Re-setting science and innovation for the next 20 years

Enabling innovation

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The link between scientific research and economic development is intuitively understood, but difficult to prove. This means not only that increasing research investment requires a leap of faith, but also that guarding what money is invested has become paramount. The effect has been management lockdown in an attempt to guarantee no wastage and drive productivity. McKinsey Quarterly points out that very few executives know what it takes to improve productivity of knowledge workers such as scientists. Researchers from Dartmouth College School of Business suggest that the answer is a twist on Skunk Works®, which concentrates innovative effort on a topic, while closing the loop between ideas and results. Building dedicated innovation teams which are free to recruit people who are wayward thinkers is the first step. The teams must also be free from some of the constraints that prevail in the rest of the company. The big difference between innovation teams and Skunk Works is that the teams remain integrated with the main company. The big difference for the scientist is focus on topic and freedom in operation. With the reorganisation of the science system, New Zealand has the chance to create an environment in which scientists flourish, can be truly creative and innovative, and their developments will drive productivity and the economy.

Introduction

The turn-of-the-century 'Knowledge Wave'[1] has been followed by a political desire for innovation. Knowledge, it is now recognised, must be turned into something in order to have more than just intrinsic value, and it is the consequent innovation that is perceived to have the impact on economic development.

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For developed countries around the world, innovation is being seen as the key to further development (in terms of household income, lifestyle and services) and the economic benefits of an engaged and motivated population.

Education, research and development (R&D) are generally considered (Bassanini & Scarpetta 2001) to be fundamental to this economic progress. More specifically, the ability to create wealth from innovation (Porter & Stern 2001) has been linked to the number of scientists and engineers in the workforce. This has been discussed in previous papers (Rowarth & Goldson 2009; Rowarth 2010).

Nobel Laureate and US science envoy Ahmed Zewail, writing in *Nature* (Zewail 2010), is clear: innovation comes from discovery based on ground-breaking knowledge which in turn comes from solid investment in science education and a fundamental science base.

Innovation and discovery shape the future and change people's lives for the better.

Because of the global focus on the role of innovation in economic development, new reports are constantly being published. This paper brings the new research behind the recent reports into

[1] In October 2000, the University of Auckland in partnership with the New Zealand Government and supported by business initiated the Catching the Knowledge Wave project. A pivotal event of the project was the Catching the Knowledge Wave Conference on 1–3 August 2001, http://www.knowledgewave.org.nz/index_home.php In Febuary 2003, the Knowledge Wave Trust organised the Leadership Forum which brought together existing and emerging leaders in an attempt to form a national network which would lead to a catalyst for achieving a prosperous, cohesive society, http://www.knowledgewave.org.nz/index.php?fpg=about [Editor]

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the New Zealand context, where the reorganisation of the science system gives the opportunity to make positive changes.

UK Innovators Council Report 2010

The first report of the UK Innovators Council, formed in 2009 'to tackle the barriers to and inspire the adoption of innovation', was produced this year. Council member Peter Housden, Permanent Secretary for the Department of Communities and Local Government, concluded that 'Innovation thrives best where there are effective alliances between small organisations and entrepreneurs (the 'bees' who are mobile and fast and cross-pollinate) and big organisations (the 'trees' with roots, resilience, and size) which can grow things to scale'.

Barriers to innovation were identified (HM Government 2010) as:

1. 'Transition support' for innovations,
2. Unintended consequences of regulations & procurement frameworks,
3. Clarity around the role of innovation hubs and innovation centres,
4. The way in which performance of small-scale innovations is measured and management information is used and valued,
5. Current funding structures, and
6. Culture which both exposes innovators to considerable personal risk and sets low expectations for what people can achieve for themselves.

All six factors have been apparent in New Zealand and are at least part of the reason for the reorganisation of the science system with the aim of unleashing time and encouraging collaboration. The emphasis is best, perhaps, not on the need for 'small organisations', but in recognising the important role of highly industrious teams/units (those 'bees') operating relatively free of the overheads and commitments of large managerial systems. Small energetic teams/units, given a greater degree of autonomy, can act quickly, the teams arising in many cases relatively spontaneously, by making the right kind of connections for the most effective collaborations.

