

What is innovation and how can it be cultivated? Discussion Paper

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In this paper we examine what innovation is, its relationship to cooperation and competition, and the features of innovative organisations. We relate the concept of “innovation” to the biological notion of “adaptation” and suggest that collaboration in the avoidance of competition generates innovation. We argue that innovative organisations have the following features:

* Supporting high levels of discretion and autonomy in solving complex problems
* Developing networks to discuss and test innovations and to share promising approaches
* Promoting the identification of, and development of opportunities, rather than focusing on risk
* Allowing staff time to try new approaches – and to discuss new ideas and approaches
* Viewing innovation as both a process and an outcome
* Focusing on the public interest.

A review of literature on “identifying and cultivating innovation” was conducted by an invited number of departmental officers, to ascertain how service organisations such as Department of Education and Communities can be more innovative in responding to change.

The broad questions attempted in this review were:

* What organisational features facilitate (and limit), innovation?
* What processes are available to analyse and evaluate innovative ideas?
* What processes are available to cultivate the most promising of these ideas and sustain them?

In order to answer some of these questions and report on new questions emerging from literature, the group agreed to the following framework of analysis of literature to keep the task focussed.

*Literature Review - Innovation in Educational Service Sector – The Framework of Analysis*

**Organisational Features inhibit or promote innovation**

Nurturing an Innovation Culture in Complex Organisations

**Organisational and Service Innovation - Policy and Practice**

**Selection of Ideas –evaluation and appraisal methods**

Cultivating, developing and rewarding Best Ideas

The context of this literature review was a recent emphasis on service innovation - a direct result of rapid expansion of service sector. Australian Government has recognised the need for public sector to become innovative. The recent *Innovation Action Plan* of the Commonwealth Government recognises that:

The role of the Australian Public Service (APS) is to support the Australian Government in responding to economic, social and environmental challenges, through effective policy development and service delivery. … To thrive in the continually changing world environment, the APS needs the leadership and mandate to deliver innovative solutions to address multidimensional issues and problems”. (DSIIRT, APS Innovation Action Plan, 2011, p1)

The action plan emphasises the embodiment of innovation in public sector organisations will require building, sharing and maintaining a common language about what innovation means and developing creative awareness of key innovative practices and insights.

Education is a service. Innovation applicable to the service sector has somewhat special characteristics. Jim Spohrer (2006), director of IBM Global University Program and the co-founder of service research area of IBM research, suggests that one challenge to systematic service innovation is the interdisciplinary nature of services, integrating across technology, business, social, and client (demand) innovations. Notwithstanding its special context, this paper seeks to identify broad features of innovative organisations.

# What is innovation?

The *Macquarie Dictionary* defines “Innovation” as “something new or different introduced. The act of innovating; introducing of new things or methods.”

Newness, or novelty, is central to the notion of in*nova*tion. The OECD states “Innovation is the implementation of a *new* or significantly *improved* *product* (good or service), *process*, new marketing method or a new organisational method in business practices, workplace organisation or external relations”. (OECD, 2005)

A plethora of innovation literature is available and weeding through seminal papers on innovation is not an easy task. Joseph Schumpeter’s (1961) thesis on creative destruction fuelled academic interest in the process of innovation. Various theorists and practitioners have postulated on how innovation comes about in organisations. The literature focuses on the role of individuals, governments, industry and organisations in bringing about the products and in process of innovation. The factors that stimulate or inhibit innovation were discussed extensively.

The NSW Public Service Commission (2013) suggests that “Innovation in the NSW public sector is about creating the right environment for ideas and actions, and adopting new ways of thinking and behaviours. It can mean generating and implementing new ideas; changing or creating more effective processes or ways of doing things; or adapting to changes. It can be incremental, substantial or radical. It can be achieved through technology or by following a targeted strategic process. Innovation is all of these things.” (NSW Public Service Commission 2013 p.7)

Innovation is a key concept in theorising organisational evolution and adaptation (Lam 2005)

In this paper we interpret innovation as a biological concept – seeing an innovation as an adaptation. Organisational innovation relates to how organisations evolve and adapt to changing circumstances.

