



**Exploring Industry's contribution to curriculum design of Civil
Engineering programmes at Universities of Technology:
A case study of Durban University of Technology**

By

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DECLARATION

This dissertation, except where otherwise indicated in the text, is this candidate's own work and has not been submitted in part, or in whole, at any other University or University of Technology. This research was conducted at DUT under the supervision of Professor P. Ramrathan and Professor D. Allopi.

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ABSTRACT

Promulgation of the Higher Education Qualifications Framework (HEQF) tasks the Council for Higher Education (CHE), South African Qualifications Authority (SAQA) and Department of Higher Education and Training (DHET) and standards generating bodies (Engineering Council of South Africa (ECSA)) with guiding institutions through the implementation of the new framework. Implementation is through a phased approach spanning a five-year period beginning in January 2011 and with anticipated culmination in December 2014.

As the Higher Education Framework Handbook (CHE 2011:2) states: 'all existing institutions, public and private, offering existing and previously accredited higher education programmes will be impacted upon by this process in some manner or form, whether it be through a minor name change or a complete renewal of the programme content.' Consequently, universities of technology (UoT's) have embarked on a curriculum renewal process and the Civil Engineering Department of Durban University of Technology (DUT) is no different.

It is within this context of participation and multiple contributory environments of different role-players that this study was founded. This research explored the Civil Engineering industry's involvement in the curriculum renewal at DUT with the intention of understanding its contribution and influence in the renewal process and particularly in terms of curriculum design.

The scope of the study was restricted to DUT Civil Engineering Department and their graduates, with subjects selected from a convenience sample of DUT Civil Engineering Department's database of employers that have in the past and presently employ DUT graduates and/ or Work-Integrated Learning (WIL) students. The sample constituted organisations from the contracting, consulting and para-statal fields of employment.

A questionnaire was designed containing both open-ended questions and rating scales that explored and probed the Civil Engineering industry level of involvement in the curriculum and curriculum renewal activities at DUT. In addition, interviews were conducted with seasoned Civil Engineering staff that have interacted with industry at

various levels to gain their view of industry's involvement with design of the Civil Engineering curriculum.

Data from both questionnaires and interviewees overwhelmingly suggested that industry is not directly involved with the curriculum renewal currently underway at DUT, some respondents only gathered that such an activity was taking place through the medium of the questionnaire. This suggests that the resultant curriculum will be void of much industry engagement and influence.

The nature of engagement that does occur is largely through the utilisation of DUT graduates or WIL students. Engagement occurs most commonly when curriculum issues are raised by staff at interviews of employers during WIL, suggesting that the nature of association with DUT is limited to employment of students or graduates. It is inferred that industry has very little direct input into the curriculum.

DUT Advisory Board is considerably under-utilised for its intended purpose of engaging industry on curriculum issues, and its existence is unfamiliar to industry at large. As much as the Advisory Board is the most appropriate avenue to discuss curriculum issues, it has limitations in that its function is not entirely realised.

The data generated also resoundingly suggests that industry is fully supportive of an inclusive participation process. Data further suggest that industry genuinely wants to be involved in curriculum discussions, and decisions for reasons ranging from participating to create more relevant course content, to contributing to creation of graduates with more appropriate employability attributes.

Participants from industry further intimated that their role remains for on-site experiential learning: they provide the working knowledge to complement the academic knowledge provided by DUT. They also consider themselves to be providers of other facets that contribute to a holistic graduate, and assume further roles such as those of mentors and supervisors.

The likely outcomes of their influence would be rapid engagement of graduates within the Civil Engineering field. A symbiotic relationship therefore becomes apparent between DUT

and industry, where with more input into the curriculum by industry; a more work-orientated graduate is produced to better serve the needs of industry.

The following recommendations emerge from the findings of this study:

- Since most of industry's engagement occurs during WIL interviews, it would be prudent if a generic curriculum-based questionnaire is devised. This should be filled in by employers during student WIL visitations by staff in addition to the existing questionnaire. In doing so DUT would be proactive in literally 'taking curriculum issues to them'.
- The DUT Civil Engineering Department should target those companies that have an interest in making a concerted effort by enlisting them onto the Advisory Board. From an institutional perspective DUT should be more proactive and advertise the existence of such an entity, created solely for curriculum discussions with the public, and particularly with industry.
- Assessments, course content and the project component of the programme generated considerable comments from industry that the Civil Engineering Department could take into consideration during the curriculum renewal process.

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Abbreviations

CHE	–	Council for Higher Education
CQPA	–	Centre for Quality Promotion and Assurance
DHET	–	Department of Higher Education and Training
DIT	–	Duran Institute of Technology
DUT	–	Durban University of Technology
ECSA	–	Engineering Council of South Africa
HEI	–	Higher Education Institution
HEQF	–	Higher Education Qualifications Framework
OBE	–	Outcomes Based Education
NQF	–	National Qualifications Framework
WIL	–	Work integrated learning
SAQA	–	South African Qualifications Authority
UoT	–	University of Technology

CHAPTER 1: OVERVIEW OF THE STUDY

1.1 Introduction

'The curriculum is never simply a neutral assemblage of knowledge, somehow appearing in the texts and classrooms of a nation. It is always part of a selective tradition, someone's selection, some group's vision of legitimate knowledge. It is produced out of the cultural, political, and economic conflicts, tensions, and compromises that organize and disorganize a people', (Apple 1993:222).

This profound statement about curriculum by Apple sets the context for this study, in which I explore curriculum renewal of the Engineering curriculum at the Durban University of Technology (DUT). With gazettement of the Higher Education Qualification Framework institutions of higher education are required to align their curriculum to this new framework, and many have commenced this process. During this alignment process, fertile ground for researching curriculum processes presents itself. Hence, I have taken this opportune moment to explore how curriculum is conceptualised, who influences curriculum and how these influences impact on curriculum design, taking cognizance of Apple's quote presented above. In particular, I focus my attention on the influence of the Civil Engineering industry on the Civil Engineering curriculum offered at Universities of Technology, DUT being the case study institution.

By engaging with relevant stakeholders and industry role- players I have attempted to locate the stance of a key player in curriculum discussions, thereby providing a basis for a more suitable platform for future development of the Civil Engineering curriculum.

In this chapter I present an argument for the need for this study, together with a clear indication of the focus, purpose and research questions that this study seeks to answer. The chapter concludes with an indication of what one would expect to read in the forthcoming chapters.

1.2 Background to the study

Educational reform is most often used as a podium for canvassing politicians when a country suddenly finds itself behind in the international arena. Issues of critiquing the legitimacy of what is taught and how it is disseminated are raised in an attempt to develop and contribute to the country's holistic progress. Moreover, when a new government comes into authority, such reform is propagated. Immediate notable changes are a review and occasionally a complete overhaul of the assessment structure, criteria or curriculum, which ultimately results in curriculum reform.

With the birth of the South African democracy in 1994 and subsequent gazetting of the National Qualifications Framework (NQF) that came into being through the South African Qualifications Authority Act (No. 58 of 1995, *Government Gazette* No. 1521, 4 October 1995), curriculum reform was promulgated.

The NQF and subsequent Higher Education Qualifications Framework (HEQF) tasks the Council for Higher Education (CHE), South African Qualifications Authority (SAQA), Department of Higher Education and Training (DHET) and standards generating bodies such as the Engineering Council of South Africa (ECSA), with guiding institutions through implementation of the new framework. These bodies are tasked with various undertakings to contribute to the curriculum renewal process, implementation is a phased process spanning a five-year period beginning in January 2011 with anticipated culmination in December 2014.

As the Higher Education Framework Handbook (CHE 2011a:2) states: 'all existing institutions, public and private, offering existing and previously accredited higher education programmes will be impacted upon by this process in some manner or form, whether it be through a minor name change or a complete curriculum renewal of the programme content.' Consequently, the DUT like other universities of technology (UoT's) throughout the country has embarked on a curriculum renewal process- a programme that subsequently provides for a new qualification profile aligned to the requirements of the HEQF, CHE, SAQA and ECSA.

The HEQF is 'promulgated by the South African government as the ruling policy on qualification types and structures', (ECSA-HEQF Position Paper, 2009:1). Its review

in 2010 was to address emerging skills and, knowledge needs and 'to enhance the coherence of the higher education system', (CHE 2011b:5).

Consequently, this legislature heralded initiation of the Curriculum Renewal Project at the DUT to bring to realization academic programmes that are aligned with national objectives. It also provided a stepping stone 'to become a student centered university through the transformation of teaching and learning and the promotion of quality enhancement' as explained by Sattar and Cooke (2012:377) and to bring to fruition its vision of becoming 'a preferred university for developing leadership in technology and productive leadership' with a mission to, amongst others 'excel through external engagement that promotes innovation and entrepreneurship through collaboration and partnership' (DUT: 2009).

The requirements of the DUT's mission and vision impacted on the curriculum through one of DUT's objectives: that of establishing and maintaining 'a profile of academic programmes aligned with the institutional and national context'. This would be done through improved pedagogical practices and programmes that are informed by the needs of society and industry. It would also be done through creation and development of a responsive curriculum that is expected to take into consideration implementation of the HEQF, amongst others.

Accordingly DUT's concerns were wide and varying, alluding to many responsibilities of the curriculum; however, ECSA, South Africa's controlling engineering body, stressed other issues that the curriculum should aspire to. It did this in 2009 by publishing its proposal for the structure for all Engineering qualifications within the HEQF. Its concerns were primarily with the tangible aspects of Engineering qualifications more than addressing historical and social issues of the HEQF or of DUT becoming a first choice of study for prospective students.

First on their agenda was that the programme must provide definite opportunities to students upon graduation. Furthermore the ECSA-HEQF Position Paper (2009:1-5) requirements are that programmes 'must have the intellectual rigor required for bachelor's degrees and not provide for an early exit for academically poor students. It must constitute a significant emphasis on mathematics, applied science and Engineering principles and finally an appropriate graduate title'.

One stakeholder, industry-specifically Civil Engineering- does not seem to be directly involved in the mix when it comes to the above mélange of requirements, transformative issues, mixture of old with new academic knowledge and expected synergies. Some reference is made to industry involvement in the CHE Founding Document, to the effect that 'provision will include but be confined to labour market responsiveness', (CHE, 2003:13). While DUT's Center for Quality Promotion and Assurance (CQPA) dominant rationale for the project would be active involvement of all key stakeholders and staff, neither of the above assurances are elaborated upon.

The most recognizable link that DUT Civil Engineering Department has to industry exists via the Advisory Board. The Advisory Board consists of members of the Civil Engineering profession and related organizations, and is meant 'to promote liaison between the Civil Engineering industry, other related professions and the Department of Civil Engineering', (Advisory Board Constitution 2004:1). These liaison events are envisioned to occur at least twice a year, with the function of, among others, 'the monitoring of courses and the recommendation of possible curriculum changes to keep up with the latest developments within the built environment'.

Of late meetings of the Advisory Board have become more of an information session for industry to find out progress on the curriculum renewal activities, the composition of the new programme and phasing out of the old programme at DUT. This is evidence of a lack of direct involvement in the new curriculum, and due to its current minimal industry representative composition, a holistic understanding of industry's contribution to the Civil Engineering programme at DUT is not possible from this body. Given this current situation on curriculum influence by industry, and in keeping with Apple's (1993) statement on curriculum, a study on stakeholders' influence in curriculum renewal is warranted. This study, therefore, attempts to contribute towards the discourse on the Civil Engineering industry's influence on DUT's Civil Engineering curriculum.

1.3 Aims of this Study

Guided by the context of this study, the main focus, then would be to derive meaning for the purposes of enlightenment from an exploration of the phenomenon of curriculum renewal of the Civil Engineering curriculum

Within this multi-contributory environment of the re-curriculum process and minimal industry involvement, the purpose, then, of this study is to explore the Civil Engineering Industry's stance towards the process of curriculum renewal. More specifically, the aim is to explore the Civil Engineering industry's influence of curriculum renewal, with a particular exploration of their contribution to curriculum construction.

Knowledge production and theorizing would stem from the data as obtained from a data production plan. The data for this research were obtained through the activities involved in the curriculum renewal process which is currently unfolding at DUT as it is at other UoT's. Its value lies in learning from 'practice' so that it informs future endeavours in curriculum renewal, awareness of the power dynamics in curriculum reforms and exploring ways of mediating these power dynamics.

Hence this illuminates the various forces that shape the curriculum and particularly how one of these forces, the Civil Engineering industry, contributes to the curriculum outcomes. This study, therefore, explores the extent to which the Civil Engineering industry is involved in the curriculum renewal process, and specifically, the nature of their consultation and the nature of the discourse. This study aims to explain how Industry influences the Civil Engineering curriculum, and to provide insight into the depth of contribution of the Civil Engineering industry to this curriculum.

This multi-contributory environment of what should constitute the curriculum, resonates with Apples (1993) belief that the curriculum is not a simple conglomeration of knowledge, and existence of a multitude of competing interests and how they come to bear on spaces in a curriculum. Ultimately, the end user of the products of a higher education institutions curriculum is the society and industry that it serves. Therefore the requirements of this group are not only pertinent but essential for a curriculum. Hence, the aim of this study is to investigate for the purposes of illumination, one of these 'groups of legitimate knowledge', (Apple

1993:222), specifically, the interaction between industry and DUT within the context of a national framework guiding conceptualisation of the Civil Engineering curriculum.

Emanating from the above, a number of pertinent questions arise that define the nature of this study, the first being, what is the nature of the Civil Engineering industry's engagement with higher education i.e. the DUT, in curriculum conceptualisation? How does the engagement happen and how does this engagement influence curriculum decisions in the Civil Engineering curriculum? Finally, why is the engagement the way that it is?

Concomitant to the nature of the above enquiry, the rationale for the study has its motives from a number of perspectives, the first being the researcher's personal reasons. As a lecturer, I am currently engaged in part of the process of curriculum discussions and Civil Engineering curriculum conceptualisations to meet the curriculum renewal aims. Through the process, curriculum decisions are being decided upon and part of the decisions may impact on the nature of Civil Engineering graduates' relationship with various places of employment. This study helps me to get a better sense of industry's needs and how these are served through the DUT curriculum. The study will also enable me to ascertain what industry's needs are, how industry should be involved and how industry can be conveyed into the process of curriculum design so that there is alignment with the DUT's Civil Engineering curriculum. This study will also provide me with insight to help reconceptualise and redesign the curriculum.

The second motive relates to the fact that, the national HEQF has been reviewed and a new framework has emerged that has certain added requirements. From an institutional position, these requirements relate to the routes of progression of students and graduates. It provides a clearer definition of the direction possibilities within qualification progression. It increases qualification types and provides more variants with particular qualifications and 'provides a greater flexibility and options with regard to professional oriented qualifications', (Republic of South Africa 2011:55). Consequently DUT as with all other UoT's have to align itself with these added conditions brought about by the HEQF and its subsequent review. Therefore,

this study will assist the researcher in making more informed decisions and choices in the process of aligning.

1.4 Statement of key questions

The following are the key research questions that were examined in this study:

- What is the nature and extent of the Civil Engineering industry's influence on Civil Engineering curriculum offered at DUT?
- How would the Civil Engineering industry see their role and participation in the Civil Engineering curriculum offered at DUT?
- How does academic staff view the Civil Engineering industry's participation in the Civil Engineering curriculum offered at a DUT?
- What are the likely outcomes of the Civil Engineering Industry's influence on the Civil Engineering curriculum offered at DUT?

The above research questions would provide responses relating to the following:

- An explanation of how industry influences the Civil Engineering curriculum.
- Demands and requisites of industry on training of Civil Engineers.
- How DUT discerns what industry requires from their Civil Engineering graduate.
- Whether the curriculum renewal of the Civil Engineering programme will meet the needs of the Civil Engineering industry?
- Contribute to the knowledge base on how curriculum should be constructed within Civil Engineering education.
- Insight into the level and depth of the contribution of the Civil Engineering industry to the curriculum itself.
- Provide a sense of how DUT address the needs of the Civil Engineering industry through the curriculum.

1.5 Methodology employed in the study

Drawing on Apple's (1993) statement, the nature of curricula at particular institutions of learning are, unique to the situation within which they are was designed, offered and experienced. Hence, the most appropriate methodology for this study would be a case study methodology that attempts to explore the phenomenon of curriculum influence in its situated reality. Case study methodology provides an opportunity to explore this phenomenon through multiple lenses, requiring a descriptive and an explanatory process to obtain a fine-grained, deep analysis of curriculum influence in curriculum renewal. Within the case study methodology, a mixed method approach is employed to provide a descriptive and explanatory perspective to the influence on curriculum renewal at DUT. The research design includes the use of interviews and questionnaires, the primary respondents being Civil Engineering Industry managers and academic staff of DUT. The research design is presented in greater detail in Chapter 3 of this dissertation.

1.6 Theoretical perspective of the study

From a theoretical perspective, in light of the above medley of guiding conditions, State imposed requirements and institutional goals further support Apple's premise that a curriculum is not merely an impartial accumulation of information put together to constitute knowledge and understanding. Apple suggests that in curriculum design, what gets into the curriculum is influenced by a host of players, each with their own ideas of what takes precedence and what should constitute a curriculum. He goes on to say that, depending on power dynamics associated with each of the players, what gets legitimated is as a result of the power influence. In this study, I hope to ascertain who the players are and the role of industry and how much power they have in the process of influencing curriculum.

Current South African curriculum trends indicate a preoccupation with meeting the demands of various regulatory bodies registration demands, globalization and massification agendas, as they focus on 'form rather than the content of the curriculum', Lockett (2001:52). However, as literature suggests, industry and

academia are inextricably connected. Griesel, (2002:39) believes as follows: 'if the employability of an Engineering graduate is determined by the graduates ability to display skills and proficiency directly applicable to the effective functioning of him/her within the Civil Engineering industry then it is apparent that institutions of higher education need to take heed of industry's views when any issues arise around the change or modification of an institution's curriculum.'

Studies by Lamb *et al.* (2010:11) in the United Kingdom reveal that continual industry input and involvement results in a symbiotic relationship between the institution concerned and the Civil Engineering industry not to mention positive spin-offs for the curriculum and the graduate. In some instances the depth of industry involvement with some institutions has led to changes in instructional programmes and even the emergence of entirely new courses that were motivated by skills shortages as defined by industry.

However in the South African context, 'several policy initiatives' (Fester and Haupt 2006:3) are responsible for changes in curriculum decisions and therefore the nature of industry involvement is not as explicit as it is elsewhere in the world. This indicates a marginalisation of the Civil Engineering industry and a dominance of policy promulgated by the changing and evolving educational landscape that is defined by the NQF and the HEQF. It is within this environment of 'cultural, political, and economic conflicts, tensions, and compromises' (Apple 1993:222), that this study finds its momentum.

1.7 Limitations of the study

As the curriculum renewal process is currently underway and at advanced stages in its development it would imply that this study was done at the same time as the renewal process. Such a method would imply research in action; however, this does not imply that it may influence what happens in the ensuing curriculum renewal. It will nevertheless be illuminating for future curriculum design processes. This research being undertaken within the curriculum renewal process can be interpreted as one of the limitations of this study. As such, I the researcher have undertaken an interpretivist epistemology. This suggests that as an interpretivist researcher, I did

this study in a way such that I derived a meaning and understanding of this phenomenon of Civil Engineering reconceptualization. This may be seen as bringing a level of subjectivity to the study, but this is the paradigmatic tradition. If working within the positivist paradigm, then the idea is to maintain objectivity and in the process exclude oneself as the researcher from the process and therefore one would refer to oneself as 'the researcher'. In an interpretivist paradigm I integrate myself as the researcher in order to seek meaning from the information gleaned from the data and therefore bring in a level of subjectivity in the meaning-making process which is consistent with an interpretivist epistemology.

1.8 Chapter Summation

I have provided, in this chapter, an overview of the situational contextual framework that locates this study. I attempt to present an understanding of the research paradigm that this study is founded in, and also the current rational and research discourses that encourage and guide the field of curriculum conceptualisation from a point of view of the Civil Engineering industry's engagement.

In Chapter 2, I present a literature review of the four areas or forces that stimulate and influence the curriculum reconceptualization at DUT namely State, institutional, and regulatory bodies and the Civil Engineering industry. I delve into the motivations and contestations of curriculum reconceptualization that provide the impetus for my study.

In Chapter 3, I present the methodological process that my study followed. I present the research design that guided the production of the data and give a detailed explanation of the research design decisions that have been taken.

In Chapter 4, I present the data and the forms of analytical methods used to decipher the results.

In Chapter 5, I conclude this study with a summary of the findings and attempt to explain what I have found.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Having presented a background to the study and a research focus in Chapter 1, I now concentrate my attention on contextualizing this study within a literature scan on curriculum, consultation and Engineering education. This chapter, therefore, presents a literature review on three components that are relevant to this study which include a gaze on curriculum, on higher education and on Engineering as a field of study within higher education. Selection of these three core components of the literature review chapter is largely based on their relevance to the focus of the study.

The main focus is to explore the Civil Engineering industry's influence on higher education curriculum construction. Hence, a literature review on curriculum is an important component of this study as it presents a frame to understand curriculum issues, dynamics and construction that influences the overt curriculum offered within higher education institutions. A review, of higher education is relevant and needed to understand how curriculum is conceptualized, why it is conceptualized in the way it is and what factors influence curriculum construction. This literature gaze on higher education, therefore, presents a contextual, site based gaze on curriculum construction. The Civil Engineering curriculum offered within higher education is the core to the unit of analysis of this study and therefore needs attention, more so as a field of study and the influences thereof.

In addition to these three components of the literature review, some process issues are pertinent. Hence this literature review chapter includes a review of literature related to key process issues like consultation and curriculum reforms. These process issues will, therefore, be presented with a view to developing an understanding of the key concepts as used in this study.

2.2 Key concepts used in this study

2.2.1 Collaborative consultation

Idol, Paolucci-Whitcomb and Nevin, (1986:329) define collaborative consultation as 'an interactive process that enables people with diverse expertise to generate creative solutions to mutually defined problems'

They use this explanation as an example to show how the collaborative consultation is interactive, engaging and inclusive. From this analysis they found that several stakeholders were invited to participate in the consultative process. Key to this collaborative consultation process is the wide and open invitation, the listening and engagement, the generation of several solution options and the consensus making process.

Kurpius and Fuqua (1993:598) allude to four generic modes of consultation: Provision, Prescription, Collaboration and Mediation. Within the collaboration mode, the stakeholders work together 'in defining, designing and implementing a planned change process'

In this study, collaborative consultation is the key focus of engagement as the researcher explores the nature and extent of industry participation in the construction of the Engineering curriculum as international literature suggests that there is a 'need for close collaboration between industry and education,' (Crossland 1985:109). The researcher, having served in the Engineering industry, had not had an opportunity to have collaborative consultation with higher education in the design and production of Engineering graduates, and by exploring the nature and extent of this collaborative process, this study will illuminate the kinds of interaction needed, the kinds of expertise needed and the process of generating solutions. Other researchers, e.g. Gutkin (1999:180) reinforces this definition by espousing that it is a 'process of jointly shared decision making between consultants and consultees, with both parties having the opportunity to exert leadership and provide input whenever they believe appropriate'. To this end, Kurpius and Fuqua (1993:598) maintain that consultation is triadic, work-related, issue-focused, voluntary and non-judgemental.

'Collaborative consultation' is derived from Tharp and Wetzel (1969) cited in Idol, Paolucci-Whitcomb and Nevin, (1986:329), who researched the triadic model as composed of the following three components: the target, the mediator and the consultant. The model places the consultee as the mediator of change between the consultant and the person in whom the behaviour is sought', (Idol, Paolucci-Whitcomb and Nevin 1986:329). The advantages of using the triadic model are numerous, steadfast and consistent in that firstly, both the mediator and consultant 'share expertise because of their mutual responsibility', (Idol, Paolucci-Whitcomb and Nevin 1986:330) for and in higher education. 'Second, the consultants role results in increased communication among diverse professional disciplines, leading to an increased sharing of material, human resources' (Idol, Paolucci-Whitcomb and Nevin 1986:331), and in this case, also knowledge. 'Third, collaborative consultation facilitates appropriate and beneficial liaison with other community agencies', fourth, facilitates the provision of instructional services based on academic and social needs', and finally, 'collaborative consultation is a student centred approach that requires both consultant and consultee to develop creative and effective programmes' ,(Idol, Paolucci-Whitcomb and Nevin 1986:331). In addition, Kezar (2005:833) reveals that in higher education eight core elements are necessary to 'create a context that enables collaboration: (1) mission; (2) integrating structures; (3) campus networks; (4) rewards; (5) a sense of priority from people in senior positions; (6) external pressure; (7) values; and (8) learning'. In this study the relationship between HEI's, state imposed requirements and external influences, particularly that of the Civil Engineering industry is explored.

Gomes *et al.* (2005:90) comments that: 'Universities and companies have fundamentally different cultures, which are reflected in divergent goals, time orientations, basic assumptions, and languages used. Additionally, universities deal with work that is abstract, complex and ambiguous: much of the knowledge is tacit in nature'. Thus, say Bruneel, D'Este and Salter, 2010:860, 'university collaboration is an activity in which firms learn from experience and develop richer and more refined ways of engaging with the university sector'. Moreover, 'universities are primarily driven to create new knowledge and to educate; private firms are focused on capturing valuable knowledge that can be leveraged for competitive advantage (Dasgupta and David, 1994, cited in Bruneel, D'Este and Salter 2010:858).

Additionally, 'unclear boundaries in interdisciplinary projects and the gap between researchers and industry representatives may lead to conflicts and disappointments because of imprecise expectations' (Bruhn, 1995) cited in Gomes et al. (2005:90). Furthermore Cyert and Goodman, 1997 cited in Gomes et al. (2005:90), state that: 'another inherent obstacle to collaboration is related to the fact that the corporate world is subject to unexpected radical changes, such as acquisitions, mergers, and bankruptcies: such scenarios are considerably less likely to happen in the academic world' as expressed by These obstacles are compounded when 'the aims and interests of different organisations participating in a cooperation venture may differ significantly from each other. Unlike companies, academic parties do not usually pursue profits – rather, they seek science development' (Gomes et al. 2005:90).