The Innovators Council concluded that success in innovation depends to an extent upon opportunities for public/industry and creative professionals to come together with the opportunity to mobilise and test ideas rapidly. Creative innovation still rests on rigorous processes and full accountability; only with rigour in combining raw insight and creative thinking with sophisticated demographic and economic analysis is innovation likely to be useful. A critical distinction for successful innovation is perhaps that the sense of the purpose of the endeavour is allowed to determine what process is required to maintain its rigour, rather than having a situation where a 'process' and its 'management' determine what level of creativity, and innovation are possible.

Creativity and management

Despite the general understanding about creativity and what it takes to achieve it, considerable research has shown that creativity is innate in humans; Florida (2003) ranks creativity on the ability to create 'new stuff' and puts scientists and engineers as the most creative in the workforce, followed by university professors, poets and novelists, artists, entertainers and actors, designers and architects. Further research (Amabile *et al*. 1996) has shown that deadlines, competition, bonuses, fear and downsizing are antithetical to achieving creative outputs. A culture of support is required to enable people to be creative potentially leading to innovation (Amabile & Kramer 2010). A culture of pressure and regulated outcome leads to suppression of creativity (Amabile *et al*. 1996).

Creativity is encouraged (or killed) by focusing on various factors and doing the right (or wrong) thing (Amabile 1998): See Table 1.

Management has a big part to play in creating the right environment, and has been blamed by business strategist Gary Hamel for lack of performance in staff (Varon 2007). The transition required of business models which currently focus on efficiency to encouraging innovation by allowing 'diversity of thought and action (Hamel 2007) has been outlined in earlier papers (Rowarth & Goldson 2009; Rowarth 2010). The transition requires a cultural shift in management which will take considerable effort and encouragement from leaders to achieve (Barsh 2007).

The Ministry of Economic Development (in conjunction with New Zealand Treasury, the Department of Labour and New Zealand Trade and Enterprise) released a report on 'Management Matters in New Zealand'[2] in May 2010. Sixteen countries

[2] See http://www.med.govt.nz/upload/72724/Management%20matters.pdf

[3] A method developed by the London School of Economics and McKinsey & Co to review management practices in manufacturing firms, identify key determinants of management performance and interpret the relationship between management capability and firm performance. (See Bloom, N.; Van Reenen, J. 2007. Measuring and explaining management practices across firms and countries. *Quarterly Journal of Economics 122 (4)*: 1351–1408.)

Table 1.Factors affecting creativity

Category	What should happen	What usually happens
Challenge	Matching people with the right assignment	Don't gather information to make a connection
Freedom	Give people autonomy to the means, not choose the ends	Keep changing the goal; give freedom in name only (short leash)
Resources	Time, money, space. Balance fit between resources and people	Fake deadlines, give impossible deadlines, restrict resources
Work-group features	Create diverse, supportive teams – share excitement, willingness to help and recognise talent	Select homogenous teams; quicker results but unexciting/nothing special
Supervisory encouragement	Recognition of work, 'cheering section', praise, not extrinsic rewards	Failure to recognise efforts, greet efforts with scepticism
Organisational support	Leader support through value emphasis, mandating collaboration/information sharing	Money – 'bribes'. No recognition or reward in place, political sabotage

have been examined using the McKinsey methodology[3], and last year 152 New Zealand manufacturing companies employing more than 100 people were examined. New Zealand companies rank tenth among the sixteen countries examined in terms of management practices.

Governance and regulatory regimes were considered to be of high standard, but there were clear areas where the country has 'room for improvement'. Worst performance was found in people management: 14th, bracketed with India and Portugal. In particular New Zealand was placed bottom on 'addressing poor performance', 14th in 'retention of high performers', 13th in 'promoting high performers' and 8th in 'building a talent mindset', 'rewarding top performance' and 'attracting high performers'.

