RELEVANCE OF ENGINEERING ENTREPRENEURSHIP: A STUDY AT CPUT

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ABSTRACT

This research examines the concept ‘Engineering entrepreneurship’, looking at the contribution that engineers make towards a rapid changing technological environment that support the growth South African economy. This research works on the premise that engineering entrepreneurship lends itself to high technology entrepreneurial activity, but seeks to understand whether engineers are sufficiently progressive to support rapid change. Global Entrepreneurship Monitor (GEM) places the catalyst for high-expectation entrepreneurship (aged: 23 - 32 years, highly educated, potential high income), squarely in the B-Tech program at Cape Peninsula University of Technology (CPUT). The answer we must find is one that seeks to understand whether engineering entrepreneurship is relevant in the South African context.

INTRODUCTION

That entrepreneurship activity contributes to Gross Domestic Product (GDP) is no secret and engineers are alert to that, but whether engineers as entrepreneurs by design or inherence are required in industry, is a highly debatable issue. In South Africa, one of the many challenges is to close the gap between the two economies, the rich and the poor. The gap continues to grow ever wider apart (Coetzer, 2006). The entrepreneurs in two economies are distinctive. Necessity entrepreneurship may be more prevalent in the poor economy due to low education levels and low income potential (GEM, 2001). The rich economy see the prevalence of opportunistic entrepreneurs, potential for high income and high educated. Engineering graduates are found in both economies and thus by implication would be reflect varied levels of creativity (survival skills) or attitude. The character traits or perceptive difference is beyond the scope of this work. The point that needs to be raise at this time is that engineers at CPUT have different persuasion fueled by different economic backgrounds.

Earlier research has shown that students were optimistic regarding their potential as entrepreneurs but that Higher Education Institution (HEI) had not contributed to this optimism in any way. In fact it is generally accepted in the engineering fraternity that creativity is suppressed in an endeavour to stimulate scientific precision. The engineer by nature is designed to seek “the one right answer” (Campbell & Fulton, 2000).

We can’t solve all the problems in the world because we as a global society do not have the plan to execute (Engelbart, 2003). Poverty and unemployment is rife in South Africa, but there is a plan in place to try and reduce poverty by 50% by year 2014 and here skills are critical to meeting this objective (Coetzer, 2006). The economy continues to grow at a healthy pace affording government to invest millions into entrepreneurial activity. Whether the funding is geared at lifestyle entrepreneurship to address poverty or whether the funding models support wealth creation, creates jobs and address the unemployment challenge, it is irrelevant. What is important is that government is addressing the policy and funding issues to help create an environment for high growth entrepreneurial activity. The government’s commitment to social upliftment, seeking to harness the potential that is locked in illiteracy, ignorance and poverty, must be noted as being progressive.

This research seeks to understand whether engineers are adept to meet the challenges of a rapid growing economy as well as a fast changing technological landscape. The greatest concern is around the static engineering output that speaks to “one right answer” at any cost (Campbell, 1997).
Inherent to entrepreneurship, small business is responsive to customer needs and able to out-perform large companies. One of the primary barriers in large companies is ‘culture’; at first glance culture plays such a role at CPUT.

**BOOTSTRAPPING**

Job creation comes about though the effort of an exclusive group of entrepreneurs. Autio (2005) and other are of the view that although variables like economy cycle, literacy rates and else, impacts on the ability of the country to be entrepreneurial, the bulk of job creation is underpinned by the efforts of 5% of all entrepreneurial effort. Entrepreneurship is key to the eradication of unemployment (GEM, 2001). The process of continuous engineering job creation can be realised through bootstrapping according to Douglas Engelbart (2003).

Isaac Newton, a revolutionary scientist, acknowledges the contribution made by other scientist when he makes the statement that, “If I have been able to see further, it was only because I stood on the shoulders of giants.” Isaac Newton meticulously continued to build on the scientific discovery and theories of researchers like Aristotle and Galileo, who had developed philosophy regarding space, energy and matter. It is this commitment to scientific progress that lofted Newtonianism forming the basis of our engineering understanding.

