of projects conducted in dynamic environments. Two subunits of a single parent organisation were selected on the basis that they had contrasting levels of dynamism. Both sub units had a mix of project types, but each appeared to have a higher proportion of one type. One sub unit had a higher proportion of projects utilising the 'instructionist' approach and the other more utilising the 'learning' approach. In this paper one will be referred to as the 'static environment' and the other as the 'dynamic environment', as a means to represent the relative levels of dynamism in each. Following is a description of challenges encountered by the higher levels of change in the dynamic environment.

- *Product lifespan*: the average mean time to failure (MTTF) was three to four years compared to several decades in the static environment. This meant that in a given year one third of the products had to be replaced. There was very little that could be called 'operational'. At any given point more than half of the environment was either being replaced or being planned for replacement. This also presented the significant risk that materials would expire before the final product was fully operational.
- *Rate of introduction of new materials*: most materials had only become available in the last three or four years, and were completely unknown less than a decade previously. By contrast most materials used in the static environment had been well understood for several decades, centuries, or even millennium, and the implementation methods were well understood and tuned.
- *Difficulty finding and managing skilled labour*: change led to a perpetually low level of knowledge about the properties of new materials, and how they should be implemented (methods), and therefore difficulty finding qualified resources. A significant amount of study and certification was required to stay qualified in using an endless stream of new materials. It was regarded as almost impossible to stay qualified and perform effectively as a manager at the same time. Staff promoted to management had to quickly decide between giving up their qualifications or giving up good management. If they chose to be an effective manager, they had to do so without completely understanding the work their staff performed. This made it more difficult to manage, understand issues, and gauge performance.
- *Level of integration with customer industry*: while some organisations can execute relatively vanilla products for a range of contrasting clients, projects in the dynamic environment required significant customisation and understanding of the client business.
- *Changing goals*: because customers were also operating in an environment of uncertainty and change, their requirements also had a tendency to change rapidly.
- *Affect on planning*: in the dynamic environment new events that compromised plans arose rapidly throughout project delivery. The quantity of change made detailed plans difficult to maintain. In the time it took to adjust the plan, additional changes would occur. Analysis and decision making had to be conducted more rapidly than the emergence of new changes. Plans with excessive detail were found to be misleading and abandoned in favour of a higher level or rolling wave approach. Even in the static environment, there could be too many unknowns at the start to be resolved by the deadline, so the rapid introduction of new unknowns in the dynamic environment was doubly challenging.
- *Morale*: in the dynamic environment, well before a product or service was produced, thoughts had turned to the next generation, making the current goal seem less valuable or important. This made it difficult to maintain quality focus, or celebrate end points for reward and recognition. This in turn affected job satisfaction,

morale and motivation. Lower product quality meant that deployed products required regular changes to continue their usefulness, and reliability. By comparison the visible achievement of a building lasts decades after it is complete.
- *Levels of interdependence*: projects were often intertwined with other projects and an existing dynamic environment. A change in one project had significant impact on other projects. The highly integrated nature of the environment, combined with high rates of change, made forward planning very challenging.
- Dependency on business units with much lower levels of dynamism who therefore may not respond as quickly, or understand the challenges being faced.

4. Project management approaches for dynamic environments

The intention here is to review literature to provide a broad overview of approaches that might be used to better deal with dynamic environments. Approaches were broken down as follows:

- Environment manipulation – making dynamic static.
- Planning approaches for dynamic environments.
- Scope control for dynamic environments.
- Controlled experimentation.
- Lifecycle strategies.
- Management controls: input, behaviour and output, diagnostic, belief, interactive and boundary.
- Culture and communication for dynamic environments.
- Categorisation.
- Leadership style.

4.1. Environment manipulation – make dynamic static

The most obvious approach to deal with the challenges of a dynamic environment is to attempt to make it more static by resisting change. This could be achieved by:

- freezing objective and design. Rejecting change requests;
- reducing or delaying adoption of new (esp. unproven) technologies or techniques;
- extending the life of existing systems.