Nevertheless, 'industrial collaboration injects a sense of reality into Engineering research in the universities and it develops close contacts with industry and encourages communication both ways. Indirectly, this influences even the undergraduate curriculum and makes it more industrially relevant' (Crossland 1985:114). Although literature suggests that there are divergent goals to collaboration nevertheless 'collaboration between universities and companies can lead to several benefits. Nissani (1997) names a few: creative breakthroughs, academic freedom, social change, outsider's perspective, and flexibility of research. Other reasons include learning from one's partner, access to knowledge networks, funding (Sa´ez et al., 2002), global improvement of both management research and management practice (Amabile et al., 2001), and blending knowledge as science and knowledge as culture (Delanty, 2001)' all cited in Gomes et al. (2005:89).

Collaboration through 'consultation has been one of the key notions of administrative politics for some years, and is regularly associated with the term 'stakeholder'. In every policy cycle, the expectation is that provision will be made for stakeholder identification and subsequent consultation' (Kane 2002:87). Subsequently, the involvement of the above interested or affected parties or stakeholders, indicate a certain degree of direct and indirect participation, connection and contribution to the Civil Engineering curriculum.

Bitzer (2006: 934) defines the notion of stakeholder as 'some person or group who appears to have some form of ownership of, interest in and responsibility for something of value'. While Mitchell, Argle and Wood. (1997:872) suggests a more advanced theory of stakeholder identification based on the following three attributes: Stakeholders legitimacy, power of influence and the urgency of their claim on the entity. Drawing on the above, from an academic perspective, Delanty (2001:4 cited in Roodt 2004:162) comments that 'institutions of higher education connect a diversity of stakeholders in a cosmopolitan culture and are therefore well-situated locations for determining cultural identity which in turn be expected to affect curricula reform'.

As such, for this study, the concept or notion of 'stakeholders' shall include all contributors to curriculum development in higher education.

2.2.2 Curriculum practices

The philosopher Jurgen Habermas in the 1970,s provided a framework for making meaning of curriculum practices by the theory of 'knowledge-constitutive interests'. This is a hypothesis centering on 'fundamental human interests which influence how knowledge is constructed', (Grundy 1987:7). According to Grundy, Habermas identified three basic cognitive interests: technical, practical and emancipator representing the three types of science by which knowledge is generated and organized on our society.

He defines technical interest as a person's basic orientation towards controlling and managing the environment which Grundy ultimately yet succinctly interprets as 'a fundamental interest in controlling the environment through rule- following action based on empirically grounded laws', (1987:12).

Habermas's practical interest is directed towards understanding the environment to be able to interact with it and as Grundy (1987:12) explains, 'the practical interest is a fundamental interest in understanding the environment through interaction based upon a consensual interpretation of meaning. This is central for implications in education and specifically for curriculum design in that it is regarded as the process through which pupil and teacher interact and derive meaning and understanding.'

The most difficult of the three according to Habermas (1972, cited in Grundy 1987:16) is emancipation, meaning 'an independence from all that is outside the individual'. Thus the emancipative cognitive interest as defined by Grundy (1987:19) is 'a fundamental interest in autonomous action arising out of authentic, critical insights into the social construction of human society'. Applying the above ethos of emancipation to curriculum would allude 'to unrestricted independence on various levels of consciousness. Consciousness of an understanding of the possibility of biases and misrepresented views in education and in practice, an attempt to effect changes in structures that constrain freedom within which learning occurs' Grundy (1987:19). Therefore this study attempts to illuminate the views of the Civil Engineering industry in light of other forces that may be biased or constrained in a particular direction other than the creation of a holistic Civil Engineering graduate.

2.2.3 Curriculum Design

The theory of curriculum design has its genesis in various methods and literature suggests various facets composite of a curriculum. Van Wyk and Higgs (2011:172) believe that 'curriculum is designed to convey a combination of knowledge and skills that are determined to be appropriate and necessary to the society and time'. Nevertheless, Petrina (2007:297) adds that 'curriculum design is the practice of organizing curriculum into a containable pedagogical form involving a series of judgements'. Therefore, if the above are the various approaches to curriculum design, then McKimm (2003:5) advocates that curriculum design in 'the educational and professional context must be clearly defined to reflect a number of factors, including but not limited to: current, prevailing or social ideology, politics, industry and professional bodies, history or influence of the past'.

Applying the above philosophy to the curriculum transformation underway at UoT's brings to the fore the possibility of preconceived notions, distorted views and the prospect of partialities and prejudice's in the journey to the programme and what should constitute the new curriculum. Of particular interest would be the contributory environment that the curriculum renewal process finds itself in. With a number of

parties with competing interests, the arena for the curriculum renewal is no longer located within the boundaries of HEI's.

Berquist cited in Tierney (1989) lists eight curricula models in HEI's:

- Heritage based: a curriculum designed to infuse students with knowledge of the past.
- Thematic based: a specific problem is identified and studied in-depth.
- Competency based: students learn specific skills and acquire proveniences.
- Career based: the curriculum is designed to prepare students for a specific career.
- Experience based: opportunities are created for the student to learn outside of the classroom.
- Student based: the curricula emphasis is on providing students with the opportunities to control what they learn
- Values based: The curriculum emphasises specific institutional values.
- Future based: the institution devises the curricula content with a concern for what students will need in the future.

As such, 'each of the above possesses inherent issues that lay dormant and are institutional specific therefore no one model defines the modus operandi of an institution. Therefore to understand the constructs behind curriculum development requires delving into the entrenched drivers of the institution. Such an investigation would reveal that different institutions have differing conceptions of knowledge', (Tierney 1989:9). Therefore, 'in order to meet the diverse needs and circumstances of learning communities, no singular curriculum model, implementation strategy, nor approach to learning will suit all academic settings', (Hubball and Burt 2004:52). This suggests that the unique location and educational environment defines the curriculum.

Bitzer and Botha (2011:61) believe that 'the fact that curriculum is viewed differently by various groups, implies that there are different ways in which a curriculum is designed'. They further explain that 'the university curriculum is one that responds to external and internal forces that ultimately reflect amongst other things, the identity and educational philosophies of the institution. Furthermore an institutions

qualification, offerings and research profile is mirrored by the universities curriculum development and as such cannot be detached from societal and cultural transformation or from the evolving trends in industry both nationally and internationally’.

Stark and Lattuca (1996:16-18) divided university influences into three alternatives that characterise the educational environment: external influences, organisational influences and interval influences. They believe that ‘it is essential that a total view of the influences both from within and outside the university is digested. Only then can curriculum development be adequately developed as it incorporates the full environment from whence it originates’. Stark and Lattuca (1996:21) go on to explain that ‘due to the diversity of influences curriculum planners are subjected to influences from society and its associated driving forces. Consequently curriculum planning and implementation occur in a specific context of influences from outside and inside the institution’. In addition Bitzer and Botha (2011:286) observed ‘that curriculum tended to be developed without sufficient collaboration between the people who actually implement it’. Furthermore, ‘there was a lack of cohesion across modules, the choice of modules often occurring as a result of who had the most influence or what expertise was available’.

Bitzer and Botha (2011:286) believe that ‘curriculum development needs to be a co-operative, holistic, participative and systematic process; otherwise the final product runs the risk of being fragmented, disjointed and contradictory containing potential omissions and duplications’. This is due to the preconceived process of curriculum renewal i.e. ‘a basic programme is agreed in a consultative manner, but the actual design of the modules are left to the institutional curriculum co-ordinators who tend to work in isolation’, subsequently producing a course ‘which only they are familiar with’ (Bitzer and Botha 2011:286).

2.2.4 Conceptualising the curriculum

From a macro perspective, Roodt (2004:162) believes that the main function of institutions of higher education 'remains knowledge production, accreditation, legitimating and dissemination', however, 'stakeholder engagement together with academic enrichment and research form the three core functions of any institute of higher education', (www.uj.ac.za) is considered more essential to their roles.

On a micro scale, Tierney (1989:6) considers that 'faculty is recognized as central to the curricula change process i.e the professional staff charged with designing and delivering the undergraduate instruction. While academic administrators are responsible for initiating change and bringing faculty together toward a common purpose'. Kruss (2009:164) however adds that 'curriculum decisions tended to be based on personal interests, authority and reputation, on academic territorialism and on ensuring institutional accreditation, rather than on academic expertise, theoretical commitments and coherent logics'. Kruss (2009:165) goes on to say that 'the accepted curriculum continues to operate in a fragmented manner determined by individual academic interests'. However, Hemson cited in Kruss (2009:165) contends that this is so due to the fact that 'external accountability to the state is stronger than internal accountability to the faculty, the university or the community it serves'. Kruss (2009:165) also suggests that 'bureaucratic compliance debilitates the force behind curriculum redesign'. In addition, Lockett (2001:51) also believes that 'any debate on the content of the curriculum has been largely side-lined by disciplinary expert's preoccupation with meeting statutory demands for qualification registration. An agenda which is largely about meeting the globalization and massification agenda'. Boersma, Reinecke and Gibbons (2008:210) believes that within the broader concept of transformation of education policy and curriculum renewal, 'the whole process of knowledge creation has been affected'.

Therefore, just within the boundaries of an HEI, curriculum decisions and choices are influenced by a multitude of nuances that shape it from within. Stakeholders that do not have a direct relationship with the finished product i.e. the graduate or their acquired HEI skills and abilities, lay claim to shaping the graduates curriculum. So in conceptualizing the curriculum it becomes evident that those closest to the changing

curriculum face are in a position to manipulate it in their particular direction. In the process this marginalizes those stakeholders who the curriculum should directly serve, such as employers and industry.

2.3 The South African Higher Education Landscape

The ills of apartheid on our education system have been well documented in more than two decades of writings by both South African and international researchers, politicians and interested individuals, the essence of which are captured in almost all of our policy documents that have been developed and enacted within the education system. The key concerns raised are inequity in educational provisions at school and higher education levels, poor quality of curriculum, pedagogy and teachers, poor socio-economic conditions that marginalized education across the majority of its citizens and poor policy context driving education, all of which are well documented and will not be engaged with in this thesis. Rather a bias towards a curriculum focus on higher education transformation will be taken for the purpose of supporting the study focus on stakeholders' participation in curriculum reforms.

Bitzer and Botha (2011:33) report that in South Africa and internationally, there has been an indication that 'higher education curricula has become sites for significant clashes of epistemologies, values and educational priorities'. However the issue that is undisputed is what notion of 'knowledge should be represented in higher education, how it might be constructed, facilitated, mediated and learnt'. Furthermore 'within the last decade internationally, institutions of higher education have been going through considerable curricula reform', (Hubball and Burt 2004:51). The reasons for this are substantially varied and country specific, ranging from socio economic challenges and pedagogical shifts in teaching and learning approaches to university initiatives to refine the purpose of undergraduate education, Hubball and Burt (2004:51-52). Also, 'regulatory bodies, market demands, regional and national development priorities, internationalization of higher education and changing student profiles, lay claim to shaping the curriculum', (Mischke 2010:145)

However 'the motivating force for South Africa's educational renewal was the new political dispensation and subsequent first full participative democracy', (Boersma,

Reinecke and Gibbons 2008:211). Hence, with the birth of the South African democracy in 1994, 'the newly elected government was confronted with the need to devise an extensive range of new programmes for the reconstruction and development of South Africa', (Boersma, Reinecke and Gibbons 2008:211). One such programme has been a transformation in education by dispensing 'several curriculum related reforms intended to democratise education and eliminate inequalities in the post-apartheid education system', (Jansen 1998:321). The first of three was directed at basic education. It focussed on the eradication of outdated content and knowledge with high racial undertones. The second was the introduction of continuous assessment within the school curriculum and lastly the most ambitious, was introduction of Outcomes Based Education (OBE). OBE was a policy driven by 'political imperatives', (Jansen 1998:323) and its implementation was 'to move away from the apartheid curriculum and to address skills, knowledge and values', (Mouton, Louw and Strydom 2012:1211). Furthermore it was based on the unfounded and unsubstantiated belief that curriculum reform is a 'solution to economic growth', (Jansen 1998:324). However, instead of refining tried and tested well-functioning pedagogies OBE was 'an approach that failed dismally in some First World countries' suggesting that a 'transition based on political aspirations is inappropriate to the highly specialised field of education and curriculum', (Mouton, Louw and Strydom, 2012:1211).

Ntshoe (2012:202) further explains that 'outcomes-based school policy itself is a product of the South Africa Qualifications Authority (SAQA) Act of 1995 which not only shaped curricula and pedagogy in the school setting in South Africa, but also by default continues to shape the curricula design process and pedagogical discourses and practice in higher education'.

As a result higher education also found itself in the spotlight as requiring an 'overhaul' based on the above motivations and with the subsequent gazetting of the NQF that materialised through the SAQA Act (No. 58 of 1995, *Government Gazette* No. 1521, 4 October 1995) and publication of the White Paper – *A programme for the Transformation of Higher Education* (Department of Education 1997). HEI's found themselves in the midst of reform fever.

The Education White Paper 3 provided the platform for South Africa's higher education policy transformation. It encompasses a range of issues taking cognisance of international subjects such as globalisation and more local pressing concerns like the socio economic challenges and imbalances resulting from the legacy of apartheid.

More specifically, it outlined the three-fold responsibility of higher education:

- 'The development of the nations human resource capital with the mobilisation of human talent and potential through lifelong learning to contribute to the social, economic, cultural and intellectual life of a rapidly changing society.
- A high level of skills training and the provision of manpower to strengthen South Africa's economy, services and infrastructure by the development of globally competitive professionals who are also socially responsible and conscious of their role in contributing to the national development effort and social transformation.
- Production, acquisition and application of new knowledge as national growth and competitiveness is dependent on continuous technological improvement and innovation, driven by well organised, vibrant research and development system which integrates the research and training capacity of higher education with the needs of industry and of social reconstruction."

(Department of Education. 1997:1.12)

The Education White Paper 3 initiated several transformatory enterprises that implicated among others, the restructuring of curricula. Furthermore this legislation calls for 'institutional autonomy', 'public accountability' and 'programme based approach' in its reference to curriculum.

2.3.1 Institutional autonomy

Bitzer (2006:935) reports that, 'the question of institutional autonomy in higher education has been well-debated. The various debates reflect the dynamics and tensions of the competitive environments where higher education institutions increasingly operate'. However, Bitzer and Botha (2011:81) argues that as much as universities exhibit 'self-regulation' when it comes to curriculum, this also infers that

academics alone determine what is taught in the courses they deliver. Thus if the Education White Paper calls for increased and broadened participation for transformation, then the curriculum of higher institutions should also be sensitive to issues outside of the institutional domain, (Bitzer and Botha, 2011:81). Therefore, 'higher education curriculum matters should be more critically debated in the public sphere and that curriculum should not narrowly be the concern of individual lectures or groups of lecturers located in their particular institutions', (Bitzer and Botha 2011:81). Further to the above, curriculum design and decisions should not also be the domain of government and regulatory bodies.

2.3.2 Public accountability

The Education White Paper 3 alludes to public accountability in a sense that Higher Education curricula also take in to account national and provincial milieus to accommodate a diverse and cosmopolitan student body. This infers that South African HEI's should not just contain local but also international content thus creating graduates that are prepared for international exposure.

2.3.3 Programme-based approach

Due to the changing education policies, South African HEI's had to also reassess their organizational structures and teaching programmes. This resulted in them abandoning the traditional Departments along disciplinary lines, opting for larger units such as schools or colleges. The teaching programmes have now shifted from academic disciplines that informs the goals and visions to one of outcomes that are linked to both national and global societies , (Bitzer and Botha 2011:85).

The programme for transformation of higher education formed the basis of both, a structural and a process pathway to transforming higher education in South Africa. On the structural level through mergers, incorporations and categorisations of higher education, a new landscape of higher education has emerged in the last two decades. Mergers took the form of bringing together institutions that were separated

by geography, resources and history, while incorporations included the un-bundling and re-association of institutions and closure of colleges, some of which were incorporated into HEIs.

Re-categorisation of institutions were final structural changes in higher education transformation. Three types of HEIs then, formed the re-landscape of higher education in South Africa: the traditional universities, UoT's and comprehensive universities. Former Technikons were now re-categorised as UoTs and comprehensive universities arose largely because of geography and offered programmes that included former Technikon programmes as well as traditional university programmes.

The process pathway for transforming higher education was initiated through the establishment of Government structures, like the SAQA) and the CHE; that developed a policy context that provided the framework within which higher education institutions would operate. SAQA developed the NQF, while the CHE provided a framework for accreditation of institutions and programmes. These two statutory bodies then laid down the foundations for curriculum transformation within higher education by asserting 'that generic transferable skills be integrated into all curricula in South Africa in such a way that the relevance or applicability of the curriculum is ensured', (Lockett 2001:52).

It is within this domain that my study is located – the construction of a Civil Engineering curriculum at a UoT, focusing on the Civil Engineering Industry's participation and influence in curriculum construction.

2.4 Genesis of DUT and the effects on its curricula

As Jansen (2003:290) put it: 'The post-apartheid government inherited a deeply divided higher education system', fraught with divisions in the various types of institutions such as traditional universities, technikons and colleges. Each of these differs from each other, in aspects ranging from racial composition and subsequent

stigmas to institutions producing similar qualifications but educating for different outcomes.

One of the 'landmarks' of the educational reforms was the amalgamation of institutions which Jansen describes as 'a direct intervention to recast institutional landscapes'. This was achieved through promulgation of the Higher Education Act 1997, which endorsed the mergers of a number of HEI's. However as Mfusi (2004:100-101) explains, 'the policy documents that steered the merging process are silent about what should happen to the curricula. As a result, it is left to the merged institutions to decide what should happen'.

In 2002, two institutions, ML Sultan Technikon and Technikon Natal merged to form the Durban Institute of Technology (DIT). However, by 2006, due to amendments in the Higher Education Act, Technikon's were renamed Universities of Technology and this institute was thus renamed DUT (DUT). The ML Sultan Technikon (an institution previously described as 'historically disadvantaged') and Technikon Natal (conversely recognised as 'historically advantaged'), following their merger and subsequent name changes and 'within a national milieu characterised by complex social, political, and economic changes', (Sattar and Cooke 2012:373), formed the backdrop of an institution that is juggling a range of dynamic internal and external forces which naturally impacted on DUT curriculum.

In their research Sattar and Cooke (2012:374) describe how the specific history of curriculum development amongst other issues is rooted in DUT genealogy. Firstly, the merger itself, led to tensions between merging Departments as opposed to the expected synergies that were anticipated. This had an adverse effect that undermined capacity building for curriculum development. Furthermore, they believe that the curriculum renewal efforts were 'technical and focused on superficial changes', (Sattar and Cooke 2012:376).

Nevertheless, the impact of the merge had implications for curriculum development as the 'connections between the dynamics impacting on the re-curriculation processes, especially institutional restructuring and the kind of curriculum that emerges', (Kruss 2009:31), thus providing a further dimension to its curriculum renewal.

Mthembu (2012:189) opines that a traditional university 'educates the bulk of its students intellectually, with the hope that those who do not remain as academics would then use their sophisticated intellectual skills to adapt to any workplace that requires cognate intellectual and practical skills'. Mthembu, Orkin and Gering, (2012:216) add that the attribute of a UoT graduate is 'oriented towards professional competencies, rather than only being competent in generic critical judgement'.

Furthermore, 'skills are taught around concrete examples from a concrete work environment, emphasising the link between theory and practice. Secondly, although it also teaches knowledge from different disciplines, it uses the work environment to allow the students to draw together the different disciplinary threads, rather than to leave it to the student to integrate the knowledge', (Mthembu, Orkin and Gering 2012:223).

However Mthembu (2012:189) believes that UoT's face a challenge that is two-fold, 'the double challenge is not just to educate intellectually, but, in addition, to ensure that graduates have practical skills they could immediately apply in a workplace', a task that is larger, one that 'requires a critical balance between the theoretical and the practical' where the combination of higher educational theories and industry aligned requirements would be synergistically positioned'. As Mthembu (2012:191) further states that 'theory must be seen as practice'.

Additionally, 'UoTs face a unique challenge when compared to conventional universities in that they are expected to produce knowledge but more importantly, to ensure that the knowledge they produce is also useable', (Ntshoe 2012:207). Ntshoe (2012:200) goes on to say that UoT's are characterised by a number of features: 'UoT's are distinct in terms of the knowledge they produce and skills for specific careers and professions'.

Due to the specific nature of the knowledge imparted, a UoT graduate is typified as someone who is able to 'hit the ground running' when exposed to in the field. He/she is immediately integrated into the working team as it is assumed that they already possess the necessary Civil Engineering basics.

They 'provide applied knowledge and adapt quickly to the demands of employment'

The curriculum is designed such that the knowledge imparted is practical and hands-on and expected to match that which is currently accepted as industry norms.

The 'work-integrated learning' (WIL) is a unique feature of UoT's. As Winberg (2005:192) asserts, 'the most significant effect of the role of industry in curricula decision making has been 'cooperative education' which in a technikon context means taking up apprenticeship'. The WIL feature of a UoT curriculum provides for a break from the classroom where undergraduates spend at least a year working for a Civil Engineering company to acquire predetermined skills as defined by Departmental logbooks. This training period is compulsory; not completing it, hinders further progression and ultimately graduation.

In terms of the curriculum requirements, a UoT needs to regularly utilise advisory groups that are heavily engaged with industry representatives so that workplace practices and principles are incorporated. As Winberg (2005:192), states, 'one of the strong practices in technikon education has been the Advisory Committee'. Accordingly DUT Civil Engineering Department's link to industry exists via the Advisory Board. The Advisory Board consists of members of the Civil Engineering profession and related organizations, and it is meant 'to promote liaison between the Civil Engineering industry, other related professions and the Department of Civil Engineering', (DUT Advisory Board Constitution 2003:1). Its aims and objectives, among others, are 'the promotion of the education, training and development of students of Civil Engineering and Surveying at the University, in industry and the community', while 'maintaining when necessary, the updating of academic and standard practices in the field of planning and training' and 'the monitoring of courses and the recommendation of possible curriculum changes to keep up with the latest developments within the built environment '.

Industry member's participation is voluntary with DUT staff representatives, the Head of Department and associate directors in obligatory attendance. Meetings are envisaged as taking place at least twice a year.

2.5 Engineering Council of South Africa

The governing body of South Africa's engineering practices is the Engineering Council of South Africa (ECSA). They have indicated their position on various issues with regard to curriculum renewal and the characteristics of the qualification by commenting that the new programme should have, 'intellectual rigor, articulation with students pursuant to higher qualifications and a programme that emphasizes mathematical, basic science and Engineering science fundamentals but allows study in another field', (ECSA-HEQF Position Paper, 2009:1).

Specific concerns of the ECSA with the new programme refer to the following:

Credits: The number of credits should increase and subsequently be pitched at a higher NQF level.

Duration: The ECSA believes that 'the minimum duration of the programme is three academic years but providers should design programmes that are appropriate to the capability of students at entry' , (ECSA-HEQF Position Paper, 2009:7). This alludes to UoT's having autonomy in the design of the programme.

Intellectual rigor: With respect to content, 'the programme must have intellectual rigour required for bachelor's programmes', (ECSA-HEQF Position Paper 2009:7), which by inference indicates that the level of difficulty of subjects should increase. How this should be done and under whose consultation is not elaborated upon.

Title: The qualification title should be Bachelor of Engineering Technology, abbreviated BEngTech, as it is more specific by including the term "Engineering Technology".

Absence of WIL: The new programme excludes the WIL component of the previous programme as it is anticipated that 'the programme will not require work-integrated learning as comparison with the present system', (ECSA-HEQF Position Paper, 2009:7). The programme requires ECSA's approval in the form of accreditation by ECSA's Technology Programme Accreditation Committee.

2.6 Civil Engineering

'Engineering by definition is the application of science and mathematics to projects for the benefit of society', (Kirschenman and Brenner, 2011:69), and the most tangible of Engineering faculties would be Civil Engineering as almost every facet of society is in some way or form concomitant to Civil Engineering. Structures ranging from basic mortar and brick facilities to huge mega structures that stand testament to human ingenuity contribute to the order of civilised society, not to mention the day to day functioning of human existence. Buildings which may often be disparaged such as waste treatment plants and unsightly power generation installations or unattractive monolithic dam structures that more often than not obstruct our natural surroundings directly contribute to the stability and civilised quality of life that we have grown accustomed. They have also been designed, constructed and commissioned by Civil Engineering expertise.

With the propagation of increasing environmental awareness, Civil Engineers now also have to take into consideration designs that impact as little as possible on the natural world around them. This adds another dimension to complicate the design and construction process as now infrastructure is not only required to 'meet the needs of the present; they must also be developed without compromising the future', (Bordogna 1998:48).

Therefore, the Civil Engineering expertise or Civil engineer is tasked with a huge responsibility. They are charged with 'devising solutions that are affordable, in accordance with the aspirations of society while contributing to economic growth, to environmental protection and to improved quality of life', (Chau, 2007:188).

'Engineers put all knowledge to work for society and, in doing so, enable the potential to create and jobs therefrom', (Bordogna 1998:48). Furthermore, 'engineers must be able to work in teams and communicate well. They must be flexible, adaptable, and resilient. Equally important, they must be able to view their work from a systems approach – across disciplines and within the context of ethical, political, international, environmental economic considerations', (Bordogna, 1998:48)

Similarly, Singh (2001:9) adds that 'fiscal discipline, efficiency and cost-benefit optimisation principles from the world of commerce and industry, are seen as the key

to the transformation of higher education in the direction of greater responsiveness to society'. To this end, 'there has been a call for tertiary education in South Africa to become more responsive to societal and economic needs', (Kruss 2003:61). Therefore 'with a global turnover running into trillions of dollars the construction industry will inevitably benefit from a curriculum that could produce graduates', (Cheah, Chen and Ting 2005:105), that can indirectly contribute to the economy of South Africa.

2.6.1 Civil Engineering and industry

Luckett (2001:50) suggests that higher education no longer holds a monopoly on research and knowledge production with industry taking a more energetic attitude toward research and development due to increased market competitiveness. This market driven change thus forces Higher Education to begin partnering with industry also, the demands of an ever changing working environment necessitates linkage between higher education and industry, (Griesel 2002:39).