Effective management practices have been shown to be positively related to productivity in many countries, including New Zealand, particularly in terms of financial performance per employee.

Although much has been said about the importance of good people management, particularly by people such as Lester Levy (University of Auckland) with his 'hearts and minds' research, a change in approach seems to be taking some time to occur. One problem may be that in large organisations, it is too easy to lose track of core purpose. Few organisations are ever set up with 'management' as the very reason for being (though this may apply for funding agencies, levy boards, and trusts). Lack of trust in the capacity of scientists to direct their own research and innovation programmes has resulted in a culture of micro-management. This problem has been diagnosed by human resource experts such as Ken Cloke, Center for Dispute Resolution in the USA[4], as leading to a 'proliferation of middle managers who play games and try to keep others in line'. These middle managers focus on Key Performance Indicators which are financial or operational (in the Management Matters report New Zealand ranked 11th) and short-term (ranked 10th). Cloke also warns that as companies expand, access to information tends to stay at the top of the company, apathy builds up at the bottom, and the combination allows the middle managers to consolidate their power.

In New Zealand, with limited research budget and considerable pressure to perform, there has been a focus on managing the science process, rather than managing the environment in which the process occurs. This is understandable with the requirement to remain financially viable, but is not good for innovation. Nor does it enhance motivation, a core driver in creativity leading to innovation (Figure 1; Amabile 1998).

Further work from Amabile & Kramer (2010) has revealed that 76% of those surveyed relate their 'best work days' to making progress. As feeling happy leads to an increase in creativity the next day (Amabile *et al*. 1996, 2005), encouraging progress is clearly beneficial. It also improves the feeling of responsibility and usefulness, which are some of the internal aspects which lead to job satisfaction (Borooah 2009). In contrast, a focus on the external aspects (those which appear in the 'what usually happens' column of Table 1) such as pay, bonuses, benefits, holidays, lead to dissatisfaction. Implementation of these external factor are, however, easier to manage (and hence tick off) than a change in culture.

In order to effect the change, stretch goals for management have been identified (Hamel 2009) in an attempt to assist the reinvention of management for the 21st century. The top five are particularly relevant in the current context of rethinking the science system:

- Ensure that management's work serves a higher purpose
- Reduce fear and increase trust in professional staff
- Reinvent the meaning of 'control'
- Redefine the works of leadership, and the distinction between leader and manager
- Expand and exploit diversity

This culture change was a major point in Matson & Prusak's report (2010) on 'Boosting the productivity of knowledge workers'. The report identified major barriers to productivity as physical, technical, social or cultural, contextual barriers, and, simply, time.

These barriers hinder the kind of interactions between professional scientists and engineers which are critical for stimulating new thoughts and ideas. Physical and technical barriers include geographic distance, which can lead to differences in time zones when the right people for world class collaborations are not available locally, or in New Zealand. Social and cultural barriers include rigid hierarchy or lack of encouragement to collaborate and engage. Contextual barriers are those that impede understanding – for instance, the difficulty in translating management-speak into bench action. Finally, the barrier of time or the perceived lack of it, usually because of conflicting requirements and time spent doing what the employee considers to be non-vital work which means lack of progress towards research goals.

One of the common ways of addressing these points is for management to attempt to improve communication and understanding by sending out newsletters and updates. Unless these are focussed on core business for the knowledge worker, they are simply a distraction, adding to loss of focus. The value of traditional PhD research is the focus on one topic, outside most of the organisational requirements for meetings/reports/newsletter and emails. It doesn't add up to the 10 000 hours required for expertise, but it is a very important start. (Malcolm Gladwell, author of Outliers, has calculated that it takes 10 000 hours to achieve expertise. He hasn't found a top player (sport or music) who hasn't put in the hours, or a mediocre player who has (Gladwell 2008).)