In highly dynamic environments the benefits of the 'make static' approach are countered by challenges such as:

- lost opportunity and productivity though delayed implementation of new approaches, materials or business objectives, that provide significant benefits, despite the challenges;
- reduced business competitiveness, especially when competing organisations offer, or make use of, new systems which are often more effective;
- reduced business compatibility when an organisation falls too far behind best practice, and find it difficult to recruit staff familiar with their environment. Sometimes technology used on a previous project simply does not exist any more, and new ones have to be used;
- low material life-spans (low MTTF) and life-cycles (period before manufacture ceases permanently). This means that most materials, and therefore products, have to be replaced within three to four years, with a next generation material/product. Next generation materials/products usually have differing properties to the original, and this has a flow on affect to dependant products. While standards may be used extensively, some variations in properties are deemed necessary to achieve improvements.

An industry with a strong public safety requirement may be attracted to the 'make static' approach. This requirement can help justify funds to test and implement strategies, and this can mitigate the reliability disadvantages of early adoption; consider the medical and the aircraft construction industries as examples. Conversely the IT industry cannot easily leverage public safety to justify costs, so it trades reliability for faster delivery, of new functionality, at lower costs. Jones argues that technology product lifecycles are now measured in months, compared to the car industry in years (about five), and in construction "change in product technology is very limited and products such as steel girders and electrical cable may remain in the mature stage indefinitely" [7]. Although the 'make static' approach has merits, it also has limitations, and so other approaches are a necessary part of the mix.

4.2. Planning approaches for dynamic environments

Project management, as defined by the bodies of knowledge, is focused mostly on a "management-as-planning" view of control [3,17,18] and appears to be an appropriate approach for projects with clear goals and methods [13]. However, Koskela and Howell [17] argue that for speedy projects, "traditional project management is simply counterproductive; it creates self-inflicted problems that seriously undermine performance". The problem is that events arise at faster rates than is practical to re-plan [3,5,19,20]. Attempting detailed long term planning for these projects can waste time and resources, and lead to false expectations.

Lampel [21] described the emergent or learning version of strategy. Motorola's multibillion-dollar Iridium project [22] could be considered a success on the basis it was 'on time' and 'on budget' from an engineering point of view, but was a catastrophic commercial failure because it did not adjust to what was being learned about the changing business environment. By contrast the movie Titanic was severely over budget and over time and touted as a $200 million flop, yet became the first movie to generate over $1 billion in revenue. High levels of detail in a plan may in fact discourage adjustment to a changing environment. Clearly the type of project discussed in this paper is more suited to the emergent approach [23] or as the PMBOK [2] describes it, "progressive elaboration", where the planning detail is progressively developed as more is learned.

Payne and Turner [24] suggested different levels of planning according to project type, and developed a project categorisation system called the Goals and Methods Matrix described in Table 2. They described how to adjust planning according to project type [13,24]. Projects are categorised based on two variables:

1. how well known the goals are, and
2. how well known the methods are

While they agreed that projects with well understood methods and goals lend themselves to detailed up-front planning (e.g. bridge construction) they argue that using this approach for projects with unknown goals or methods will increase the chance of failure [24]. They found that for projects with unknown goals and unknown methods planning should have:

- a high level project definition report, with level of detail proportional to project size;
- a milestone plan and project responsibility chart, where milestones represent the lifecycle;
- lower level detail developed use rolling wave planning.

Damon [25] described filming on the streets of Tangiers without crowd control. They made a basic plan, that would be easy to change, anticipating there would be problems they could rectify either during execution or in later iterations, e.g. post production editing. So a high level plan was developed and then high levels of communication used during execution, in multiple iterations, with expectations of unpredictability.

4.3. Scope control for dynamic environments

Failure rates increase with project size [26,27]. The author argues that this phenomenon is compounded in dynamic environments. The McIntosh and Prescott review [28] of the troubled Australian Submarine Project stated, in regard to its combat system, that "the main problem is the extremely rapid rate of technological change, which can give rise to new technologies which could do the job far better emerging during the course of the contract". For a dynamic environment breaking the project into stages, starting with the smallest possible scope in the first, mitigates against the negative impacts of environmental change. It also works as a proof of concept which is important in an uncertain and changing environment. Finally, it allows different parts of the project to be run in different ways. Components less subject to change can be run using a more detailed planning approach, and components subject to higher change using the learning approach.