Underpinning Darwinism is a generative heuristic, in which entities (or variants) are generated, and later subjected to tests. Entities which survive the testing are regenerated, and so on (Schaverien and Cosgrove 1999). Applied to innovations, ideas are generated and later subject to tests (evaluation or selection). Ideas that survive the testing are regenerated. According to this way of thinking, innovation involves three stages:

1. idea generation
2. selecting/testing of idea
3. regeneration / implementation.

Similarly, Green and his colleagues suggest that innovation can be thought of as having a cycle with four phases: idea generation and discovery, idea selection, idea implementation, and idea diffusion. (Green et al 2013 p.12)

# What is the relationship between innovation and collaboration?

One of the themes of contemporary literature on innovation is that successful innovation in human scientific and technological communities (knowledge organisations) depends on collaboration in the form of:

* specialisation – that in turn depends on the organisation of labour – a combination of labour
* the diverse partners of the community working together to achieve the purposes of the whole
* partners communicating well with each other
* partners sharing resources and information with each other to achieve the ends of the whole
* partners depending on each other to achieve the purposes of the whole.

Successful innovation depends on mega-collaboration. Scientific communities are collective knowledge-building enterprises. As Green and his colleagues note in relation to innovation in the public sector, “Innovation is a ‘team sport’.” (Green et al 2013 p.4)

If this is so, it is not something that is unique to human enterprises – but rather a repetition of a pattern typical in the living world. For innovation and the growth of knowledge within living systems - from bacterial speck to ecosystems and the whole biosphere - depend on vast cooperation between their living components. Competition has its place in generating innovation, but it is the *avoidance of competition* (through establishing niches or ways of making a living) rather than winning of competition that is essential to innovation and the growth of knowledge in living systems – including human societies. Living systems tend, where possible, to shun rather than engage in competition.

# What organisational design features facilitate (and limit) innovation?

*Autonomy and discretion*

The OECD (2010a) found that in nations where work is organised to support high levels of discretion in solving complex problems, firms tend to be more active in terms of innovations developed through their own in-house creative efforts. In countries where learning and problem-solving on the job are constrained, and little discretion is left to the employee, firms tend to engage in a supplier-dominated innovation strategy. Their technological renewal depends more on the absorption of innovations developed elsewhere (OECD 2010a page 57).

Why might this be so? Part of the reason is that innovations (or ideas) can be generated at any level of an organisation. Senior management has no monopoly on good ideas, nor need it have any special capability in generating them. Senior managers are not necessarily selected on the basis of their capacity to generate new ideas. Thus a top-down organisation may tend to restrict idea generation. Even at the selection stage of innovation, senior officers within a hierarchical organisation may not give due consideration to ideas of more junior officers. They may be more impressed by the merits of their own ideas rather than looking deeply into the shortcomings of their own ideas and the strengths of alternative ideas. Thus rational consideration of a variety of ideas may be limited.

Green and his colleagues identify as a key driver of public sector innovation “As in the private sector, the men and women who join the public sector are increasingly highly educated and seeking to contribute as fully as possible to their organisations and outputs, and through this broader engagement to develop themselves and deepen the meaning of their professional lives: Humans are wired for creativity; we long to express it. By emphasizing innovation, you will be tapping into your staff’s deepest intellectual and professional desires…” (Green et al 2013 p.18-19) If so, the deepest intellectual and professional capabilities of staff would be best utilised by extensive devolution of responsibilities and discretion to staff at lower levels of the organisation.

Green and his colleagues specifically state “Top-down decision making and an emphasis on detailed planning may limit the identification of options and impede innovation.” (Green et al 2013 p. 25) An over-emphasis on hierarchy and ranks inhibits staff from freely contributing their ideas and expertise to projects, and hampers communications among people of different grades. (Green et al 2013 p. 26)

The Public Service Commission (2013) points to the importance of leadership in supporting a culture of innovation. The Discussion Paper states

Good leadership includes delivering positive messages that support innovation, giving permission to try new ideas, and making a commitment to being open-minded to suggestions about new ways of doing things. It is also important to change the perception that leadership just comes from the top. Authority should be delegated and people on the frontline trusted to make decisions. (Public Service Commission 2013 p. 15)

## Networks

Worker autonomy and professionalism appears to be necessary for innovation. So too are networks. For example Johansson suggests

School autonomy goes hand-in-hand with being connected to community, other educators, and the broader society. Hence, the key roles of networks and partnerships. Too much educational practice in OECD countries is characterised by isolation: schools from parents and the community and from each other; teachers and learners in isolated classrooms. (Ylva Johansson, of the Swedish E-Learning Organisation, in Johansson, 2003, p149).