In addition, Lamb et al. (2010:i) believes that 'the curricula of Engineering qualifications, particularly degrees aim to provide a firm grounding in the principles of Engineering science and technology, while inculcating an Engineering method and approach that enable graduates to enter the working environment to tackle 'real world' problems with creative yet practical results'. Furthermore, 'faced with the exponential growth of the information age 'industry participants are increasingly calling for the need for Engineering graduates that are trained to work in diverse educational, cultural and economic multidisciplinary teams with a thorough understanding of and application knowledge of Engineering principles and information technology', (Christodoulou 2004:90). Christodoulou goes on to say that 'Engineering institutions are thus called upon to complement or reorganise their education curricula with a transfusion of information technology' to keep up with the pace. In addition, 'the ability for relatively easy intercontinental transportation and subsequent exponential growth of information technology has coined the term, globalisation', (Cheah, Chen and Ting 2005:105). Business and economic activities are no longer restricted to domestic markets as international changes are quickly

resounded domestically, typifying globalisation at work. According to Barnett ((1994), cited in Luckett (2001:50)), 'the impact of globalization has caused a shift in the relationship between Higher Education, knowledge and society. Whereas previously, Higher Education was allowed to impose its own definitions of knowledge on society, society is now demanding the Higher Education provide more instrumental and operational definitions of knowledge'. Furthermore, 'clients of the Civil Engineering industry are themselves globalising and therefore in order to remain competitive and generate repeat business, Civil Engineering firms have to raise their competencies to an international level', (Cheah, Chen and Ting 2005:106).

Therefore, 'a broader knowledge base is required to excel in the global environment' so as to 'cultivate Engineering graduates with such multifaceted knowledge', (Cheah, Chen and Ting 2005:105). In the light of such industrial diversification 'Engineering curriculum reform in tertiary institutions is becoming inevitable and has already been observed in several Western countries', (Cheah, Chen and Ting 2005:105).

2.7 Curriculum and the World of Work

Due to the evolving nature of industry as alluded to above, 'it is becoming apparent to academia and industry professionals that a new generation of Civil Engineering graduates needs to be produced and introduced to the industry', (Christodoulou 2003:90). To this end 'a generation that can successfully integrate traditional Engineering knowledge with fundamental knowledge of information technology, management, and financial principles', (Christodoulou 2003:90) is what the ultimate graduate emanating from an HEI should embody. The benefits 'would guarantee that the academically altered construction manager of tomorrow can successfully tackle the professional challenges of the construction industry and become an effective and productive professional who will, in turn, help the construction industry move forward', (Christodoulou 2003:90).

Therefore, the affiliation between the world of work and the curriculum of HEI's alludes to a very wide function as Griesel (2002:39) explains 'if the employability of an Engineering graduate is determined by the graduates ability to display skills and

proficiency directly applicable to the effective functioning of him/her within the industry then it is apparent that institutions of higher education need to take heed of industry's views when any issues arise around the change or modification of an institutions curriculum'. Therefore any curriculum renewal discussions should actively involve industry representatives

Concerns such as employability, personal and academic attributes of the graduate, and the bridge between theory and practice become crucial items that require further scrutiny in the discussion of curriculum design.

2.7.1 Employability: Concerns about recent graduates of Engineering

'Research nationally and internationally found that technical graduates are lacking in employability skills', state Rasul et al., (2012:43). As graduates possess the necessary qualifications, 'employers however felt dissatisfied because their employees lacked motivational skills, communication skills, interpersonal skills, critical thinking, and problem solving and entrepreneurship skills', (Rasul et al. 2012:43).

'Individual employability is defined as graduates being able to demonstrate attributes to obtain jobs', state Daud et al., (2010:2). However, Brown, Hesketh and Williams (2002:9) add that employability is primarily determined by the labour market rather than the capabilities of individuals and hence 'employability cannot, therefore, be defined solely in terms of individual characteristics'. Nevertheless 'what constitutes an employable and productive person has been identified as a major issue confronting employers who often report that university graduates lack business awareness and are poorly prepared for work', (Brown, Hesketh and Williams 2002:14). Findings from Rasul et al. (2012:43) reveal that employers consider the following seven skills as significant to employability: interpersonal skills, thinking skills, personal qualities/values, resource skills, system and technology skills, basic skills and informational skills.

To this end Marques (2006:648) asserts that 'enhancing employability requires a holistic approach integrating knowledge, work experience and technical and

interactive skills development and reflecting on how these can meet the needs of a flexible organisation' and should be 'based on close collaboration between HEIs, employers and government'. Nilsson (2010:540) believes that 'the role of higher education in the construction and development of the employability of the future workforce has been the subject of debate for nearly as long as the universities have existed'. Further, 'higher education programmes are expected to prepare students for future professional work experience. Students are expected to learn how to become effective professionals ready to handle the demands associated with his or her job shortly after graduation', (Nilsson, 2010:541).

Therefore Ntshoe (2012: 209) correctly argues that 'UoTs are expected to align their curricula with the demands of the market, the prevalent practice in these institutions is that the starting point should be outcomes and competence to make graduates employable'.

2.7.2 Engineering graduate attributes

If literature suggests that HEIs take cognisance of industry's views in producing the most appropriate graduate, the question arises as to what are the theoretical and cognitive attributes of such a graduate, and what is the nature of the curriculum that concomitantly produces such an individual?

2.7.2.1 Graduates' personal attributes

Harvey (2000:7-8) explains that 'employers and their representatives consistently say that to succeed at work, most people in future must develop a range of personal and intellectual attributes beyond those traditionally made explicit in programmes in HEI's'. He goes on to say that 'the core interactive attributes are communication, teamwork and interpersonal skills which are necessary to communicate, formally and informally, with a wide range of people as well as a range of external stakeholders, work effectively in teams, often more than one team at once, and to be able to re-adjust roles from one project situation to another in an ever-shifting work situation'. Furthermore, generic skills that are specific to the career may have not changed but have been compounded by 'technological and organisational changes that have added ICT skills, team working, flexibility and adaptability to the point where there is

much less emphasis on knowledge and far more on willingness to continue learning', (Harvey 2000:8).

2.7.2.2 Graduate academic attributes

Internationally strides have been taken by numerous professional Engineering and accreditation bodies to re-evaluate the curriculum of Engineering programmes 'with an investigation of the practice and development of Civil Engineering curricula', (Gavin 2010:177). To this end a generic list of competencies has been suggested such as 'an ability to apply technical/scientific/mathematical principles, to design components/systems, to undertake critical thinking, to operate in multi-disciplinary teams, to communicate effectively, and an understanding of the need for and an ability to undertake lifelong learning and an understanding of professional and ethical responsibility', (Gavin 2010:177). Crosthwaite *et al.* (2006:41) concurs, believing that 'these lists of attributes are also reflections of the desires and needs of the community, industry and employers, and the changing workplace and social environments in which our graduates work and live. They are also intended to inform curriculum design and delivery in an even broader sense than employability alone'.

However, Griesel (2002:42) contends that 'it is very problematic in attempting to list, classify or group attributes or qualities on the basis of views or opinions, be these of employers or educationists. It seems that in order to create a common discourse and shared understanding about the role of higher education, attributes are of necessity labelled in what amounts to an everyday discourse informed by opinion. It is therefore not a straightforward matter to move beyond a mere description of attributes and qualities, and to classify or group attributes in order to determine the importance and employers satisfaction with the attributes that graduates display'. Her research has revealed the following attributes 'in terms of importance and employer satisfaction: Basic skills and understanding, Knowledge and intellectual ability, Workplace skills and applied knowledge and lastly interactive and personal skills', (Griesel 2002:56).

In terms of UoT's, Mthembu, Orkin and Gering (2012:220-221) 'synthesise four key attributes of graduates:

i. Trained to do something

Technically competent: Sufficiently expert in the field to be able to be immediately productive and employable in the work environment;

Computer numerate: Able to use the computer packages used in the specific work environment and sufficient conceptual ability to adapt to new packages;

Business literate: Able to write clear reports and comprehend workplace documents.

ii. Trained to question

Conceptually able: Confident with conceptual material, as in the more abstract elements of the syllabus;

Articulate: Able to test ideas and raise thoughts 'one-on-one' and in groups;

Problem solving: Able to participate in actual innovation.

iii. Trained to innovate

Able to plan: With planning and project management skills;

Connected: Able to source, assess and apply work-related information, e.g. from the internet;

Innovative: Able to use knowledge and research products to produce something new: products, processes, services.

iv. Trained to interact

Socialised: Able to work with co-workers and supervisors;

Articulate: Able to express themselves and offer ideas and opinions in discussion to peers and seniors;

Able to work: Both in teams and independently, as embodied in the course teaching methodology.

Taken in conjunction, these attributes imply that UoT graduates arrive in the workplace able to take generic skills and to work in teams to apply them innovatively to concrete problems. Simply put, these are graduates who have learnt how to learn and been taught how to apply their knowledge'.

If the above are the internationally and nationally recognised attributes of graduates then Harvey (2000:8) believes that as much as ‘the employer-higher education interface is thus a complex nexus that needs to address organisational structures and missions on the one hand and graduate attributes on the other, it is further complicated by a third dimension: the purpose of learning’.

2.8 Bridge between theory and practice

In trying to produce a graduate that possesses the wholesome attributes as defined above, ‘universities are increasingly coming under pressure from governments and employers to be more accountable to society –to align their goals and priorities with national goals, to deliver more graduates with fewer resources and to ensure the acquisition of the skills and competencies demanded by a global economy and an information society’, (Luckett 1995:126). The purpose of the graduate needs to be adhered to alluding to the theoretical knowledge imparted by HEI’s. Fester and Haupt, (2006:6) has observed that ‘over the last decade, it seems that ways of learning in higher education have been gradually getting closer to the needs and methods of the real world. However, studies have shown that there still is a mismatch between what construction employers appear to want and what higher education provides’. This view is further substantiated internationally (Ninth Malaysian Plan, 2006-2010 quoted in Daud et al. 2010:2), stating that ‘at the tertiary level of education, curriculum and teaching should be relevant to market requirements in order to avoid a mismatch of skills. Collaboration between education providers and the industry’s is strongly encouraged to reduce the gap between graduates abilities and the requirements of industry’

Fester and Haupt (2006:4) further acknowledge that much research indicates that ‘there should be an appropriate teaching approach that bridges that perceived gap between formal and academic instruction and on the job training’ and ‘to balance the relationship between theory as taught in the classroom and practice in the field or industry’, (Ross and Elechi 2002:297). Haupt (2003:31) draws on ‘several authors that have highlighted that apart from course content relevant to job-related situations, there should be an appropriate teaching approach that bridges the perceived gap between formal academic instruction and on the job training’, because Haupt

(2003:32) believes that there is a 'separation between practical and academic work which creates a division in the mind of students rather than relating the theory to the application that reinforces the basic concepts taught in the classroom'.

This is compounded when 'complex real-life problems encountered in practice do not lend themselves to such neat distinctions between theory and practice', (Gavin 2010:176). Furthermore, 'segregation between courses implies that methods memorised to solve typical problems for respective courses, would not be flexibly available for solving open-ended real-life problems', (Gomes 2002:480). In the process graduates are produced that are poorly prepared to solve tangible engineering problems.

Bordogna (1998:49) concurs with Gavin when he opines that 'present curricula require students to learn in unconnected pieces, separate courses whose relationships to one another and to the Engineering process are not explained until late in a baccalaureate education, if ever and that the content of courses may be valuable but this view of Engineering education appears to ignore the need for connections and for integration, which should be at the core of an Engineering education'. This suggests a disconnection between the spoken descriptive word of the class-room and the hands on practice of industry.

2.9 Cooperative Learning

It is within this environment of inconsistency and divergence from theory and practice that the concept of internship has found its place in the pedagogy of practice. This 'concept is not novel and has been a skill acquisition method for many occupations since medieval times', Ross and Elechi (2002:298). According to Knowles (1975:205), 'traditionally, cooperative education has been defined as a programme of study which incorporates alternating periods of classroom learning and paid work experiences related to the students field of study'. 'Variously referred to 'fieldwork', 'practicum' or cooperative education,' 'experiential learning or work based learning', (Haupt 2003:32), 'internship programmes are a viable mechanism for experimental education', (Ross and Elechi 2002:297). It is 'an educational model designed to achieve the objective of bridging the gap between the classroom and the workplace

by incorporating productive work experiences into the curriculum as an integral and regular element of a higher education programme', (Haupt 2003:32). Furthermore, its purpose is to 'give undergraduates an opportunity to link their theoretical knowledge to professional practice as well as gain an appreciation of the contextual issues which impact on professional work', (Hager, Holland and Beckett 2002:14).

In terms of learning cooperative education 'can be linked to the deep approach to learning as it has a holistic nature of combining experience, perception, cognition and behaviour. Moreover, it is about a process of learning where ideas are formed and reformed through experience, a process which permits adaptation', (Chell, 2001) quoted in Manthe and Smallwood (2007:106). Accordingly, 'certain factors must apply. (1) The students off campus experience should be related as closely as possible to his field of study and individual interest within the field. (2) The employment must be regular, continuing, and essential element in the educational process. (3) Some minimum amount of employment and minimum standard of performance must be included in the requirement for the degree or certificate presented by the school. (4) The working experience ideally should increase in difficulty and responsibility as the student progresses through the academic curriculum', (Knowles 1975:205).

'It is therefore evident that the cooperative education experience comprises of two components, namely an academic component and an experiential learning component', (Haupt 2003: 31) because it 'enables the student to combine the theoretical knowledge taught in academe with the problem solving skills necessary on the shop floor. The experience also gives the student a gradual introduction to the professional world, which is often at odds with the academic ethos', (Karbhari 1989:246).

2.9.1 Benefits to students

Ross and Elechi (2002:307) believe that cooperative learning provide the 'litmus test of whether classroom teaching has enough relevance and usefulness to translate into the work place'. This is achieved, as Fester and Haupt (2006:5) explain that through cooperative education 'students acquire valuable and specialised knowledge

and skills by learning from experience and reflecting on that experience while becoming acquainted with the work processes. They are given the opportunity to demonstrate their abilities to prospective employers. Through this approach, they already have work experience at the moment of academic graduation'. As such it provides the 'underpinning knowledge and attributes of competence needed for the job as a whole such as workplace culture, work norms and values'. Additionally it 'is characterised by the proliferation of knowledge production in the context of application, which is mostly problem specific and guided by the requirements of practical relevance such as a specific industrial sector', (Fester and Haupt, 2006:5).

To this end students 'not only observe but participate in the actual operations' of the company and consequently many come to appreciate the workings and challenges of that particular job', (Ross and Elechi 2002:298) and 'provides opportunities for students to have direct hands-on experience as part of their course of study', (Haupt 2003: 32).

2.9.2 Benefits to industry

Fester and Haupt (2006:4) perceives that cooperative education 'bridges the gap between education and training while enhancing the total educational experience of students to produce a graduate or diplomat that is both educated and trained and able to add value to the construction industry'. In addition, 'employers benefit from having a significant influence on course design and content by ensuring that industry-specific knowledge, awareness and values are integrated into the higher education process', (Fester and Haupt 2006:5). Evidence of benefits to industry is documented in literature worldwide with HEI's creating many pioneering and innovative methods to facilitate cooperative learning. For example Brown *et al.* (2002:139) explain: 'the University of Malaya has established an industrial training unit to facilitate cooperative education. Industry-based courses represent a smart partnership all round for the educational institutions and employers. It is a cost-effective way for employers to identify and recruit potential full-time professionals, build fruitful long-term relationships with industrial institutions, and develop employees who have the skills and knowledge their industry's need'.

Lamb et al. (2010:11) also provides accounts of how small to medium enterprises benefitted from technological advancements from student research as a result of the School of Engineering and Applied Science at Ashton University in the United Kingdom employing a visiting academic. The Faculty of Engineering and Computing at Coventry University 'has industry contacts who come in as guest lecturers to provide underpinning support for the taught programmes' (Lamb et al. 2010:19). In addition, 'Visiting professors and bought-in retired engineers from industry have also been used significantly to help understand and address industry needs' Lamb et al. (2010:24). The Department of Engineering at the University of Liverpool, believes that this 'is an effective way of using professional engineers to provide industrial relevance to undergraduate programmes at relatively low cost and low risk. These industrialists act at a high level, advising and helping with strategic change and curriculum development or simply providing the students with ready access to senior-level industrial experience', (Lamb et al. 2010:30). For the companies that take on students, it amounts to 'a year-long interview and many students subsequently receive offers of employment from their placement company', (Lamb et al. 2010:17). Consequently, 'the employer is able to help them adapt to the culture of the organisation and develop work habits and skills that the employer values', (Taylor 2001:7).

2.9.3 Benefits to HEI's

Lamb *et al.* (2010:22) located a number of perceived benefits to HEI's of such collaboration efforts. Their research indicates that HEI's experience 'improved student retention and progression, enhanced standards of student achievement and enhanced reputation leading to increased student recruitment leading to 'increased graduate employment rates'. In addition, HEIs have a 'better engagement of students and staff in the learning experience' and cultivate 'a vibrant learning community attractive to students and staff'. Furthermore, this type of collaboration produces other more tangible benefits in that it brings 'the potential for research opportunities with the sponsoring companies', (Lamb *et al.* 2010:18). It is also reported that 'most staff report seeing increased levels of enthusiasm for the subject and of self confidence among returning students, correlated with grade improvements', Lamb *et al.* (2010:16). Furthermore, 'academics in active dialogue

with industry managers may thus spot emerging research issues earlier than their less active colleagues', (Gomes *et al.* 2005:89), consequently creating new avenues for exploration in areas or fields that may not have ordinarily have been afforded research attention.

Gomes *et al.* (2005:89) go on to explain that also, 'know-how in companies may be diffused to universities not only through research, but also through networking, for example when company representatives act as visiting lecturers'. The benefits of occasional input into HEI's via lectures from industry representatives are acknowledged widely in literature, such benefits extending not only to the institution but to staff and students alike.

'In addition to this, final course assignments and training periods may lead to employment opportunities for graduates, and improved reputation and competitiveness of universities', (Azaroff, 1982 cited in Gomes *et al.* 2005:89).

2.10 Curriculum requirements for the Civil Engineering industry

Vesilind (1991:287) reports that 'Civil Engineering education has not evolved substantially'. The reason for such steadiness is that mathematical and design principles have not changed radically. However Newson and Delatte (2011:1016), contends that 'there have been significant changes in undergraduate Civil Engineering curricula due to various reasons'.

Over the decades Civil Engineering structures have taken on a more and more complex nature. Client demands for structures to suit various requirements and at times flamboyant, aesthetically pleasing structures, requires engineers that not only are competent but technologically inclined and up to date with the latest and modern design techniques and codes of practice both nationally and internationally to remain in an ever-competitive market.

Furthermore, environmental awareness is now at the forefront of legislation with impact studies being imperative before design even begins. Civil Engineering is a key profession to the incorporation of sustainability into society. Therefore the 'need

arises to equip Civil Engineering graduates with concepts to include sustainability issues in Civil Engineering', (Chau 2007:188).

Due to a myriad of new developments and technological advancements within basically all the branches of Civil Engineering, internationally there has been a call from technical bodies for Civil Engineering curricula to 'address these new technologies', (Grigg et al. 2004:160). Furthermore, Koehn (1999:35) reports that 'there have been recommendations from employers and various technical/professional societies to revise the Engineering curriculum to ensure that students are prepared for the increasing complexity and international aspects of Engineering work'. This sentiment is echoed by Bordogna (1998:48) as he believes that 'the true wealth of a nation resides in its human capital, especially in its Engineering workforce and to realize the full value of this capital and compete on a global scale Engineering graduates must provide added value from knowledge gained though participating in the process of Engineering throughout the curricula experience'.

To this end, a range of studies have taken place over the years. Taking the form of surveys, questionnaires and interviews, they were aimed at different stakeholders from the Civil Engineering fraternity. These instruments attempted to gauge various views, perceptions and required requisites aimed at the ultimate betterment of the profession. For instance a study conducted by Jonvall (1979) who sent surveys to graduated engineers from the early 1930's to the early 1970's, attempted to generate data aimed at acquiring a balance of different subjects, course content and duration, to determine the needs of further Civil Engineering education and to collect information in general about the Civil Engineering profession. They include studies that 'intended to capture what employers consider to be priority attributes of graduate Civil Engineers and their subsequent satisfaction with the degree to which graduates display these attributes and also employers' views on the role of higher education in preparing graduates for the changing needs industry', (Griesel, 2002:40). More recent studies bring to light deeper underlying issues that impact on the Civil Engineering knowledge transfer due to the influence of South Africa's new political dispensation.

Exhaustive literature on curriculum discourse that range from political to socio cultural environmental, legal as well as technological advancements suggests that any interference with a curriculum of any institution of higher education does not simply lie with the institution.

Rojter (2011:701) comments that ‘the epistemology of Engineering practice is too broad for a single Engineering curriculum but must be addressed by developing multiple disciplinary curricula’. However Lamb *et al.* (2010:i) believes that ‘the best Engineering degrees achieve the right balance between scientific and technical understanding and their practical application to problem-solving’ while Crosthwaite *et al.* (2006:41) assert that ‘the identification of learning objectives is in essence a definition of the ‘content’ of a curriculum. However, the linking of these two attributes via learning activities and assessment criteria and standards, both formalizes the “content” and characterizes the educational “processes” that can be used to appropriately target the attributes’. Moreover technical knowledge forms the basis of Engineering with “first principles” being the backbone of the field of any Engineering discipline. Karbhari (1989:247) attests to this by making a point that ‘undergraduate engineering curriculum must emphasize broad Engineering education with strong grounding in the fundamentals and science’. However given the wide variety of courses that constitute a Civil Engineering programme, other disciplines that contribute to creating a holistic Engineering graduate are also crucial to the employability of the graduate. To this end Russell and Stouffer (2005:127) believe that ‘to successfully blend a sound liberal arts and technical foundation with a broad, holistic appreciation of Engineering practice in the modern world, Civil Engineering programmes must take an active hand in assembling a series of courses, offered at the correct time and at the correct depth, that help address the issues most pertinent to becoming a well-rounded professional engineer’.

Karbhari (1989:243) believes that “there is ample proof that the current curricula and standards, i.e., the quality of undergraduate Engineering education, is lacking. Specific areas would include those in design and analysis, communication skills, and knowledge of the humanities, arts, and social sciences’. Furthermore, ‘given that construction is a scientific process, which entails working in the elements at different locations, with numerous contributors from divergent cultures it is critical that built

environment tertiary education empowers the students in the understanding of structural principles, health and safety (H and S), and quality systems, practices and procedures', (Smallwood 2002, quoted in Manthe and Smallwood 2007:105).

Additionally, 'the optimum use of software in the instructional process is a subject of continuing debate among Civil Engineering educators', (Koehn 1995:243). Koehn's research has revealed that the value attached to computer graphic skills should be increased suggesting that this discipline needs to be placed higher within the hierarchy of Civil Engineering courses within the programme as 'these subjects are often strongly utilized early in a professionals career', (Koehn 1995:246).

Moreover, 'engineering curricula have solid foundations in science and mathematics, with the expectation that students connect mathematical and scientific concepts to engineering practice', (Froyd and Oiland 2005:147). Froyd and Oiland further believes that 'the relationships among mathematics, engineering, and science have not been clearly communicated through science-based engineering curricula'. However, Koehn (1995:246), who researched the opinions of seasoned practicing engineers reports that 'a decrease in mathematically oriented subjects such as calculus, differential equations, linear algebra, statistics and numerical methods is recommended as they are not used in their day to day engineering work'. This finding is corroborated by Vesilind (1991:294) whose research revealed that 'mathematics appears to be of much less importance to our graduates than anticipated, and casts doubt on the requirement of upper-level mathematics for all graduates'.

In addition, it is believed 'there should be greater emphasis in oral communications and technical writing skills', (Koehn 1995:246); this is further substantiated by Vesilind (1991:294) who reports that 'engineering communication skills appears to be of growing importance, especially as the professional careers appear to move increasingly into management and away from engineering'. Clearly evident from the assertions made by Koehn and Vesilind are that those subjects that may be construed as tangible should receive more attention as they disseminate skills necessary for the daily functioning of a graduate Civil Engineer.

Tullis and Tullis (2001:992) believe that 'some courses should also demonstrate how to apply engineering concepts to practical engineering problems' because 'students are often faced with much theory and little practical information on the application of basic principles'. To avoid this 'engineering students should be exposed to projects that require meaningful analysis, allowing students to exhibit creativity in their design and analysis without getting bogged down with too many details'.

Gomes et al., (2006:121) believes that the project component 'poses significant, contextualized, real-world situations, while providing the necessary resources, guidance and instruction to learners as they simultaneously develop content knowledge and problem-solving skills. The learning is highly student-focused and carried out in small groups with the staff member being more of a "guide" than a formal teacher. Inherent to project and problem based learning are needed skills for communication (both oral and written) and teamwork (both as team member and leader), and abilities in interpersonal relations, critical thinking and reflective judgement'. Furthermore, Chau (2007:189) believes that 'the design project is an ideal opportunity for students to experience real-life problem solving, project management, interpersonal skills of written and verbal communication, working productively in a team, work integrated education and leadership skills. One of the objectives of the project is to furnish students with an understanding of sustainability issues in relation to the Civil Engineering industry'.

The Project component is therefore a critical element to enhance the learning experience while linking the classroom with the outside working world.

2.11 Chapter summation

It is imperative to understand the contexts described above in order to locate the discussion of the Civil Engineering curriculum. Furthermore, this discussion provides the background to the data analysis in the forthcoming chapters; all of these inputs provide an integral means of framing the discussion of the contributory environment in the development of the Civil Engineering curriculum that this study reposes on. In Chapter 3, I present the research methodology employed for this study.

CHAPTER 3: METHODOLOGY

3.1 Introduction

Tierney (1989:4) believes that 'if knowledge is socially constructed, then the methodology used to study the curriculum needs to unearth the multitude of organisational voices in order to understand how knowledge has been constructed, who constructed it and what alternative constructions are possible'. In this ontological study, the researcher is substantially involved in the field of Civil Engineering with experience from industry and currently in academia, and has located this qualitative study in the interpretative paradigm. As Wiersma and Jurs. (2009:232-233) explain, in the interpretative paradigm, 'the researcher operates in a natural setting, maintaining openness about what will be observed, collected and documented. Also, the perceptions of those being examined are to be captured so as to obtain an accurate measure of reality'.

In this chapter I present the research design developed to produce the empirical evidence for this study. Recalling that, I focus on the influence of the Civil Engineering industry on the Engineering curriculum offered within HEI's in South Africa. More specifically, this study aims to explore the nature and extent of influence that the Civil Engineering industry has on the curriculum conceptualized by a UoT. This specific aim would suggest that, in light of the critical literature on curriculum conceptualization and construction, the epistemological and methodological positioning of such a study would lie in the interpretivist and naturalistic research approaches. This chapter, therefore, presents arguments for the research design choices that I have made in producing the empirical data for the study.

