

REGIONAL ENGINEERING EDUCATION HUBS

**AN INVESTIGATION INTO MECHANISMS FOR IMPROVING
THE SUPPLY OF ENGINEERS FOR NEW ZEALAND INDUSTRY**

A REPORT PREPARED FOR:
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EXECUTIVE ABSTRACT

The context of this study is the New Zealand vocational engineering education system. A problem previously identified is an undersupply of graduates at the precise level identified as the key to driving future economic growth; a problem at least in part attributed to insufficient numbers of suitably prepared students emerging from the school system. Regional education groupings, in the form of 'hubs', were proposed as one possible solution to this supply problem.

In 2017, researchers from Massey University School of Engineering and Advanced Technology (SEAT) were invited by the Tertiary Education Commission (TEC) to examine regional hubs which would arguably establish popular and effective pathways into engineering and offer a single entry point for engineering qualifications. The research conducted in this report proceeded via the following stages: Firstly, a literature review was undertaken to define the key definitions and models for, and enablers and barriers in the formation of, educational 'hubs'. Secondly, primary, empirical data were collected from a panel of experts to evaluate the understanding, feasibility, potential, barriers to and drawbacks of such hubs in the New Zealand engineering educational context. Sixteen (16) respondents were selected to take place in a 'Delphi'-type study. The respondents represented major cities and regions in New Zealand, and comprised academics from universities (5), polytechnics (4), and ITPs (1); high schools teachers (2); and industry experts (4). Most respondents could give a national perspective, but specific regions covered included Manawatū, Hawke's Bay, Waikato and Taranaki; while cities included Auckland, Wellington and Christchurch. We examined the issue of the supply of engineering through the lenses of supply chain management and systems theory.

Regional engineering education hubs are more a focused entity than the regional industrial clusters adopted in other countries. We identified two main functions for hubs:

- A facilitation and leadership function: bringing stakeholders together to develop a unified approach to engineering training and education at a regional level, identifying opportunities for collaboration and innovation within regions, and providing feedback to national policymakers.
- A service function: advising and informing students, providing liaisons between students, institutions and industry. This could be web-based, but human resource would be highly beneficial.

We identified a series of factors that needed to be considered in the establishment of regional hubs. These include the following factors:

DEFINING 'REGIONAL' IN THIS CONTEXT

'Regional hub' describes groups that are organised around local geographical locations or populations (whether those locations are provincial or metropolitan) rather than national,

centralised institutions; notwithstanding the formation and funding of regional hubs may be centralised (Section 3.2, section 4.2 Q2c).

HUB 'DRIVERS'

Regional Hubs should be formed based around a specified need or gap of relevance to the region. The willing collaboration of like-minded organisations and institutions requires such a common need, which will ensure the participation of all players.

HUB PARTNERS

Hubs should be formed from 'like-minded' organisations, which are willing and able to co-operate to fill the common need or gap. These actors include: educational institutions (universities, technical colleges, polytechnics, schools); employers; and civic groups (e.g. careers service, professional industry bodies).

HUB GOVERNANCE

Regional hubs require a governance structure in order to be 'viable' self-sustaining entities. Governance, as always, implies defining the vision, ensuring there is accountability and oversight of operations, managing risk, controlling budget and continual evaluation and improvement. A two-tier structure is suggested with a central governance group (open to all partners) supported by (educational) institution local governing board(s).

CO-CREATING EDUCATIONAL PATHWAYS AROUND THE NEEDS OF THE LEARNER

Regional hub members should co-create educational pathways around the needs of the learner. This is in keeping with the contemporary lean thinking principle of the 'value stream', whereby the value is first defined from the user's perspective, and then the delivery process is (re)designed around the flow of value through the experience.

PHYSICAL CONTACT WITH THE HUB

Regional hubs need a point of contact for the learner. This will be a space where the learner can interact with employers or educational providers, be guided by them, but also inform them of their needs and requirements, so that a pathway can be tailored for them.

PILOTING THE REGIONAL HUB PROPOSAL

In attempting to establish regional hubs in the New Zealand context, there is a need for a pilot hub to be trialled in one region. The hub will be based around an identified need within one region, and will 'test' or validate the mechanisms for governance, cooperation, physical location and delivery.

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1. INTRODUCTION

The context of this study is the New Zealand vocational engineering education system. Engineering education certainly does have a higher level of academic research–focused degree education, but even NZQA level eight honours degrees are primarily meeting the demand of industry for highly capable engineers rather than meeting demand for research scientists. Engineering education therefore has a strong vocational element at all levels, even if the “vocation” at the higher levels of qualification is professional in character. The demand for level six and seven technicians and technologists has been recognised by Government as a key driver of future economic growth (IPENZ, 2010). The demand for graduates in the IT industry is particularly notable, with University IT engineering staff reporting that tempting job offers are removing potential Masters and PhD students from the engineering education supply chain (Frater & Grigg, 2015). A problem identified in the New Zealand engineering education system is an undersupply of graduates at the precise level identified as the key to driving future economic growth; a problem at least in part attributed to insufficient numbers of suitably prepared students emerging from the school system (Frater & Grigg, 2015). In addition to an undersupply of skilled and qualified engineers, New Zealand has high levels of youth unemployment (around 13% in 2017), especially among the indigenous Māori and Pasifika population, despite a growing economy. This investigation was conducted as a review of literature; a survey of opinions from selected experts across the range of stakeholders and an analysis of these two elements. The report’s authors are systems researchers, and have applied the systems thinking and cybernetics bodies of knowledge as an interpretative lens.

1.1 BACKGROUND

Trends such as the ‘binary’ tertiary systems adopted in the 1960s in Australia and the UK (Scott, 2014) have influenced the New Zealand engineering education system, despite early Government policies that sought to isolate New Zealand from external influences (Abbott, 2000). Government intervention in the late nineteenth and early twentieth centuries addressed the reluctance of high schools and universities to provide vocational training, firstly through school-based training then through the establishment of technical schools. Technical schools were expressly regulated against degree level education, and from the 1950’s onwards industry needs were met by the “middle ground” qualification of NZCE; an engineering certificate that sat just below degree level, but which provided a pathway to higher professional qualifications. New direction was provided during the economic reforms of the late 1980s, with the stated intention of de-centralising tertiary education, although analysis claimed that the end result was devolution of responsibility, but centralisation of power (Snook, 1991). NZ Government relaxed policy, allowing and encouraging polytechnics to provide degree-level education.

A new degree, the Bachelor of Engineering Technology (B.EngTech) was adopted by the Metro Group of polytechnics as the New Zealand Qualifications Authority (NZQA) level seven successor to the New Zealand Certificate in Engineering (NZCE), with a level six diploma (the New Zealand Diploma in Engineering, the NZDE) fulfilling the requirements of trade (Blakeley, 2013). While polytechnics have sought to achieve university status, universities have moved towards the provision of work-ready professional engineering employees. Abbott (2000) described this as a “blurring of the boundaries” between university and polytechnic. This ‘hybridisation’ is an international trend that is becoming more pronounced, with more overlaps and interconnections between employers and education providers (UNESCO, 2015). Another notable feature of the post 1980s period was the emergence of private training organisations. Whatever the ideological motivation of Governments, the result has been a level of competition between providers that can on one hand be argued to provide the consumer with more choice, but on the other hand be argued to result in a confusing landscape for students planning their careers. These initiatives represent the collective importance of employers, high schools, universities and ITPs in this challenge and the distinct strands that have been addressed in the work done so far. These are: public awareness, collaboration between secondary/tertiary institutions and employer engagement.

1.2 TERMS OF REFERENCE

In 2017, researchers from Massey University School of Engineering and Advanced Technology (SEAT) were invited by the Tertiary Education Commission to examine ‘regional education groupings’ in the form of ‘hubs’ which would arguably establish popular and effective pathways into engineering and offer a single entry point for engineering qualifications. Our remit entailed a review of higher education models, specifically hub models, and development of a set of factors which should be considered when establishing the engineering education hubs in New Zealand. This report provides a synopsis of recent literature on the nature of higher education models and the findings of an empirical survey used to collect the insights of key stakeholders. The literature review focused on higher education models that involve policy makers actively engaging with tertiary providers and employers to design and/or deliver, and perhaps fund a programme of learning. The survey questionnaire was focused on integrating the insights and experience of the key stakeholders regarding the regional education groupings. Conclusions and recommendations are made based on combined findings.

2. RESEARCH DESIGN

2.1 ANALYTICAL LENSES: SUPPLY CHAIN MANAGEMENT AND THE VIABLE SYSTEMS MODEL

The authors of the present report are educators and researchers from the engineering and industrial systems management field. We work extensively with systems thinking concepts, including quality systems and supply (value) chain management. In addressing the issue of regional hubs and in our previous related work (Frater & Grigg, 2015), we have adopted a supply chain system view to the supply of engineers to meet the needs of industry. In this view, industry is the customer and education is the supplier. Education as a supply (or value-adding) system, should work cooperatively and harmoniously towards addressing the needs of the market. Competition, localised optimisations or individual gains tend to sub-optimize the system as a whole. Secondly, and more relevant to the present study, in considering the structure of a regional hub, we have we have considered literature informing the structure of organisations; in this instance organisations that have been established to achieve national objectives, but which are delivered at a local level.

One widely endorsed theoretical model for organisations is Stafford Beer's Viable Systems Model (VSM). (Beckford, 1998; Beer, 1966, 1972, 1984, 1985; Raul Espejo, 1990; Raúl Espejo & Gill, 1997). The term 'viable' is used in the pediatric sense – a 'viable' child is able to survive and adapt within its environment. A key principle of this model is that organisations should be structured recursively rather than hierarchically. That is, organizational structures exist within larger structures (as cells exist within organs; organs within bodies; bodies within families etc). A fundamental insight of Beer's model is that every recursive level of an organisation requires the same five essential sub-systems: system one - operations; system two - co-ordination; system three - control; system four - planning or "intelligence"; system five - policy. These five systems comprise the sufficient and essential subsystems for all functions at all levels of an organisation. Beer referred to the three meta-system management functions: control, planning and policy, as the system 'brain'. To achieve adequate control with devolution, Beer proposed key information flow mechanisms:

- Attenuators; mechanisms that reduce the upward flow of information to the 'brain', to prevent it being swamped with 'noise'.
- Amplifiers; mechanisms that allow upper management to limit its directions to general instructions, allowing local autonomy and devolution of responsibility
- Random audits
- Algedonic 'pain' signals; messages relaying a need for high level intervention.