The presence of networks even within a hierarchical organisation may contribute to innovation. Caldwell (2009) provides evidence that *networks* are making a contribution to the *transformation of education* - significant, systematic and sustained *change* that secures success for all students in all settings (Caldwell 2009 page 4) – or innovative change on the scale of an epidemic as Hargreaves puts it. A network is defined by Caldwell as an association – formal or informal, temporary or permanent, mandatory or voluntary – between individuals, organisations, agencies, institutions or other enterprises, through which participants share knowledge, address issues of common concern, pool resources or achieve other purposes of mutual benefit. (Caldwell 2009 page 6).

Caldwell argues that networks “appear indispensable if knowledge about best practice is to be spread quickly and if there is to be flexibility in response to the rapidly-changing needs of nations. Advances in technology make this more feasible than ever.” (Caldwell 2009 page 43) Thus networks appear crucial to the re-generation of innovations. Networks are also important in idea generation and in testing (or developing) innovations.

Caldwell suggests that hierarchies should not be replaced by networks, but rather organisations should be seen as a sort of double-helix system, with hierarchy and networks perpetually influencing each other, ideally co-evolving over time to become more effective. (Caldwell 2009 page 8). Networks enable ideas to be generated, tested and disseminated within an organisation that may have received little consideration without the networks.

Nor need traditional approaches to schooling be replaced by networks. Using an epidemiological metaphor, Hargreaves (2003) suggests that networks in schools may create innovative change on the scale of an epidemic. But be sees these networks as enhancing rather than replacing traditional approaches. Hargreaves writes:

Knowledge-based networks are not the alternative to existing forms of public provision: they are an essential complement. Rather than being represented by an organisational structure or single policy lever, transformation becomes [a feature] of the whole system as it learns to generate, incorporate and adapt to the best of the specific new ideas and practices that get thrown up around it (Hargreaves, 2003, pp12–13).

The presence of networks themselves, of course, is not sufficient to create innovative change. To transform education, these networks need to be effective. Hargreaves argues that networks in education tend to succeed when:

1. There is a clear and agreed outcome to the network’s activity.
2. The benefits of networking – creating the network, operating is and maintaining it – exceed the costs, since lack of pay-off is disincentive to continuation.
3. The participants are committed to professional learning through collaboration, sharing and joint activity, with agreed ways of working.
4. The network contains high social capital and its two key components: trust between members and norms of reciprocity.
5. Leadership and management are distributed and supportive.
6. There is appropriate support in terms of time and/or resources, an appropriate model for professional development that connects innovation to normal professional practice.
7. There is a good balance in communication between face- to-face and electronic and virtual forms and e-networking is instituted after trustful, face-to-face networks have been established (Hargreaves, 2008, p33).

Recent advances in information and communications technologies have the potential to transform school education in part because these technologies are increasingly an effective medium for networking. As Brown and Adler (2008) note, Web 2.0 has blurred the line between producers and consumers of content and has shifted attention from access to information toward access to other people. New kinds of online resources— such as social networking sites, blogs, wikis, and virtual communities— have allowed people with common interests to meet, share ideas, and collaborate in innovative ways. It has thus extended networking capacities.

It is important for the promotion of innovation that organisations balance support for *individual autonomy* by allowing employees high levels of discretion in generating ideas of their own and promoting *networks* to discuss and debate these ideas. Girotra, Terwiesch and Ulrich (2009) conducted a field experiment in which they compared two models of *generating ideas*:

• Team structure: Group works together at the same time together in a room to generate ideas.