In summary, the research design is located within an interpretivist epistemology, using largely qualitative frames of analysis interlaced with quantitative data derived from a statistics using a case study methodology. In this chapter I present the decisions and processes followed in the collection of data. The chapter extends to include issues of validity and reliability, ethics and biases and the methodological limitations that were envisaged and addressed through the data collection process.

3.2 Interpretivist epistemology informing the research design

Working within an epistemological framework that is interpretive in nature, this explorative study takes on a primarily qualitative stance because the researcher is 'interested in insight, discovery, and interpretation rather than hypothesis testing', (Merriam 1988:10). In addition to qualitative data, some quantitative statistics have emanated in the data generation process that reinforces the suggestions and implications in the analysis, therefore a mixed method approach within the case study design was considered most appropriate to the study. Mixed method research involves two or more methods used in the same research study and may include both quantitative and qualitative methods in the same study', (Wiersma and Jurs 2009:11). Also 'when a qualitative design, e.g. a case study, can be enhanced by quantitative data, a mixed method design is the preferred design', (Creswell and Plano Clark 2007:33). Furthermore, 'it focuses on collecting, analyzing and mixing both quantitative and qualitative data in a single study' to provide 'a better understanding of research problems than either approach alone', (Creswell and Plano Clark 2007:5).

An interpretivist paradigm would suggest that meaning is sought for the purpose of understanding the phenomenon and how participants make meaning associated with it. Further, it allows for the exploration of, for example, how the Civil Engineering industry understands its role and contributes to programme design within HEI's and how the phenomenon of curriculum design is constructed and what influences it. 'This kind of focus in researching industry's understanding and contribution to curriculum development 'distinguishes the objectivists social science work to a more subjectivist work' (Henning, Van Rensburg and Smit 2004:19) of the researcher. In a sense, I, as an interpretivist researcher, am not concerned about proving the truth. Rather, I attempt to generate knowledge that is constructed by 'observations and participants' description of their intentions, beliefs, values, meaning making and self-understanding', (Henning, Van Rensburg and Smit 2004:81). By exploring the Civil Engineering industry's intentions, values, beliefs and self-understanding of curriculum conceptualization and their influence on HEI's curriculum design, this study will then give me a broader, more realistic perspective on what, how and why

the Civil Engineering industry influences the higher education curriculum in the way they do or do not.

3.3. Research approach adopted in this study

With the hallmarks of an interpretivist epistemology, being that of understanding and meaning making within a context (Henning, Van Rensburg and Smit, 2004; Cohen, Manion and Morrison, 2005) the most appropriate approach to the methodological design would be to embark upon a qualitative research approach. However with the simultaneous generation of both qualitative and quantitative data in the research instrument, Creswell and Plano Clark (2007:34) asserts that 'when quantitative results are inadequate to provide explanations of outcomes, and the problem can best be understood by using qualitative data to enrich and explain the quantitative results in the words of the participants, a mixed methods design is thus the preferred design'.

The quest, according to Henning, Van Rensburg and Smit, (2004:3), in qualitative research 'lies in understanding and for in-depth inquiry', rather than counting and controlling variables, as is the case in quantitative research. In qualitative research the 'freedom and natural development of action and representation' ,(Henning, Van Rensburg and Smit 2004:3) is what I as a qualitative researcher, hoped to capture but concomitantly with the use of quantitative data to 'enhance the description of results or the identification of salient themes', (Creswell and Plano Clark 2007:33).

In this study, I planned on capturing the thoughts and actions of Civil Engineering industry managers on curriculum conceptualisation and their influence on curriculum design within a UoT, with a view to interpreting and understanding what, how and why they (Civil Engineering industry) influence, or not, the curriculum design at a higher education institution.

Henning, Van Rensburg and Smit, (2004: 7) makes an important statement about the research process, where she strongly advocates that 'the researcher is unequivocally the main instrument of the research', in qualitative studies, suggesting that I, as a qualitative researcher, will make meaning of the data produced through

the research process and express this as findings of the study. This is precisely what occurred through the research process. In producing the data, I used more than one data collection instruments in order to gain a deeper insight of the phenomenon. Following on, I had decided on the categories of analysis that guided the data presentation which finally allowed me to make meaning of the data and present the findings of this study. All of these actions by myself as the researcher, suggest that I am the main instrument of this research.

3.4 Case study and the methodology for this study

As the field of curriculum design and development is a contested terrain and happens differently in different contexts and different instances, the most appropriate way to investigate this phenomenon is through a bounded case study methodology as it 'investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used', (Yin 1984: 23).

A case study allows one to understand the event within the realities of that system and what exists within, and as such would allow one to explore the phenomena within their deep context. As Thomas (2010:309) believes, 'a case study approach is especially useful in situations where contextual conditions of the event being studied are critical and where the researcher has no control of the events as they unfold'. These sentiments are further echoed by Merriam (1988:32) who believes that case studies 'offer insights and illuminates meanings' that are 'anchored in real life situations'. Hence this study epitomizes the above traits in that the curriculum renewal is a real life situation that is currently underway. As such, this is an explorative, observational case study and will be restricted to the Civil Engineering Department of DUT.

3.4.1 The case study institution

Having articulated the core principles of a case study methodology, this section articulates how and why DUT as a case study institution and more specifically, the Department of Civil Engineering at DUT were chosen. Merriam (1988:11) describes particularistic as a characteristic of the case study that 'focuses on a particular situation, event, programme or phenomenon. The case itself is important for what it reveals about the phenomenon and for what it might represent'.

Descriptive implies that 'the end product of a case study is a rich, 'thick' description of the phenomenon under study', while heuristic means that 'case studies illuminate the readers understanding of the phenomenon under study'. Case studies are also inductive in that they 'rely on inductive reasoning'. To this end a qualitative aspect of this case study was conducted that entailed all of the above.

3.4.2 Qualitative aspect

There have been numerous descriptions of qualitative case studies that have originated from various researchers, the most appropriate for this study, emanating from Merriam (1988:xiv), who suggests that a qualitative case study can be defined as an 'intensive, holistic description and analysis of a bounded phenomenon such as an institution, process or social unit. Merriam further suggests that 'there are four characteristics that are essential properties of a qualitative study: Particularistic, Descriptive, Heuristic, and Inductive'. These characteristics are discussed further below.

3.4.2.1 Particularistic

DUT is a particular HEI that resulted from a merge and is situated across a number of campuses located in an urban setting. This institution is currently re-conceptualizing its Civil Engineering curriculum and was therefore the most appropriate choice of institution. The case study focuses on the curriculum renewal that is unfolding at DUT. It involves a multitude of role-players that have both a direct

and indirect impact on the end result and as such would provide insight into the nature of Civil Engineering curriculum development and reveal the driving forces that ultimately define it.

3.4.2.2 Descriptive

In line with Merriam's (1988:11) argument, the study provides a 'thick' account of the phenomenon of the curriculum. 'Thick' has its origins in anthropology and infers a 'complete, literal description of the incident or entity being investigated' (Merriam, 1988:11) - the phenomenon being the curriculum renewal that is unfolding at DUT. As this is a qualitative study, the results focus on underlying structures, relationships among entities and influencing factors. Furthermore, 'thick descriptions are interpretive for the researcher seeks to interpret how and why individuals and groups behave as they do', (Wiersma and Jurs, 2009:241). As Mouton and Marais (1990:50) describe, 'the aim of the researcher is to broadly describe the phenomenon, event or group within the context of the unique background of the domain phenomenon.' Subsequently the views, perceptions and opinions of the Civil Engineering industrial fraternity were explored within the background of DUT to gauge their level of involvement in and contribution to the curriculum renewal.

3.4.2.3 Heuristic

This research delves into the phenomenon of curriculum renewal with a specific purpose of illumination, knowledge production and theorisation. Its value lies in learning from 'practice' so that it informs future endeavours in curriculum renewal, awareness of power dynamics in curriculum reform and exploring ways of mediating these power dynamics. Hence, of all the forces that shapes the curriculum, this study illuminates particularly how one of these forces, the Civil Engineering industry contributes to the curriculum outcomes. This study aims to explain how industry influences the Civil Engineering curriculum, and provides insight into the depth of the contribution of the Civil Engineering industry to the curriculum itself.

3.4.2.4 Inductive

As Merriam (1988: 13) explains, a certain degree of generalisations emerge from the data analysis, from 'data grounded in the context'. There may exist at the outset of a study an acknowledged assumption which may change or be 'subject to reformulation' as the research ensues. Using analytical induction, the sample of respondents was carefully chosen to represent the target group that this study is based on, from among those that are or have been associated with DUT Civil Engineering Department and whose experience locates them as able to provide valid and reliable data on its curriculum. Thus the data generated from the study positions me to be able to surmise and deduct conclusions relating to relationships, latent requirements and underlying motivations behind the actions of the key role players from the Civil Engineering industry in the phenomenon as it unfolds at DUT.

3.4.3 Quantitative aspect

Creswell (1994:2) defines quantitative research as 'an inquiry into a social or human problem, based on testing a theory composed of variables, measured with numbers, and analysed with statistical procedures in order to determine whether the predictive generalizations of the theory hold true'. While Wiersma and Jurs (2009:13) explain that quantitative research usually takes place in situations that are controlled and manipulated, they go further to elucidate, that the 'research design in quantitative research tends to be structured and prescriptive', the outcomes of which 'are to a large extent expressed as numbers'. The quantitative data derived in this study were used to poll opinions of participants, to gauge preferences and inclinations to aid in answering the research questions of this study.

3.5 Participants in the study

The participants of the study are the curriculum champions of the discipline and the institutional curriculum drivers; the principal number of participants would be from the Civil Engineering industry. These participants have been identified as companies

that have in the past employed DUT graduates or have supported the WIL more commonly known as the 'in-service' programme of DUT by taking them in as student engineers during the study programme. This target group has interacted with products of DUT Civil Engineering curriculum and would therefore provide an unbiased and insightful opinion of the Civil Engineering curriculum, its paucity and how, if any, attempts have been made to contribute to its improvement by industry.

This study effectively relies on a single case study as Creswell (1998:63) advises, that 'the study of more than one case dilutes the overall analysis; the more cases an individual studies, the greater that lack of depth in any single case'.

3.5.1 Sampling

Employing convenience sampling as explained by Drew (1980:193) who describes it as, 'a logistically convenient procedure that may be expected to result in a representative sample', I chose respondents to whom I had easy access to. As this research involves a case study, this sampling strategy was also appropriate as reported by Cohen, Manion and Morrison, (2005:102). The research sample was conveniently drawn from DUT Civil Engineering Departmental database of employers that has in the past and presently employs DUT trainees, diplomats and graduates and who were conveniently located i.e. with the KwaZulu-Natal area. Respondents within the rest of South Africa were also contacted electronically and politely requested to contribute to the study.

From DUT Civil Engineering Departmental database of employers the researcher chose to select 100 localized companies to serve as respondents. As companies have more than one senior employee that either directly mentored or supervised a DUT student, it was inevitable that some companies provided multiple respondents.

The choice of the respondent companies was deliberately planned to meet the criterion of 'fitness for purpose' as recommended by Cohen, Manion and Morrison, (2005:91) who believe that 'the research plan must suit the purposes of the research'. The sampling strategy was premeditated and mindful of the research enquiry to attempt to provide a holistic opinion of the Civil Engineering industry limited to the microcosm of DUT so that validity was maintained.

3.6 Data sources and collection

As this study employs a mixed method approach Lang et al. (1999:43) believes that 'qualitative methodologies such as formal surveys and structured interviews can be used to capture and quantify industry expectations of the needed attributes (i.e., knowledge, skills, and experience) for entry level Engineering employees. Such instruments can provide key data useful in determining objectives and designing curricula to attain those objectives'.

Miles and Huberman (1994:27) suggest that 'studies tend to be purposive in nature rather than random, usually working with small samples of people nested in their context and studied in depth'. Wiersma and Jurs (2009:342) concur, that 'purposive sampling is very different from random sampling in that the researcher selects a sample to meet the purpose of the research'.

Corresponding with the above traits, the alignment of this study takes the form of a sample of participants from the Civil Engineering field that is limited to the KwaZulu-Natal Province of South Africa. The primary research instrument employed for data collection of this study takes the form of a survey questionnaire. Guided by the research questions, the questionnaire was constructed to explore the depth and level of involvement of the Civil Engineering industry in DUT's curriculum renewal. The questionnaires were distributed electronically or hand-delivered to consenting respondents.

3.6.1 Interviews

Owing to the nature of this study I also employed unstructured interviews. As this is a qualitative explorative study interlaced with quantitative data, Welman, Kruger and Mitchell (2005:166), encourages unstructured interviews as 'they identify important variables in a particular area to formulate penetrating questions about them and to generate hypotheses for further investigation'. Furthermore, as Denzin and Lincoln (2005:705) espouse, 'unstructured interviewing can provide greater breadth than do other types given its qualitative nature'. Denzin and Lincoln (2005:705) go on to say that, 'unstructured interviewing attempts to understand the complex behavior of members of society without imposing any a priori categorization that may limit the

field of inquiry'. This view is also shared by Welman, Kruger and Mitchell (2005:166), in that 'unstructured interviews allow the interviewer to use probes with a view to clearing up vague responses, or to ask for elaboration of incomplete answers.'

Therefore in order to seek deeper meaning the researcher found it prudent to employ this method to encourage participants to draw on their own personal opinions and perceptions of their role in the Civil Engineering industry. The interviewees for this study were the Curriculum champions from each Department for the curriculum renewal as they were charged with among other tasks, ensuring 'that informed decisions are made through the active involvement of all relevant stakeholders', (Sattar and Cooke 2012:377). Interviews were conducted in a natural private setting (offices and boardrooms) using an electronic voice-recording device that would provide the least amount of disturbances or intrude on the course of the interview.

3.6.2 The questionnaire

As this case study involves a phenomenon that is specific and localized to DUT, Cohen, Manion and Morrison, (2005: 248) suggest that a 'qualitative, less structured, word based and open-ended questionnaire is more appropriate as they capture the specificity of a particular situation'. This varied typology was done deliberately for various reasons as Cohen, Manion and Morrison, (2005: 248) believes such a questionnaire 'sets the agenda but does not presuppose the nature of the response'.

In line with the above, the questionnaire took the form of a semi-structured design composed of multiple-choice questions, rating scales and open-ended questions. The inclusion of multiple-choice questions and rating scales although limiting in interpreting, allows respondents to answer quickly and succinctly and was easier to code during data analysis. Open-ended questions are not easily codable or classifiable but allow respondents to answer freely in their own words.

The questionnaire was designed using Likert scales (named after its deviser Dr Rensis Likert) as Likert-type questions 'capture the extent of agreement or disagreement with an idea, and not measure some sort of quantity', (Johns, 2010:4). The use of Likert scales enabled the researcher to synthesize measurement with

opinion. However, Likert scales can be limited in their exposure of opinions, in that their answers can be too abrupt and inflexible. Therefore, the questionnaire also incorporated open ended questions that allowed respondents to reply in their own words and 'invite an honest, personal comment from the respondents in addition to ticking numbers and boxes', (Cohen, Manion and Morrison 2005:255). Furthermore, Wiersma and Jurs (2009:204) explain that 'open ended items allow the individual more freedom of response because certain feelings or information may be revealed that would not be forthcoming with selected response items'. This allowed respondents to voice their opinions and therefore be beholden for the data as 'it puts the responsibility for and ownership of the data much more firmly into the respondent's hands', (Cohen, Manion and Morrison 2005:255). Furthermore, open ended questions provided 'a genuine response, rich in value and honesty that are the hallmarks of qualitative data', (Cohen, Manion and Morrison 2005:255).

Questionnaires were hand delivered to respondents who consented after telephonic contact was made. This *modus operandi* ensured a level of personalism instead of being sent via mail. It allowed the respondent to 'put a face to the researcher' as the stigma attached to the filling in of questionnaires is one of tediousness and boredom. This made respondents more considerate to filling in the instrument upon follow up calls for the completed questionnaires.

With the aid of the researcher's supervisor, questions were then streamlined to make them structured and coherent so that data analysis would not be jeopardized by ambiguity and lack of lucidity.

As the research instrument explored various contributory sectors of the Civil Engineering industry, a certain degree of statistical methods were required for probing into the nature of characterizations and analysis thereof. Therefore, to further streamline the research instrument, the researcher engaged the assistance of a statistician.

To establish validity and reliability of the instrument a pilot test was done. A pilot study, as explained by Connelly (2008:411), is 'designed to guide the future study'. Connelly further opines that, 'the lessons learned in the pilot study can prevent major problems that could not be anticipated'. Furthermore, a pilot test assesses 'whether a questionnaire has been designed in a manner that will elicit the required

information from respondents', (Sharma 2009:53). Lanphear (2001:33) adds that the advantages of pilot testing are that it allows for 'changes that arise from unforeseen events or ideas not originally considered'. Lanphear (2001:33) further explains that other advantages include the 'opportunity to validate statistical approaches and instruments to strengthen their impact when full implementation is tested and also the potential for considerable cost savings as another reason to undertake pilots prior to investing resources'.

There is considerable literary debate on the size of pilot studies. Hertzog (2008:180) reports that there is limited 'guidance with respect to sample size for pilot studies' with the final size dependent on various issues specific to the study in question not to mention time and budget restraints. For this study, the sample size of the pilot test was limited to approximately 10% of the final study size as recommended by Brink and Wood (1998:380).

3.7 Validity of research

As validity is 'a requirement of both qualitative and quantitative research', (Cohen, Manion and Morrison 2005: 105) and 'deals with the accurate interpretability of the results (internal validity) and the generalizability of the results (external validity)' (Wiersma and Jurs 2009:5), it therefore creates the grounds for this study to be externally validated.

Lincoln and Guba (1985:290-327) advocate, that 'the foundation for interpretation rests on triangulated empirical materials that are trustworthy', while Thomas (2010:319), explains that, 'trustworthiness is the term used in qualitative research as a measure of the quality of research. Trustworthiness consists of four components: credibility, transferability, dependability and conformability of the data'. Therefore, addressing these four components reinforces and enhances the qualitative research design that defines this study.

Thomas (2010:319) defines credibility in qualitative research as 'the extent to which the data and data analysis are considered to be believable and trustworthy', while, Lichtman (2006:194) contends that 'credibility suggests that the results should be

evaluated from the point of view of the participants'. To establish credibility for my study I employed triangulation methods by developing a questionnaire and secondly interviewing seasoned Civil Engineering staff while simultaneously examining literature on curriculum theories in the field of Civil Engineering. In order to increase credibility, an iterative position was taken in that; feedback on the data from the members interviewed was scrutinized and usually re-questioned for clarity.

However, due to the possibility of multiple realities, the research may only be considered valid by the researcher; therefore the onus is on the reader to judge the credibility of the study, based on his or her depth of understanding of the study and its results.

'Transferability is the extent to which the results can be transferred to other settings', (Lichtman 2006:194), while Thomas (2010:320) regards 'research findings as transferable or generalizable only if they fit into contexts outside the actual study context'. Transferability is analogous to external validity and is therefore in line with the validity of this study as indicated above. Thomas (2010:320) goes on to say 'that transferability is a major challenge to qualitative studies due to the subjectivity of the researcher'. Lincoln and Guba (1985:290) concurs that 'in qualitative research, transferability is not determined by the original researcher, but by future users of the research finding. The original researcher should only provide sufficient data which will enable other researchers to compare their data.'

Therefore to circumvent any bias or prejudice, transferability will be enhanced by a thorough, rich and detailed description of the setting to be studied to provide adequate background information so that an informed picture is derived from the situation under study.

Lichtman (2006:195) believes that 'dependability emphasizes the need for the researcher to account for the ever-changing context within which research occurs. The researcher is responsible for describing the changes that occur in the setting and how these changes affected the way the researcher approached the study.'

Therefore, to enhance the dependability of my research, respondents and interviewees were occasionally contacted again for further explanations in light of new discussions and decisions taken during the curriculum renewal process.

Confirmability examines 'the degree to which results could be confirmed or corroborated by others', (Lichtman 2006:195). It is analogous to objectivity, that is, 'the extent to which a researcher is aware of or accounts for individual subjectivity or bias', (Thomas 2010:322). As indicated earlier the participants would be from the Civil Engineering Industry that comprise of consultants, contractors and local government. The participants of the study being either questionnaire respondents or interviewees were specifically chosen as they were considered to be well versed and knowledgeable within the field of Civil Engineering. Therefore all the data assimilated in the form of opinions and perceptions for this study were viewed as critically important and relevant to the study. Subsequently, the results emanating from the interpreted data shall be validated in Chapter 4 of this study.

3.8 Ethical considerations

Miles and Huberman (1994) list numerous considerations that a researcher has to consider in the process of data acquisition, assimilation and analysis. They advise the researcher to constantly take cognizance of these throughout the research process. Of significant importance are informed consent, benefits, cost, reciprocity, risk, privacy, confidentiality, anonymity and research integrity.

Taking due cognizance of the above, this study informed the participants of the nature of the study, purpose, data collection, depth of the study and their rights to participation. Furthermore, informed consent in writing was obtained from each of the participants as evidenced in Appendix A.

The benefits of the study to the researcher were revealed in the cover page of the questionnaire (Appendix A) which subsequently may lead to academic recognition and career advancement of the researcher. The expected benefits to the participants would be assisting with the creation of a Civil Engineering curriculum that takes their (Industry) requirements more adequately into consideration which will realize a better graduate for their future employ.

The potential hazards of the study are minimal if not nonexistent. As this is a qualitative study, participants are voicing an opinion or perception which is within their Constitutional rights to do so.

As the researcher's background is in the Civil Engineering field he has a vested interest in the Civil Engineering curriculum and subsequent curriculum renewal. The participants are all from the Civil Engineering field and therefore a certain degree of trust is expected as both parties are driven by the upliftment of the curriculum and ultimately of Civil Engineering as a whole.

As the participants emanate from the Civil Engineering arena but from different spectrums of the field, a certain degree of disagreement and difference of opinion is envisaged. To this end, privacy, confidentiality and anonymity prevailed at all times.

This study followed the route taken by numerous other exploratory and curriculum investigation studies, thus the researcher maintains the research standards as set by previous researchers in the field while exhibiting the same degree of integrity.

3.9 Biases

As I am currently employed by DUT, I am therefore involved the process and therefore there may be an element where I may influence the research process or manipulate and prejudice the data in favor of DUT Civil Engineering Department. Therefore in order to mitigate against the biases that may arise from my engagement I have relied specifically on the data; provided a deep description of the process and the data as a way of informing my conclusion and finally employed an externally located statistician to reduce any biases.

3.10 Limitations of the study

As much as the enquiry takes on a case study approach with a 'thick' in-depth account of the unfolding events, the acquisition of the entire database of employer's cooperation in devoting time to completion of the questionnaire may not be possible.

Due to the nature of Civil Engineering work being located both in an office and on remote sites, some may not have the time to complete the questionnaire. Therefore not all chosen participants may be in a position to complete the survey. Furthermore, some may just not wish to participate in the study and therefore this indicates a probable limitation of the study.

Another limitation may be an inaccurate conclusion derived from the data explication. Some of the respondents may be too passionate in their responses to the point of exaggeration leading the researcher to generalise theories. Also some employers may have taken on academically poor students that would inevitably give a poor reflection of the Civil Engineering curriculum.

As the study explores industry's contribution via DUT Civil Engineering Department's database, it implies a limitation to the study. Curriculum renewal activities are occurring within all Departments of DUT and in fact at all UOT's throughout the country however the research is restricted to the Civil Engineering Department of DUT. Therefore the inferences, outcomes and generalizations found in this study are extended to DUT only.

To best serve the research problem, a mixed-method approach was considered to be the most appropriate research paradigm. The choice of sampling strategy was governed by fitness for purpose, cautious of the nature of the research enquiry. The primary method of data collection was via interviews and a survey questionnaire taking due cognizance of validity and trustworthiness. In order to attain trustworthiness I found it prudent to carry out a pilot study.

3.11 Results of pilot study

The pilot study revealed that the research instrument needed further streamlining in some of the questions. Some questions were of an ambiguous nature and seemed repetitive or a question was so strikingly similar to others, that the respondent would feel as if he had already answered it previously. With guidance from the researcher's supervisor and statistician, the concerns raised by the pilot study were reevaluated. Problematic questions were subsequently interrogated to finally arrive at more

precise and explicit questions that went to the heart of the research questions underlying the nature of the study.

The pilot study further provided some information on the quality and depth of responses from respondents. Some answers to open ended questions were abrupt to the extent that some responses required further probing. Through the pilot study the researcher realised that some of the open ended questions would require going back and forth to respondents to gain a clearer, deeper understanding of their opinion.

3.12 Chapter summation

For the criterion of fitness for purpose, all elements of research should be carefully considered and planned. In adopting a strategy for this research I have been mindful of the research purposes, wary of the data collection methods and the dominant choice of methodology. My selection of sampling strategy was not random but governed by its suitability for the study so as to best serve the research purposes.

In the following chapter I present the information generated from the data collection. I further describe the forms of analytical methods chosen as most appropriate to decipher the results that are characteristic of this mixed-method approach study.

CHAPTER 4: STATEMENT OF FINDINGS, INTERPRETATION AND DISCUSSION OF THE PRIMARY DATA

4.1 Introduction

Having presented the research design for the production of the data in chapter 3, this chapter focuses on the presentation of the data through which emerging and key findings are identified. An analytical framework is presented to orientate the development of the chapter. The analytical framework was developed through, both, an *a priori* approach as well as from the data produced through the methodology. Details of the analytical framework will be presented below.

The questionnaire was the primary tool used to collect data and was distributed to Civil Engineers at 3 particular organisation types, namely consulting, contracting and parastatal engineering organisations. The data collected from the responses were analysed using SPSS version 21.0. The results are presented by the descriptive statistics in the form of graphs, cross tabulations and other figures. In a qualitative study, as Dey (1993:4) believes 'there is no reason to exclude quantitative methods, such as enumeration and statistical analysis' from a qualitative method. Inferential techniques include the use of correlations and chi square test values; which are interpreted using p-values.