The VSM model proposes a high level of local autonomy with minimal, but adequate management intervention. Its key characteristics are adaptability with appropriate lines of communication and control; management's role is primarily to enable. The VSM in its diagnostic mode may explain how the present system with its identified shortcomings has come about. The VSM requires a system to have a 'brain' – essentially a meta-level function containing systems 3, 4 and 5; control, planning and policy. When environmental factors such as market forces act on independent functions (e.g. schools and tertiary organisations); functions that are intended to act as an integrated system, those forces result in uncontrolled oscillation (Beer, 1972). The late 1980s/1990s reforms emphasized the power of market forces to regulate the economy, resulting in widespread deregulation. However the VSM lens suggests that regulations were previously acting as the system 'brain'; albeit a mechanistic, inflexible brain. At that time (early 1990s) the education system was meeting the needs of a relatively depressed economy. The ineffectiveness of the present system suggests that the system has not adapted to a changing environment. In this report we examine the factors within the system that have prevented it from acting as a healthy, adaptive whole, and we question whether hubs would fulfill some of the essential system roles. We also draw on the VSM in making recommendations in relation in to establishing viable hub models.

2.2 RESEARCH STAGES

The research conducted in this report proceeded via the following stages:

Firstly, a literature review was undertaken to define the key definitions and models for, and enablers and barriers in the formation of, educational 'hubs'. This is presented in section 3 of this report.

Secondly, primary, empirical data were collected from a panel of experts to evaluate the understanding, feasibility, potential, barriers to and drawbacks of such hubs in the New Zealand engineering educational context. Based on the literature review and previous research undertaken in this area, a set of questions was developed. Sixteen (16)

respondents were selected to take place in a 'Delphi'-type study (Okoli & Pawlowski, 2004). The respondents represented major cities and regions in New Zealand, and comprised academics from universities (5), polytechnics (4), and ITPs (1); high schools teachers (2); and industry experts (4). Most respondents could give a national perspective, but specific regions covered included Manawatū, Hawke's Bay, Waikato and Taranaki; while cities included Auckland, Wellington and Christchurch. The questionnaire was sent to a subset of the respondent panel for content validity assessment. Appendix A shows the final questionnaire instrument that was circulated, on which section 4 of this report is based. Two rounds of data collection were used. A full Delphi study would normally iterate until full consensus is reached, but in this case that was not practicable due to time constraint. Each of the two rounds used here focused on a specific objective as below:

Round 1: Identifying potentially useful and important factors to develop a vision and direction for engineering education hubs. Respondents were also asked about the validity of the fundamental assumption underlying the hub proposal, which is that increased collaboration and co-operation between employers, high schools, ITPs and Universities at a regional level would enhance the flow of engineering graduates at all levels.

Round 2: To further clarify and collect the stakeholder insights following circulation of the collated responses from round 1.

Upon completion of the two tasks, additional data were collected via interviews (face-to-face and by telephone) to cross-validate the findings.



3. REVIEW OF LITERATURE ON EDUCATIONAL ‘HUB’ MODELS

This section outlines our review of the body of literature that describes the educational models and related concepts pertaining to higher education.

3.1 COLLABORATION IN THE TERTIARY SECTOR

Collaboration has been adopted as a pedagogical strategy (Bruffee, 1999; Daniels, Cajander, Pears, & Clear, 2010), as a mechanism for leveraging relationships between individual institutions and industry (Thune, 2011) and as a means of fostering cross-disciplinary research. Kitagawa (2004) examined the roll of collaboration in fostering regional innovation, reporting that in successful regions such as Santa Clara County in California, Cambridge in the UK and Twente in the Netherlands universities are seen to play a significant role, but that this success is not a readily transferable model. Achieving integration between universities and regional industry and economy has generally proven to be challenging.

3.2 REGIONAL EDUCATION GROUPINGS

In our previous report (Frater & Grigg, 2015) we highlighted the value of *supply chain* and *systems thinking* concepts such as end-user focus, feedback loops and system constraints, concluding that these concepts are readily applicable to the supply of engineers to industry. A solution we proposed for addressing the critical issue of lack of feedback and communication and control within the engineering education supply chain is regional education/industry groupings (a “hub” or “co-operative”). The groupings were initially conceived as a STEM (science, technology, engineering and maths) initiative. Addressing the critical supply chain deficiency in the existing system in communication, feedback and control mechanisms were concluded to be of urgent importance. The implication of the proposed co-operative solution is that regional hubs would have the freedom to be innovative with respect to local circumstances; responding to local needs, resources and economies. However a critical benefit would be providing feedback to central policy-forming functions. Educational institutions have previously been accorded freedom in terms of responsibility; however real power is claimed to lie with the centralised control of finances (Snook, 1991).

The concept of “regional engineering hubs” has a variety of meanings outside of New Zealand from that proposed by Frater & Grigg (2015). In Europe for example the term ‘region’ is frequently applied at a macro scale referring to groups of countries (Knight & Morshidi, 2011), while in New Zealand the term ‘regional’ is frequently used to describe provincial areas that lack major centres. In New Zealand vernacular the term ‘region’ has been used in media to distinguish provincial centres and their surroundings (e.g. New Plymouth and Nelson) from areas dominated by larger cities (e.g. Auckland, Christchurch). In this report the term ‘regional hub’ describes groups that are organised around local geographical locations or populations (whether those locations are provincial or metropolitan) rather than national, centralised institutions; notwithstanding the formation and funding of regional hubs may be centralised.

3.3 THE VOCATIONAL AND EDUCATIONAL TRAINING MODEL (AUSTRIA)

Success of the Austrian model of Vocational and Educational Training (VET) is reflected in 80% of young people choosing one of the several courses of VET after completing compulsory schooling (Archan and Mayr, 2006). This system is characterised by early, high level differentiation. Enrolment in vocation education colleges provides skill certification and access to higher education. The dual apprenticeship / school-based VET system ensures that all young people are afforded the opportunity to enhance their strengths. The success of the system results in low levels of youth unemployment. One of the prominent features of the system is involvement of important parties such as Ministry of Education, associations of employers and employees and Employment service based on voluntarism. The important features of the Austrian model are carefully designed support, funding, administration, accreditation, representation and co-ordination structures, resulting in flexibility and permeability in courses and relevant qualifications at the student level.

The Austrian model is characterised by early differentiation into distinct career pathways but with “permeability” between those pathways, including bridging courses where necessary. An unique feature of this model is continuous revision and upgrading of school curricula to ensure relevance and compatibility. Vocational training forms a prominent feature of the Austrian educational landscape. The great importance of VET also manifests itself in the range of courses on offer and also all VET programmes exceeding two years lead to an entrance qualification to higher education.

Though the Austrian system is meritorious and deserves further attention, it doesn’t lend itself readily to replication in New Zealand in that it is a fully integrated education system, fundamentally embedded in that society and culture (Frater & Grigg, 2015). However, in the present context it provides an example of the effective communication, feedback and control systems that were recognised as lacking in the New Zealand system. Features such as involvement of educators and employers together in management and planning are relevant in developing the New Zealand system.

3.4 REGIONAL CLUSTER STRATEGY (IRELAND)

The Irish Higher Education Strategy Group proposed the National Strategy for Higher Education to 2030 (Hunt, 2011). Restructuring was identified as a key factor in the creation of an ‘innovation economy’. Hunt writes:

“Services need to be more appropriate and locally responsive. This is particularly the case in the relationships between higher education, schools, further education and training providers and the wider community, where there is now much greater emphasis on principles of partnership, empowerment, participation and capacity building.”

One of the features of higher education in Ireland is the collaborative behaviour that has developed between universities, institutes of technologies and other related parties. Examples include recently formed university alliances, regionally based collaborations between universities and institutes of technology, and national level collaborations on particular research programmes.

Initially, collaboration between institutions was politically driven. The Programme for Research in Third Level Institutions (PRTL) funding introduced in 1998 specified collaboration between Higher Education Institutions (HEIs) as a pre-requisite for funding. Later, inter-institutional collaboration was a pre-requisite for the Higher Education Authority (HEA) Strategic Innovation Fund launched in 2006. The strategic alliances between HEIs across Ireland’s binary system are reported to have outlived the actual funding (Harkin & Hazelkorn, 2014). The PRTL initiative emphasised “three C s”: “consolidation, coherence and concentration”. Up to this point the evolution of the Irish model appeared to be based around collaboration as a mechanism for stimulating research (with underlying economic objectives). The wider responsibilities of the HEIs (education and societal leadership) were yet to be addressed.

Further change in Ireland ensued from calls for more top down direction. The Hunt report (Hunt, 2011) recommended further radical change, based around three strategic directions:

1. Reform of the Institutes of Technology (IoT) sector through amalgamations;
2. Consolidation and absorption of smaller institutions into the university sector; and
3. Establishment of regional clusters of collaborating institutions within geographical area.

One of the important approaches described in the Hunt report is Ireland’s regional cluster approach. Hunt highlighted the importance of preparing policy for higher education to develop the regional collaboration between clusters of geographically proximate institutions, to ensure that individual, enterprise and societal needs are addressed in a planned, clear and efficient way. A specific focus is workplace learning, achieved through collaboration between industry and educational institutions. Maguire, Murphy, and Kirk (2009) describe “a model of cooperation and partnership that recognises and values the needs and contributions of the worker and identifies the workplace as a centre of learning.” The regional cluster model is reported to bring benefits such as:

- Better planning and organisation of programmes, allowing for differentiated offerings;
- greater impact through pooling of effort and development of shared services;
- more explicit attention to student Pathways and progression;
- a coordinated approach to enterprise and other stakeholders at regional level.