• Hybrid structure: Individuals generate their ideas independently then meet together in a group.

Their objective was to determine which of those two structures generated more ideas, ideas of higher quality and is better able to discern the quality of ideas. They found in all cases that the hybrid structure outperformed the team structure.

This study suggests that to best generate ideas, organisations should develop space for employees to generate ideas in advance of discussing them collaboratively in a network.

## Opportunity promoting culture

The NSW Public Service Commission notes that “an innovative public sector cannot be risk averse. The causes of risk aversion are many and varied…. To counter risk aversion, the Commission suggest, at least initially “building the capability of public sector decision makers to effectively manage calculated risk.” (NSW Public Service Commission Page 15)

Better risk management may be a necessary counter to a risk-averse culture, but it is not sufficient. Furthermore, it does not go as far as the adoption of risk-*taking* norms, as suggested by research relating to organisational characteristics that support innovation (Crossman and Apaydin, 2010).

Cultivation of innovation requires a greater focus on identifying and fostering *opportunities* and less on risks and risk management. Too great a focus on risk and risk management may divert attention from opportunities to improve organisational performance, and identification of ways to realise these opportunities. Too much focus on risk management can result in looking inwards and myopia. An organisation that identifies opportunities to improve its services, and develops strategies to realise these opportunities is more likely – by definition – to be innovative. Risk management may be necessary at the stage of testing innovations, but it will do little to help identify opportunities or to foster them.

As Green and his colleagues note “the empowerment of staff, the encouragement of new ideas, the tolerance of risk-taking and mistakes, so important for innovation, are muted by a conservative, risk-averse culture.” (Green et al 2013 p. 21)

An opportunity promoting culture is tolerant of risks and mistakes. As Thomas Edison is reported as saying, ‘I have not failed, I’ve just found 10,000 ways that won’t work’. Edison captures the spirit of experimenting and learning expressed in ‘Fail often, fail well’ (Green et al 2013 p. 28)

## Innovation as both a process and an outcome

Crossan and Apaydin (2010) suggest that innovation is both a process and an outcome. According to this view, the means through which an innovation is developed will have an impact on the outcome.

It is therefore worth questioning how characteristics of the innovation process might impact on the nature of the innovation outcome. If the opportunities for collaboration are typical of the prevailing organisational culture it is worth considering how this might influence the type of ideas that are proposed. These characteristics include the seniority and roles of those responsible for its oversight and leadership, the degree to which the innovation process is structured, and how the formality of the interactions might impact the nature of the innovation outcome. Such characteristics may convey presumptions about the nature of ideas that would be deemed acceptable in pursuit of the innovation outcome.

The NSW Public Service Commission is establishing an innovation leadership program open to executives. This program will focus on building capabilities in, and exposure to, innovation trends through information sessions and the application of innovation principles to public policy problems. This group will also form the core component of an innovation network; a forum to improve innovation in the NSW public sector (NSW Public Service Commission, 2013).

It may be worth considering whether these arrangements parallel current organisational practices and culture. These arrangements might limit the potential vision of innovation to outcomes. For example, limiting membership to the leadership program according to seniority reaffirms existing power structures which may have the potential to bias attempts at innovation towards the status quo.

Alternative collaboration opportunities may create temporary spaces that can flatten perceived or actual power structures and highlight values that promote innovation, such as information-sharing.

## Time for innovation

The planned innovation strategy in the NSW Public Services Commission can also be evaluated in terms of five strategies for cultivating a culture of innovation in schools identified by Breakspear (2010). Three of these strategies relate to the development of networks and are supported by the innovation plan proposed by the NSW Public Services Commission. They are:

* Open Forums **–** Leaders need to create a forum for sharing innovative ideas in a non-hierarchical and open way
* Regular Exposure ‘to best’ and ‘next practice’ - Creative thinkers purposefully expose themselves to ideas outside of their dominant discipline or sector
* Share between silos **–** for example**,** teachers observing each other’s classes.