Table 2
Turner and Cochrane's goals and methods matrix [13,24]

	Goals well defined	Goals not well defined
Methods not well defined	Product development "water"	Research & organisational change "air"
Methods well defined	Engineering "earth"	Systems development "fire"

4.4. Controlled experimentation

Organisations in environments with high levels of unknowns should benefit from experimentation, discovery and selection processes. Pich, Loch and De Meyer [12] relate how NASA used this approach to develop the lunar module in the 1960s. Sobek [29] relates how car manufacturers develop a number of prototypes in parallel, choosing the ones that give the best market reaction. More recently, Cleland [30] relates how Kmart initiated a package of low cost probes, monitoring progress and then switching resources to the most promising projects once feasibility had been evaluated. The key advantage here is the ability to confirm an approach with feedback from the real world, allowing either customisation or cancellation, thereby optimising resourcing. Pfizer's disappointing heart medication, Viagra, turned into a success because they took the time to investigated its side effects [31].

Researchers can not just sit down and write a plan guaranteed to deliver a cure to cancer. They experiment, identify likely possibilities, and methodically eliminate dead ends. The time spent testing the ideas that don't work out is just as important as the time spent testing the ones that do. The ability to select more promising ideas is enhanced by the elimination of others. Sometimes, as was the case with Viagra, researchers start with a completely different objective, but keep in mind alternate applications [31]. A perpetual portfolio of initiatives (fixed scope experiments) can test ideas and eliminate dead ends.

This fundamental principle underpins species survival, where natural selection provides gene mutations, which are in effect experiments allowing us to adapt to a changing environment [32]. In the case of management, however, teams working on projects that are not ultimately selected for completion should not be punished but rather share in the rewards, fostering motivation and information sharing. At the very least they should not be punished for failure due to uncontrollable events [32]. The key to controlled probing is to set clear limits in the form of an agreed deliverable (e.g. feasibility report), time limit, and stage-gate in the form of a review meeting. The gates allow management to cancel or refocus as required, before excess effort is wasted [7]. See Fig. 2 on low cost probes for an illustration of this approach.

Dodgson [33] talks about the essential ingredients of innovation being option-creating; playing – choosing/selecting; and doing – implementing "experimenting,

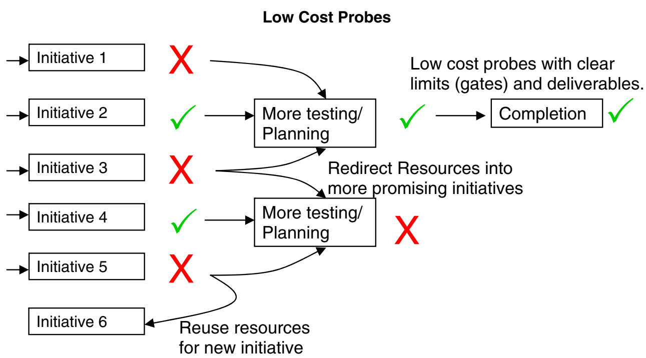

Fig. 2. Low cost probes.

feedback loops, prototyping, failing". Acha, Gann and Salter's [34] study of four cases argued there were managerial precepts for the management of research and development in project-based environments including:

- attaching small amounts of research work to "safe" projects;
- using high profile projects to attract talent;
- using supplementary liaison devices to fill gaps in organisational structure for specialist skills groups: Skill group meetings, mentoring programmes, incentives;
- creating time-off to build and integrate capabilities;
- developing a separate career structures to encourage capability development in both management and technology.

4.5. Lifecycle strategies

Many researchers argue that the approach should be tailored to the project type [22,24,35–39]. Molin [40] distinguishes between the 'planning approach' to projects, in which a well-defined path to predetermined goals is assumed, and the 'learning approach' which "sees the project as an ambiguous task with changing objectives as the project proceeds". So the 'planning approach' relies on a directive style of control where a plan is developed and execution is controlled using it. The learning approach uses a more participative style [23]. The optimum approach for a project should be chosen according to environment and the type of project being undertaken. Clearly the types of project discussed in this paper would favour the emergent style, which appear to be more adaptable.