The cluster approach is intended to achieve close coordination and cooperation between various types of independent higher education institutions. Together they can determine and meet the needs of a wide range of students, communities and enterprises in their region. This involves joint programme planning, collaborative research and outreach initiatives, agreements on mutual recognition and progression, and joint strategies for advancing regional economic and social development. To develop integrated regional learning strategies the institutions can also engage with other statutory providers of education and training. The Hunt report also emphasised the role that central government (the Higher Education Authority) should play to promote such regional clusters by providing incentives and by requiring institutions to build regional collaboration into their strategic plans. The cluster model is intended to complement the National Strategy. Moreover clusters will enhance links between higher education institutions and local authorities, local state agencies and other stakeholders, and to assist in developing shared solutions to local and regional needs. Collaboration across the system at a national level will also continue to be encouraged, focusing on areas where there is potential to build national scale and strength.

Through this approach it is expected significant potential for institutional collaboration on a cross-border regional development and strategically advances Irish higher education on an all-island basis. Benefits in inter-institution co-operation are anticipated, whereby those in Institutes of Technology could obtain some of the benefits that come from being at a research-oriented university – they could be encouraged to join seminars in the associated university, and possibly carry on joint research projects, which would strengthen their own teaching. Graduate students might also be able to attend courses in both institutions. Universities can derive benefits in that their applied research, opportunities for consultancy and even course teaching would be strengthened by the closer contacts that institutes of technology have with the needs of industry and labour market.

3.5 'FAMILIES OF LEARNING' (UK - LONDON)

The 'families of learning' initiative is considered "*a bold response* [to the challenge of helping local institutions and communities produce local educational solutions] *built on a new model of collaboration between educational providers, businesses and communities to co-create a learning and skills eco-system that works in the interests of individuals, communities and employers*" (Phoenix, 2017). The initiative is centered at London South Bank University (LSBU). The approach involves like-minded organisations (educational providers, employers and civic partners) collaborating as 'families' to offer learners differentiated, tailored, learner-centered educational pathways. It has been designed to overcome traditional educational funding policies that encourage competition between providers (*ibid.*).

This approach places the learner at the centre of the journey, and is regionally based: in this case, the region being South London. The learners are supported via individualised learning pathways that support their preferred styles of learning. This includes aspects of academic and practical work, according to the learner's preferences. Learners are of varying ages and starting points. Some are school leavers, others mature returning students who have raised families.

LSBU has established a 'passmore' centre. This is a one-stop shop where learners can talk to a range of employers about their employment and training needs. The employers can also use this resource to tailor development programmes for their own employees.

The learning family is identified as:

"...a formal grouping of like-minded educational institutions, each retaining their identity and autonomy but with overarching governance and quality structures, a common Educational Framework and shared values, approaches and operations."
(Phoenix, 2017, p.13).

The key factor in the success of the 'families' model, is identified as being a two-tiered governance structure comprising: (1) a central, whole-group structure where the group Chief Executive takes responsibility for governance and quality assurance; and (2) institutional level governing boards which have responsibility for the student journey. It is argued that this structure removes competition enabling a collaborative, cooperative pathway to be co-created.

The 'Learning Families' governance structure is a necessary condition for viability under the VSM. There is no mention of a random audit function in the report. In supply chain terms, the approach of a network of providers is similar to supply chain networks, whereby a supply chain can be tailored and refined via a range of partnerships, providing the possibility of 'switching' between actors. In terms of lean thinking, tailoring the educational pathway to the needs to the learner is a value stream approach, where the user defined the value that they seek to attain, and the flow of value is tracked through the value chain. Thus the 'families' model has elements of contemporary best practice and systems thinking.

This approach has high relevance and value for the New Zealand context, being regionally focused, relatively easy to administer, relatively low cost to establish, and involving multi-tiered educational partners within an area or region. In areas with low educational competition, such as the Manawatu (one university, one Polytechnic, several PTEs, schools and many employers of varying sizes), the model has enormous potential.

3.6 DEVELOPING A PHYSICAL INNOVATION HUB (UK – EAST LOTHIAN)

Queen Margaret University (QMU) in East Lothian, Scotland, has taken a longer term strategic approach to the development of a regional innovation hub. In September 2015, QMU announced plans for an £80 million innovation hub supporting 13,000 jobs (QMU, 2015). This a submission made under a £1bn city regional plan aiming to capitalize on strengths of the region. The University identified *food and drink; entrepreneurship and creative industry; and biomedical and enabling technologies for rehabilitation*; as key areas of innovation and growth. In 2016, one of the present authors visited the QMU campus at Musselborough, East Lothian, UK. At that stage, this custom-design new campus stood in a green field, situated close to a railway station with fast links to Central Edinburgh. Speaking with senior staff of the university, he was informed that plans were in place for the co-location of commercial developments, including business, retail outlets, cafes and restaurants, fitness and residential facilities. Phase one of the plan involves development of an innovation centre. At the time of writing, this development is approved and underway.

This approach develops on the strengths of a key academic institution and its surrounding area. In this case the food and drink sector, marked as one with high growth and innovation potential. It circumvents the 'tyranny of distance' by bringing hub partners physically together. This approach requires targeted central investment, a goal of regional growth and the courage to commit hard funds to the strategic initiative.

3.7 ISSUES IN BUILDING RELATIONSHIPS BETWEEN INDUSTRY AND EDUCATION

Students need clear pathways for career planning. *Education choices leading to employment* is a repeated theme in vocational education literature. Mourshed, Farrell, and Bartob (2012) report 2008 OECD data that place New Zealand youth 22nd out of 32 in terms of NEET (not in education, employment or training), and males lowest (of 29 surveyed OECD states) in terms of the perceived value in pursuing tertiary study. A contributing factor reported is the lack of clarity in the relationships between parties, and in the outcomes of various pathways. To achieve visible relationships within pathways, real relationships must exist between key actors in the pathways.

The most common co-operative stakeholder relationship (within the context of this study) reported in literature is between employers and educators. Generally the relationships examined are those between industry and vocational training institutions or universities. Even though these are natural supplier – customer relationships, specific issues have been identified. The authors of a UNESCO report (UNESCO (2015) note issues which need to be addressed to build healthy relationships between educators and employers:

- *“The availability and willingness of suitably qualified industry representatives to work in such areas cannot simply be assumed. Equally, getting the right quality of employer representatives appointed to governance structures, and getting them to work well in concert with educational professionals and other stakeholders, is a complex challenge.*
- *There is a danger that the collective voice of employers is often that of larger enterprises and better organized sectors, with the voices of small, micro and informal enterprises too often neglected.*
- *In workplaces responsiveness to multiple stakeholder networks is not simple. Managers making training decisions are often not owners, and may have their own vested interests.*
- *Individual firms’ rationality regarding investment in skills may not aggregate to national needs.*
- *A tendency for decisions about vocational education in firms to be driven by short term concerns that is not sufficient for the firm or the nation to achieve and sustain international competitiveness in the longer term.”*

The literature is relatively silent on the issue of achieving co-operation between competitors in education.

By whatever means these pathways are achieved, key components of successful engineering education programmes achieve clear and flexible transitions between school, vocational education and higher education, leading to reliable employment opportunities.

3.8 GEO-POLITICAL AND HISTORICAL INFLUENCES ON ENGINEERING EDUCATION IN NZ

New Zealand has a small population distributed somewhat unevenly over a geographically convoluted landscape; its education system constrained by geography and demography. A further contextual factor is the dominance of neoliberal “free-market” thinking – political philosophy arguably driven in New Zealand by the need to reduce tariffs to obtain access to international markets in the 1980s (Evans, Grimes, Wilkinson, & Teece, 1996; Guthrie, 2001). The challenge for successive New Zealand policy makers since the 1980s economic reforms has been to guide, constrain or coerce organisations operating more or less in a free market into serving public good. The challenge for educators has been to satisfy the needs of consumers as well as the health of present and future economies, whilst being accountable for the success of their own institutions.

Of particular significance is the influence of neoliberalism on accountability in secondary schools. Gordon and Whitty (1997) argue that the Education Review Office (ERO) and the New Zealand Qualifications Authority (NZQA), both independent agencies, work from divergent philosophies, and that New Zealand schools have “become victims of competing discourses”. They report the publication of league tables as a reflection of neoliberal philosophy. The formal accountability of ERO reviews results in one form of pressure, while market accountability, in the form of funding linked to school rolls, results in another form of pressure. School rolls can suffer from the publication of poor performance. While NZQA and ERO might be guided toward an agreed philosophy, thus enhancing the engineering education outputs demanded by industry, the focus of decision makers in schools is economic survival rather than altruistic goals.

A previous report (Frater & Grigg, 2015) proposed a supply chain model for engineering education, and education conforms in many respects to the supply chain model. There does not appear to be any essential conflict between supply chain theory and neoliberalism; however, Olssen and Peters (2005) explain that neoliberalism is a “politically imposed discourse”, while globalisation and the knowledge economy, which inform supply chain thinking, are the result of social and technological evolution. Arguably, the imposition of neoliberal philosophy in New Zealand education has resulted in education sectors that are driven to optimize their own performance at the expense of the whole education supply chain. This review is not the venue for arguing the propriety or efficacy of neoliberalism *per se*, but it is clear that the application of this philosophy in New Zealand education is a significant factor in the reported failure of the system to adequately supply the needs of the New Zealand economy.

3.9 COOPERATION OR COMPETITION: CONFLICTING PARADIGMS?

The situation in New Zealand at the outset of this research can be argued to represent a conflict in paradigm. Collaboration is ideal when all parties are working towards a common goal; where common interest is best served by co-operation and communication. This is the supply chain paradigm argued by Frater & Grigg (2015) to be appropriate for the engineering education system. The “free market” paradigm which drove widespread change in New Zealand the late 1980s, and from which the current system has evolved assumes that competition between parties is beneficial, and that collaboration between parties results in anti-competitive behaviour that disadvantages consumers. The two exemplars briefly examined here (Austria and Ireland) both favour collaboration over competition. An implicit goal of the present research is to find sufficient common ground or compromise between these opposing ideals to reach consensus and achieve a basis for collaboration between all stakeholders in New Zealand engineering education.