Another two of Breakspear’s strategies relate to encouraging greater autonomy and discretion to innovate. They are:

* Experiments with new approaches– avoiding a culture of risk aversion based on the “misinformed assumption that schooling is too important to try new things”.
* Giving permission and providing time– in reality, the only way to encourage innovation is to structure innovation time, into the regular working week.

Breakspear gives the example of Google. Their staff is encouraged to devote 20 per cent of their work time to innovative projects of their own. The message to employees is clear - continual improvement will come from your ideas and initiative. In the context of schooling, encouraging innovations in teaching practice by providing time for teachers to innovate, has implications for the design of curriculum.

Van den Broek (2012 p. 5) identifies eight innovative research-based approaches to learning and teaching:

* *Fostering Communities of Learning* is a constructivist approach in which teachers help students discover important curricular concepts.
* *Learning by Design* is an inquiry-based science learning program based on case-based reasoning models.
* *Central Conceptual Structures* (CCS) theory describes developmental changes in children’s thinking and what is needed to progress through stages in specific cognitive domains.
* *Web-based Inquiry Science Environment* (WISE) is an internet-based adaptive learning environment building on the principles of knowledge integration.
* *Cognitive Tutors and ACT-R theory* are intelligent adaptive software programs that provide students with scaffolded instruction and feedback.
* *Direct Instruction* aims to accelerate learning through clear scripted direct instruction by the teacher and scaffolded practice aimed at student involvement and error reduction.
* *Higher Order Thinking Skills* (HOTS) is for disadvantaged students especially to engage in Socratic dialogues about ideas and strategies to solve computer game-based problems.
* *Knowledge Building* is a constructivist teaching approach centred on building knowledge and creating knowledge communities.

These approaches are by no means exhaustive of innovative research-based pedagogies. Van den Broek would urge teachers to use these and other approaches in combination and not to rely too heavily on any one approach.

Design of the curriculum can influence the uptake of innovative research-based pedagogies and experimentation.

Curriculum specifications in syllabus documents can influence the types of pedagogies adopted by teachers. For example, giving too much emphasis to propositional knowledge (knowing that...) in a syllabus over skills or capabilities (knowing how...), or specifying too much content (propositional knowledge) in syllabus documents can result in pressuring teachers to rely on didactic pedagogies to deliver that content. While in many English speaking nations there is a well-established division of labour between curriculum developers and teachers, curriculum authorities make decisions about what is in the curriculum and teachers make decisions about how to teach it, *curriculum developers need to be mindful of the influence on pedagogy that curriculum might have*. Care needs to be taken with the amount of content specified in syllabus documents. There are political pressures to include too much content in syllabus documents. To suggest that particular content should not be included in the curriculum is seen as tantamount to suggesting that this content is not important.

Is it feasible to reduce the content specified in curriculum without compromising quality of education?

The current Global Education Reform Movement (Sahlberg 2012) would answer this question in the negative. Since the 1980s, at least five globally common features of education policies and reform principles have been employed in attempts to improve the quality of education, especially in terms of raising student achievement.

1. *standardisation* in education….
2. *increased focus on core subjects* in curriculum, such as literacy and numeracy.
3. teaching with *prescribed curriculum;* in other words, searching for safe, low risk ways to reach predetermined learning goals. *This minimises experimentation, reduces use of alternative pedagogical approaches, and limits risk taking in classrooms and schools.*
4. *Transfer of models from the corporate world* as a main logic of change management.
5. *High stakes accountability policies for schools* (Sahlberg 2012 page 101 emphasis added)

However, at least one high performing nation, Finland, does not have a content driven curriculum.

Andy Hargreaves (2010) notes that

In Finland, the state *steers* but does not *prescribe* in detail the national curriculum. Trusted teams of highly qualified teachers write much of the curriculum at the level of the municipality, in ways that adjust to the students they know best.” (Hargreaves 2010 p 53)

Linda Darling-Hammond observes that the current national core curriculum in Finland is a lean document – featuring fewer than 10 pages of guidance for all of mathematics – which guides teachers in collecting local curriculum and assessments. (Darling-Hammond 2011 page 169). This lean curriculum appears to be compatible, at least, with the use of a variety of innovative pedagogical approaches. Darling-Hammond observes