4.2 Analytical framework for the management and analysis of the data

There are three major aspects to industry participation in the curriculum process that can be identified. The first aspect relates to the nature of current participation of industries within the curriculum processes of HEIs as stakeholders interested in the training of graduates to meet its needs. The second relates to the concerns in and of industry participation in curriculum processes and the third is a forward-looking, inclusive engagement of all stakeholders related to Civil Engineering training and development that is reflexive in nature. Hence, what might be an appropriate inclusive relationship between industry and higher education in curriculum planning, implementation and review processes, is an important consideration in future

development of curriculum. Hence an analytical model has been conceptualised to guide the data analysis section that will bring coherence and resonance with the research focus, aims and outcomes of this study.

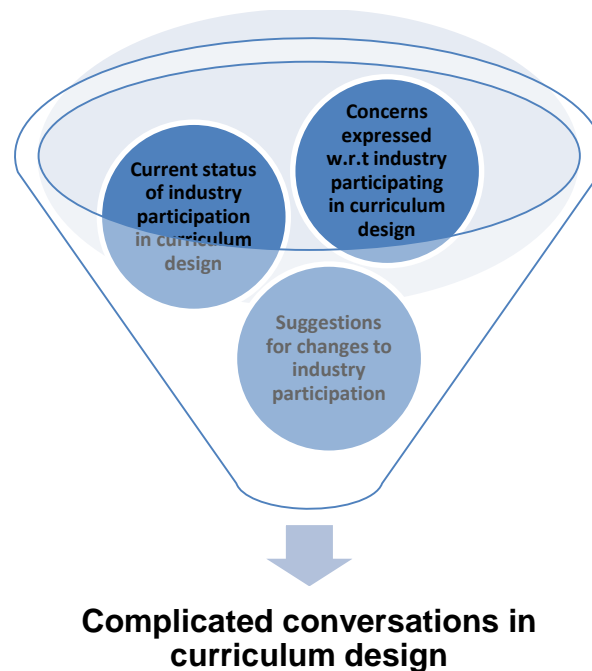


Figure 1: Analytical framework for the data analysis

The choice of a funnel depiction to represent the analytical framework is driven by what Pinar (1999:xvii) refers to as ‘complicated conversations’ in curriculum design, where the source of the complicated conversation occurs within the funnel, and what emerges through the funnel nozzle is the outcome of this complicated conversation. The framework organises the themes of the data presentation. Each of the circles within the funnel constitutes a theme and the nozzle of the funnel focuses on discussions emanating from all three themes. The three circles within the funnel represent the conversation circles that, in each of its own engagements have a particular conversation about curriculum design, delivery and influence, shaped by congruent, competing and contesting dialogues about curriculum influence.

4.3 Biography of participants from industry

In this section I present a background to the participation rates and the nature of industry’s that participated in the data production process. This is done to illuminate two issues: first the breadth of specialisation areas within the Civil Engineering

industry to show inclusivity of specialisation in this research process, and second to allude to some of the limitations that could have an influence in interpretations of the data.

Recalling that the target participants were those from Civil Engineering industry's that had a relationship with DUT, 240 questionnaires were given out for completion. Of the 240 questionnaires, 169 were completed and returned, producing a response rate of 70%. In establishing the reliability of the returned questionnaires, the Cronbach alpha score test was done, 'where the closer the Cronbach alpha was to 1, the higher the internal consistency reliability', (Daud et al. 2010:2). This test revealed that the overall reliability score of 0.798 deemed the questionnaires to be reliable (see Table 4.1). Reliability is computed by taking several measurements on the same subjects. A reliability coefficient of 0.70 or higher is considered as 'acceptable'. This type of statistical data provide the quantitative aspect, a hallmark of a mixed method approach study.

Table 1: Cronbach's alpha score for all items that constituted the questionnaire.

QUESTION	Number of Items	Cronbach's alpha
6.3	6 of 6	0.686
7.1	5 of 5	0.570
7.2	4 of 4	0.713
8	4 of 4	0.836
9	5 of 5	0.775
10	4 of 4	0.618
11.1	4 of 4	0.723
12	5 of 5	0.605
13.1	5 of 5	0.800
14	4 of 4	0.734
15.1	6 of 6	0.745
Overall		0.798

The overall reliability score of 0.798 exceeds the recommended value of 0.700. This indicates a high (overall) degree of acceptable, consistent scoring for this research. Question 7.1 has a value that is slightly lower than the standard. Primary amongst the reasons for this is that the construct is newly developed and would require further testing.

4.3.1 Demographic data

This section summarises the demographic characteristics of the respondents.

The figure below describes the organisations to which the respondents belong.

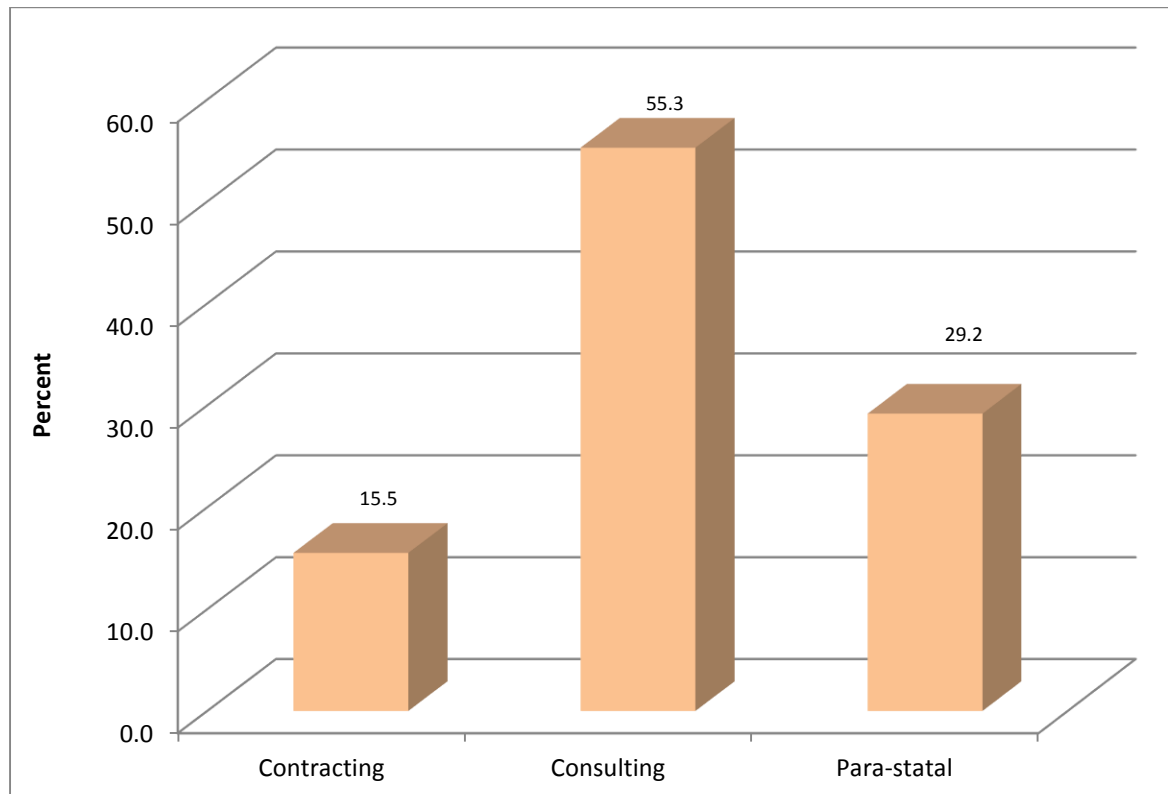


Figure 2: Participants in terms of Civil Engineering company types

A little more than half of the respondents (55.3%) were consultants while a little over a quarter of the respondents (29.2%) worked in para-statal organisations. This demographic profile of respondents reflects a bias of participation by consulting companies and is a factor that needs to be kept in mind as a possible limitation. It would have been useful to have equal representation from each type of company for statistical generalisation. This demographic profile may compromise the generalisability of the findings. One possible reason for this bias is the relative ease of access by this organisation type to DUT, as almost all of our students are required to do design work which would involve close association within consulting companies.

There are several specialisations within the Civil Engineering industry. The participants were drawn from all the specialisations of Civil Engineering (see Table 4.2)

Table 2: Participants according to Civil Engineering specialisations

Area of specialisation	Responses		% of cases
	N	%	
Structures	37	14.8	22.4
Water	85	34.0	51.5
Roads	71	28.4	43.0
Geotechnical	10	4.0	6.1
General	47	18.8	28.5
Total	250	100.0	151.5

While Table 2 reflects that participants were drawn from all known specialisations within the Civil Engineering industry, there seems to be more participants from Water and Road specialisations (51.5% and 43% respectively). Possible reason for this is that there is a demand for basic infrastructure for civil society and therefore more of these specialisation companies exist. The variable participation rates across these specialisations could also point to a potential limitation related to statistical constraint. However, as this study is aiming for both analytical and statistical generalisation, the qualitative and quantitative findings are therefore relevant to this study in addition to the extent of influence.

The cross-tabulation table below (Table 3) indicates the relation between the type of Civil Engineering organisation and their areas of specialisation. The cross-tabulation revealed a number of findings about the areas of specialisation which are described below.

Table 3: Cross-tabulation of areas of specialisation

		Civil Engineering organisation (Q1)			Total	
		Contracting	Consulting	Para-statal		
Area of Specialisation	Structures	Count	13	21	2	36
		% within specialisation	36.1	58.3	5.6	
		% within Q1	24.5	15.4	3.9	
		% of Total	5.4	8.8	.8	15.0
	Water	Count	10	54	19	83
		% within specialisation	12.0	65.1	22.9	
		% within Q1	18.9	39.7	37.3	
		% of Total	4.2	22.5	7.9	34.6
	Roads	Count	13	40	14	67
		% within specialisation	19.4	59.7	20.9	
		% within Q1	24.5	29.4	27.5	
		% of Total	5.4	16.7	5.8	27.9
	Geotechnical	Count	4	4	1	9
		% within specialisation	44.4	44.4	11.1	
		% within Q1	7.5	2.9	2.0	
		% of Total	1.7	1.7	.4	3.8
	General	Count	13	17	15	45
		% within specialisation	28.9	37.8	33.3	
% within Q1		24.5	12.5	29.4		
% of Total		5.4	7.1	6.3	18.8	
Total	Count	53	136	51	240	
	% of Total	22.1	56.7	21.3	100.0	

4.3.2 Areas of specialisation

4.3.2.1 Structural Engineering

Within the structures specialisation, 36.1% emanated from the contracting environment, 58.3% were from consulting firms with the remaining 5.6% being from para-statals.

4.3.2.2 Water Engineering

In this field, 12 % emanated from the contracting environment, and 65.1% from consulting firms with the remaining 22.9% being from para-statal.

4.3.2.3 Transportation Engineering

Within the Roads discipline 19.4 % emanated from the contracting environment, 59.7 from consulting firms and the remaining 20.9% from para-statal.

4.3.2.4 Geotechnical Engineering

Here the split between consulting and contracting firms, at 44.4% each, was equal with the remaining 11.1% being from para-statal.

Analysis of the above reveals a trend of consulting specialists superseding contracting firms. This infers a bias in respondents toward consulting. However, this data should not be construed as a limitation but rather as providing a much deeper input due to the closeness with which consultants work with DUT students.

4.4 Level of involvement with DUT

The data below (Table 4) represents a summary of the level of involvement that the participants have had with DUT. This table attempts to highlight the various avenues of involvement that may exist for industry to engage with DUT.

Table 4: Level of involvement with DUT

		Responses		% of cases
		N	%	
Nature of association	Provide consultative work to DUT	6	2.00	3.60
	Provide opportunities for in-service training to students of DUT	107	35.90	64.10
	Staff lecture/ consult on DUT's academic programme	10	3.40	6.00
	Employs DUT graduates and diplomates	110	36.90	65.90
	Partners with DUT in external project works	3	1.00	1.80
	Funds DUT (bursaries/project sponsorships etc.)	37	12.40	22.20
	No association with DUT	21	7.00	12.60
	No association with DUT but do have associations with other tertiary institutions	4	1.30	2.40
Total		298	100.00	178.40

The largest level of involvement with DUT emanates from industry's direct interaction with students via in-service trainees (35.9%) and from the employment of graduates and diplomates (36.9%), suggesting that student engagement by the Civil Engineering industry is largely through employment and in-service training. This kind of situation is useful as these participants responses to the questionnaires would be largely informed by their first-hand experience of both the output of the Civil Engineering programme and the curriculum experiences of the student in relation to their workplace competence. There may also be a limitation relating to this bias of involvement with DUT, in that, they could be overtly critical in their responses based on negative experiences of having students and graduates at their worksites. Therefore this may point to a possible limitation in that the respondents maybe commenting poorly on students whose actual performance may not be a true reflection of DUT Civil Engineering curriculum.

4.5 Duration per annum for organisations with an association with DUT

The table below represents a summary of the multiple responses for duration per annum for organisations with an association with DUT (Table 5). The purpose of this is to illuminate the levels of commitment the industry would have once any form of association is initiated.

Table 5: Duration per annum for organisations with an association with DUT

	Responses		% of cases
	N	%	
On-going association	57	40.1	47.5
Only during in-service training	50	35.2	41.7
Only during project work duration	7	4.9	5.8
Attend consultative forum meetings	7	4.9	5.8
Minimal association on needs basis	21	14.8	17.5
Total	142	100.0	118.3

It is interesting to note from Table 5 that 40.1% of respondents maintain an on-going association with DUT. Possible reasons for this are that these companies regularly recruit students through WIL and therefore choose to maintain an on-going association. Of the organisations, 35.2% associate only during in-service training when students are visited by DUT Departmental representatives.

4.6 Current status of industry participation in curriculum at DUT

4.6.1 Levels of involvement with curriculum development at DUT

This section attempts to highlight the nature of involvement in and influence on the curriculum at DUT Civil Engineering Department. The purpose of this is to establish the extent to which they influence curriculum with a view to understanding how that impacts on the graduates.

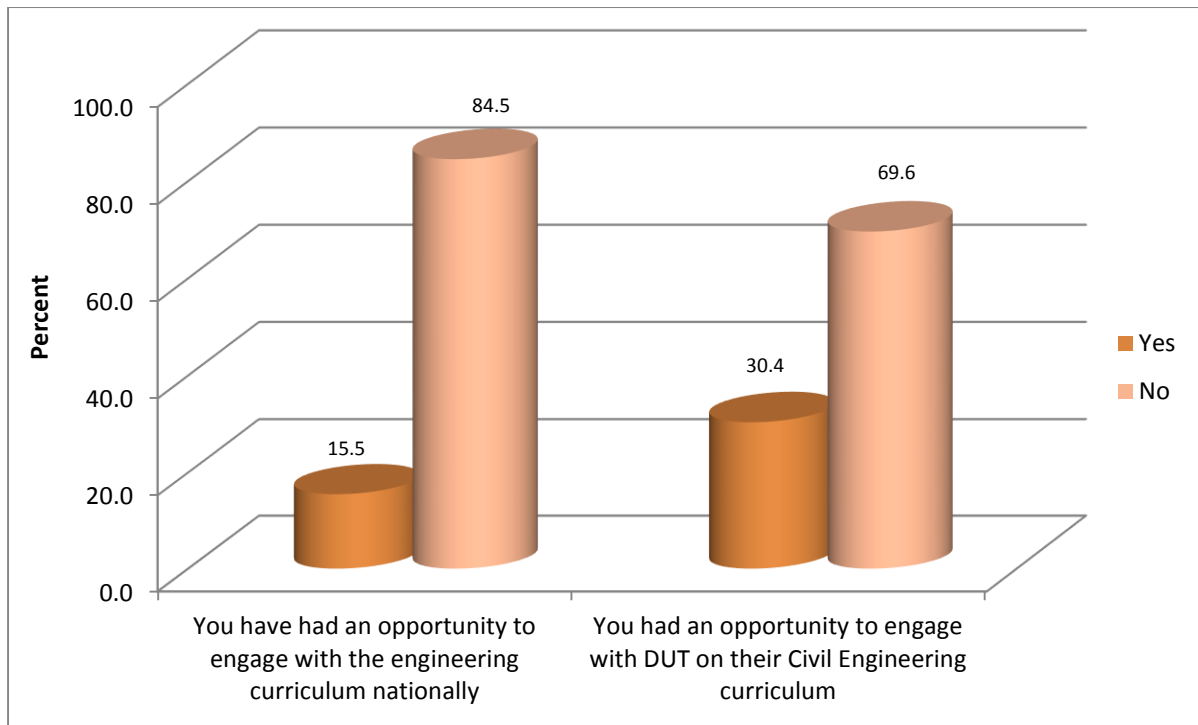


Figure 3: Levels of involvement with curriculum development at DUT and nationally

Figure 3 reflects the levels of involvement that respondents have had nationally and with DUT on the Civil Engineering curriculum. Only 15.5% of respondents have indicated that they have had an opportunity to engage in curriculum. The reasons for such a minimal quantity of involvement could be multiple; however the volume is double (30.4%) for those that have had an opportunity to engage with DUT on their Civil Engineering curriculum. This is significant as it indicates that local companies have had more of an opportunity to engage with a local HEI on curriculum issues, but concomitantly points toward a limitation. These data suggest that is more input at a local HEI but not as much nationally. Therefore, the question arises: How uniform is DUT Civil Engineering curriculum nationally? As the answer to this is beyond the scope of this study it can be accepted that this indicates a limitation to the study.

4.6.2 Types of curriculum engagement

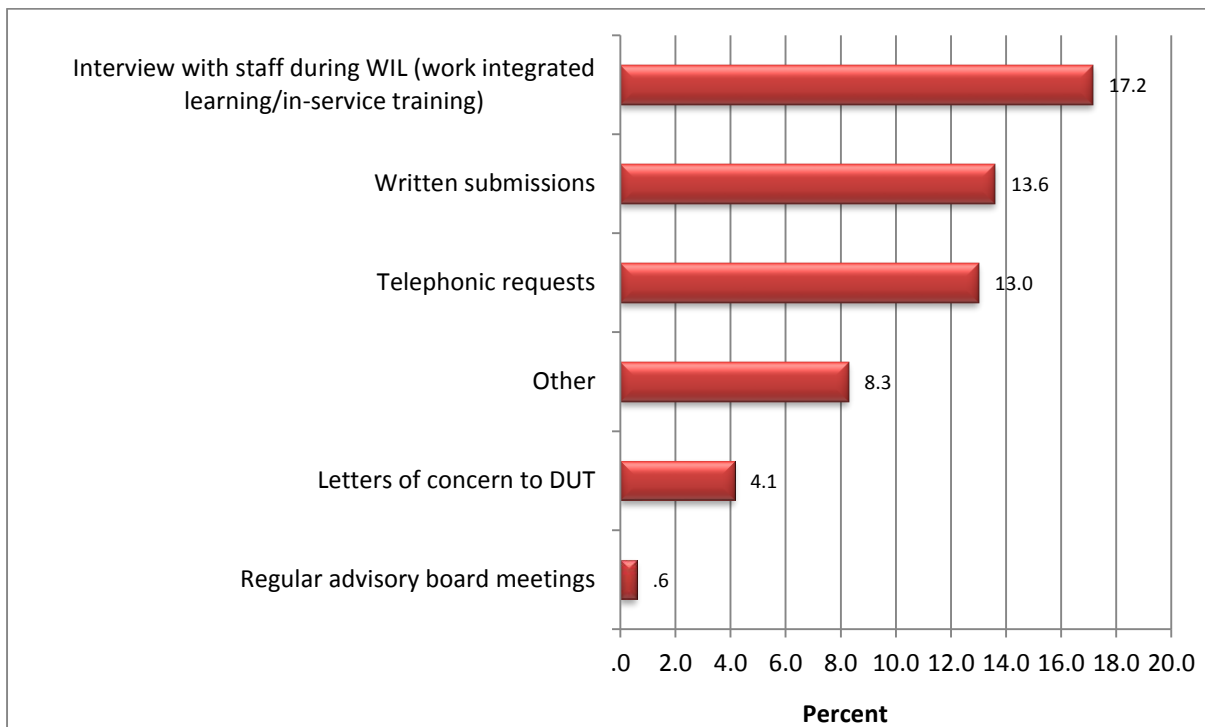


Figure 4: Types of curriculum engagement

Figure 4 depicts the different opportunities for engagement that are available for industry to engage in the curriculum with DUT with respondents indicating their preferred mode of engagement. Approximately 17% found it most convenient to engage with DUT staff during WIL. The possible reason for this is because of convenience, as DUT staff travel to meet them at a time and location that is convenient to them. Thirteen per cent indicated that telephonic or written correspondence was their preferred mode of engagement.

Discouragingly, however, only 0.6% had used the regular Advisory Board meetings to engage in the curriculum. Ironically, this method was created specifically for industry to make an input into the curriculum. The motives for this could be various, ranging from not knowing of its existence to being far too busy to dedicate time to attending these meetings.

4.6.3 Outcomes of industry engagement with DUT on curriculum issues

This section aims to display the outcomes of attempts made by industry to engage with DUT on curriculum issues. It analyses the types of changes, if any, that materialised after curriculum engagement occurred. The aim of this is to get an idea of how any attempts made by industry are acknowledged by DUT and to what extent their input is transferred to the Civil Engineering curriculum.

This was done by analysing the scoring patterns of the respondents per variable per section. Levels of disagreement (negative statements) were collapsed to show a single category of “Disagree”. A similar procedure was followed for the levels of agreement (positive statements). This is allowed due to the acceptable levels of reliability.

The results are first presented using summarised percentages for the variables that constitute each section (Figure 5). Results are then further analysed according to the importance of the statements.

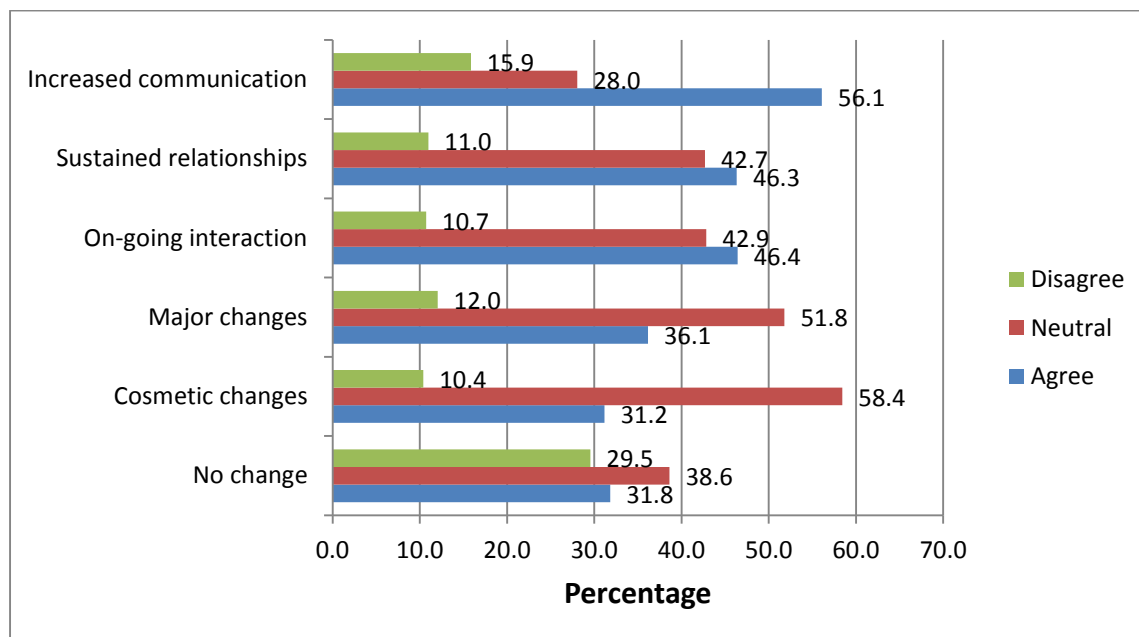


Figure 5: Outcome of industry engagement with DUT on curriculum issues

The general trend is that the levels of agreement are higher than those for disagreement in all instances, although Q6.3.1 shows a marginal difference. In most instances, the level of neutrality is as high as the levels of agreement.

For example, there were nearly as many respondents who agreed that there was no change regarding curriculum matters as there was who disagreed. The level of uncertainty was even higher. This implies that some contributions were heeded whilst others were not.

Of interest is that over 50% of respondents have agreed that one of the outcomes of engagement has resulted in increased communication between the Department and industry with 46.3% indicating a history of sustained relationships following a curriculum engagement with DUT. An almost equal percentage (46.4%) maintains an ongoing interactive relationship. Further data corroborates the above statistics as generated below, when respondents were asked to rate the calibre of DUT students (Figure 6).

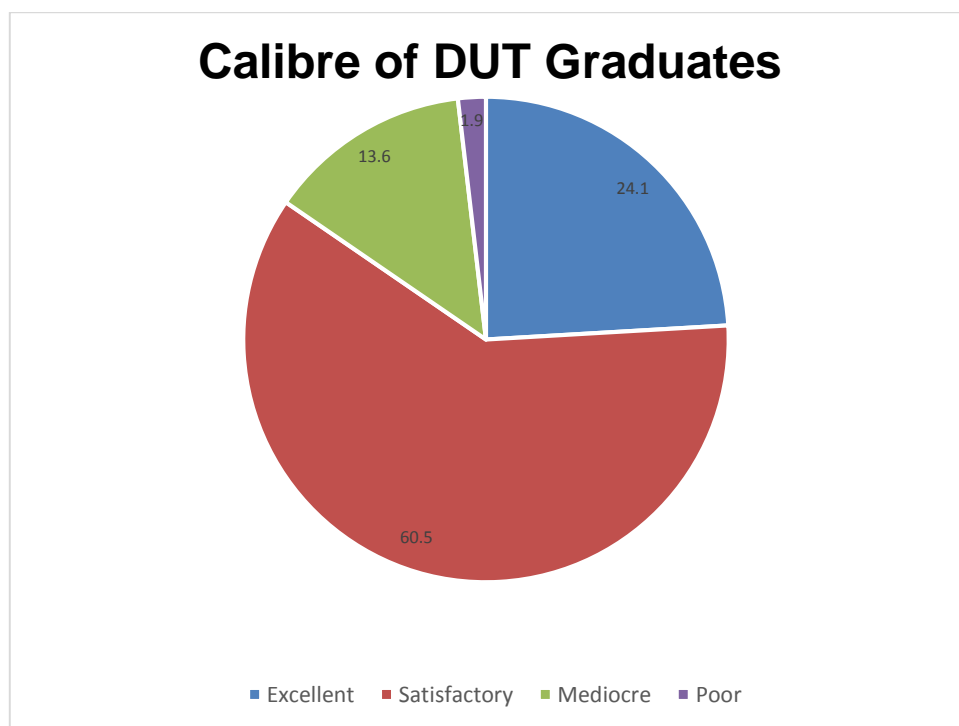


Figure 6: Calibre of DUT graduates

Over 60% of respondents believe that DUT is currently producing satisfactory graduates. This level of satisfaction stems from respondents believing that graduates 'struggle to adapt/ find their feet quickly enough in industry' even though 'they have

the necessary knowledge, but it's always the practical side that requires time to build-up' or 'they have a basic idea of what's required, but still require further training'. Also, 'most are still reticent which could be contributed to cultural factors' which probably stems from graduates finding themselves in the brand new rapid paced, multi-cultural environment of the world of work which many could find intimidating at first. This new mind-set could be a limiting factor on the immediate performance of the graduate, creating a less than excellent impression on the employer.