3.10 REGIONAL HUBS: ENABLING FACTORS FROM LITERATURE

Collaboration

Tertiary education in Ireland is notable for collaboration between Higher Education Institutions (HEIs) and between HEIs and other research organisations and industry. Collaboration between institutions was initially driven politically. The Programme for Research in Third Level Institutions (PRTLTI) funding introduced in 1998 specified collaboration between HEIs as a pre-requisite for funding. Later, inter-institutional collaboration was a pre-requisite for the Higher Education Authority (HEA) Strategic Innovation Fund launched in 2006. The strategic alliances between HEIs across Ireland’s binary system are reported to have outlived the actual funding, arguably due to the benefits of collaboration (Harkin & Hazelkorn, 2014). The PRTLTI initiative emphasised “three C s”: “consolidation, coherence and concentration”. Up to this point the evolution of the Irish model appeared to be based around collaboration as a rather narrow mechanism for stimulating research (with underlying economic objectives). The wider responsibilities of the HEIs (education and societal leadership) had yet to be addressed.

Central coordination

Further change in Ireland ensued from calls for more top down direction. The Hunt report (Hunt, 2011) recommended further radical change, based around three strategic directions:

- Reform of the Institutes of Technology (IoT) sector through amalgamations;
- Consolidation and absorption of smaller institutions into the university sector; and
- Establishment of regional clusters of collaborating institutions within geographical area.

These reforms can be contrasted to New Zealand’s apparent focus on competition as a driver for educational efficiency. The Hunt report endorsed the binary system, but encouraged collaboration through a “carrot and stick” approach.

Technology

Digital technologies are recognised to have changed the ‘education landscape’. An Irish national strategy for the enhancement of digital learning (NFETLHE, 2015) identified a need to integrate digital learning across educational sectors. Significant progress in collaboration between higher learning institutions was reported:

“It is clear that there is a serious collective commitment among Irish higher education institutions to work together to embrace technology in education in order to build a stronger educational future.”

A key recommendation was:

“We must continue to engage with stakeholders in the sector including employers, external communities, schools and further education providers, acknowledging that they are best placed to identify current needs, and thereby to scope a future vision for technology-enhanced learning”

Conducive geography

In Ireland, regional clusters are emphasised – strategic collaborations of higher education and industry stakeholders. Harkin and Hazelkorn (2014) report that regionalism is not strongly developed in Ireland, but that students do tend to stay within a 50 kilometre radius. In New Zealand, by contrast, regionalism is relatively strong, with geographically defined local governance structures, sporting loyalties and educational institutions. However tertiary level students do not display regional loyalty, and are quite prepared to travel to institutions perceived as leaders in the students’ preferred fields.

3.11 INDUSTRY CLUSTERS VIS Á VIS EDUCATION HUBS

In some engineering education literature the term “hub” is used as a synonym for “regional cluster”, describing an economic / industrial structure rather than a structure to facilitate engineering education. It may well be that engineering education hubs should be considered a mechanism within a broader regional cluster strategy. Clusters have been initiated

by collaboration between educational institutions and by collaboration between industry actors. Industry-initiated clusters typically focus on leveraging research opportunities. In Ireland, clusters involving both levels of the binary education system and industry partners have proven successful.

3.12 THE RÔLE FOR SCHOOLS

The proposed New Zealand hubs include schools as well as tertiary and industry stakeholders. The inclusion of schools does not offer obvious mechanisms for research benefit, but would certainly provide medium to long term benefit to industry in terms of provision of future skilled workforce. The involvement of schools would be highly beneficial for planning and enabling engineering education pathways, and potentially to address resistance to uptake of STEM subjects in early high school years (Frater & Grigg, 2015; IPENZ, 2010). Since the breakdown in STEM uptake in New Zealand occurs close to the transition from primary to secondary school, both primary and secondary school levels should be represented.

Other European models (such as the Austrian model) favour early commitment to career pathways (Archan & Mayr, 2006). This model is characterised by high levels of communication and collaboration between industry and educators, but despite the models being described as offering permeability between career paths there is a risk that early commitment may lead to individuals being constrained (e.g. by peer or family pressure) to career paths that they are later dissatisfied with. We regard this as a lesser risk than having a shortage of individuals with the educational pre-requisites for science and engineering careers, or capable students failing to achieve their potential.

One Irish researcher noted that a key determinant in uptake of engineering career training is proficiency and enjoyment of mathematics at school, which in turn is strongly linked to teaching factors, especially individual teachers (Goold, 2013). Mathematics has unique characteristics. Goold reports:

“mathematics is a highly affective subject where motivational beliefs such as affective memories (previous emotional experiences with mathematics), goals, task value (why should I do mathematics?) and expectancy (am I able to do mathematics?) are major influences on students’ engagement with mathematics.”

A potential function of hubs is to encourage and support mathematics teaching and teachers as a prerequisite to uptake of engineering at tertiary level. This support presumably needs to extend throughout primary and secondary levels.



4. SURVEY RESPONSES AND ANALYSIS

The previous section introduced key themes associated with regional hubs. These themes were developed into questions (Appendix A) which were circulated to our panel of 16 experts from NZ education and industry. The themes were as follows:

- Theme 1 (Question 1): Expected functions of hubs
- Theme 2 (Question 2): Perceptions of the effectiveness of hubs
- Theme 3 (Question 3): Communication and competition
- Theme 4 (Question 4): Challenges and barriers to developing hubs
- Theme 5 (Question 5): Panel experience with hubs

In this section we present the results of our empirical research. The section is structured according to the questionnaire sections as above. We present here each major question (1-5) and its sub-questions; a summary of responses obtained under each; and any relevant discussion or analysis of those responses.

4.1 EXPECTED FUNCTIONS OF HUBS (QUESTION 1)

The starting point for this analysis is a definition provided by TEC:

Engineering hubs are regionally-based centres for engineering education involving employers, high schools, universities and ITPs. Hubs establish popular and effective pathways into engineering and offer a single entry point for engineering qualifications. Hubs support students to make good decisions about their courses of study and allow them to staircase between qualifications. Hubs run secondary-tertiary pathways projects, cadetships, scholarships and work experience. They will implement new initiatives including co-created and taught curriculum and degree apprenticeships. Hubs will support initiatives which raise awareness of engineering.

While this definition focuses on engineering, hubs need not be limited to engineering. In our conclusions, we will generalise from the following responses, and the literature.

Question 1 began by noting two distinct functions that are embodied in this definition.

- To bring major stakeholders together with the objective of developing a unified approach to engineering training at a regional level
- To provide engineering education and career planning advice to students

Q1a. Are there other potential functions of hubs?

Responses were grouped into three themes:

Theme 1: Interaction, collaboration and information sharing

- *To give Secondary school teachers the opportunity to interact with University members of the hub. This would allow us to pass on information and guidance to students who are thinking of entering the Engineering field.*
- *A focal point for collaboration among providers, e.g. between Universities, ITPs, PTEs, secondary schools.*
- *It could also help advise / assist teachers learning.*
- *A consolidated marketing presence information exchange between stakeholders undertaking innovative projects*

Theme 2: Engineering employment

- *To raise the profile of Engineering as a career in the Region.*
- *To 'enliven' the connections between education and employment, and projects wherein students might find valuable work experience (to broker internship).*
- *A proxy for 'employment agency' for employers*

Theme 3: Education

- *To inform the design and distinctiveness of different offerings in the market (of engineering education/training pathways). To discern where the gaps are.*

Theme 1, the "interaction, collaboration and information sharing" theme expands function (i), bringing stakeholders together to facilitate the development of a unified approach. The benefit of an integrated, unified approach is supported by the success of European models, and is supported by the high priority given to integrated education in the European models (Archan & Mayr, 2006). A deduction underlying these responses is that the New Zealand educational system is in some respects disjointed and dysfunctional in terms of achieving excellent education for a broad spectrum of its own population. Evidence for systemic dysfunction is the shortage of suitably qualified New Zealand educated candidates for

tertiary engineering training, and an identified shortfall in NZQA level six and seven technicians and technologists (Frater & Grigg, 2015; IPENZ, 2010). Communication between key stakeholders at a regional level is seen potentially as a valid mechanism for improving educational outcomes in the system as a whole.

An expressed reservation draws attention to the limitations of regionally-based initiatives

- *Engineering has a national as well as a regional focus. A regional hub may not be effective at a national level.*

A theme repeated in other responses is concern that regional solutions may not address underlying systemic issues that require national strategies. However, if a function of regional hubs was to report to central policy makers, then hubs would constitute a mechanism for informing national-level responses.

Q1b. Do you envisage significant roles or benefits from hubs other than those described in the introductory statement?

Two comments suggest that new roles and benefits might emerge after the establishment of the hubs:

- *The hub itself should lead to the generation of initiatives and outcomes and these shouldn't be over-proscribed [sic – intended as over-prescribed?]*
- *Realising other significant roles or benefits might follow the job of getting hubs established and working effectively, but it is difficult to envisage that presently. The primary focus should be on establishing and effectiveness as per stated mission*

Further possible roles suggested were:

- *Co-ordination*
- *Liaison*
- *Leadership*

It is self-evident that a mechanism enabling, resourcing and encouraging communication between people who have a common interest will result in positive, unforeseen outcomes. Engineering education stakeholders certainly share the common altruistic interest of wanting to provide graduates to fulfil the demands of New Zealand industry. However, the “front and centre” motivators for educational institutions are measurable outputs such as financial and academic indicators. A fundamental principle of the management of productive systems and supply chains (of which the engineering education system is an example) is that local optimisation is counterproductive to whole system efficiency. In this context, “local” is interpreted as individual sectors, or individual providers. In the present New Zealand system, motivators are almost entirely local. Individual institutions are measured and financed through local metrics (such as Performance Based Research Funding for tertiary institutions), while whole-of-system system motivators are absent.

Suitable strategies for improving whole system performance would align local motivators with factors beneficial to national interest. An example described earlier is where funding in the Ireland system was tied to collaboration between regional providers. A role of hubs would be to clarify the drivers and constraints that have led to the present position, and to identify areas where collaboration and communication are constrained by existing structures and motivators.