While SEIs must claim its rightful place along the education continuum, it is the HEIs that produce the opportunistic entrepreneur (GEM, 2004) which must make a substantial contribution to effect sustainable economic growth. Douglas Engelbart (2003) understands the importance of continuum progression, when as an inventor of computer technology; it holds the view that great men improve the way that they improve things, building meticulously on the successes of their predecessors. Suggesting that bootstrapping could be the only way that we as humans will ever be able to conquer the problems we face, he says that challenges compounds too rapidly for an individual endeavour.

The theory on cause and effect is as pivotal to Newtonian mechanistic physics as it is to entrepreneurship. The fundamental strengths and tenacity, mental vigilance and creativity are element instilled within the young mind while negotiating the essential truths of physics and mathematics. The effects of academic and scientific endeavour is truly realised when expert research is commercialised, this is caused through a more proactive role played by universities. Just “being there” is no longer adequate. Part of the role of universities must be to provide academics with experience of the business world to allow them to translate their technical expertise into commercial terms (Weatherston, 1993).

This creativity in the engineering world presents exciting opportunity to engineers that have the propensity to take advantage of the niche. When the issue of culture is addressed, this research found evidence of ‘entrapment’ as discussed by Petroski (1994, 1996). When one considers that much of entrepreneurship is discussed in the business realm, then debating engineering perspectives suggest a sense of exclusivity, a sense of freshness. The focus shifts from economic impact to technological progressiveness and engineering culture.

**CPUT GRADUATE RESEARCH**

Douglas Carl Engelbrecht with a degree in electrical engineering invented the mouse in 1963. It took the engineering world twenty years to understand this ‘different engineering thinking’ known as high technology entrepreneurship. Only in during the 1980’s was the technology integrated into engineering systems. Future thinking is about markets and shareholder value. Engineering future thinking must be about progressive knowledge production.

The electrical department, in the engineering faculty at CPUT has for the last 10 years been able to showcase the artifacts that graduates have researched and developed at the annual BTech conference. This illustrated the graduate engineering competence in the area of research. Over the last two years did 10% of the students diverge, focusing on engineering entrepreneurship? Engineering academics grew increasingly alien to the idea, branding it as non-engineering and thus not worthy of engineering recognition ensuring that policy be developed to support standards of engineering excellence that addresses the ‘one right
answer’ regime thinking. Engineering entrepreneurship research focuses on non-linear issues that impact on a linear engineering science, endeavouring to create alternate thinking.

In the real world, we speak to integration and competitive advantage, while the electrical department speaks to streaming and specialism. While the world is speaking to collective applied outputs, the electrical department continuous to speaks to unique individualism. This sentiment is based on the researcher’s observations over the last three years. What fuels this research apart from the theory focus on the topic ‘engineering entrepreneurship’ is the accumulation of more than 500 artifacts, more than 3 200 months of research and the graduation of more than 500 graduates over a ten year period. This collective wealth is locked within the primitive embrace of career engineering academics with a deficiency for progressive economics and applied engineering.

South Africa would enjoy benefit from the value that engineering entrepreneurship offers the country through alternate thinking. Developing fresh approaches to maximize the engineering potential which is locked within a single paradigm.

ENTREPRENEURIAL VALUE

Given the global awareness of the value of entrepreneurial activity in economic and societal life, it remains a challenge to investigate and develop understanding around the elements that prohibits progressive thinking. South Africa has an unemployment epidemic resonating around 25%. The only way to eradicate unemployment is through job creation. New businesses are seen to do just that and generate jobs according Birch (1987, 1995).

New firms may operate as an important alternative employment mechanism for many subsets of the adult-age population (Acs, 1996; Audretsch, 2002; Michelacci, 2003. Graduates in the faculty of electrical engineering, CPUT, is potentially one such subset who could contribute to the South African economy, generating wealth and providing much needed jobs in the high technology sector. The high concentration of job creation was expropriated by a small group of entrepreneurs, namely high-expectation entrepreneurship that subscribes to rapid growth and high employment (GEM, 2006).