The 'waterfall' lifecycle has strictly limited overlap between phases, and high levels of planning and process control. This is suitable for projects with a well understood scope and enabled using proven technologies. This approach is favoured in the construction industry. In unpredictable environments waterfall does not allow sufficient adaptability to permit maximisation of benefits. Novice managers might believe this approach is lower in risk but in environments with high levels of unknowns it can have a higher risk of failure because of the time and effort required to be invested before environmental incompatibility is discovered. High levels of control inhibit the adaptability needed to maximise business benefits in dynamic environments.

In the rolling wave approach the plan for each phase is completed at the end of the preceding phase. This allows for improved environmental adaptation. With the 'iterative' approach all phases run in order many times over. Successive releases evolve into a more complete product [41,42]. This is a good way to reveal unknowns and adapt to a changing environment. Iterative is also known as 'spiral' or 'incremental'. See the spiral approach in Fig. 3. When there is limited knowledge about how a product might interact with its environment, an 'iterative' approach is an effective way to test and collect that information, and minimising resource expenditure on bad choices. Some versions of the 'iterative' approach use feedback as the primary control mechanism, rather than planning [43]. The feedback is driven by regular tests and releases of the evolving product. Agile development for instance tries to keep scope small, and to deliver early and often [43]. It focuses more on communication than process [43]. The Standish Group claim their research indicates this approach will increase project success rate [26].

Shenhar explains how engineers dealt with uncertainty using repeated design cycles followed by a design freeze. He found that projects in his 'high technology' category were "characterized by long periods of development, testing, and redesign" [38] with two or three design cycles, before a freeze in the second or even the third quarter of the project's duration. This is a version of 'iterative' where only the design, prototype or pilot cycles are repeated, and the main execution phase (to build the production product) is only carried out once.

Highly dynamic environments pose a design freeze dilemma. Rapid and perpetual environmental changes tempt excessive design adjustments. As military leaders lament, striving too long for a perfect plan can result in the endeavour being over-run by circumstances, before anything useful is produced [44,45] i.e. a good plan executed in time is better than a perfect plan hatched in a prison camp. Some key approaches are to:

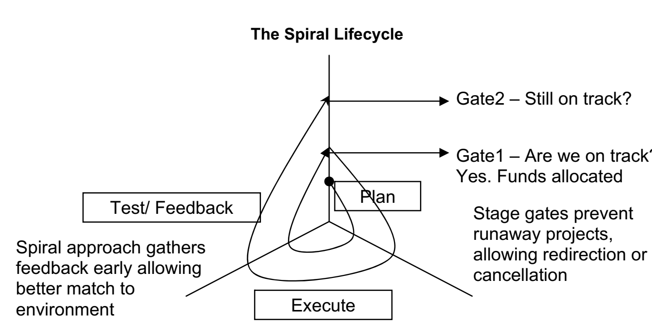

Fig. 3. The spiral lifecycle.

- proceed first with the components least subject to change. Finalise the most variable components last [46];
- use fast and repeated design/development cycles allowing the project to adapt at a higher speed than environmental changes. Refer to previous discussion on the rate of resolution of unknowns [38];
- have the discipline to freeze the design in time to meet the overall objective. Break into stages if required and defer unmet requirements to later stages [38];
- build in maximum flexibility so the product can be further adapted in later stages [11,14,38,47].

4.6. Management controls: input, behaviour and output

Snell [48] described three types of management control: behaviour, output, and input. Project management, as defined by the various bodies of knowledge, is focused on behaviour control as a way of directing and regulating actions from above [3]. A process such as a project plan is developed and adherence to the process is monitored, and deviations corrected. This works best if a well understood and stable process can be created, so its effectiveness is dependant on what is described as "task programmability" [49]. Bonner, Ruekert and Walker [50] found that excessive behaviour control can reduce productivity. Sometimes the cost of surveillance is simply greater than the benefits of adherence [3,5,19,20]. Enforcement of strict behaviour controls can offend workers, thereby affecting morale, or stifling creativity [50].