Q1c. Can the dual functions (i. and ii.) be effectively achieved by a single hub?

Responses generally felt that they could:

- *if staffed / resourced correctly.*
- *Yes they can. However, as a Secondary Teacher of Physics I am at the “coal face” and often get asked questions related to Engineering as a career. Therefore I feel it is important that there is an opportunity for teachers to interact several times a year with Engineering staff and Engineers. We reach and develop a relationship with far more students than a one-off promotion can have.*
- *Yes - difficult to imagine one working without the other*

One response gave a hint of a reservation with respect to local situations:

- *Maybe, but local politics will be important to negotiate and could significantly impact.*

Two clearly defined functions for hubs have been proposed; two functions resulting in two distinct roles:

1. A facilitation and leadership role
2. A service role

The first function - bringing stakeholders together to develop a unified approach to engineering training at a regional level - would be achieved by liaison between local stakeholders. This would help identify local efficiencies and opportunities for collaboration and innovation within regions, and would include feedback to national policy makers, and horizontal sharing

between regions. To achieve this function, the hub would assume a facilitative role, supported by a reporting structure and higher level analysis and response.

The second function – that of advising and informing students, and providing liaison between students, institutions and industry is a service role. This role could be supported by, and even partly achieved through web-based entities. Accessible and visible human resources would be beneficial if not essential. The advice given by our respondents is that these two functions should be linked, but that they might be sensitive to local circumstances.

Discussion: Hubs versus Clusters

The hubs envisaged here are relatively small initiatives with the potential to catalyse positive educational outcomes. They are quite different to approaches such as the Irish or UK models which are based on regional economic clusters with appropriate infrastructure. The Irish model is a large scale initiative, economically motivated, politically enabled, financially resourced and strongly linked to research and innovation. Within New Zealand, localised industry-based collaborations have been reported. However such models do not have educational outcomes as their core purpose, and have not (to the present authors' knowledge) included schools as key participants.

Regional clusters constitute a more ambitious vision than regional hubs, and if Government were to initiate clusters after the Ireland approach, the goals of the regional hub initiative would be met within those clusters. However, the educational focus of the proposed hubs is arguably more fundamental, and certainly less resource intensive than a broader regional economic initiative.

4.2 PERCEPTIONS OF THE EFFECTIVENESS OF HUBS (QUESTION 2)

Q2. The assumption underlying the hub proposal is that increased collaboration and co-operation between employers, high schools, ITPs and Universities at a regional level would enhance the flow of engineering graduates at all levels. (Regional is interpreted as provincial or geographically localised)

Q2a. Is this assumption valid, or can you suggest other points of view?

Responses generally agreed that the assumption was valid. A common theme was that the proposal as stated isn't inclusive enough. Other bodies (IPENZ, ACENZ, ITOs etc.) should also be included.

- *I believe it's a valid assumption.*
- *I would think it could enhance the flow of graduates ultimately, but that might depend on what sort of programmes and activities the hub might host.*
- *The on-job (ITO) trained engineers should be noted as another significant group. ITPs deliver training to their trainees via contracts, but the ITO [named] and apprenticeship brokering organisations are key stakeholders too.*
- *[Several identified ITOs] should be consulted. We run the risk of shutting students and potential employers out from significant opportunities in these key [...] sectors*
- *Yes should include Engineering bodies such as IPENZ and ACENZ.*
- *As long as all parties are included. e.g. Industry Training Organisations (ITOs)*
- *The definition of 'engineering' bears some further analysis too. In regional NZ, the 'engineer' tends to being (sic) a mechanical/fabrication/civil engineer..... whereas in reality engineering is so, so, much broader a discipline.*

Reservations about engagement were also expressed:

- *The concept requires proof testing. It may be valid, but the factor not accounted for is 'learner choice'. What will be the imperative for a learner to engage with the hub?*

Respondents drew attention to the limitations of regionally defined initiatives.

- *A lot of engineering education occurs at a national level so a hub just operating at a regional level seems naive.*

Respondents were concerned about full representation. At some point compromises would have to be reached about the composition of local hubs. There is considerable diversity within educational and training organisations, within industry and within educational establishments. Mechanisms for representation of specific local needs should be included; however the most pressing need is for decisive decision making to effect radical change.

Establishment of hubs would be a recognition that top-down policy development and implementation has failed to achieve an effective system. The establishment of hubs would be an attempt to improve the system by encouraging collaboration and integration at the local level. There is a real danger that such collaboration would be undermined by existing policies that have led to the current state.

The consensus of our respondents is that local structures connected to and reporting to a national body would be a suitable model. New Zealand education is structured vertically within educational sectors and there are no obvious contenders for a single existing organisation representing all educational levels and representing employers. Such a body would report to Government policy makers.

Q2b. What do you suggest as the key features of hubs that would benefit regional New Zealand?

This question was intended to elicit ideas of the form(s) a hub might take. Would it be a physical venue with permanent staff, or might it be a virtual entity? Most responses interpreted the question in terms of the potential functions of a hub.

Career pathways theme:

- *Career opportunities Co-Presentation of training Work Experience Careers Expo Careers web Page*
- *Smoothing the pathway from secondary schooling, to tertiary to employment. Creating a pathway that is more evident and visible to the learner and ensures that the learner is connected early in their educational journey with potential employment and a sound vocational outcome.*
- *Providing learners with non-partisan information that allows them to make informed choices about an engineering career pathway.*

Focus and efficiency and information sharing comments:

- *This would [make] students more aware of what is offered in the region with regard to studying Engineering.*
- *Leveraging the input of all partners consolidating their marketing and information resources. Being a point of focus to promote engineering.*
- *A single point for info*

Expanding the profile of engineering:

- *The above comment (Q2a) leads to what I think might be a key feature of hubs... in that they could shine a light on the much, much broader applications for engineering-trained/educated personnel. If the 'breadth' of what engineers engage with is taken into account, there could, and should, be relevance in having some profiling of ICT/innovation/geotechnical/food processing/industrial design via the activities of these hubs.*

Potential for innovation:

- *If this occurs, and industry, teachers, students 'collide' in such a hub, this could/should result in some syncretic innovations in region.*

The proposal that hubs might constitute a vehicle for educational research and innovation takes the hub concept a step beyond the preconceived notions of the researchers. The idea that the learning philosophies of different sectors might be coalesced into new methods or even new pedagogy is interesting, possibly even exciting.

However, to address the objectives of this question, we need to consider what physical (or virtual) forms a hub might take, and what resources would be required to achieve:

Since this guidance was not provided directly by respondents, it is appropriate to propose some starting points for future debate:

- *The liaison and collaboration role might be achieved by regular meetings of key stakeholder representatives – meetings of individuals such as Principals, Heads of Schools and industry representatives; probably not a role for dedicated employees, although a suitably qualified facilitator or chairperson might be appointed. The venue for such meetings could be organised on an ad hoc basis. A critical aspect to consider is how these meetings might be actioned. Respondents suggested a number of factors that have worked against this level of co-ordination happening naturally, despite the obvious benefits of collaboration and communication, so some form of motivation is indicated, such as the Irish solution of tying aspects of funding to collaboration.*
- *The student advisory service role would require dedicated, full-time employees and a neutral venue. We envisage the role being achieved via dedicated staff, a visible venue, and (probably) a web-based interface. Engineering-focus would distinguish this role from broader career-path advisory services. Advisors would be participants in meetings of stakeholder representatives, and probably responsible for organising meetings and reporting transactions. This role would have 'gatekeeper' and triage characteristics.*

Q2c. Please comment on whether you believe that regional hubs are more (or less) likely to be successful than national structures of some sort?

The consensus here is fairly clear. Most agree that hubs need to be primarily a regional entity.

- *Regional would work better.*
- *More if momentum for Region can be gathered and if all local stakeholders get behind the initiatives.*
- *More likely to be successful than national structures*
- *Unsure. However I think that regional hubs would be a good place to start as this allows you to develop a relationship with the local student body.*

However there were suggestions that some sort of national oversight would be required.

- *Need both. Well informed coordinated, coherent national strategy and local delivery*
- *I am certain that the 'hubbing' does need to be regional. Something at national level won't give effect well to changes at regional level. Especially as far as industry buy-in and connectivity is concerned.*
- *They will need to be linked to a national hub but locals like working with locals*

The consensus is that the 'front end' of hubs would be regionally located, but that they would need to be integrated at the national level:

- *both regional and national aspects need to be integrated.*

However, our research has indicated that the present situation (for which hubs are a proposed change-agent) is the result of present policy, so a carefully designed two way communication channel would be necessary for hubs to inform the re-development of policy.

Integrating feedback from our respondents with guidance from literature (the most appropriate form for a hub to take would be autonomous local service delivery and facilitation units, reporting to and resourced by a national management entity. At the national level, the management entity should exist within a Crown Agency so that there are straightforward reporting lines to policy makers. The responsibilities of the management unit (according to the VSM model (Section 3.3) are to develop the organisation's identity through policy (conforming to present government policy) and to be the 'outward eye', maintaining awareness of and communication with the environment ('environment' encompassing all external aspects: social, political, economic and educational).

Taking advice from Stafford Beer's VSM, management should be highly selective over both the information it receives and the instructions it provides. Information travelling upward (from hub to management) is necessarily 'attenuated', while information travelling to the hubs requires 'amplification' into useful procedures. Mechanisms for horizontal communication (between hubs) should also be encouraged.

Q2d. Would major cities (i.e. Auckland, Christchurch, Wellington) require a different model? Give details if possible.