While entrepreneurial firms are synonymous with job creation (Birch, 1987), large, established firms were net destroyers of jobs. This is not necessarily a bad thing in the South African context. The restructuring of corporation in most cases could reflect a growing economy, with a healthy influx of foreign investment thus encouraging companies to be more competitive.

While a part of job creation by new firms undoubtedly reflects downscaling and restructuring of established firms, and therefore, job migration rather than job creation, economists are in agreement that the genuine job creation potential of new firms is also significant.

Several studies suggest that only a relatively small proportion of all new firms end up generating the bulk of new jobs. Autio (2005) found this evidence to be regional yet consistent and reports that 5% of all entrepreneurs account for 80% of jobs. Highly dynamic firms are a product of creativity as well as experience (Autio, 2005).

Within the high technology sector, customers are price conscience as well as brand conscientious. The graduate may not possess the tools to market his entrepreneurial potential early on in his career. With new firms being to out-perform the old firms, could it be graduates with entrepreneurial intent join a new firm to energise the innovation process as well as reserving the right to join a large firm as an engineer with entrepreneurial intent.
SOUTH AFRICAN CHALLENGE

Engineering has over time underpinned and continues to underpin economies around the world, but it is no longer the gatekeeper of societal progressiveness (Lacquet, 2004). The technological age has introduced rapid change that meets customer demand. This change continues to be integrative and iterative presenting engineering as a static element of economic structure.

In the article entitled, ‘knocking back technology’, the writer suggests that emerging economies like South Africa were still battling deal with the far reaching implications of the technological age (Staff Reporter, 2006). This assessment is in line with Lacquet (2004), who proposes that academia revisit the portfolio of engineering skills, saying that engineers need to be technically and non-technically competent. The future of technology redefines the role of engineering within society.

South Africa, through government commitment to readdress the imbalances of the past is committed to economic stability through collective participation from all South Africans. With restructuring comes ‘chaos’ a phenomenon that lends itself to instability and uncertainty. South Africa is in state of change. 13 years on and the young democracy is still be refined. Policy is still being developed and social society’s demand for normalisation fuels debate.

The skills shortage in South Africa is one problem, but increasing numbers of highly educated people without employment is another. “This represents one of the most important challenges facing CPUT and government: ensuring that the education system produces the mix of skills required by the labour market.” Piet Coetzer (2006) puts forth the view that the skills problem in South Africa is of epidemic proportion and if the issue is not addressed soon the economic growth targets of SA could be threatened.

Mr. Vavi, Cosatu general secretary in his address to the National Skills Development Conference said: ‘One of the saddest ironies in South Africa is the coexistence of vacancies in skilled occupation alongside a mass unemployed who lack the skills to fill the position.’ Professional skills are required to leapfrog South Africa out of this unemployment crisis. ‘Nothing short of a skills revolution by a nation united will eradicate South Africa from the crisis that the country faces’, said Deputy President Phumzile Mlambo-Ngcuka at the launch of the Joint Initiative for Priority Skills Acquisition [JIPSA] (Coetzer, 2006).

This program was rolled out in response to the poverty levels and the unemployment epidemic that South Africa is experiencing. One of the growth sector in South Africa is technology and communication (8.7% - 9.8%) which suggests that engineering entrepreneurship could help in creating the engine that drives the economy of the South Africa (Coetzer, 2006).

ENGINEERING ENTREPRENEURSHIP

Despite the huge interest in the subject, a definition of entrepreneurship is hard to pin down because of the different descriptions used by a multitude of authors (Drucker, 1999). Entrepreneurship has been used to describe creating, founding, adapting and managing a business (Drucker, 1999).

The Oxford Dictionary describes an entrepreneur as one who ‘….organises, manages and assumes the risks and reaps the benefits of a new business enterprise or commercial venture.’ Entrepreneurship is also believed to involve ‘rethinking conventional paradigms, and discarding traditional ways of doing things’ (Magnanti, 2005).