In addition, 24% believe that the graduates are excellent upon exiting the institution. This substantial positive attitude suggests that industry would consider taking on DUT graduates in the future.

However, 13.6% believe that DUT Civil Engineering graduates are of mediocre calibre. This choice of description is defended by comments such as the following: *'they have students at various levels of study without a basic understanding of measurement units i.e. kilopascals etc.'* and *'over the last few years I have had to spend a progressively larger percentage of my time on mentorship'*.

These comments bode negatively for the curriculum and further indicate more specific issues that require addressing within their respective disciplines and course content. However interviewees believe that there may be too much of a specific course content that may be irrelevant or far too in-depth for this level programme :

'the needs of industry are for instance a contractor doesn't require a person with Maths 3 and that level of depth. You would probably find that there is an entry level requirement where contractors would say they need a guy with a 3 year diploma who can start working immediately while a consultant would want something different.'

4.6.4 Concluding comments on current status of industry participation in curriculum at DUT

This section of the study considered input from participants from the range and breadth of specialisations within Civil Engineering. It does not cover any one specific area of specialisation but covers all. Within that context, I report on the trends and observations below:

More than 50% of the respondents were from the consulting environment. As much as this may compromise any generalisability's, the richness of their comments is still extremely valid, more so due to the nature of the close working relationship between consultant and graduate.

The majority of respondent's specialisation lay within the fields of Roads and Water which would imply a bias to those disciplines. However, these specialisations constitute basic infrastructure that are fundamental to the Civil Engineering field especially in any developing country and therefore there is a propensity for these areas of specialisation to be in abundance.

The majority of responses suggest that the nature of association with DUT is in the form of training for undergraduates and subsequent employment of graduates. Employers experience with them generated some responses that correctly indicate that graduates do not 'hit the deck running' Harvey (2010:6) but also corroborates Kruss's (2003:64) point that 'work experience and occupational specialisation were the preserve and domain of the employers, who would build on the general foundation laid by HEI's to develop the requisite specialised skills, knowledge and dispositions to produce skilled employees'.

In addition, comments from employers and staff concur that the Civil Engineering programme may be laden with material that is either far too deep within the field or material that may be extraneous for a graduate. Koehns' (1995:246) research attests to this when he comments that 'practicing engineers recommend a decrease in mathematically oriented subjects such as calculus, differential equations, linear algebra, statistics and numerical methods' as they 'do not use these subjects in their

day-to-day Engineering work.’ Concomitantly Koehn (1995:246) adds that ‘there should be a greater emphasis on oral communications and technical writing’.

Of the respondents who have an association with DUT Civil Engineering Department, 40.1% maintain an on-going association throughout the year. This is a positive note, as it would indicate they do not sever ties with DUT once they have taken on undergraduates. Furthermore, this is significant as these respondents could potentially be recruited to the Civil Engineering Department’s advisory board.

Also noteworthy is that 35.2% maintain an association only for in-service training. This presupposes that DUT graduate is preferred over other local HEI’s. This is also inferred positively on the Civil Engineering curriculum, as it would imply that they would continue hiring DUT undergraduates.

It is concluded from these statistics that industry has very little direct input in the curriculum therefore any shortcomings in the curriculum are realised by industry late in the student’s studies as they get to experience the end product, i.e. the graduate.

4.7 Concerns about industry participation in the curriculum renewal process.

The second circle from my analytical framework explores the particular conversation on the concerns of industry's participation in the curriculum renewal process. This particular direction provides insight into the depth of participation, which would be congruent to what emerges from the funnel nozzle. It attempts to illuminate the concerns on industry participation by industry itself and by the staff in the teaching and learning of Civil Engineering.

4.7.1 Types of interaction industry would prefer to have with DUT

The data below represents the various types of interactions provided to participants to ascertain the preferred method of engagement that industry would have with DUT (Figure 7). It considers various discreet avenues that are available to industry to engage with DUT and evaluates the extent of their preference with the intention of gauging future attempts by DUT to involve industry in curriculum discussions subsequent to this study.

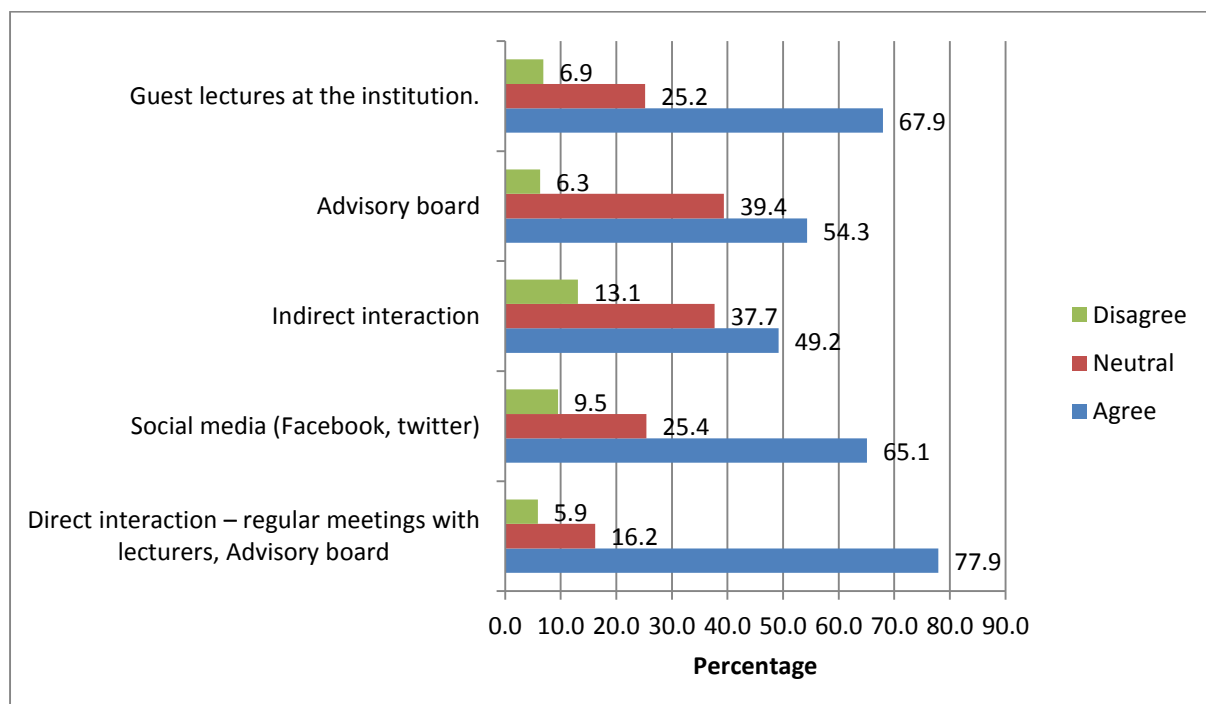


Figure 7: Types of interaction industry would prefer to have with DUT

The highest percentage (77.9%) of respondents indicates that they would prefer direct interaction with DUT. Direct interactions in terms of regular meetings with the Civil Engineering Department are preferred. However, interviews with experienced Civil Engineering staff showed that they are sceptical, believing that there is *'no guarantee that they will pitch because they are busy'*. Furthermore interviewees believe that a more proactive stance needs to be adopted by staff to directly engage with industry:

'If you just invite people, then you are not going to get anywhere. It is happening right now. You almost need to force it and go out and make yourself available to industry by meeting daily, talk to and need to identify the contractors'.

This direct interaction should extend not only to invitations: *'you should be able to identify a few consultants or the bigger contractors, you would have to go meet with them for just half an hour just trying to find out exactly what they need'* but take curriculum discussions to them.

Second highest (67.9%) was respondents suggestion of guest appearances from industry to present lectures. This is interesting to note as interviews with Civil Engineering staff also revealed similar sentiments:

'my observation is the best way to get input is to get industry to help you lecturing. The guys from industry, the experts from industry, they don't have to lecture the whole subject, they should be guest lecturers'.

This method of interaction would serve a dual purpose. Firstly, these lecturers would give a direct insight into the world of work and secondly they would provide an awareness into what the latest trends and/ or methods are that are currently being used by industry. They would also provide an idea of the type of employee they would be looking for, something that students could aspire to:

'It creates an opportunity for our students to meet the actual professionals in the field. It will show what's relevant out there, what's current, what's needed out there. Even if they come in as guest lecturers or someway in between and just do a certain section, it creates an opportunity for our students to meet the actual professionals in the field. The guys are actually out there and doing the work, it motivates them, helps

them, and shows them what's out there. They (industry) can also tell us, what's not relevant anymore'.

As suggested above, the benefit of such interaction would provide an indication into where the shortcomings are with the current Civil Engineering curriculum. It would further hint at what is outdated within the teaching and learning of the Civil Engineering programme. These presumed benefits are also hinted at by interviewees who stated that *'lecturers must be more up to date with modern techniques and technology and therefore lecturer-industry liaisons are very important'.*

It is, however, discouraging to note that only 54.3% preferred interaction via the Advisory Board, a means made available to industry by DUT to purely engage with industry on curriculum issues. Interviews with staff concur with the above inference drawn from the data for various reasons. The advisory board meetings have become more of an information session where DUT reports on their progress on the curriculum renewal. As one interviewee dishearteningly explained:

'Advisory Board is created for feedback but if you look at the minutes that is for the past 2-3 years, there is enough information sessions to tell them what they would have or should have been doing because that is what has been happening in the field. Especially when it comes to the curriculum renewal process it is more of a feedback session for us to tell us what we need, what we changing to. They are clueless, they don't know what's happening and why we doing this and where it goes. That's the scary part when it comes to industry liaison'.

The data suggest put guest lecturers (67.9%) and social media (65.1%) quite close to each other as forms of interaction; however, guest lecturers would provide positive benefits (as elucidated above), but social media could be unreliable for various reasons unsolicited and/ or unqualified comments could be made, and the users cannot be validated.

4.7.2 Industry's opinion on developing curriculum with DUT

The data below (Figure 8) were generated to assess how interaction should be developed between industry and DUT. The intention of this is to assess which means of interaction industry believes is the most suitable form of engagement for them and concomitantly to indicate a possible shortcoming in DUT's efforts to engage with industry

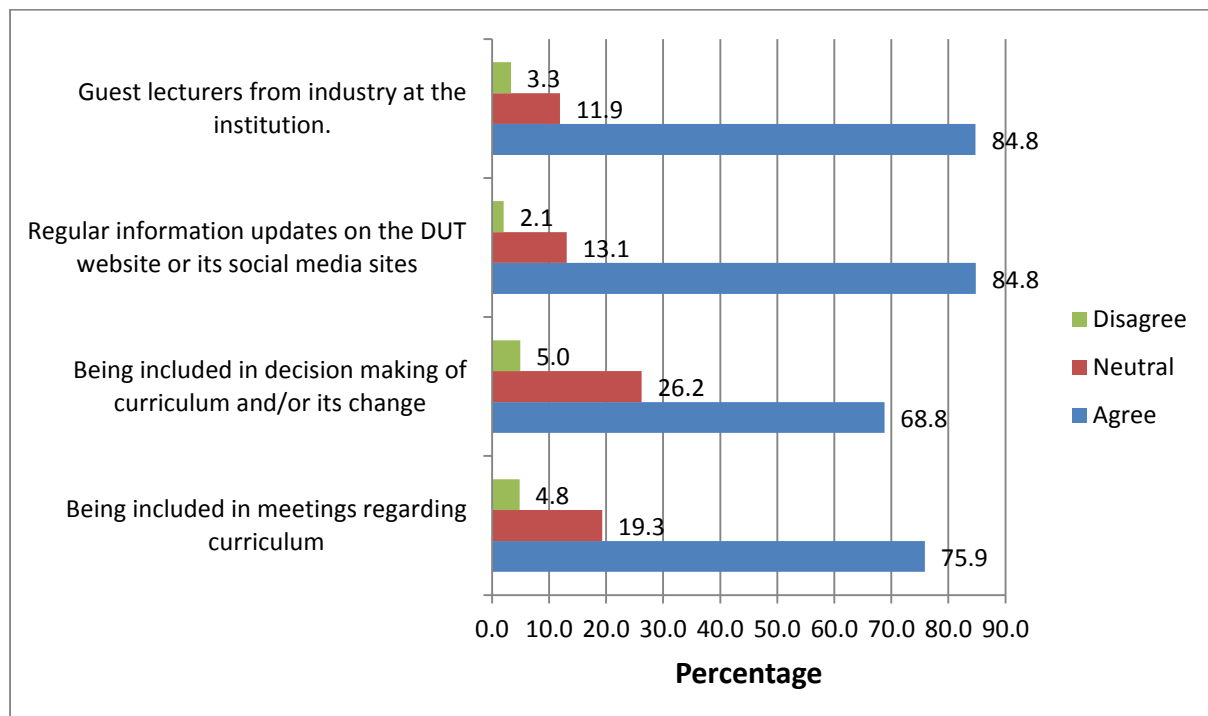


Figure 8: Industry's opinion on developing curriculum with DUT

The general consensus shared by industry is that of inclusion. As the data suggests, 75.9% would like to be included in meetings regarding curriculum possibly to ensure that a better quality of student is produced if they have a say in what their curriculum constitutes. While 68.8% would prefer to be included in the decision making or change of curriculum, 84.8% would welcome regular updates via DUT website and social media sites on curriculum decisions and curriculum change. This larger percentage preferring the use of social media could be because it is so readily available and easily accessible by all concerned.

The data overwhelmingly suggest that industry would prefer a presence in curriculum discussions. However, the staff are sceptical regarding industry making themselves available evidenced by comments such as *'they are certainly interested but actually whether they make themselves available is a big question here'*. Furthermore, interviewees have alluded to other problems that may arise out of the above interactions. As one interviewee explained:

'The major challenge is satisfying the different trends in industry. The contractors versus the consultants and trying to strike that balance. The contractor will always tell you that we don't need a guy to come there with his suit and laptop, we need a guy that is hands on and a consultant will tell you that he needs a guy with a more detailed knowledge of design'

Nevertheless, interviewees do believe that such interactions are imperative, as one succinctly explained:

'I basically think that DUT is providing a product that services the industry, but we are selling a product so we have to make sure that the industry wants this product that we making. We can't be making something that the industry does not need. So that is why they need to tell us what it is that they want.'

4.7.3 Most effective way to influence the Civil Engineering curriculum

The following data (Figure 9) were generated to gauge industry's opinion on what it feels would be the most effective avenue to influence the Civil Engineering curriculum. In doing so the data attempts to enquire about their level of participation in the stimulus.

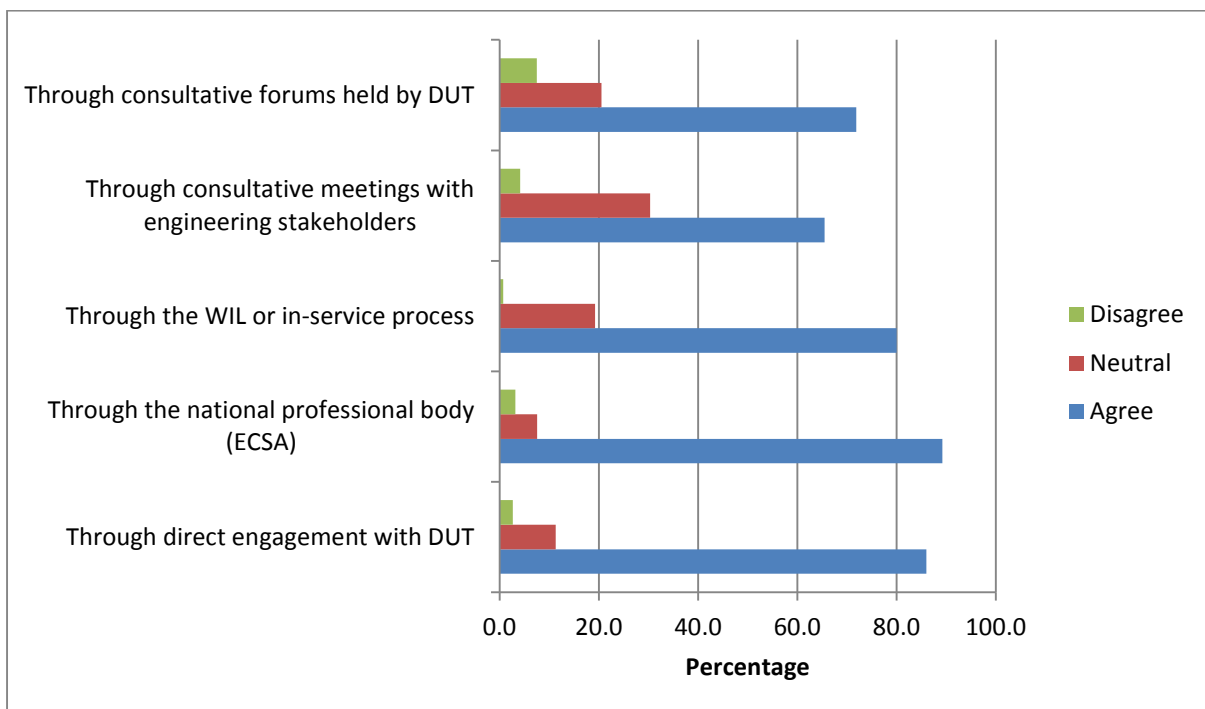


Figure 9: The most effective way to influence the Civil Engineering curriculum.

The majority of respondents (89.2%) choose the ECSA as the most influential in defining the Civil Engineering curriculum, with 86% agreeing that direct engagement with DUT would be effective. This close margin could be due to the fact that DUT is at the 'coal face' of the curriculum as one interviewee expressed it, by being directly involved in disseminating the curriculum.

Other interviewees insist that as much as direct engagement would be effective, how this is to be achieved is the real concern alluding to the challenges in getting industry to contribute in influencing the curriculum. This opinion was supported by the response of an interviewee, who said, when probed on what he perceived as a challenge: 'Trying to get them (industry) to come to a meeting'.

4.7.4 Frequency of industry involvement with curriculum issues

To discover the frequency at which industry would prefer to participate in curriculum discussions respondents were required to indicate the most appropriate duration between curriculum discussions (Figure 10).

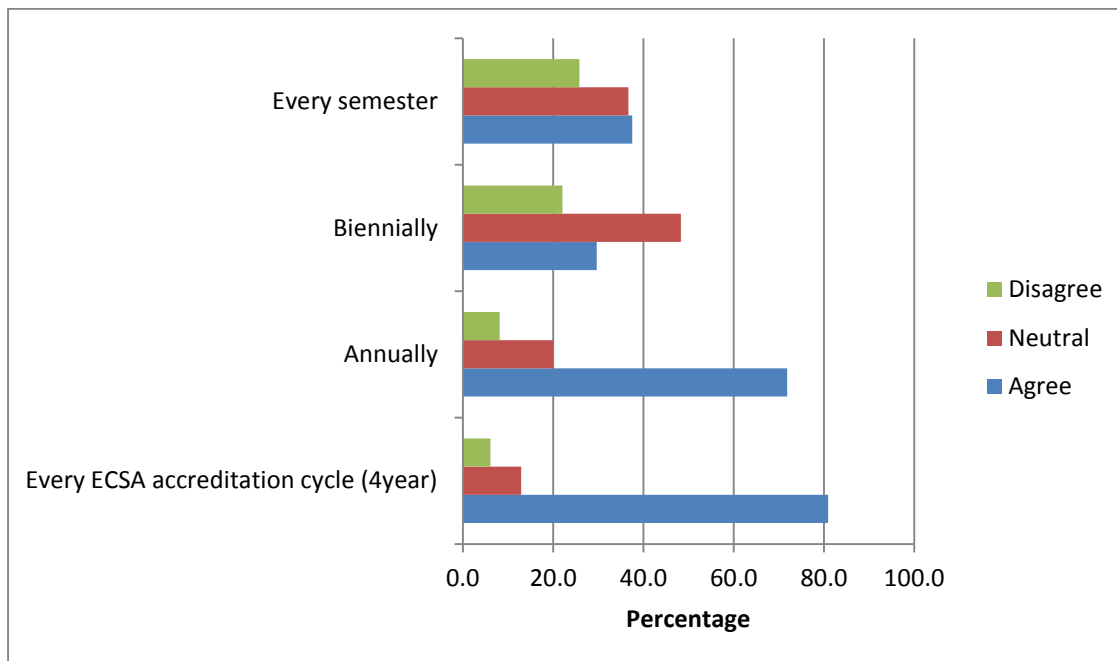


Figure 10: Frequency of industry’s involvement with curriculum issues.

The majority of respondents (81%) agree that participation should occur every accreditation cycle, i.e. every 4 years. Shorter periods such as every semester or biennially, featured low (29.7 and 37.5%). Reasons for this may not be lack of commitment but purely practical reasons such as time and availability constraints. Industry operates at a rapid pace, which leaves them with limited time to engage in meetings of this nature on a frequent basis.

Furthermore, Civil Engineering advancements do not occur so frequently as to justify curriculum changes and subsequent meetings to accommodate these advancements.

Moreover, any shortcomings or problems with the curriculum would only be discernible upon graduation of students, which would be after a graduation cycle. Therefore it would only then be prudent to discuss these shortcomings and act on them.

In addition, changes to the curriculum could be a lengthy process if the requested changes are radical, which would require ECSA approval or costly to implement as in the case described by interviewees where DUT had to migrate from free computer software to a pricey one being used industry-wide.

4.7.5 Taking the lead in Civil Engineering curriculum discussions

The data generated below attempts to elicit opinion on who should take the lead in curriculum discussions (Figure 11). In doing so this information would provide an idea of how industry prioritises its place in participating in curriculum decisions.

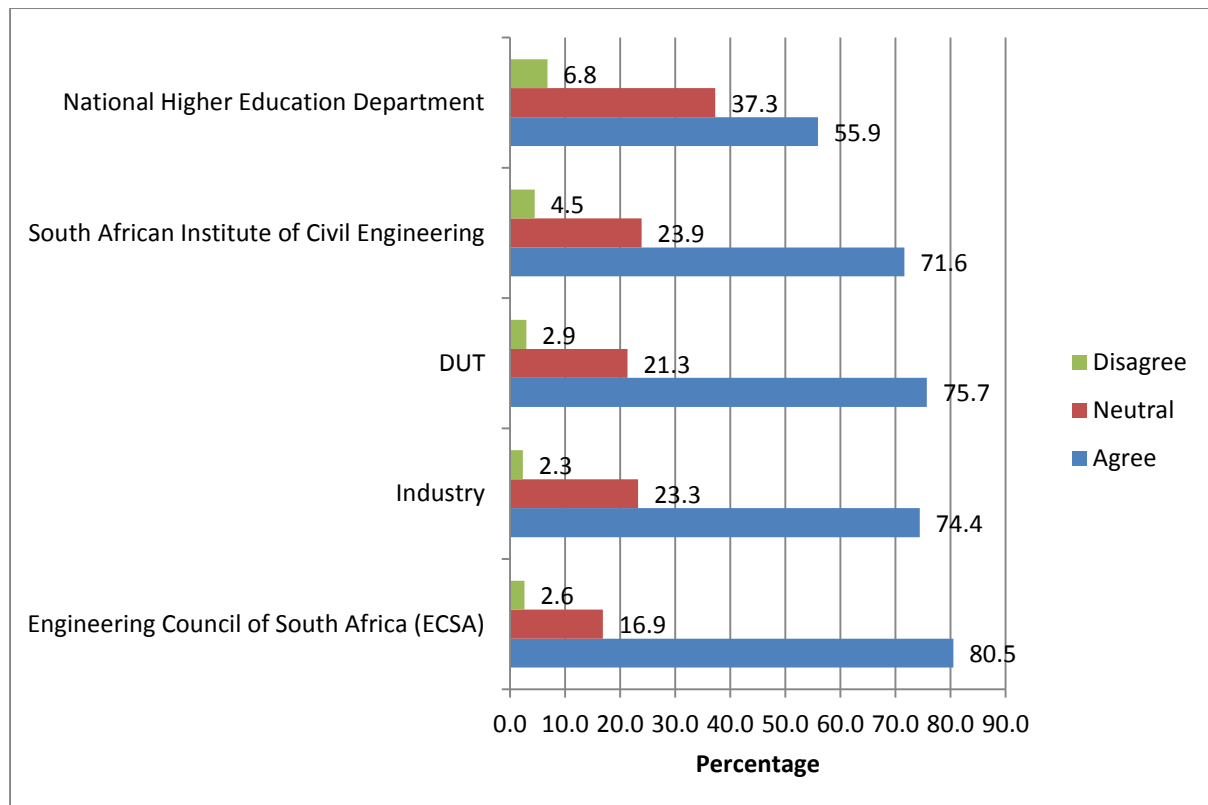


Figure 11: Taking the lead in Civil Engineering curriculum discussions.

A large percentage (80.5%) of respondents are of the opinion that the lead in curriculum discussions should be taken by South Africa’s Engineering controlling body, ECSA, with DUT being second (75.7%). The possible reason for this could be that industry believes that both ECSA and DUT need to collaborate for the most

appropriate and adequate curriculum. National Government falls within the lowest percentile (55.9%).

A few inferences can be made from the above observations. ECSA, should be the sole body responsible for leading and initiating curriculum discussions. This is however not the case in South Africa as the reason for the curriculum renewal at DUT stems largely from a Government initiated programme. However, ECSA has provided a guideline as to the composition of the new programmes. Ironically, National Government, falls into the lowest percentile, which suggests that Industry feels that government should not be directly involved in curriculum issues.