Sometimes the controls just don't exist. What is the process to create a unique work of art, or to create ground breaking research? Sometimes the actual control measurements can be inaccurate or inappropriate, resulting in unexpected and counterproductive behaviour. Managers may lack the knowledge or experience to develop the right controls. In order to achieve the measurable objectives workers bypass other less measurable, but more important, objectives. If the process is flawed, even if the employee can see it is flawed, it may be difficult to correct. Burdening workers with onerous processes and few incentives could discourage adaptation to a fast changing environment. Other control techniques, not covered well in the various bodies of knowledge, also need to be considered [3,38].

Another form of control described by Snell [48] is output or outcome control. Targets are set, thereby providing direction and discretion for staff [48]. Rewards are developed to reinforce achievement of the targets. Where behaviour control is difficult to define, or expensive to monitor, output control should be considered as an alternative. Consider the researcher working on a disease cure. There is no way to define for the researcher the steps required to achieve the solution, but the result is clearly defined and contains rewards that guide and motivate the researcher to the desired outcome. The danger with output control is that mistakes are harder to prevent early as they are not discovered until the output is produced and measured. Another problem is that sometimes outputs can be difficult to measure e.g. improving morale. However, for project management in fast changing environments, a simple statement of the goals, deliverables or milestones, combined with appropriate motivation may be a more effective approach than the development and following of a highly detailed project plan.

If process and output control are unattractive for the reasons described above, then input control might be considered [48,51]. In dynamic environments, where defining behaviour or measuring output is difficult, an organisation might be better to evaluate staff on values, motivation and compliance with traditions [1]. George and Jones [52] confirm this. Snell describes it as "the knowledge, skills, abilities, values and motives" [48] of employees. Examples include staff selection, training and socialisation [51]. For instance a university will not have a step-by-step checklist to achieve ground breaking research, and will not even be able to predict exactly what research results are achievable, but they can select academics with a track record of achievement. The 'science of sales' may be elusive but an agency can have success selecting successful sales professionals. An advertising company can provide training and induction and then allow staff freedom to achieve.

Ouchi [52] explains that although it would be viable to create behaviour controls for a warehouse picker, it would require a very complex system to achieve the same for the foreman's job, which is more subtle. A better approach might be to select foremen for the job who have previously demonstrated a high level commitment to the organisation's objectives. Input control minimises 'divergence of preference' thereby enhancing the ability of employees to work together [51]. The same could be applied to project work. Rather than attempting to control staff with a complex and detailed project plan, it may be better to select staff that have experience with the work and demonstrated a commitment to achieving the objective. Fig. 4 provides guidance on control selection. The project manager should optimize the mix of controls according to their viability. For instance academia has evolved to have a mix of input control (selecting academics with a track record), lower levels of process control (to give them freedom), and higher levels of output control, in the form of self-satisfaction, and recognition for publications and discoveries.

Ouchi argues that in reality management "do not transmit control with any accuracy from top to bottom" [1] and

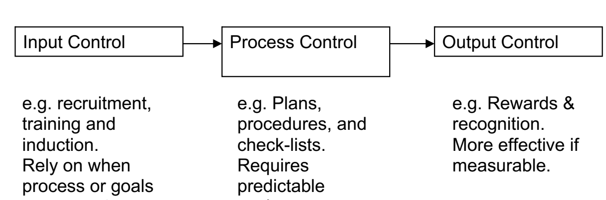

Fig. 4. Control selection – based on Ouchi [1], Eisenhardt [51] and Snell [48].

therefore coordination is a more appropriate description of the process. Careful selection of controls may involve an acceptance that managers have less control than they would like, but that it is better to optimize than focus on a single unrealistic approach.

4.7. Management controls: diagnostic, belief, interactive and boundary

Simons [47] speaks about the difficulty controlling work in organisations that demand flexibility, innovation, and creativity. He describes four types of management control, including diagnostic controls which are formal feedback systems to monitor outcomes, and correct deviations from goals, to keep performance within limits. He argues that belief systems, in the form of mission and value statements, and strategic goals, can supplement diagnostic control [47]. He also describes interactive control which constitutes formal strategic discussion based on data, which he argues is good for fast changing environments because they are monitored constantly and discussed in regular face to face meetings [47]. Interactive controls are most useful where there is strategic uncertainty, or when data, assumptions and plans need to be continually challenged and debated [47].