[4] See http://www.kennethcloke.com/index.html

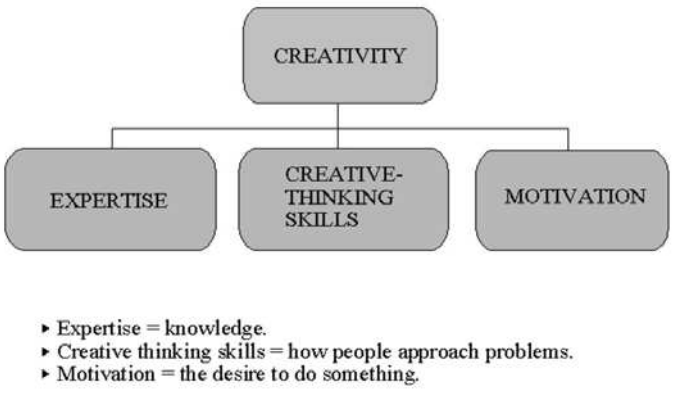

Figure 1. Core drivers in creativity.

The importance of focus

Gallup Poll Research has identified that 91% of those surveyed in the USA who felt 'well-being' the day before the survey, had experienced being treated with respect. Over 80% had enough energy to 'get things done', and 'smiled or laughed a lot', over 70% felt well-rested, and nearly 70% felt that they ate in a healthy manner. Sixty per cent of people surveyed who felt happy had learnt or done something new or interesting. Only a third worried about money.

Of further note, from research by Harvard University happiness experts Daniel Gilbert and Matthew Killingsworth, is that people are most happy when they're focused. The Gilbert & Killingsworth study involved 2200 people and approximately a quarter of a million responses via iPhones as to what they were feeling and what they were doing at the time they were contacted; significantly higher levels of happiness were reported by those that were focusing on an activity than those who were not (Bower 2010)

Focus leads to being in 'the zone' – the concept when everything gels and flows ... It applies as much to science and engineering as it does to sport, writing and painting. Focus allows progress to be made, leading to motivation (Amabile & Kramer 2010). Add to this the satisfaction that comes from having responsibility and feeling useful in work (Borooah 2009), and the theme is clear: people are happy when they feel that they are doing useful work, can make progress and get things done.

Ed Hallowell, psychiatrist and director of the Hallowell Centers in New York City and Massachusetts, says that focus is increasingly difficult to achieve in the workplace, where an ever-increasing amount of time (over 40%) is spent tending to unplanned interruptions and then reconstituting the mental focus the interruption caused (Hallowell 2010). His suggestion is augmented by research from University of London which shows that multi-tasking drops effective IQ by 10 points (the same effect as losing a whole night of sleep) – focus is lost, progress is delayed, and productivity drops.

This suggests that a system based heavily on frequent detailed reporting, as a presumed measure of accountability, removes the sense of responsibility that is so important for satisfaction (and the ongoing implications for creativity and innovation). It also suggests that reporting can act as a major reduction in time for focus, which, again, leads to reduced progress and hence creativity and innovation. Perhaps the worst thing is that it removes the personal responsibility for development and challenge.

The importance of the wayward thinker for adaptation and survival has been discussed in previous papers (Rowarth 2010). Pascale *et al*. 2010 support the contention in 'Power of Positive Deviance: How unlikely innovators solve the world's toughest problems'. They advise leveraging positive deviants – the few individuals in a group who find unique ways to look at, and overcome, seemingly impossible difficulties, and then spread and sustain the needed change.

In order to create focus, and so enhance creativity and innovation in employees, Govindarajan & Trimble (2010), from the Dartmouth College School of Business, Hanover, USA, advocate a new take on Lockheed's Skunk Works®.[5] The aim is to allow people to concentrate innovative effort on a topic, while closing the loop between ideas and results. The first step is to allow the building of dedicated innovation teams which are free to recruit people, even from outside the company, who are wayward thinkers. The teams must also be free from some of the constraints that prevail in the rest of the company so that although they have freedom to operate, they also maintain integration with the main company. Of equal importance is that although tight management might be maintained, customised rules are vital. Performance metrics can be difficult to identify in knowledge work, making it challenging to manage improvements (Matson & Prusak 2010). Being held accountable for ability to learn from mistakes rather than ability to hit budgets has also been proposed (Govindarajan & Trimble 2010), in conjunction with activity within a supportive environment (thereby removing fear, which is detrimental to creative outcomes).