Additionally the data also suggests that DUT should also be at the forefront, second to ECSA (75.7%) in leading curriculum discussions. This sentiment is possibly due to the fact that DUT is at the forefront of administering the curriculum and should therefore be taking a substantial lead in curriculum discussions.

However, interviewees had a different opinion on who should lead this change as one interviewee stated, *'the university should be at the coal face, be in touch with new developments so that they can take leadership role in curriculum development'*. Furthermore, this lead should be taken by the following:

'...certainly academics, people on the ground, with a leader to gather information. And then I think there should be stakeholders from industry, from municipal, consultants and contracting give them an opportunity to state their side as consultants might look at it quite differently from contractors. Contractors might insist on the old diploma but consultants may go for the new degree so you got to balance the whole thing out. Quite extensive outside input is required.'

4.7.6 Benefits derived by industry in contributing to the design of the Civil Engineering curriculum

By vesting an interest in participating in curriculum discussions it would also be prudent to determine the benefits that industry would derive from such engagement. The data generated below (Figure 12) provide some insight into kinds of benefits, not just for industry but for graduates too.

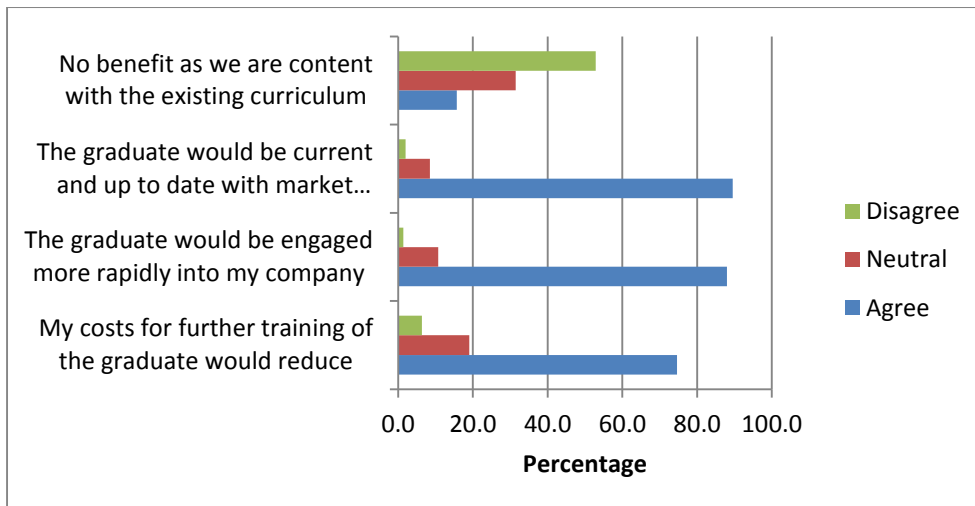


Figure 12: Benefits derived by industry in contributing to the design of the Civil Engineering curriculum.

The benefits that the Civil Engineering industry believes it could derive by playing a more significant role in curriculum design are primarily twofold: Firstly, the graduate and/ or diplomate (88%) would be rapidly engaged into the Civil Engineering field and subsequently into the company. Secondly, 89.5% of respondents agree the graduate’s inherent knowledge would be current and in line with most recent market trends and practices. This is notable as it indicates that industry favours a graduate that is up to date with the most current knowledge and trends. The data above further suggests that due to rapid engagement within the working environment, coupled with reduced costs of further training, the resultant graduate becomes suitably employable.

Conversely, interviewees also derive benefits from their engagement with industry in terms of networking with like-minded professionals. Furthermore, interviewees believe that due to their engagements with industry they would be constructively critiqued on what they are doing:

‘Then we know whether we are in the right direction or the wrong direction. Are we serving the needs of the industry or not? We need to serve academic interest and the industry interests as well. At least we get to see what our weak points are.’

4.7.7 Industry's role in providing professional development

Data were generated to identify where industry located itself within this participatory environment (Figure 13). In doing so, statistics provided insight into the role that industry saw itself in, in providing continuing professional development for Civil Engineering graduates.

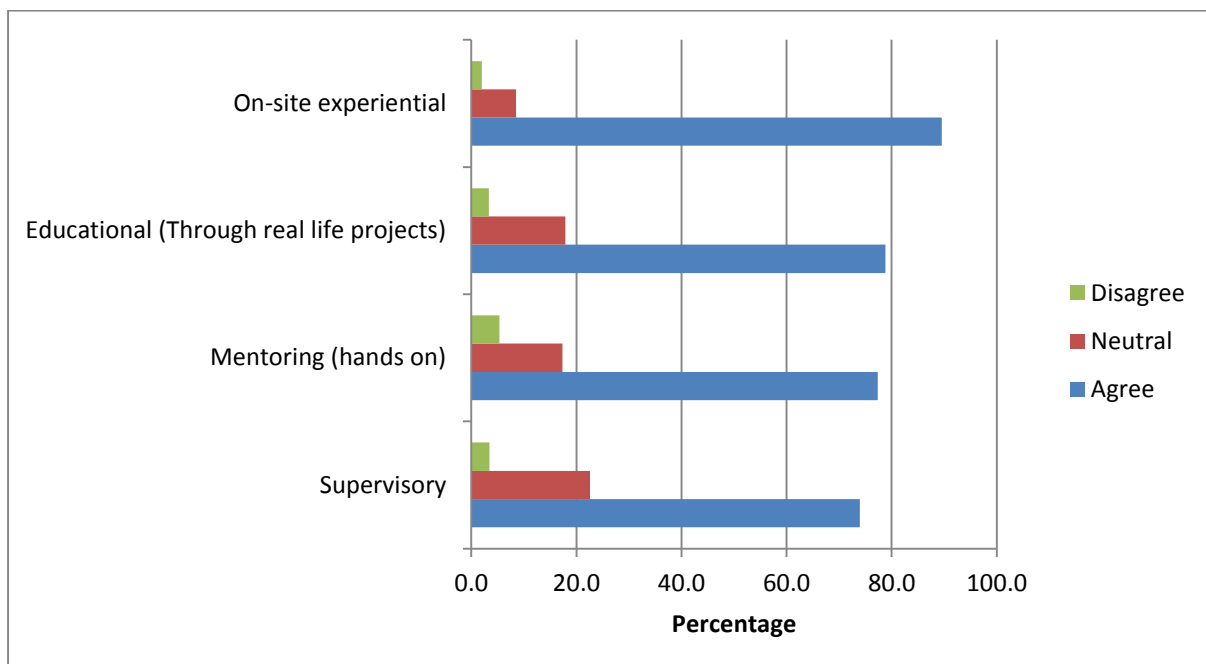


Figure 13: Industry's role in providing professional development.

A substantial number of respondents (89.5%) indicated that industry's role remains that of on-site experiential learning. They provide the working knowledge to bolster the academic knowledge provided by DUT so that students are 'able to translate and apply core generic skills into the practical requirements of particular job demands and employment context', (Mthembu, Orkin and Gering 2012:215). Fester and Haupt (2006:6) further endorse this view by providing further roles of industry. They believe that industry provides the 'link between theory and practice; reinforcement of theory through practical experience; increasing of student's motivation and commitment; increasing student employability once complete with academic study'.

In addition industry players also considers themselves to be providers of other facets that contribute to constituting a holistic graduate; apart from providing experiential learning they assume further roles such as those of being mentors (77.3%) and supervisors (74%).

These added roles are crucial to graduates, since they contribute to what is required for a graduate to attain professional status with ECSA.

As much as industry provides the above educational experiences and industrial relevance, interviewees contend that *'industry is very selfish'* as they:

'...take our technologists and use them on site as a 'super' foreman. Most of our graduates will not go out and work at the level that they are qualified for. The guys may have a B-tech degree but they are doing the work of a technologist, they might be doing the work of technologists, they might be doing the technicians work, they might be doing drafting or depraving work.'

Furthermore, interviewees believe that the Civil Engineering industry is biased in the type of professional development that they provide:

'the construction companies will push towards construction methods, management, while consulting companies will be geared toward design.' Subsequently, the graduate experience will be subject to the type of Civil Engineering environment s/he is exposed to.

4.7.8 Concluding comments on the concern about industry participation

The preferred method of participation as indicated by industry would be a direct method of interaction and engagement in terms of regular meetings with the Civil Engineering Department. Research from Fester and Haupt (2006:16) corresponds with this finding when they assert that 'direct industry/academic collaboration' should be imperative in the design of university curricula'.

Furthermore, interviews with staff concur with the above findings as there would be multiple benefits not only to the curriculum but also for them as well. It would identify shortcomings in the existing curriculum, on teaching and learning and give invaluable insight into current industry practices.

The Advisory Board however, seems to feature low among industry's preferred method of engagement. Reasons for this could be that many are not aware of the existence of the Advisory Board as the most appropriate route to effect curriculum discussions or its changes. In addition, interviewees believe that:

'...although it (Advisory Board) seems to be representative of a large sector of industry unfortunately you will find that at that point of time that not everybody is available, so whether it reaches all concerned parties, we would have to consider if somebody is not there and he/she represents the industry, he would have to get the feedback at the next meeting.'

So as much as the existence of the Advisory Board is the most appropriate avenue to discuss curriculum issue, it does have its limitations, to the point where its function is not entirely delivered.

DUT's accreditation cycle occurs every four years which is what industry believes is the most opportune period to effect curriculum changes and modifications. Using this time period affords many practicalities that range from frequency of industry advancements in relation to effects on the curriculum, to the lengthy administrative processes required to effect changes and the unavailability of industry due to time constraints.

Further data suggest that industry believes that the lead and initiation of curriculum discussions should be assumed by ECSA, followed closely by DUT and then industry themselves.

From the data generated there is a resounding inference that suggests that industry is fully supportive of an inclusive participation process. From such an engagement a symbiotic relationship becomes apparent between DUT and industry: the more input into the curriculum provided by industry, the more work-oriented graduates are produced to better serve the needs of industry.

4.8 Suggestions for change from industry

In the final circle of my analytical framework, I interrogate the suggestions for change provided by industry for curriculum and its renewal. Recalling that curriculum conversations are a 'highly contested terrain' with a multitude of 'voices', each referring to what is constituted as 'legitimate knowledge', I examine what industry's suggestions are on curriculum renewal and whether their views are incorporated in curriculum design. Evaluating these suggestions for change could ultimately contribute to making more informed decisions on curriculum design or augmentation for DUT Civil Engineering Department.

4.8.1 Curriculum components that require changes

Respondents were probed to establish which components of the Civil Engineering curriculum they believed required changes. Components of the curriculum such as subject content, means of instruction and methods of assessment constituted their responses with an opportunity to elaborate in their own words how and why they believed such changes were necessary. This method of using open ended-questions provided a rich source of pertinent information but does however have its limitations. Comments could be biased according to each of the respondent's field of expertise, and since DUT produces a generalist graduate without expertise in any specific discipline, respondents could thus believe that this is a shortcoming of the curriculum. Nevertheless, their observations provided valuable insights into what they perceive as deficiencies in DUT's curriculum.

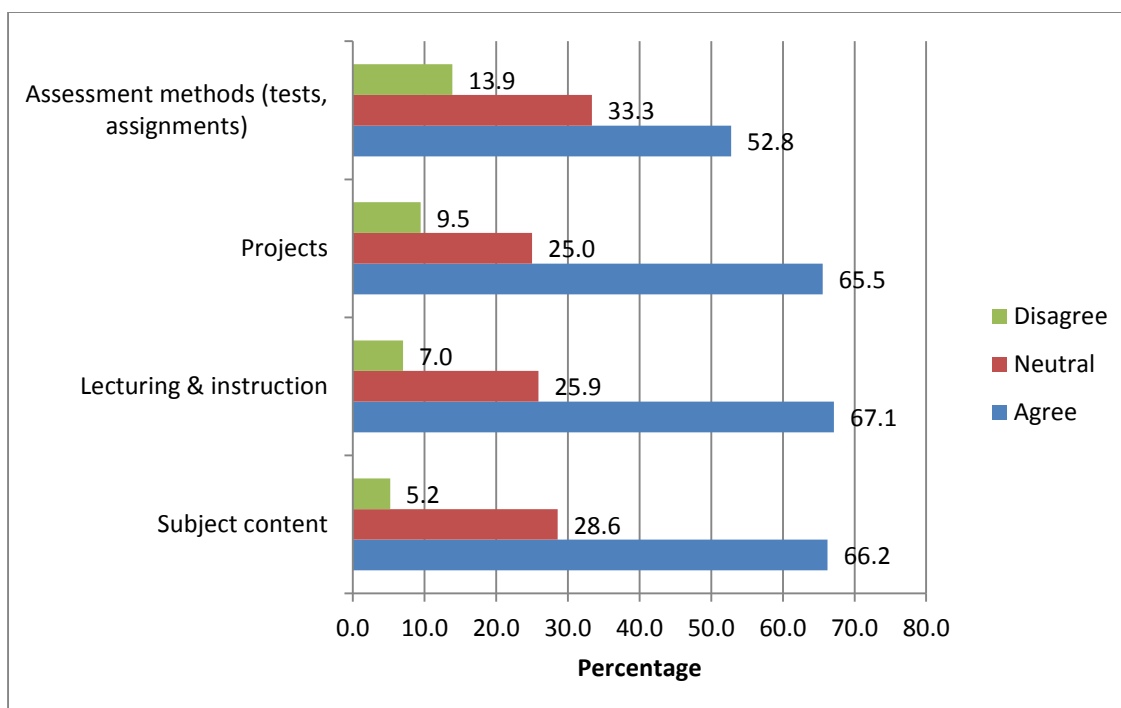


Figure 14: Curriculum components that require change

Crosthwaite et al. (2006:42) believes that ‘skills are acquired through knowledge, need and sustained practice. Meaningful assessment of such skills must look at demonstration of these practices in realistic and relevant contexts. Therefore, we must build these experiences into our curricula’. Therefore gauging industry’s opinion on which aspect of the curriculum components requires adjustments or alterations would provide valuable information on the present Civil Engineering curriculum and indicate shortcomings that would require attention during the renewal process. In addition, ‘only those teaching methods that are robustly validated and easily incorporated will lead to the necessary changes in curricula and pedagogies that will achieve the ambitions of the industry’, (Newson and Delatte 2011:1018).

Findings from this evaluation (Figure 14) revealed the following:

More than 50% of respondents believe that the assessment methods require some manner of transformation, while over 60% of respondents agree that projects, lecturing and subject content require alteration.

4.8.1.1 Assessments

A central component in the teaching and learning process of the Civil Engineering programme are the assessments. Gomes et al. (2006:122) believe that 'the objective of any assessment is to ensure that students reach an acceptable level of competence by submitting evidence relating to their achievements in the form of reports, plans, drawings, examination results and other reported material'.

The Civil Engineering programmes assessments are structured in a way that attempts to align with teaching and the competencies that are expected of a Civil Engineering graduate. The different types of assessments for teaching and learning within the current programme are tests, assignments and projects that are done in groups of between 4 and 5 students.

Traditionally, assessments of learning have been very focussed on getting a sense of what the students have learnt whereas assessment for learning provide students with a view of developing further to reach an objective outcome. For example, 'the instructor will initially illustrate a concept through a tangible example, rather than through generic instances. Students then attempt to make appropriate generalizations from observations (often quickly recognising the need for relevant particulars, skills and concepts), with the support of the instructor. This provides a more experiential, guided form of discovery learning', (Newson and Delatte 2011:1018).

Assessments are done in every learning module within the programme and an important consideration is how industry feels about the assessments for student. More than half of the respondent's (52.8%) agree that the assessments require changes from various segments. They believe that assessments 'should be relevant to industry' as they are not 'practical' according to industry standards. This suggests that the assessments should have more practical content, with a view to 'move away from book theory to industry applications'.

Crosthwaite et al. (2006:41) argues 'that both "content" and "process" must be an integral and interdependent part of curriculum design as the nature of the attribute profoundly affects the processes through which it can be targeted'. Therefore in

terms of assessments DUT's programme has been structured to provide base line training and development in respect of concepts, theories and principles with the idea of further development where they will be able to use these principles and theories to complete industry-orientated practicals. Therefore the order of assessments is more content focussed than applications focused. However, respondents believe that as much as *'subjects can be up to date, some content is outdated'* and that the subjects should *'be more industry related'* with a wish for *'more practical assessments in early levels (S1,S2) in areas such as 'construction basics, safety basics, environmental and economic understanding of the role of engineer'*.

4.8.1.2 Subject content

Applying the above to subject content, a large percentage of respondents (66.2%) agree that the subject content, of DUT curriculum requires transformation. As one respondent says, *'assessment's process should be more practical and related to the work place environment'*, while another opines that *'there is enough content in the syllabus, its just needs to be explained in more detail to students so there is an understanding. In addition, more 'tutorial periods should be allocated for more efficient understanding' of Engineering concepts'*. The curriculum needs to become more aligned with or more relevant to industry projects:

'Concepts in lectures should be put into context of problems in industry' and 'subject content to be more industry related including the use of the appropriate design software packages'. The above comments are further corroborated by other respondents, who say that *'the subject content should be more in-depth, analytical and engaging. The lecturers should gear students for industry by using more practical examples'*.

Currently subject content for some courses emphasizes the first principles of Civil Engineering rather than real world problems and rightly so, as this is within the ambit of the academic environment. In other courses, content mimics real world problems in an effort to get first principles across but in most instances these exercises are substantially 'watered-down' due to complexities and the interdisciplinary of real

world problems. Attempting to incorporate real-world problems impinges on other subjects and is very time consuming.

There have also been comments on the need to increase the practical content of subjects. This is probably how industry perceives DUT as providing a more hands on approach to Civil Engineering. However, concomitantly industry does acknowledge (54.4%) that as much as practical content should increase; there may be insufficient time to cover everything.

4.8.1.3 Projects

The project component of the curriculum requires more attention in terms of Industry requirements. This form of assessment is crucial to any Engineering programme including Civil Engineering as 'projects are designed to be substantial pieces of original work that simulate real engineering practice using topical tasks and problems sourced from industry and research', (Crosthwaite et al. 2006:43). Furthermore, Crosthwaite et al. (2006:43) believes that 'as students move through the programme, the projects progressively increase in the extent of open-endedness, ambiguity, uncertainty, complexity, technical challenge, scale, breadth, creativity and all such factors that contribute to emphasizing and building real professional practices'.

Data from this evaluation endorses the above as 65.5% of respondents suggest that the curriculum should incorporate assessments that are more projects based. Crosthwaite *et al.* (2006:43) believes that the reasons for this are because 'they (projects) encompass real scenarios that incorporate diverse factors, views and perceptions and therefore provide opportunities to develop both technical and generic skills'. Their research further substantiates the belief that it 'more effectively aligns educational practice with professional practice' Crosthwaite *et al.* (2006:47). Some respondents endorse this view about DUT Civil Engineering Projects, commenting that 'the syllabus and projects scheduled for students including practicals and software are in line with the industry'.

Respondents further opine that DUT should migrate away from group based projects evidenced by comments such as 'for diploma students projects are group based which doesn't help the individual'.

Possible reasons for this could be that when graduates enter the world of work they are expected to manage projects individually and thus are solely responsible for them. Allowing them to work in groups would not be appropriate grooming for industry. Furthermore, when they are expected to work in groups their individuality is lost which does not offer a true reflection of the student's performance nor accomplish of what this type of assessment set out to achieve.

Currently at DUT there are many project components to the curriculum which are subject-specific, i.e. students perform projects for each subject during a period set aside solely for group work on the projects for each respective subject. They are not interrelated to other subjects and are discipline-specific; therefore if it is a Road Design project for Transportation 331, the project concentrates on the physical design fraught with calculations and omits the contract documentation component to the design. However, Gomes (2002:480) believes that 'students continue solving problems of manageable dimensions within specific courses for the major part of their undergraduate education. Thus crucial connective links between different courses remain unexplored. The consequence is a distorted view of real-life problems' thus alluding to a shortcoming of the current DUT Civil Engineering curriculum. Therein lies the disparity between a UoT and that of a traditional university.

With the researcher's personal background emanating from a traditional university, this disparity from a project assessment perspective is evident. The traditional universities project component is substantially different; it is separate from the course work in its entirety, and from the administration of the course, in the evaluation of the student. Evaluation is done by an external party, usually someone from industry, and culminates with a one-on-one interview. The project is the choice of the student and encompasses a full design and documentation situation thus mimicking the situation in industry.

Because the projects at DUT are discipline specific, they may not have the rigour expected of a real world project which synthesizes with one respondents comment

that 'projects must be challenging to produce a graduate of an acceptable level to enter industry'. Furthermore, projects must be '*multidisciplinary and interface with report writing*', as one respondent maintains that this '*is key in the consulting industry*'. In addition, respondents believe that '*the project should be more relevant to the subject and be more real to what is required by industry*', and that '*where possible, actual industry based projects to be used*'.

4.8.2 Additional training provided by industry to graduates

In terms of the kind of additional site-based training provided by industry, more than half of respondents, (55.5%), find themselves forced to provide additional hands-on training to graduates who enter the profession. Most of them believe that this type of training should have happened during graduates time in DUT. The additional types of training provided range from software packages to management control.

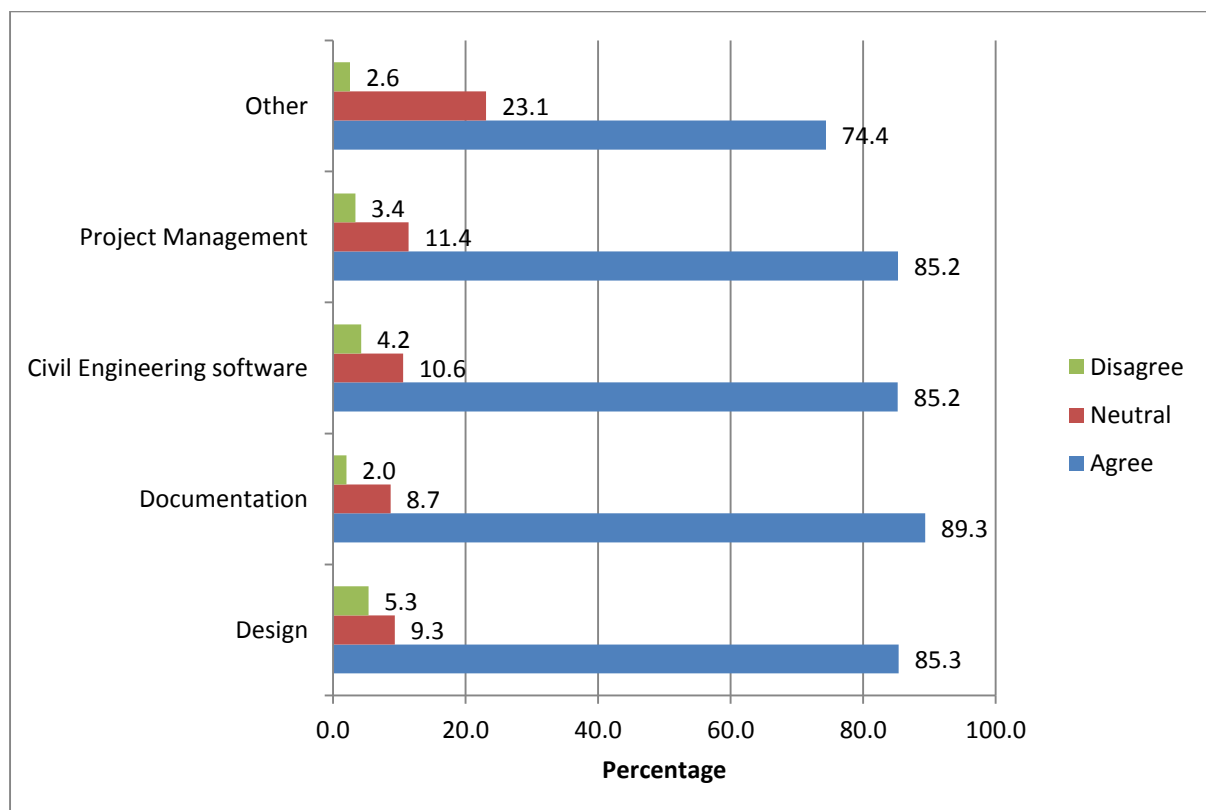


Figure 15: Additional training provided by industry to graduates

Figure 15 shows that a substantial number of Civil Engineering companies provide additional training in most of the disciplines. Over 85% of respondent's indicate that they have to provide additional training, in Project Management, and Civil Engineering software and design and 89.3% provide Documentation training.

A substantial number of respondents believe that the reasons for them having to expend further time and resources on graduates are because of the absence of a tangible link between knowledge and practice. As one respondent explained: *'while students may have the theoretical knowledge, they lack the ability to apply that knowledge to industrial application'*. This stems from the fact that *'graduates are unable to relay theoretical knowledge of course content'* or *'lectures are not able to link the actual syllabus to how we have to apply it'*. Other respondents concur by stating that *'we often get students who know which formulae or approach to use in a given scenario but they do not have a conceptual grasp of the underlying principles- if anything is out of the ordinary, they struggle to revert to first principles'*. These experiences are once again further substantiated by Gomes (2002:479) who suggest that *'students often do not recognize all the links between courses in the curriculum'*. The reasons for such graduate attributes as expressed by industry is further explained by Gomes (2002:479) when he states that *'engineering curricula often allow fragmentation of concepts to such an extent that students have difficulty in integrating these concepts to solve complex problems even after graduation'*.

These comments suggest that DUT Civil Engineering curriculum expends more time on engineering concepts than the practical application of these concepts, to the point that the line between theory and real-life engineering problems is obscured. Graduates also expect similar types of text book situations in industry, which is almost never the case.

Furthermore, basic construction practices are not adequately addressed, which is a cause for concern. As one respondent indicated: *'construction practices are very important like installing storm water pipes, constructing slabs, columns etc. which we lack and are usually taught by foremen and labourers'*.

From the above analysis, one underlying factor seems to emerge: that industry would like an all-rounder, a graduate basically proficient in all crucial elements of the programme because *'employers are demanding a greater level of competencies*

from engineers – versatility in a range of areas, not just the core technical domain’, (Gomes et al., 2006:116). The presumed benefits of having such a graduate are that *‘industry would gain better trained graduates that would lead to an inevitable increase in productivity’* as explained by one respondent. However, this underlying factor needs to be considered as part of curriculum design when engaging with levels of competence expectation, i.e. the limitations associated with beginning Civil Engineering competence (usually developed through programmematic intervention at an institution, and an on-going competence related to the nature of professionalism (which is largely site-based and individually initiated).