Finally, Simons [47] described boundary control systems which allow innovation within set limits and might include codes of conduct, workplace health and safety regulations, gender equity and anti-racism regulations. Boundary controls are useful for projects with many unknowns as a way allowing staff flexibility of behaviour, within reasonable boundaries.

4.8. Culture and communication for the dynamic environment

There is evidence dynamic projects might benefit from a culture that is:

- organic and informal, supplementing formal [38,52–54];
- egalitarian with a flat management hierarchy [7,55–59];
- supporting of experimentation [60];
- sharing of rewards for experimentation [32];
- tolerant of failure [54];
- valuing experimentation and the elimination of ‘dead ends’ [57,60].

4.9. Categorisation

While there is some merit in a standardised approach, such as consistent reporting, resource management, and training, there is an increasing belief that customisation will make a project more successful [22,24,35–39]. Payne and Turner’s [24] study shows that managers tailoring their procedures reported better results. Simply identifying the project as having significant levels of dynamism is a worthwhile prerequisite to applying the approaches outlined in this paper. Some of the measures that might be applied to identify high levels of dynamism might include:

- product life-spans;
- rate of introduction of new materials or methods;
- rate of necessarily changing requirements;
- levels of interdependence with other projects and an existing environment.

4.10. Leadership style

There is evidence that dynamic projects may gain benefit from selecting their project manager according to how well suited they are to the type of project [61]. Specifically they would benefit from managers with flexibility, the ability to trade-off extensively, and the ability to find trouble, even if its not readily apparent [14,38]. If a project deals with high levels of new material then the project manger’s subject matter knowledge needs to be correspondingly high [16]. Hands on managers are beneficial on innovative projects, even if to the extent of meddling [54].

5. Discussion and further research

This paper supports the BOKs and aims to build on the current state of thinking. It is accepted that dynamism is one of an infinite number of project dimensions, However, it is argued that it is one of increasing importance, and one

Table 3
Approaches for dynamic projects

Environment manipulation (make static)	Make static if viable, else develop a static core that permits higher rates of change around the edges
Scope	Break into stages that are as small as possible
Planning approach	The emergent exploratory approach is more suitable
Controlled experimentation	Consider multiple low cost trials with information sharing, and shared rewards. For each, used strict fixed scope and stage-gates. Refocus resources into most promising initiatives
Lifecycle	Try multiple design cycles with freeze, pilots and prototypes. Consider iterative development with client feedback looping back into design improvements for subsequent versions or stages
Controls	Avoid over relying on process control. Supplement output control if measurable, and input control
Culture	Promote flexibility and experimentation. Use flat structure
Communication	Implement concrete measures that promote faster, more open and less formal communication as a supplement
Leadership Style	Use of leaders with high levels of subject knowledge. Use fast informal and participatory style

not well studied, exclusively, in project management theory. Further study would benefit from development of an instrument to measure dynamism in projects. Table 3 summarises some of the project management approaches available to deal with dynamic environments. The approaches identified here are likely to be far from comprehensive so identification of new approaches, along with more thorough investigations, would be useful. The investigation of organisations currently operating in dynamic competitive environments would seem to have the most merit. The initial observation of these organisations makes them appear chaotic, but the author believes they consciously or unconsciously adopt a range of approaches ideally adapted to this type of environment, simply through natural selection in a tough business environment. An in-depth qualitative investigation would tease out some of these approaches. Finally, a quantitative investigation into the merits of all approaches identified would a significant goal to achieve.

6. Conclusion

As more industries encounter higher rates of change they will seek management processes to help them cope. Through experimentation and from empirical evidence, many learn that the classic process orientated approaches benefit from fine tuning in these environments. From a theoretical point of view it is hoped the ideas here will prompt further investigation of project dynamism, and from a practical point of view this paper has begun to identify approaches to help in their management.

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