Respondents reported that a flexible model, scaled for demographics and adapted to local conditions would work throughout New Zealand:

- *The purpose of the hub doesn't alter because it is metropolitan based rather than regionally based, therefore does the delivery/operating model need to be any different? I think not.*
- *No but will have to be set up for greater volumes/population. The Regions may find they have to have a different model to get equivalent efficiencies e.g. Manawatu- Taranaki .*
- *Particularly for Auckland you may require to have a few hubs as there is a vast number of prospective students. Those students from outside the region who want to go to a particular University for Engineering would probably still go.*
- *Could be the "hubs" with sub-regional "spokes"*
- *I can't speak for those. I can speak for Taranaki and comment that this region is well connected in the engineering space. This could be leveraged for good, if parties are worked with in a 'relational' way and so that they co-construct the model that might work in region. If not, what is done 'nationally' can sometimes not translate well (given some prevailing mindsets and practices).*

If the management model proposed in (2c) were adopted, large city hubs would be free to adapt to their local environment. So long as the general purposes of the organisation are met within the resources provided, the actual means by which they are achieved should be flexible.

4.3 COMMUNICATION AND COMPETITION (QUESTION 3)

Previous reports have identified *communication between stakeholder groups* as a key area in which improvement might yield benefits to engineering education, and *competition between stakeholder groups* as a negative factor.

Q3a. Do you think that improved communication between stakeholder groups (employers, schools, ITPs and Universities) would benefit NZ engineering education?

Answers here were mostly unequivocal:

- *Without a doubt.*
- *Communication between groups is always a benefit.*

However a couple of comments suggest communication per se isn't enough:

- *I think it is more about having this communication consolidated*
- *Collaboration is of prime importance; any patch protection activities will kill this dead (because people who should be included will be left out)*

The purpose of this question was to confirm what we already accepted as common sense; that improving communication between sectors in a supply chain would result in improvement in the end result. A point omitted is that open communication requires trust, and trust cannot be taken for granted. However, the starting point is that improved communication with goodwill between parties would inevitably result in whole system improvement.

Q3b. Where or how might unbeneficial competition occur between these stakeholder groups? i.e. Which groups are competing and which resources are subject to competition?

Some responses were quite specific:

- *Schools for places on training courses. Training providers for participants.*
- *The various Engineering Schools are competing for the students wanting to enter into the field of Engineering.*
- *There is competition at most points in the value chain, largely driven by the allocation of funding to provider education. If the funding attached to the learner, and the learner was able to make informed choices then greater collaboration is likely to prevail amongst providers, and less competition as a consequence.*
- *Necessarily employers also compete for graduates. However that is a given element of a free labour market. It is easy to perceive that employers would find benefit in being connected with the hub, as this is a potential source of graduates*
- *ITP's competing for the same learners*

Other responses addressed the question in a broader way:

- *The issue could be that the groups feel they are "competing" for the same resources.*
- *At a local 'industry level' there are some strong philosophies around 'homegrown is best', 'on-job training is best', and in many instances a reluctance to employ (even on an internship basis), university students or graduates, as they are considered not 'practical enough'. However, industry problem solving and innovation might be further stimulated if there was more appetite for hiring from outside sources (e.g. university trained, and sometimes from other countries). It's a bit hard to convey in a few words. I think the pulling together of a hub in a region would draw out the views etc. There are 'hubs' in Taranaki around engineering - Taranaki Engineering Consortium, and also the engineering companies who connect in relation to WITT's engineering programmes. However there are significant gaps in engineering provision in region in relation to several 'branches' of engineering.*

One response challenged the suggestion of attaching funding to learners:

- *Attaching funding to learner will probably result in more competitive and less collaboration especially in the short to medium term.*

Q3c. Is competition necessarily negative?

Supply Chain Management theory recognises the phenomenon of 'co-opetition', whereby firms within a supply chain both compete and co-operate at various times. An example would be restaurants in the same niche market cooperating to achieve economies of scales in the supply of particular ingredients. We note, therefore, that there are often two sides to competition.

Most argued that competition can be positive:

- *No, if competition drives us to make improvements then it can be seen as a positive.*
- *No it unlocks customer focus and innovation.*
- *Competition is not negative. The question is whether it is a useful strategy when the goal is not to attract customers to a particular product but rather to expand the customer base through information, presence, communication, consolidation*
- *Not always; if the student is getting the best deal (not just talking about money!)*
- *Competition that results in continuous improvement, raising the standard of education and ensuring the learner is well served is not necessarily negative*

However one response offered a hint of caution:

- *Competition that drives an agenda of less collaboration, less sharing of resources, less agreement around curriculum, entry requirements, and educational pathways is negative.*

A further response developed this theme:

- *Competition in education does work the same way as in business. In particular, the decision making of students is complex and does not always seem logical.*

The issue of competition between parties in a supply chain requires examination. Our respondents engaged strongly with questions around competition. They argued firstly from the end result, that if students are “getting the best deal”, then competition is beneficial. However others cautioned that education models and business models are inherently different. We go on to examine the mechanisms by which competition can harm students:

The education system does a disservice to students if:

1. Students fail to achieve entry requirements for a subsequent level of learning and were:
2. Capable of achieving that level
3. Sufficiently motivated to achieve that level if they had been advised appropriately
4. Students enrol for a course of learning, and subsequently fail in a required subject when it could have reasonably been predicted that they would fail.
5. Students complete a course of learning, but subsequently realise they are unsuited to the career path for which they have qualified.
6. Students graduate inappropriately, lacking sufficient capability to succeed in that career path.

Any of these scenarios could be due students themselves making foolish, over-ambitious or under-ambitious decisions. However, in a market-driven, competitive environment, students may be encouraged to over or under-extend themselves. This situation arguably occurs mainly in the tertiary sector, where there is direct competition for students. Polytechnics might willingly accept students who are capable of completing higher level tertiary qualifications, and universities might for example accept students in honours programmes who would be better suited (on the basis of capability and aptitude) to technician or technologist roles. Industry Training Organisations (ITOs) fill another important role, competing with both Polytechnics and Universities for students. Mistakes in career training paths would be inconsequential if there were clear transition points or pathways between programmes, but in a competitive environment it is not in any organisation’s interest to allow students to change institutions without penalty.

An issue that has been recognised previously is students choosing “soft options” at year nine in maths; options that prevent them from progressing to tertiary engineering study and to careers to which they might be well suited. However, the strangled supply of students enrolled in appropriate STEM courses may be more than just poor course selection by students; it may be the result of systemic drivers. Competition occurs between secondary schools. Schools optimise the metrics against which they are measured, and so are motivated to discourage students from taking subjects in which they are perceived as being at risk of failure. Publically reported information (such as League Tables) further exacerbates distortion, in that capable students favour schools that are viewed as ‘high performing’. Our respondent stated *“Competition that drives an agenda of less collaboration, less sharing of resources, less agreement around curriculum, entry requirements, and educational pathways is negative”*.

Q3d. Do you think local collaborative hubs would improve the situation? How?

Respondents offered qualified reasons why hubs might offer improvement

- *Unsure, it is somewhat untested.*
- *Maybe. It may just allow completion which is a good thing. Or it could share best practise and ideas.*
- *Yes. It could, however, end up increasing trans-regional competition. It would certainly let students and other stakeholders make more informed decisions.*
- *Yes, because the parties would be more likely to be known to each other*
- *They have the potential to. There needs to be proof of concept established though.*

When institutional decision-making is visible it is more likely to be ethically sound than when decisions are hidden within institutional bureaucracy. Hubs might enable the nurturing of individual students through their transitions between institutions by ensuring that they are adequately guided toward specific career paths. It is arguably better for students to succeed in an educational path that they later perceive as being less than ideal, than to simply fail. A model that we have identified as achieving progression toward a specific career outcome is the Austrian Model.

- *Hubs should help provide better information to students.*

We agree, but suggest that information alone is not enough. Students need informed guidance, especially in the early stages (i.e. year 9) where decisions are made that constrain future opportunities.

Further comments suggested that collaboration and communication might be over-ridden by financial drivers:

- *The major driver for change does rest with the way in which the funding is allocated. If funding is allocated to the providers and providers are needing to fill places then collaboration becomes secondary to meeting targets for learner recruitment. No amount of 'hub' based collaboration will alter the inherent financial imperatives that providers face in the current funding model.*
- *This is surely the nub of the matter when considering the collaboration/competition tension. Tertiary Education is NOT a commodity.*

A theme that emerges from literature, and is identified by our respondents is that the present educational funding model is deeply flawed, however ideologically correct it might appear. The funding model is intrinsically linked to metrics by which system actors are measured. The measurement system also requires examination. The issue as we perceive it is not so much that the ideology is inherently flawed (although it can be argued to be), but that the interpretation and application of it so as to optimise individual sectors or individual supply chain actors to the detriment of the whole system is fundamentally unsound.

The respondent's statement that "tertiary education is not a commodity" can be broadened to "education is not a commodity" and narrowed to "students are not commodities". The application of economic philosophies to education has been examined and questioned by various commentators e.g. (Gordon & Whitty, 1997; Olssen & Peters, 2005); the present authors acknowledging that the adoption of neo-liberalism in the late 20th century has negatively influenced the present state. Hubs might provide a mechanism for moderating the unforeseen consequences of the application of economic philosophy to education.

4.4 CHALLENGES AND BARRIERS TO DEVELOPING HUBS (QUESTION 4)

What might be the major challenges or barriers to establishing effective engineering education hubs, and how might we overcome them?

Some identified barriers were practical, especially with respect to school involvement

- *Transport of students to the hub, time - i.e. students already have a lot on, depending on activities there could be H&S regulations to consider, the Vulnerable Children Act / Police Vetting, time away from other curriculum areas, the "paper trail" that exists in schools.*

Others related to:

- **Attitudes and perceptions**
Previous perceptions of where the best Engineering Education can be gained. Local hubs would give students access to insights of what Engineering as a career may look like.
- **Engagement**
If not engaging with the engineering education players and industry in the region at the outset this would immediately create major barriers to progressing. If they are asked at the outset what they think of this idea, and have input (e.g. by doing this same questionnaire) this could help matters.

- Missing steps; not having all of the relevant parties included
- How to make something like this sustainable. Would work best if “industry led”
- Strategy

Overcome the funding battle that prevails among the providers (including the secondary school system, which is not incentivised to see learners depart early from schooling to tertiary), attach funding to learners, empower learners to make choices that shift them along a pathway to a meaningful vocational pathway, and make this the focus of hub activity.