4.8.3 Changes to course content

Respondents were requested to rank the Civil Engineering disciplines of the curriculum that they felt required changes to their course content because as literature suggests, ‘engagement between universities and industry is crucial to the development and delivery of components of engineering degrees’, (Lamb *et al.*, 2010:45) .

A trend emerged from the analysis that indicated that if a company specialised in a certain field, e.g. Structural Engineering, their comments gave a poor reflection of the students for that field.

Furthermore, one cannot generalise that this deficiency is a shortcoming of the Civil Engineering curriculum. Graduates usually accept positions as they come along and many are not in a position to pick and choose a company that specialises in a Civil Engineering discipline that they excelled at as an undergraduate. Furthermore, the aptitudes of students vary greatly, and he or she may be employed in a company whose area of expertise may not be their forte subsequently struggling while in the employment of that company, thus creating a negative impression of DUT.

4.8.3.1 Specific changes to course content

When requested to make comments on specific course content that needed more depth or items that required attention to detail or should be excluded, respondents were vociferous in their observations.

Geotechnical Engineering: The most remarks were received for this course, such as a need for *'more attention to Geotechnical Engineering with a broad understanding of how it fits into Engineering projects'* and *'there should be greater emphasis on Geotechnical Engineering, specifically materials and laboratory testing. Currently the scope covered in materials testing is too small'*. The respondents further believe that *'geotechnical engineering is taken to a far greater extent than what needs to be. Rather focus on requirements of industry.'*

The above comments suggest that industry is somewhat conflicted in their opinion of this course. On the one hand comments abound that it is inadequate in some aspects as graduates exhibit poor understanding of the concepts or application thereof. On the other hand, others say that it delves far too deeply for such a specialist discipline. Common ground on its extent of coverage within the curriculum is an issue that requires consideration.

Water: Respondents were not as critical of the Water courses however one stated that *'in water engineering the curriculum should include the design of water supply for urban and rural water supply schemes'*

Project management: Although a formal Project Management course does not exist within the programme, this particular training currently exists as two undergraduate courses called Management I and Management II.

Upon completion graduates find themselves in positions where they are expected to manage sites individually. In this capacity certain basic Project Management skills should have been learned during the course of the Civil Engineering programme.

Undergraduates are groomed to meet deadlines for their assessments early in their studies. Most lecturers go as far as penalizing late submissions in an effort to create a sense of gravity and responsibility. This sense is naturally compounded in industry as 'time is money'; however, one respondent revealed that *'most graduates are not*

time and cost sensitive' which is a direct indication of graduates lacking project management skills.

This indicates a limitation to the current Civil Engineering programme; hence the comment the *'project management should equip a student to be a site agent for contractors'*

Roads and Transportation: Some respondents felt that *'roads and transportation needs to include maintenance'* which implies that the current focus of the transportation courses is more on design with little emphasis on roads maintenance. Another statement made was that *'more emphasis needs to be placed on freeway engineering and the design of dual carriageway roads. Storm water design receives very little attention in the curriculum and often has a huge impact in roads and platform design'*.

Structural Engineering: Some respondents believe that *'there is too much emphasis on structural engineering, whilst most DUT graduates don't major in structural engineering in their B-Tech's'*.

4.8.4 Specific requests from industry

4.8.4.1 Site visits

The Joint Board of Moderators, (2008:1) states that *'site visits for engineering students provide an excellent shop window for the many and varied career opportunities that construction industries have to offer. They can benefit everyone involved'*.

Site visits are literally excursions to large Civil Engineering developments that are currently under way. Students are taken to construction sites and chaperoned by lecturers and given a first-hand view of an actual construction site to see some of the methods of construction and engineering principles in practice. Other sites also include Water and Wastewater treatment works to view operations and understand the practical side to the theories disseminated in lectures.

A regular comment from respondents was the need for such site visits to assist and reinforce principles imparted in lectures. This is evidenced by one respondent who believes that, *'site visits should be encouraged and students exposed on the site to experience what they are learning in classes'* and by another who believes as follows:

'in addition to in-service training, compulsory vacation work would be beneficial to DUT students. This will help put the theoretical aspects of engineering into better perspective. The university should engage with industry to put a system in place which allows for students from the S1 level to attain some sort of exposure to the industry'.

These comments are further substantiated by the Joint Board of Moderators (2008:1) which comments that among 'universities is the lack of opportunity afforded to students to visit sites, and observe construction activities being carried out in the workplace'.

4.8.4.2 Software

A wide variety of computer software exists to assist with almost every discipline of Civil Engineering. One respondent believes that *'software packages are the heart of the industry today'*; other respondents state that *'most graduates' lack computer knowledge, the computer is the key to a successful career'*, and as such require more content in the Civil Engineering curriculum.

Some Civil engineering packages are more popular than others. One such programme, Autocad, has become an industry norm that DUT has been overdue in incorporating within the curriculum. Subsequently as recently as 12 months ago, the institution migrated to the software preferred by industry at a substantial cost to accommodate this imperative.

4.8.4.3 Office etiquette

A regular comment was that graduates lacked a higher proficiency and command of the English language and report writing skills e.g. *'DUT students lack communication*

etiquette (email, report writing) and *'skills in report writing need to be enhanced'*. However, it has to be acknowledged that for most graduates English is not their first language and therefore rapid adaption to a formal working environment and, dealing with associated seasoned professionals may take longer, in the process creating the impression of a graduate that is poor in language comprehension and understanding Civil Engineering 'lingo'. These comments are corroborated by Russell and Stouffer (2005:125) who have observed that 'many beginning engineers (Civil) continue to struggle with communication skills' for reasons ranging from 'timing' because 'both composition and speech courses are generally required in the first years of college, well before the student has developed a technical vocabulary or facility' and 'the lack of integration with technical subject matter'.

Currently there is no course dedicated to technical report writing in the Civil Engineering curriculum at DUT at either undergraduate or post graduate level. The reports generated by students are at the behest of the lecturers concerned, in a format as recommended by him or her. This may not be in line with industry norms, but in a manner sufficient for the lecturer to perform an assessment for that particular subject. Therein lies a possible shortcoming of DUT curriculum.

4.8.5 Preferred association and benefits derived from establishing a relationship.

Respondents were questioned on the type of association they prefer to have with DUT and the subsequent benefits derived from such an association. Of respondents 40.8% indicated that either a 'participative', 'interactive relationship' or 'on-going' relationship best describes their inclination. These comments were further vindicated by their beliefs that such an association would provide *'current knowledge of new trends and methods used in industry, 'ongoing growth for both individuals and the industry'* and that *'DUT will be in tune with the kind of standard industry expects exiting students to be'*.

This type of association would provide other tangible benefits such as the fact that *'course content would be updated to latest application in industry'* and create an

environment where graduates will have more relevant knowledge and be able to *'hit the ground running'*. As one interviewee explained: *'industry will tell you what the shortcomings are of our graduates and what's required, missing in our graduates, and what's good about our graduates and that would help us to fine tune ourselves'*.

Another interviewee felt that such interaction is vital:

'We know whether we are in the right direction or the wrong direction. Are we serving the needs of the industry or not? We need to serve academic interest and the industry interests as well'. Another believed that *'if you don't have industry input then you might be producing a qualification that no one wants'*. This type of association would create a symbiotic relationship, and as one respondent indicated, *'industry would gain better trained graduates that would lead to an inevitable increase in productivity'*.

4.8.6 Concluding comments on suggestions for change from industry

Gomes (2002:480) espouses, that *'engineering as a body of knowledge has structure and form, is built upon fundamental laws, concepts and data that we believe are self-consistent and integrative. Our discipline is not an unrelated collection of a few thousand equations put together to solve problems in a "cook-book" manner'*. Therefore in analysing the data a substantial amount of inferences can be deduced. Furthermore, *'the identification of learning objectives is in essence a definition of the "content" of a curriculum. However, the linking of these to attributes via learning activities and assessment criteria and standards, both formalizes the "content" and characterizes the educational "processes" that can be used to appropriately target the attributes'*, (Crosthwaite *et al.* 2006:41).

A collective outcome of the curriculum components was that the assessments were not practical and requires more alignment and relevance to industry. The same sentiments were shared for subject content with a further requirement that it needs more practical content.

Respondents do acknowledge that there is difficulty in providing adequate practical training in an academic environment due to time and project constraints as alluded to by comments such as *'there is insufficient time to cover all aspects (content) of*

courses due to limited timespan in the semester' and 'due to time restrictions, it is not always possible to provide sufficient exposure to real world engineering problems'. However, the underlying consensus is that real life projects and academic work needs to be integrated on a greater scale, as this respondent stated: *'relationship between real projects and academic work is essential throughout a student's study period'*. This is corroborated by Gomes (2002:480) who believes that 'meaningful learning can be greatly facilitated by relating what is known to students with solving open-ended problems'. As another respondent explained: *'if students understand the outputs they will have a better understanding of subjects/studies'* and *'more practical experience to fill the knowledge gap'* that lectures cannot provide. Crosthwaite *et al.* (2006:42) concurs with these statements and asserts that students 'must recognize it as essential to successful professional practice and they must receive repeated opportunities to practice and develop these skills in a disciplinary context. Lectures and examinations alone cannot do this'

The comments regarding the project component of the Civil Engineering programme were disconcerting. Industry believes that the manner in which the project component is being conducted is inadequate and ineffectual in cultivating the skills that this particular assessment is expected to develop. They commented further that project management skills are poor to non-existent.

Another crucial outcome of the additional training provided by industry to graduates was basic management skills. Although two such courses exist within the programmes curriculum, the suggestion is that they may not be inculcating the skills that are required in industry. Nevertheless industry also in the same breath do acknowledge that this particular skill matures with time and experience and is therefore something the curriculum may not be entirely responsible for.

Industry also indicated that graduates find difficulty in applying theory to the practical situations that are found in industry. The basic first-principle's are adequately perceptible to employers; however, the physical application thereof is where graduates fumble implying a limitation in the link between the curriculum and practice.

Furthermore, there have been comments that some basics of construction work are not included in the curriculum like basic pipe laying and installation of precast pipes and curbing. This impacts on employers creating the impression of a curriculum that is deficient in menial Civil Engineering tasks and graduates are then coached by foremen and in extreme cases laborers.

With regard to specific changes to course content, Geotechnical Engineering and Project management received substantial pertinent remarks.

In terms of new requirements, industry would like to see site visits becoming a regular occurrence. They believe that such a practice would provide an invaluable insight into the goings on at a construction site, especially with academic staff in attendance to explain, guide and reinforce principles disseminated in lectures.

They also believe that as much as effort has been made to mimic the most popular software used in industry, there are other software packages that DUT should also introduce into the curriculum, preferably with industry consultation.

The suggestions provided by industry related to shortcomings of graduates as experienced first-hand by industry. They may be specific in terms of the curriculum that is disseminated, but intrinsically allude to the attributes of a DUT Civil Engineering graduate. Hence, the deeper underlying messages hints at what their required talents and characteristics should be, thus intimating on their preferred graduate attributes. As Walkington (2010:137) opines, 'in an engineering environment, responsiveness to the field (profession and industry) is a vital consideration if proposed change is going either to change the qualities of graduates, or involve the field in the progress of the course'.

To this end Fester and Haupt (2006:16) believe that 'if Universities of Technology are to offer a full contribution to educating the built environment consulting professionals, they should take a more proactive role in offering a multidisciplinary, continuous professional education not based on or limited to the standard curricula, hence the need for constant revision'. This constant revision is, therefore, necessary to keep the curriculum conversations on-going, topical and influential, all of which needs the participation of all stakeholders, including industry, in the curriculum review process.

Having presented the data analysis located within the funnel presented in Figure 1, the emergent findings are vast ,convoluted and complex in the complicated conversation that is curriculum and its influence. Drawing from this analytical framework, the essence of the three themes may now reflect the findings that emerge from the funnel nozzle as depicted in Figure 16 below.

In doing so, the findings provide for the development of relevant recommendations that bode well for the Civil Engineering curriculum.

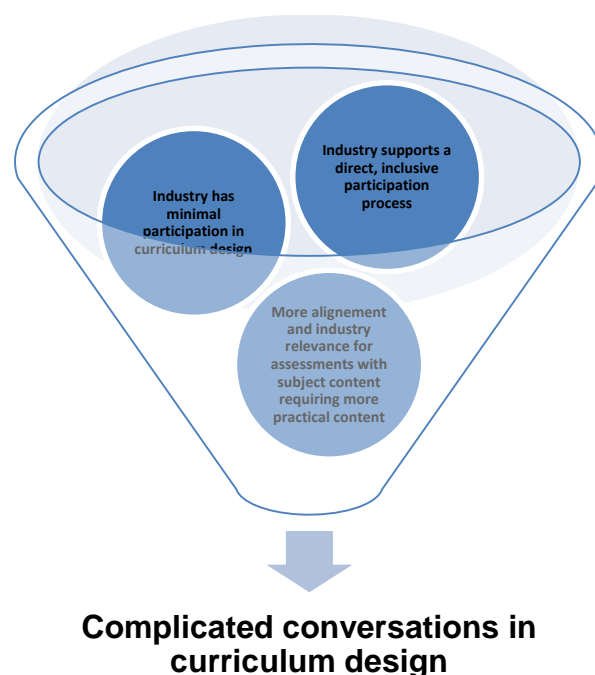


Figure 16: Emergent themes from the data analysis

In the final chapter I present such recommendations which are defined by the objectives of this study and informed by the data analysis just presented.

CHAPTER 5 – IMPLICATIONS AND RECOMMENDATIONS

5.1 Introduction

In Chapter 4 the results and analysis of the data were presented. In this chapter I present a summary of the findings of this exploratory research and attempt to explain what I have found in light of the research questions alluded to at the inception of this study. The aims of this study were to investigate for the purposes of illumination, what the nature of the Civil Engineering industry's engagement with higher education (i.e. DUT) is in curriculum conceptualisation; how this engagement happens and how it influences curriculum decisions in the Civil Engineering curriculum; and why engagement is the way it is.

The thoughts and views that materialised from the analysis of the data as alluded to in Chapter 4 were vast, convoluted and complex. Hence, the themes that subsequently emanated could be used to inform possible new, more beneficial directions in the curriculum of the Civil Engineering Department and possibly other similar faculties of DUT.

5.2 Implications and recommendations

Some of the main inferences arising from the data are outlined below.

The nature of engagement is largely limited to the utilisation of graduates and therefore the nature of industry's involvement is largely as users rather than contributing to development of the graduates competence. Engagement occurs more commonly when curriculum issues are raised by industry at interviews during WIL. This suggests that the nature of the association with DUT is limited to the employment of students or graduates, inferring that industry has very little direct input into the curriculum. However, data further suggests that those companies that do employ DUT students, in which-ever capacity maintain an on-going association with the institution.

Engagement should happen in the form devised by DUT at the Advisory Board meetings; however, comments and data suggest that this avenue for curriculum

discussions with industry is considerably under-utilised for its intended purpose, and its existence is not entirely familiar to industry. Therefore as a recommendation, using the data generated from this study, DUT Civil Engineering Department should target those companies that have an interest in making a concerted effort, by enlisting them onto the Advisory Board and inviting them to its meetings. From an institutional perspective DUT should be more proactive and advertise the existence such entities created solely for curriculum discussions with the public and particularly industry.

Nevertheless, the data do strongly suggest that industry genuinely wants to be involved in curriculum discussions and decisions. Therefore, as a recommendation, it would be considered prudent if another generic curriculum based questionnaire be devised to be filled in by employers during student WIL visitations by staff, in addition to the existing questionnaire. In doing so, DUT would be proactive in literally 'taking curriculum issues to them'.

The type of limited and perceived engagement by industry provides a partial and inadequate influence of the curriculum decisions as they unfold in the curriculum renewal process. On the one hand, stakeholders from industry want to be included and have indicated the various preferences they have in being included; however, they also seem to be contradictory in how they locate themselves within the discourse. As much as the resultant graduates serve industry's best interests, industry does not believe that they should take the lead in curriculum decisions and discourses. Data suggests that the lead should be taken by Civil Engineering's governing body, ECSA followed closely by DUT. This type of protracted indecision on curriculum engagement will ultimately result in a mismatch between what the graduate is, what industry wants, and what they actually get in reality.

As much as industry does indicate the methods it would prefer to exercise in engaging with DUT and the kind of interaction they envisage having, the opinions of seasoned academics provide a contradictory opinion. They firmly believe that as much as industry would like to have input in the various forms and methods, trying to get them to attend engaging sessions has from past experience been fruitless and difficult.

Consequently this suggests a type of errant attitude making it difficult to create a symbiotic environment between DUT and industry, and subsequently validating staff perceptions of industry as not really being interested in getting involved in the 'complicated curriculum' matters.

Data from both questionnaires and interviewees overwhelmingly suggest that industry is not directly involved with the curriculum renewal currently under-way at DUT. In fact, some respondents only gathered that such an activity was under way through the medium of this study. This therefore suggests that the resultant curriculum will be void of any industry engagement and influence.

As a recommendation as advised by one interviewee an 'open day' should be organised by the Civil Engineering Department when the generic structure of the new qualification is ready, in order to gauge first-hand the public opinion of it.

This study has revealed that curriculum design at DUT is a taciturn, isolated process devoid of feeling and not constituting a complicated curriculum conversation. This has implications for me as an employee of DUT, as the focus on curriculum highlights the importance of curriculum engagement with industry. There is a misalignment between assessment in the curriculum and what industry wants, or the topics that have been chosen for generic learning and specific learning are different. Industry would like to see this alignment happening on certain subject content areas, and, we as academics charged with disseminating the Civil Engineering curriculum to future industry leaders need to take cognisance of.

5.3 Concluding remarks

The summary and findings are outlined above. The data generated have been outlined; and deliberated and salient issues that emerged were discussed. The main findings are that industry is not involved enough in the design of the Civil Engineering curriculum at DUT. In addition, areas of the Civil Engineering curriculum that require more attention were pointed out, and recommendations for the production of a more holistic graduate were made.

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Appendix A

Questionnaire

Dear participant,

Thank you for taking the time to complete this survey. This study is being undertaken to explore the Civil Engineering Industry's' contribution to the re-education of the Civil Engineering programmes at Universities of Technology with the DUT (DUT) as a case study. Your input is greatly appreciated. This survey will take approximately 15 minutes to complete.

Title of the research study: Exploring Industry's' contribution to the re-education of the Civil Engineering programmes at Universities of Technology (M.Tech. Civil Engineering).

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Introduction and purpose of the study: The purpose of this survey is to gather information from the Civil Engineering industrial fraternity in an effort to understand their contribution to the re-education process at Universities of Technology (UoT's) with a case study being the DUT. The results from this study will be used for research and publications purposes only and will be made available in the DUT library, in the form of a Masters dissertation.

Confidentiality: We would like to assure you that the information that you offer in this survey is strictly confidential and that no personal details are required of you. Your participation is voluntary and should you choose to refuse or withdraw from participating, you may do so at any time with no consequence. Your name will not appear on the survey and the individual answers you give will be treated as strictly confidential.

Persons to contact in the event of any queries:

Researcher: Shalindra Hariparsad 083 232 6930 / 031 373 2233

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If you understand and agree to participate in this study kindly proceed with the survey.

Please answer the following questions as completely as possible.

PLEASE INDICATE WITH A TICK ✓ IN THE SPACES PROVIDED

1. Civil Engineering organisation:

Contracting Consulting Para-statal

2. Area of Civil Engineering Specialisation:

Structures Water Roads Geotechnical Project Management

3. Type of organization (Multiple answers accepted)

Small enterprise (employ under 50 staff)	<input type="checkbox"/>
Medium enterprise (employ between 50 and 300 staff)	<input type="checkbox"/>
Large enterprise (employ more than 300 staff)	<input type="checkbox"/>
Multinational (global) enterprise	<input type="checkbox"/>
Provincial/National government	<input type="checkbox"/>
Local Municipality	<input type="checkbox"/>
Other (please specify)	<input type="checkbox"/>

4. Describe the nature of association between your organization and DUT (Multiple answers accepted)

Provide consultative work to DUT	<input type="checkbox"/>
Provide opportunities for in-service training to students of DUT	<input type="checkbox"/>
Your staff lecture/ consult on DUT's academic programme	<input type="checkbox"/>
Employs DUT graduates and diplomates	<input type="checkbox"/>
Partners with DUT in external project works	<input type="checkbox"/>
Funds DUT (bursaries/project sponsorships/etc.)	<input type="checkbox"/>
No association with DUT	<input type="checkbox"/>
No association with DUT but do have associations with other tertiary institutions	<input type="checkbox"/>

5. If associated with DUT, please indicate duration per annum with DUT (Multiple answers accepted)

On-going association	<input type="checkbox"/>
Only during in-service training	<input type="checkbox"/>
Only during project work duration	<input type="checkbox"/>
Attend consultative forum meetings	<input type="checkbox"/>
Minimal association on needs basis	<input type="checkbox"/>

6.1 Curriculum engagement with Universities of Technology.

	Yes	No
You have had an opportunity to engage with the engineering curriculum nationally.		
You had an opportunity to engage with DUT on their Civil Engineering curriculum.		

6.2 Describe the nature of your curriculum engagement with DUT.

Regular advisory board meetings	
Telephonic requests	
Interview with staff during WIL (work integrated learning/in-service training)	
Written submissions	
Letters of concern to DUT	
Other, specify	

6.3 The outcome of your engagement with DUT on curriculum issues.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
No change					
Cosmetic changes					
Major changes					
On-going interaction					
Sustained relationships					
Increased communication					

7.1 The kind of interaction you would prefer to have with DUT in order to contribute to the production of a better Civil Engineering graduate and/ or diplomate.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Direct interaction – regular meetings with lecturers, Advisory board					
Social media (Facebook, Twitter)					
Indirect interaction					
Advisory board					
Guest lectures at the institution.					

7.2 In your opinion, interaction should be developed between industry and DUT by:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Being included in meetings regarding curriculum					
Being included in decision making of curriculum and/or its change					
Regular information updates on DUT website or its social media sites					
Guest lecturers from industry at the institution.					

8. The role you see your company playing in providing continued professional development for students of DUT.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Supervisory					
Mentoring (hands on)					
Educational (through real-life projects)					
On-site experiential					

9. In your opinion, the most effective way to influence the Civil Engineering curriculum would be:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Through direct engagement with DUT					
Through the national professional body (ECSA) or institute (SAICE)					
Through the WIL or in-service process					
Through consultative meetings with engineering stakeholders					
Through consultative forums held by DUT					

10. The Civil Engineering industry should become involved in curriculum issues:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Every ECSA accreditation cycle (4year)					
Annually					
Biennially					
Every semester					

11.1 Which of the following components of the curriculum would describe the type of changes you would like to see implemented at DUT in terms of the curriculum change?

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Subject content					
Lecturing and instruction					
Projects					
Assessment methods (tests, assignments)					

11.2 Please explain your response above.

12. The lead in Civil Engineering curriculum discussions with industry should be taken by:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Engineering Council of South Africa (ECSA)					
Industry					
DUT					
South African Institute of Civil Engineering					
National Higher Education Department					

13.1 The kind of additional/site based training you provide to diplomates or graduates of DUT.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Design					
Documentation					
Civil Engineering software					
Project Management					
Other, please specify					

13.2 This/these additional training should have happened whilst the student is studying for her/his Civil Engineering qualification.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

13.3 Please explain your response to 13.2 above.

14. The benefits you think your company would derive from getting involved in contributing to the design of the Civil Engineering curriculum?

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
My costs for further training of the graduate would reduce					
The graduate would be engaged more rapidly into my company					
The graduate would be current and up to date with market trends					
No benefit as we are content with the existing curriculum					

15.1 Rank the following areas of the Civil Engineering spectrum that, in your opinion, requires changes to the course content. With the number '1' indicating 'least changes' and the number '4' indicating 'most changes'.

	Least changes			Most changes
	1	2	3	4
Water				
Structural Engineering				
Roads and transportation				
Geotechnical Engineering				
Surveying				
Project and Construction Management				

15.2 Please elaborate on the specific content that you prefer to be included/ excluded.

16.1 The calibre of Civil Engineering diplomates/ graduates that are currently exiting DUT.

Excellent		Satisfactory		Mediocre		Poor	
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16.2 Kindly elaborate on your choice above.

17.1 What kind of relationship do you envisage would contribute towards an appropriate Civil Engineering curriculum development at DUT?

17.2 What would be the benefits of establishing such a relationship between industry and DUT?

18.1 DUT is currently underway with a re-education process to their Civil Engineering programmes to meet an envisaged implementation by 2014. What are your views on this?

18.2 How often and when do you think DUT should re-educate?

19. Any other comments should you feel are pertinent.

End. Thank you for participating in this survey.

Appendix B

Interview guide

Interview questions: Curriculum champion and Civil Engineering lecturers

- In the curriculum renewal process that is unfolding within DUT, how do you see the process as being inclusive?
- Who do you feel should be included in this curriculum renewal process?
- What contributions do you think that these various persons, bodies, etc. can make in the curriculum renewal process?

- What interactions do you have with the Civil Engineering industry as an academic? (e.g. communications for placement, supervision, advice, support, collaboration, etc.) ?
- If you have such interactions, why do you see the need for such interactions?

- What benefits do you draw from your engagement with CE industry?
- Do you believe that CE industry's should become involved in curriculum design at an institution of higher education and why?
- If so, how do you think that they should be included?
- What do you hope to achieve from them through this inclusion?
- Are there any reasons why you think that industry's should not be involved in curriculum design at universities?
- What are some of the opportunities that could be open for industry's to influence curriculum design at DUT?
- How could these opportunities be sustained?
- What challenges do you see with involving CE industry's in curriculum design?
- Why do you see these as challenges and how would you overcome them?
- Would you be able to give me an example, from past experience, of curriculum issues raised by industry's? Through this example, tell us what

you did as a representative of the institution (DUT) and of the CE Dept, in respect of the curriculum issue raised?

- Is your input into the discussions being taken into consideration or do you believe that your presence is to meet an institutional requirement?
- To what extent are all the requirements of role players accommodated in the discussions or do you feel that certain interested and affected parties have been side-lined or omitted entirely?
- How would you describe your curriculum renewal discussions: Content based or legislative i.e. are the discussions too biased in a particular direction or field?
- If so, what is that direction and what do you think it should be more focussed on?