We in engineering don't study entrepreneurship; we do entrepreneurship. We create products and processes that people use. Together the combination of management and engineering provide an ideal underpinning for technological innovation and entrepreneurship concludes: D.T.L. Magnanti (2005).

Oxford dictionary defines; engineering as the discipline dealing with the art or science of applying scientific knowledge to practical problems. And also it is defined as the applied science of acquiring and applying knowledge to design, analysis, and/or construction of works for practical purposes. However, in a fast changing world of technology engineers persist in their pursuit of the ‘one right answer’. This is no
longer sufficiently pragmatic to deal with the technological challenges the South Africa faces. Engineers must be more creative, dealing with technical and non-technical issues (Lacquet, 2004).

The very nature of technical and non-technical speaks to integration. The nature of linearity and non-linearity speaks to integration. Engineers require an integrated skills set to face a rapid changing world. This innovation, this fresh perspective could be synonymous with entrepreneurship. Engineering uses science to improve the lives of ordinary people (Ward & Angus, 1996), and entrepreneurship uses technology to resolve challenges in society.

By implication, Magnanti (2005) is saying that entrepreneurship is the technological, creative and innovative arm of engineering. Small business is responsive to customer needs and perpetual change but it remains business. Entrepreneurship is an innovation in response to customer needs based on engineering principles in a technological environment, thus it remains and engineering exercise. Engineers do entrepreneurship.

The view that this paper holds underpins the Schumpeter (1934) definition regarding successful ventures over time. In a technological environment, entrepreneurship speaks the same language as engineering, addressing social issues and developing policy to govern the paradigm thinking. The outcomes are the same and can be measured using engineering or entrepreneurial metrics. Entrepreneurship presents the engineer with different skills set and an altered perspective on the challenge at hand. Thus engineering entrepreneurship addresses the social problems in rapid changing environment. This responsiveness is critical to the enhancement of the South African economy.

New business creation is fundamental to the growth of the South African economy and to our future sociopolitical stability. Education and experience are key elements in successful venture creation. South Africa needs a growing pool of potential entrepreneurs who have the motivation and the ability to identify and to realise new business opportunities.

While the role of new venture creation – and specifically its potential to solve the unemployment crisis

Are South African schools developing entrepreneurial skills? Not with standing the reasons that Gem (2001) quotes for the disparity between white and black schools and learners, the 1st student Sample says no. the entrepreneurship effort of schools did very little to enthuse them.

**ENTREPRENEURSHIP EDUCATION**

South Africa’s tertiary education system prepares engineering graduates relatively well with the knowledge and skills required in industry. Young South African adults with tertiary education are almost as likely to start an opportunity-motivated business as are their peers in other developing countries. When asked about the education system, HEIs and SEIs did very little to enthuse.

In South Africa poverty alleviation is not a product of opportunistic entrepreneurship per se, it is more a survivalist strategy one that appeals to lifestyle entrepreneurship where the bare essential is taken care of. Poverty alleviation speaks to necessity entrepreneurship as suppose to opportunistic entrepreneurship that are job creators.

Be this as it may, Gem (2006) found that potential entrepreneurs lack the mindset and skills to become true entrepreneurs. Opportunistic entrepreneurs are not trained and recent study has shown that engineering graduates found this incompetence rather disturbing.

The graduates considered themselves more of an engineer as opposed to an entrepreneur. However, it is these engineers that recognised the potential value that entrepreneurship holds and shown a strong desire to receive such training at CPUT.

Although positive entrepreneurial culture is starting to develop at a macro level this has not filtered down to academic level. The engineering fraternity is entrenched in engineering principle beyond due concern of the future need of graduates to make decision regarding the future.
Employment creation is not encouraged and every attempt is made to encourage segregation and island thinking. There can be no serious challenge on unemployment and job creation when the impact that entrepreneurship makes on the economy and the impact it has on job creation and social restructure is not articulated at an institution of learning.

The academics at this institution seem to embrace a firm believe that principles embraced during the last century is relevant in a fast changing global industry. There is a need for broad thinking and a dual approach to develop impact and create employment capacity.