Inquiry is a major focus of learning in Finland… In a Finnish classroom it is rare to a teacher standing at the front of a classroom lecturing students for 50 minutes. Instead, students are likely to be conducting science investigations; measuring, building or calculating answers to design problems; and reading and writing for a variety of audiences and purposes. Students are likely to be rotating through workshops, or gathering information, asking questions of their teacher, and working with other students in small groups. (Darling-Hammond 2011 p. 169)

Despite not prescribing its curriculum in detail, Finland is widely recognised as having a highly successful school system – amongst the most successful in the world. Indeed, contrary to the approach of the Global Education Reform Movement, the OECD states that most successful school systems – those that perform above average in international tests and show below-average socio-economic inequalities – grant greater autonomy to individual schools to design curricula and establish assessment policies. (OECD 2010b page 14)

## Focus on the public good

The OECD (2010a) suggests that a customer focus is a feature of innovative workplaces. The OECD writes:

Customer focus is interesting from two standpoints: on one hand customers are an important source of feedbacks, comments and suggestions on the organisations’ activities; on the other hand, changes initiated by customers’ feedback have a “natural” legitimacy and lower conflict potential than changes initiated from inside the organisation. This is particularly true in the public and service sectors where a large fraction of the labour force works in direct contact with the customer (whether client, citizen, pupil, patient, etc.) (OECD 2010a page 128)

The OECD analysis might be broadened to better take account of innovation in scientific organisations. Gertner (2012a) cites Mervin Kelly, President of Bell Labs 1951-1959 as suggesting that all innovation arises from definite need, for example from economic, operational, cultural or military necessities. If so, a focus on the *public good* might be a feature of innovative workplaces. A focus on the public good may foster a shared sense of purpose and a commitment of employees so that they are all pulling in the same direction. As Gertner (2012b) observes “The teams at Bell Labs that invented the laser, transistor and solar cell were not seeking profits. They were seeking understanding. Yet in the process they created not only new products but entirely new — and lucrative — industries.”

To summarise the discussion so far, innovative organisations have the following features: they support high levels of discretion/autonomy of employees in solving complex problems; they allow staff time to try new approaches; they encourage the development of networks to discuss and test innovations and to share promising approaches; they promote the identification of, and development of, opportunities, rather than a focus on risk; they view innovation as both a process and an outcome and they focus on the public interest. In the following section, we consider how these features are reflected and combine together in examples of innovative organisations.

# Some case studies of innovative organisations

## Bell Labs

Gertner (2012) reported on a five year study of innovative processes at Bell Labs, formerly the R & D organisation of USA’s formerly monopolistic telephone company AT&T. Its approach had staff working on incremental improvements while thinking far ahead towards revolutionary inventions. This approach is the very opposite of Facebook’s Mark Zukerberg – who has as one of his mottoes, ‘move fast and break things’. Bell Labs could be described as “move deliberately and build things”.

Massive achievements of Bell Labs include the transistor in 1947. There are now billions of transistors residing on microchips powering our phones and computers; the silicon solar cell leading to first patent for laser; the first communications satellites; the first mobile phone systems; the first fibre optic cable systems; and so on. Some Bell Lab engineers focused on creating extraordinary processes rather than products.

Why did such a relatively small group of scientists and engineers at Bell Labs in New Jersey over a relatively short span of time produce an astonishing cluster of new technologies and ideas? According to Gertner “They invented the future, which is what we now happen to call the present”. Gertner identified one man in particular, Mervin Kelly who rose from researcher to Chairman of the Board, as a catalyst to this innovation. Kelly sought harmony and sometimes tension between scientific disciplines; researchers and developers; soloists and groups [autonomy and networks]. “Essentially Kelly was about creating interdisciplinary groups [networks?] – combining chemists, physicists, metallurgists, and engineers; combining theoreticians with experimentalists – to work on new electronic technologies.” (Gertner 2012 page 79)

Bell Labs featured an architecture and design from 1941 to ensure personal interaction [networking?] including long corridors linking offices. Gertner comments “By intention, everyone would be in one another’s way. Members of the technical staff would often have laboratories and small offices – but these might be in different corridors, therefore making it necessary to walk between the two, and all but assuring a chance encounter or two with a colleague during the commute.” (Gertner 2012 page 77) Corridors housing many physics researchers were intentionally made hundreds of metres in length. “Travelling its length without encountering a number of acquaintances, problems, diversions and ideas would be almost impossible.” (Gertner 2012 page 77)

Gertner writes “Physical proximity, in Kelly’s view was everything. People had to be near one another. Phone calls would not do.” (Gertner 2012 page 151)

All employees at Bell Labs were instructed to work with their doors open.