4.5 PANEL EXPERIENCE WITH HUBS (QUESTION 5)

5. Have you experienced similar collaborative arrangements (e.g. in other education systems, or in other sectors within NZ) that might provide lessons for NZ engineering education, and if so describe the key features of those models:

Q5a. The key players

- *Have worked with an initiative that brought together a regional group of stakeholders - industry, community, providers, schools to address water management. Have also experienced a similar initiative in horticulture development*
- *The now disestablished Metro group of ITPs formed a collaborative grouping to establish the B.EngTech degree programme and related programmes. The collaborative model was hard to establish, but a key feature of the model was the adherence to a single common curriculum. This not only offered the potential for the providers to share resources, avoid resource duplication, draw on one another’s strengths, and share expertise, but it also provided learners with transferability and portability if they wanted to shift from one provider to another. This is a key feature of this model and it is worth continuing to harness this into the future*
- *ITOs certainly look into how an industry, or industries, might be served by training and education that works from the ‘ground’ up to higher levels. ‘Industry voice’ is perhaps quite well harnessed in ITO contexts. I have worked for two ITOs and seen how the industry need, and mindset, can drive education (sometimes at odds with the opportunity to maximise industry funding for education). This is a ‘biggie’. Industry voice needs to be ‘moderated’ by being ‘informed’ by an understanding of what could work in their ultimate interests. ITP’s and Uni’s sometimes might find it less easy to respond directly to industry needs. They have their own structures and processes, timeframes and responsiveness limitations that can impede development of a truly synergistic model.*

Existing models reported to us (Maori and Pasifika Trades Training (MPTT) and the Metro Group) have certainly succeeded in achieving some of the goals and objectives that hubs seek to achieve. The MPTT initiative is a partnership, or more accurately a group of partnerships between training organisations and industry. As such it achieves some of the transitions at the adult, or near adult end of the education supply chain. If hubs were to be established in the Auckland Region, then the MPTT group would be a ‘natural ally’. The Metro Group was essentially a horizontal collaboration between metropolitan polytechnics, and as such differed from the regionally located vertically integrated Hub concept. However, the Hub concept includes a proposal for horizontal information sharing, so the Metro group experience would be invaluable. The mechanisms described for achieving the strategic role of Hubs (Section 2B) - regular meetings of key stakeholders in an independent venue with a facilitator – appear similar to some of the Metro Group mechanisms.

Other types of collaboration tend to be either research and development focussed (e.g. innovation parks) or industry led collaborations of business and universities or polytechnics. Some of our respondents indicated a preference for industry-led initiatives. However the education-focus of the proposed hubs suggests that a broad education perspective with National oversight would be most appropriate. This implies a Government-sponsored and led initiative rather than an industry-led model. Our examination of literature indicates that the present system can be reasonably described as under-performing; that being largely the result of Government Policy over many decades. It will require careful and deliberate policy change to remedy, and that will be Government responsibility.

Q5b. The challenges that had to be overcome

Getting funded staff

- *The main thing was having a funded co-ordination role.*
- *Getting staff in each of the providers to work to a collaborative delivery model.*
- *There are many, many challenges involved. But getting people together is a start.*
- *Staff time and cost are challenges given many competing demands.*

Procuring the right people

- *Having someone(s) in the room who can see a bigger, better picture, albeit one that means folk might have to shift out of their comfort zones (on all sides) is key..... Then what follows offers up many, many more challenges too.*

Establishing an agreed vision/mission

- *But with goodwill and agreed vision for 'better future' and smart people working on a project, with inclusive governance (including industry), good things can happen.*

Previous experience of poor systems; organisational and technological

- *The clunkiness of the technology/tools that allowed for collaboration and sharing*
- *The 'system' (both TEC funding and NZQA QA) settings not supportive of a collaborative approach*

And further experience

- *I have certainly worked in contexts where I have worked with industry representatives and within government-funded education providers (various) to try to emerge qualifications and pathways (including internships) that will ultimately result in more talent for industry*

A respondent noted that the 'system settings' might not be supportive of a collaborative approach. The present authors note that this comment precisely addresses the purpose and potential of hubs – to identify 'system settings' that are preventing the operational units of the system achieving a common purpose.

Q5c. Strategies adopted to foster collaboration

- *Open communication and common / agreed purpose.*
- *Identification of "wicked problems" that could only be solved by the parties working together.*
- *Representative management and governance, with oversight and responsibilities for the collaborative undertaking. Adherence to a single curriculum. Recognition of expertise, place in the value chain*

These comments implicitly acknowledge the need for systems thinking. "Wicked problems" are problems that can't be solved with linear logic – they require a whole system approach, 'systems thinking' and 'systems tools' (Brassard, 1996). The need for an agreed purpose needs to be established at the whole system level – the policies of schools, universities and polytechnics have to be consistent with each other and with whole system guidance. 'Systems thinking' allows for and enables flexibility and adaptability within such guidance. The authors acknowledge value chain theory (Kramer & Porter, 2011), but have preferred the language of the supply chain model.

5. CONCLUSIONS

The following conclusions result from our investigation. These conclusions relate to factors that should be considered when establishing and operating hubs. We are unable to presuppose what hubs will produce, develop or coordinate, since those are outcomes and decisions to be developed by each hub as it operates.

5.1 THE NEED FOR HUBS

Through this investigation it became clear that the New Zealand education system (with respect to engineering education) has focussed in recent years on the effectiveness of individual sectors at the expense of the system as a whole. Structures and motivators have been put in place to optimise sectors of the system without sufficient consideration of the integration of those sectors into a whole education system that meets the demands of the economy.

Our expert respondents agreed that creating collaborative structures that would inform students and bring education and industry stakeholders together, would be a positive initiative. Our research revealed reservations in the form of feedback from our respondents and from our examination of literature, suggesting that the present system, which we have characterised as dysfunctional, has come about through policy. The effectiveness of the proposed hub structures would inevitably be constrained by existing policy, but hubs would constitute a mechanism for providing corrective feedback to policy-makers.

5.2 THE FUNCTIONS OF REGIONAL HUBS

We found the regional hubs to have three major functions.

Function 1: A (lateral) facilitation and communication function between key stakeholders.

The hub enables key stakeholders (primary and secondary schools, tertiary institutions, ITOs, employers and industry professional bodies) to meet, exchange ideas and develop new programmes and models.

Function 2: An (upstream) advisory function

The hub provides a communication link to upstream stakeholders (Government, IPENZ, ACENZ, treasury etc.) based on the decisions, recommendations and other outcomes resulting from hub discussions.

Function 3: A (downstream) service provision function

The hub provides a point of contact for downstream client groups (students, parents, employers). This extends to provision of information, guidance, and coordination.



6. CRITICAL FACTORS FOR REGIONAL HUB SUCCESS

Based on the foregoing study, we determine the critical factors that should be considered for effective hub development to be as follows. In the following, reference is made to relevant sections of the report, to other published works, and to the 'Wilder Collaboration Factors Inventory', a publicly available tool for measuring the success of a collaboration (Mattessich, Monsey & Murray-Close, 2001), which was adapted for the New Zealand collaboration context by Fraser, Honeyfield, Breen, Protheroe & Fester (2015).

6.1 DEFINING 'REGIONAL' IN THIS CONTEXT

'Regional hub' describes groups that are organised around local geographical locations or populations (whether those locations are provincial or metropolitan) rather than national, centralised institutions; notwithstanding the formation and funding of regional hubs may be centralised (Section 3.2, section 4.2 Q2c).

It is important to underscore the physically regional aspect of the hubs being proposed herein. The Irish 'cluster' model (section 3.4) works because there is geographical co-location of players (e.g. ICT firms). With New Zealand's elongated geography, a 'sectoral' hub (or cluster) model is unlikely to be as effective with partners located at various points across the length of the country. In certain sectors, parts of industry are necessarily located in specific regions (with access to ports, forestry, coal, fishing etc.). Where the players are geographically dispersed, it is unlikely that a hub can be formed that effectively places the learner at the centre. Thus, sector-based hubs are not within the scope of this study. One long-term strategy for overcoming the 'tyranny of distance' would be to emulate the approach adopted by Queen Margaret University (UK) among many others; namely to co-locate manufacturers, research organisations, tertiary institutions and supporting infrastructure into a physical cluster (section 3.6). This approach requires sustained governmental commitment and substantial targeted investment, such as incentivising business to start up at, or relocate to, the physical hub. This type of solution is outwith the scope of the current report.

6.2 HUB 'DRIVERS'

Regional Hubs should be formed based around a specified need or gap of relevance to the region. The willing collaboration of like-minded organisations and institutions requires such a common need, which will ensure the participation of all players (section 3.5). Engineering is *one* example of such a gap, where there is a specific need that has been identified by industry for capable engineers and technicians at level 7 and below (Fraser & Grigg, 2015). This need is common to many regions. Other needs may be more regionally specific, such as need for knowledge of aquaculture, mining, tourism, geology, product development and so on. Naturally where partners perceive benefits to themselves through involvement in the hub, such as a good source of able apprentices and graduates, this will be a key factor in securing their engagement. Thus the collaboration should meet the self-interests of the participating partners (Fraser et al, 2015).

6.3 HUB PARTNERS

Hubs should be formed from 'like-minded' organisations, which are willing and able to co-operate to fill the common need or gap. These actors include: educational institutions (universities, technical colleges, polytechnics, schools); employers; and civic groups (e.g. careers service, professional industry bodies) (Section 4.5 Q5a). Having a range of alternative providers in a hub provides for some flexibility of learning experience, but any competition between actors will be detrimental to the outcomes sought. The industrial analogy is of a 'supply chain network', which is a collection of organisations in a supply chain, where 'switching' is possible between actors to tailor the chain, but the chain operates towards a common goal. This type of partnership implies balanced power relationships, and '*mutual trust, understanding and respect*' between partners (Fraser et al, 2015).