**RESEARCH DISCUSSION**

**Entrepreneurship Education**

Graduates are unsure of their engineering competency, unsure of what innovation is, unsure of what entrepreneurship is. They certain that all graduates at CPUT do not have same job prospects and that entrepreneurship creates an alternative to industry jobs thereby giving them a chance in life. Desire for entrepreneurship education, as shown in the graph below, is huge (88%) among engineers as shown in fig 1 below.

*Figure 1: Entrepreneurship Education*

The impact that entrepreneurship makes on world economies are real and measurable, the researcher is not sure whether the graduates are aware of this fact. Graduates identified the need for entrepreneurial training throughout the course but more specifically at graduate levels as shown in fig 2 below.

*Figure 2: Levels for Entrepreneurship Education*
Innovation and Wealth Creation

The economy and growth are directly dependent on creativity and innovation, which are some of most critical attributes of an entrepreneur. And these all prove the relevance of engineering entrepreneurship towards economic growth of South Africa.

85% shows graduates are highly innovative, in fig 3 above. However, fig 4 below shows that 86% of graduates are aware of the potential that entrepreneurship offers for wealth creation and purpose in life.
Graduate demand for Entrepreneurship

The sample as shown in fig 5 above showed that there is still a need for CPUT to create an option for graduates to decide on career paths by offering alternate education, such as engineering specialist program as well as an engineering entrepreneurial program. All graduates do not have the same job opportunity due to the government’s commitment to normalise the imbalances of the past. There are many jobs in industry but few skills to take advantage of this opportunity. Graduates agree that engineering is critical to support a growing economy but engineering entrepreneurship provides the alternative to the problems in the job market. And even within industry, graduates have a diverse set of skills and are therefore more employable than other engineers. As shown in fig 7 below, there is a strong consensus regarding the relevance of engineering entrepreneurship.
CONCLUSION

The engineering education system at CPUT, does not encourage entrepreneurship as a career option, it is perceived as a replacement for joblessness. This could be why entrepreneurship is perceived as the creation of a new venture, while perhaps that is not the case. Could it be the outcome of entrepreneurship activity leads to new ventures? Engineering culture does not permit alternative thinking.

Entrepreneurship is relevant in a changing society and engineers have a role to play in job creation and developing sustainable endeavours. Engineers no longer control technical change, technology enforces technical change and engineering must be restructured to compete in a fast changing high technical environment. Albeit that technology dictates the pace of change, engineering underpins the existence of society and it is thus incumbent on CPUT to drive projects and student thinking to absorb and understand the new dispensation.

Engineering entrepreneurship is relevant in South Africa and student has identified the need for this new way of thinking. That entrepreneurship is the science of starting new ventures is not a closed subject, it could be that entrepreneurial activity stimulates new venture creation or perhaps that the output to applied research could lead to the creation of a new venture.

Entrepreneurship must be related, directly or indirectly, to alternate thinking. Engineers must develop a set of skills to manage business challenges. These sort of skills are generic to business thus and not new venture creation. Engineers develop artifacts and if commercialised, will yield a value, this is called business.

At CPUT students have developed artifacts as part of the final year project. Nothing had been done to develop an interest in technology transference save two projects. The amount of intellectual capital in wasted in the artifact because the concept of bootstrapping and discontinuous research is a foreign concept to many academics.

Although the demand for engineering entrepreneurship is huge in the faculty, decisions are based on academic ignorance as opposed to student demand, a fundamental business principle that academics don’t understand.

South Africa require all the help it can get to continue to grow a healthy economy and HEIs are charged with responsibility to produce market leader to mobilise creativity and innovation. These engineers have the ability and the tenacity to effect change but the old senior engineers fails to see a changing engineering landscape and undertakes to stick to analogue thinking in a digital age.

John Hamm (2003) says that engineers must be trained to relent single-mindedness, working in isolation, being task oriented if they would fit into a world of creativity, innovation and entrepreneurship.

Engineers with entrepreneurship ability are a sort after commodity, one that should be nurtured from SEI level through HEI and into industry. CPUT must develop strategy to level the playing for students and help develop competence for all South Africans.
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