The researchers were *given lots of time* – years even - to pursue what they felt was essential. Gertner explains “In technology, the odds of making something truly new and popular have always tilted toward failure. That was why Kelly let many members of his research department roam free, sometimes without concrete goals, for years on end.” (page 152)

The fundamental goal of Bell Labs was to transform new knowledge into new things. *Freedom* was crucial especially in research. Kelly *trusted people to create. Trusted them to help one another.*

## ATLAS

ATLAS is a High Energy Physics detector built by an international community of researchers and located at CERN near Geneva. It forms an integral part of the Large Hadron Collider, a particle collider that accelerates particles – protons - in opposite directions in a ring beam at a speed very close to that of light before smashing them together. The colliding protons produce new, elementary particles. A theoretical prediction that ATLAS is involved in testing, concerns the Higgs-Boson particle that is hypothesised, by the Standard Model in particle physics to impart mass to elementary particles. (On 4 July 2012, it was reported that the ATLAS detector had indeed found a particle that is likely to be the Higgs Boson).

Designing and building ATLAS involved a complex combination of labour – or as Tuetscher (2011 p77) put it the “decomposition of tasks into smaller subtasks that facilitate distributed problem solving. The output of these sub-tasks has then to be reassembled into an integrated system that functions as a detector. Such integration requires coordination across boundaries.”

This combination of labour was *not imposed “top down”*. Rather the collaboration was organised as a loosely coupled network of independent research institutions. *No authority hierarchy* bound them to one another or drove the emergence of architectures. (Tuetscher 2011 p.78)

Technological issues alone did not drive the emergence of the ATLAS architecture. Tuetscher notes that ATLAS was informed by a perspective that acknowledges ongoing interactions between the social and technical facets of a sociotechnical system. None of these facets can independently explain the emergence of architectures. (Tuetscher 2011 p.79)

ATLAS was a collaboration involving 88 institutions. To sustain such a vast collaboration, research and development projects generated several competing technological options for each of the sub-systems. *Alternative technologies were kept open and irreversible technological choices were postponed* for fear of losing members whose favoured options were not selected. (Tuetscher 2011 p.82)

*This allowed time* to set up review panels to evaluate options. These had no mandate to make choices but could investigate the potential of competing technologies and make recommendations to the ATLAS collaborative board. The review panels functioned like a tribunal – challenging both advocates and critics of a technology. Taken-for-granted assumptions required justification. Scientists were required to justify their preferred options and to identify the potential shortcoming of competing alternatives. In effect, this required them to develop a deep understanding of the concepts that underpinned such alternatives. (Tuetscher 2011 p.85)

Mastering the question-and-answer procedure of the review process required knowledge, not only of the particular system components that a given group was working on, but also of the interdependencies that linked these components to others. A confrontation with alternative perspectives prompted scientists to scrutinise their own proposals and rethink some of their – often deeply held – assumptions. From the resulting deliberations, a collective knowledge structure emerged that provided scientists with an understanding of how ATLAS and its related components functioned – interlaced knowledge. (Tuetscher 2011 p.86)

# What processes are available to analyse and evaluate innovative ideas?

In terms of the Darwinian account of innovation adopted in this paper, the analysis and evaluation of ideas relates largely to the testing/selection stage.