The big difference between innovation teams and Skunk Works is that the teams remain integrated with the main company. The big difference for the scientist is focus on topic and freedom in operation.

Govindarajan & Trimble (2010) recognise that there is a trade-off between efficiency and innovation, but that in established companies it is the implementation of new ideas (rather than just their generation) that is the major challenge to be overcome.

Conclusions

In mid-November an article entitled 'The three threats to creativity' was posted on the *Harvard Business Review* website (Amabile 2010). 'Without the creativity that produces new and valuable ideas, innovation – the successful implementation of new ideas – withers and dies.' Successful organisations have an abundance of smart people who think differently, are passionately engaged with their work, and are employed within a creative atmosphere: freedom to pursue passions, challenging goals, collaborative norms, sufficient time to really think, and the resources people need to follow their dreams.

This is the ideal for the New Zealand science system.

Deep rethinking of goals and processes is required for the ongoing justification of curiosity-driven and mission-oriented research in the future (Nichols 2010). In the USA the emerging 'science of science policy' is assisting, with the recommendation that past returns on investments should be documented thoroughly to help set priorities and estimates of outcomes. Furthermore, reviewers must use intuition as well as analysis to sort out new ideas, and funding agencies must impose rigorous quality standards (Nichols 2010).

Increasing research investment into a regime of greater freedom and trust of highly trained professionals requires a leap of faith, given that the past environment of high accountability, and guarding what money is invested remains paramount. However, the alternative – a micro-management 'lock-down' in an attempt to guarantee no wastage and drive productivity, has not been conducive to satisfaction, recruitment, or retention.

Matson & Prusak (2010) point out that very few executives know what it takes to improve productivity of knowledge workers such as scientists; the focus on budgets (Ken Cloke, pers. comm. 2010) has not enhanced the creative culture. With the reorganisation of the science system, New Zealand has the chance to create an environment in which scientists flourish,

[5] See http://www.lockheedmartin.com/aeronautics/skunkworks/14rules.html

can be truly creative and innovative, and their developments will drive productivity and the economy.

Recommendations for the new science system

As Boards of Directors for organisations appoint the CEO, who sets the culture of the organisation, the composition of the Board must be considered in terms of reflecting the activities of the organisation.

Management at all levels must be re-educated, developed and realigned to the new intent. Managers taking responsibility for driving science endeavours must be professionals trained to a world-class standard in that area of science.

Research funding for scientists should follow track record, and have a component of free-time for investigator-led research. Young researchers, who haven't yet done their 10 000 hours, should be part of large programmes with expert scientists with track record as role models, mentors, and coaches.

Absolutely critical is that professional promotion should be by national or international (depending on grade) external peer review. New Zealand is too small to have within-organisation science career promotion, and the judgement of science professional performance cannot be made by middle managers untrained in science.

It is essential to allow trust, and a sense of profession, to build. This is vital to enhance the possibility of creativity and innovation. It requires more than a proliferation of internal newsletters and reports to demonstrate a belief in science. It requires a fundamental acknowledgement by government and industry of the importance of science, research and development in civilisation and for economic development. Not least, it requires recognition of the importance of the people who dedicate their lives, beyond the 10 000 hours, to the pursuit of knowledge and innovation in an attempt to improve our economic future, and increasingly, our mere existence.

In short – support the intent of the Report of the Crown Research Institute Taskforce (Jordan 2010).

Acknowledgements

Scientists, researchers, academics and policy analysts with whom considerable discussion has occurred over the past decades – all focused on constructing a system in which highly educated and knowledgeable people could excel for New Zealand's good.

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