Participation in a hub will require an investment of time from all partners. Thus partners in the hub need to have an investment in '*both process and outcome*' (Fraser et al, 2015). While a skilled apprentice or graduate might be a valuable asset to an employer, the employer will need to invest time in the co-creation of the educational pathway, with no guarantee that the learner will eventually be employed by them. However, it is likely that the learner will feel an affinity or loyalty towards the organisation that has willingly invested its time in their development. Such an outcome for the employer was not uncommon under the UK 'Teaching Company Scheme' (TCS) which was established in 1975. This scheme united a university with an employer, with funding support, to provide technology transfer into the industrial partner from the educational partner, via the learner (Associate). The learner gained skills that were both academic and industrial.

Other factors identified by Fraser et al (2015) relating to success of collaborative relationships include: ability to compromise; flexibility; adaptability; *open and frequent communication* (section 4.3 Q3a); *development of clear roles and policy guidelines*; *concrete, attainable goals and objectives*; and *shared vision*.

6.4 HUB GOVERNANCE

Regional hubs require a governance structure in order to be 'viable' self-sustaining entities. Governance, as always, implies defining the vision, ensuring there is accountability and oversight of operations, managing risk, controlling budget and continual evaluation and improvement. A two-tier structure is suggested along the lines of the 'families of learning model'. This has a central governance group (open to all partners) supported by (educational) institution local governing board(s). This structure allows for centralised governance (as above); and also localised monitoring of outcomes and student attainment. This cascaded structure is in line with the Viable Systems Model, which recommends attenuating the amount of information that is passed upwards, since the governing group does not require detailed operational detail (section 3.5). Employers and other partners should have the opportunity of representation on one of the governance groups.

Practical considerations for the central group will include the composition, constitution, and secretarial support. The group will establish its own constitution, and determine meeting method, frequency, location, chairing and so on. Secretarial support will be essential.

The local governing boards will be at the level of tertiary providers, and will deal with more operational aspects of programme development, assessment, learning outcomes and progression, per the requirements of TEC.

6.5 CO-CREATING EDUCATIONAL PATHWAYS AROUND THE NEEDS OF THE LEARNER

Regional hub members should co-create educational pathways around the needs of the learner. This is in keeping with the contemporary lean thinking principle of the 'value stream', whereby the value is first defined from the user's perspective, and then the delivery process is (re)designed around the flow of value through the experience. In this way, the learner receives an experience that matches their age, stage, needs and learning preferences. This is only made possible through effective collaboration between hub actors (sections 3.5, 6.3, 4.2 Q2b).

6.6 PHYSICAL CONTACT WITH THE HUB

Regional hubs need a point of contact for the learner. This will be a space where the learner can interact with employers or educational providers, be guided by them, but also inform them of their needs and requirements, so that a pathway can be tailored for them. This requires the presence of a coordinator or coordinating group, who can direct the learner to the relevant parties and *vice versa*. In the Families of Learning case this was referred to as the 'passmore centre'. This is where a one-stop-shop where the 'rubber meets the road', and requires multiple input from, involvement from, and interaction with all hub partners. It is worth noting that in April 2017, Southwark Council pledged over \$5million as a grant towards the creation of this centre, with the "aim of creating 2000 apprentices by 2020 to help boost a strong local economy" (LSBU, 2017). The centre will be based in a currently disused victorian building, and it is envisaged that it will offer spaces for employer meetings, community engagement, in addition to teaching facilities. Employers can come to find out about apprenticeships and potential apprentices.

6.7 PILOTING THE REGIONAL HUB PROPOSAL

In attempting to establish regional hubs in the New Zealand context, there is a need for a pilot hub to be trialled in one region. The hub will be based around an identified need within one region, and will 'test' or validate the mechanisms for governance, cooperation, physical location and delivery. The pilot will provide learning from early practice and recommendations to help tailor the approach before repeated or wider development of further hubs. Given the substantial lead times involved, it is envisaged that the pilot will take learners to the point of programme development, but not to completion of the learning journey.

Prior to launching a pilot regional hub, it is anticipated that some central support infrastructure will be needed. This will provide *pump-priming* start-up funding, and initial administrative support until a newly-established governance group can determine operational aspects of their own functioning. If the governance group consists of representatives from like-minded tertiary institutions in the first instance, then schools, organisations and other stakeholder groups can be approached and integrated.

REFERENCES

- Abbott, M. (2000). The development of vocational education and training in New Zealand. *Education research and perspectives*, 27(1), 90.
- Archan, S., & Mayr, T. (2006). *Vocational education and training in Austria*. Luxembourg: European Centre for the Development of Vocational Training (Cedefop).
- Beckford, J. (1998). *Effective Organization Quality: A Critical Introduction*. London: Routledge.
- Beer, S. (1966). *Decision and Control*. Chichester: Wiley.
- Beer, S. (1972). *Brain of the firm: a development in management cybernetics*: Herder and Herder.
- Beer, S. (1984). The Viable System Model: Its Provenance, Development, Methodology and Pathology. *The Journal of the Operational Research Society* 35(1), 18.
- Beer, S. (1985). *Diagnosing the System for Organisations*. Chichester: Wiley.
- Blakeley, J. P. (2013). *Development of Engineering Qualifications in New Zealand – a brief history*. Wellington: Institute of Professional Engineers of New Zealand.
- Brassard, M. (1996). *The Memory Jogger Plus+*. Salem, NH: GOAL/QPC.
- Bruffee, K. A. (1999). *Collaborative learning: Higher education, interdependence, and the authority of knowledge*: ERIC.
- Daniels, M., Cajander, Å., Pears, A., & Clear, T. (2010). Engineering education research in practice: Evolving use of open ended group projects as a pedagogical strategy for developing skills in global collaboration. *International journal of engineering education*, 26(4), 795-806.
- Dowden, T., Bishop, P., & Nolan, C. (2009). Middle schooling in New Zealand.
- Evans, L., Grimes, A., Wilkinson, B., & Teece, D. (1996). Economic reform in New Zealand 1984-95: The pursuit of efficiency. *Journal of Economic Literature*, 34(4), 1856-1902.
- Espejo, R. (1990). The viable system model. *Systemic Practice and Action Research*, 3(3), 219-221.
- Espejo, R., & Gill, A. (1997). The viable system model as a framework for understanding organizations. *Phrontis Limited & SYNCHO Limited*.
- Fraser, C., Honeyfield, J., Breen, F., Protheroe, M. & Fester, V. (2015), *Critical Success Factors in inter-institutional project collaborations.*, RHPF, Regional Northern Hub Project Fund Ako Aotearoa.
- Frater, T. G., & Grigg, N. P. (2015). *Creating Engineers - Climbing the Educational Staircase* (Commissioned Report). Wellington: Tertiary Education Commission. Retrieved from <http://www.engineeringe2e.org.nz/Documents/Creating-Engineers-climbing-the-educational-staircase.pdf>
- Goold, E. (2013). Mathematical Self-Efficacy: Addressing the Declining Interest in Engineering Careers.
- Gordon, L., & Whitty, G. (1997). Giving the 'hidden hand' a helping hand? The rhetoric and reality of neoliberal education reform in England and New Zealand. *Comparative Education*, 33(3), 453-467.
- Guthrie, J. P. (2001). High-involvement work practices, turnover, and productivity: Evidence from New Zealand. *Academy of management Journal*, 44(1), 180-190.
- Harkin, S., & Hazelkorn, E. (2014). Restructuring Irish Higher Education Through Collaboration and Merger.
- Hunt, C. (2011). National strategy for higher education to 2030.
- IPENZ. (2010). *NEEP Project Group, National Engineering Education Plan*. Institute of Professional Engineers of New Zealand.
- Kitagawa, F. (2004). Universities and regional advantage: Higher education and innovation policies in English regions. *European Planning Studies*, 12(6), 835-852.
- Knight, J., & Morshidi, S. (2011). The complexities and challenges of regional education hubs: Focus on Malaysia. *Higher Education*, 62(5), 593-606.
- Kramer, M. R., & Porter, M. (2011). Creating shared value. *Harvard business review*, 89(1/2), 62-77.
- LSBU (2017), £5M funding pledge to create LSBU centre for community engagement and learning, (retrieved from) <http://www.lsbu.ac.uk/about-us/news/grant-southwark-passmore-centre>, October, 2017.

- Maguire, T., Murphy, R., & Kirk, D. (2009). *Meeting the needs of the Modern Workplace through Employment Academic Partnership*. Dublin: Dublin Institute of Technology.
- Mattessich, P., Monsey, B. & Murray-Close, M. (2001), *The Wilder Collaboration Factors Inventory*. Retrieved from <http://www.wilder.org/Wilder-Research/>
- Mourshed, M., Farrell, D., & Bartob, D. (2012). *Education to Employment: Designing a System that Works*. McKinsey Centre for Government.
- NFETLHE. (2015). *Teaching and Learning in Irish Higher Education: A Roadmap for Enhancement in a Digital World, 2015–2017*. Dublin. Retrieved from <http://www.teachingandlearning.ie/wp-content/uploads/2015/03/Digital-Roadmap-web.pdf>
- Olszen, M., & Peters, M. A. (2005). Neoliberalism, higher education and the knowledge economy: From the free market to knowledge capitalism. *Journal of education policy*, 20(3), 313-345.
- Phoenix, D. (2017), *Families of Learning: Co-creating Local Solutions to Educational System Failings*, London South Bank University, and PA Consulting Group, Ltd., London, UK, 15pp.
- QMU (2016), Plans Unveiled for £80m Innovation Hub supporting 13,000 jobs at Queen Margaret University, Press Office, Queen Margaret University, Edinburgh, UK. <https://www.qmu.ac.uk/news-and-events/news/20150908-2-plans-unveiled-for-80m/> (accessed October, 2017)
- Scott, P. (2014). Robbins, the Binary Policy and Mass Higher Education. *Higher Education Quarterly*, 68(2), 147-163.
- Snook, I. (1991). Policy change in higher education: the New Zealand experience. *Higher Education*, 21(4), 621-634.
- Thune, T. (2011). Success Factors in Higher Education–Industry Collaboration: A case study of collaboration in the engineering field. *Tertiary Education and Management*, 17(1), 31-50.
- UNESCO. (2015). *Unleashing the Potential: Transforming Technical and Vocational Education and Training*. United Nations Educational, Scientific and Cultural Organisation. Paris: UNESCO.