Very briefly, networks play a crucial role at this stage, in terms of a facilitating debate within the organisation and promoting what Amartya Sen calls reasoned scrutiny from different perspectives. According to Sen to be objective, reasoning about justice needs go beyond the boundaries of a state or region because of the pertinence of other people’s *perspectives* to avoid under-scrutinised parochialism of values and presumptions in the local community. (Sen 2009 page 402) Similarly, in selecting ideas, an organisation needs to foster reasoned scrutiny from different perspectives. The process described above in relation to the review panels in the ATLAS project is a useful model. Again, delaying and keeping open irreversible choices to allow time for debate is an important process in the successful analysis and evaluation of ideas. The success of the analysis and evaluation depends on selectors giving each idea its due, and not being too hasty to dismiss ideas. Scrutiny of ideas should involve drawing on contexts from outside of the organisation as well as within it.

It is important to have a fair process for assessing ideas, for as Green and his colleagues observe “Any organisation that encourages and is open to a flow of new ideas soon faces the challenge of assessing those ideas. If proposers of new ideas for change perceive that their ideas are not assessed competently and fairly, that flow will soon dry up, replaced by a cynicism that will impede future change efforts.” (Green et al 2013 p.26)

The approach to assessing ideas adopted by the ATLAS project, and described above, is a model for better practice.

A number Hughes and Brock’s (2008) principles seem pertinent to the analysis and evaluation of ideas in the context of innovation in education.

* As a starting point for any proposed reform, review and learn from the lessons of history,
* Conceptualise reform as a spiral, rather than as a linear, process. This leaves *time and conceptual space* for ongoing reflection, critical questioning, and reconsidering initial assumptions.
* Identify instances where inter-group tensions engender information hoarding.
* Critical questioning should be recognised and rewarded; and innovation should be encouraged.
* Reduce organisational rigidities: identify and decrease functional as well as hierarchical and non-hierarchical barriers; and encourage staff to expand their skills and knowledge beyond narrow specialisations.
* Prize organisational / corporate memory: establish systemic structures to ensure that lessons learnt are not subsequently forgotten.

# What processes are available to cultivate the most promising of these ideas and sustain them?

Again, networks have a key role to play in cultivating the most promising ideas. Recall Caldwell’s claim that networks “appear indispensable if knowledge about best practice is to be spread quickly and if there is to be flexibility in response to the rapidly-changing needs of nations. Advances in technology make this more feasible than ever.” (Caldwell 2009 page 43)

One model to respond to the need to implement and sustain innovations is Design-Based Implementation Research (DBIR; Fishman et al, 2013). DBIR is a research-based method for solving practical problems with view to bridge the divide between education research and educational practice. DBIR offers an approach to address the implementation needs and challenges that are specific to education and learning environments through the design and testing of effective, scalable and sustaining innovations.

For example, tools and practices for learners and educators are the refined through iterative cycles of design as are the necessary means of support for implementing these tools. The iteration cycle loops back to researchers who apply the sample principles of refinement to the tools used for implementation to better reflect what is being learned through the research.

The principles of DBIR include:

* A focus on persistent problems of practice from multiple stakeholders’ perspectives
* A commitment to iterative, collaborative design
* A concern with developing theory and knowledge related to both classroom learning and implementation through systematic inquiry
* A concern with developing capacity for sustaining change in systems

In relation to innovation in general, DBIR expands the methods available for developing evidence related to the implementation, efficacy and scaling of innovation.

# Conclusion

Innovation is trying something new - organisational adaptation to changing circumstances. Collaboration rather than competition is necessary to collaboration. Competition may be a circumstance requiring adaptation and innovation.

Innovative organisations support high levels of discretion/autonomy; allow staff time to try new approaches and to discuss new ideas and approaches; develop networks to discuss and test innovations and to share promising approaches; promoting the identification of, and development of, opportunities, rather than focusing on risk; view innovation as both a process and an outcome; and focus on the public interest.

Processes for analysis and evaluation of innovative ideas include: reasoned scrutiny from different perspectives; avoiding under-scrutinised parochialism of values and presumptions in the organisation and delaying and keeping open irreversible choices to allow time for debate.

Processes to cultivate the most promising of these ideas and sustain them include: a focus on persistent problems of practice from multiple stakeholders’ perspectives; a commitment to iterative, collaborative design; a concern with developing capacity for sustaining change in systems.

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