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Nelson Mandela Metropolitan University

for tomorrow

2012

NMMU ENGAGEMENT EXCELLENCE AWARD

APPLICATION

1. **Name of Applicant: B Zeelie**_____

2. **Names of Team Members:** Barnard, Johan; Bosma, Coos; Bosma, Margriet; Dokwana, Thami; Dugmore, Gary; Erasmus, Pieter; Esterhuizen-Londt, Maranda; Gouws, Melissa; Gouws, Shawn; Lessing, Otto; Luiters, Natasha; Mafu, Lubabalo; Mcingana, Lwandile; Mdlatu, Nobahle; Mpalala, Mildred; Mpuhlu, Batsho; Mtwa, Nozuko; Saunders, Cecilia; Vorster, Nicole.

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3. **Indicate the Award Category being applied for**

3.1.	NMMU Engagement Excellence Award	
3.2.	NMMU Engagement Excellence Team Award	X
3.3.	NMMU Emerging Engagement Award	

4. **Nature of the engagement activity/project**

The InnoVenton engagement activity encompasses four main activities, namely technology support services, expert analytical and testing support, R&D and teaching and learning. These engagement activities are mainly aimed at the SME and SMME sector in the chemical and allied industry sector. Due to its varied nature, the activities referred to above span all four the NMMU engagement categories. Thus, examples of engagement are found under Outreach & Community Service, Professional/Discipline Based Service Provision, Teaching and Learning, and Research and Scholarship. Holistically the objective of InnoVenton's engagement activities is to improve the sustainability of regional industries in the specific industry sector and to improve the quality of life of people using our scientific knowledge and capabilities.

The stakeholders in InnoVenton's engagement activities span a range that includes regional and national Government, industry, and the community. With respect to Government, InnoVenton hosts one of two Technology Stations at NMMU, namely the Downstream Chemicals Technology Station, which strives to execute Government initiatives to strengthen industrial activities regionally and nationally. In addition, InnoVenton also acts as the host for a Department of Science and Technology demonstration project, namely the Microalgae to Energy project. As a result of its expert knowledge in specific industrial fields, InnoVenton often acts as reviewer for the DST on proposals for Government support from external (international) agencies. In terms of the industry sector, InnoVenton has engaged with close to 200 different industries during the period January – December 2011, providing inter alia analytical and testing services, technology development and evaluation services, and teaching and training services. InnoVenton also strives to provide service to the community in its field of expertise and capabilities. Examples (see later) of this would include water quality evaluation and the development of sustainable rural technologies in energy, food and water supply.

Finally, due to its close interaction with external stakeholders, InnoVenton strives to translate aspects of its engagement activities into its own, and the wider Faculty academic functions. As example, InnoVenton developed the new Diploma in Process Technology in close collaboration with industry (HEQC approved); it has provided the Department of Chemistry with a full framework (including a competency profile) for the re-curriculation of the Diploma in Analytical Chemistry; it has developed a new (voluntary) training course in "Good Research Practice" according to international practices in Good Laboratory Practice and Good Manufacturing Practice; it has provided training opportunities in chemometrics to NMMU post-graduate students across different departments; and has provided Internship opportunities to five individuals in its facilities for the period January – December 2011. Annexure 1 provides a tabulated summary of the engagement activities during 2011.

5. **Assessment Criteria**

5.1. **Criteria 1: The impact and significance of the engagement activity.**

We will attempt to address this criteria by directly commenting on how our engagement activities support, or are aligned to Vision 2020.

1. Vision

To be a dynamic African university, recognised for its leadership in generating cutting-edge knowledge for a sustainable future.

In positioning InnoVenton at the interface of the traditional "University" and the external stakeholder community, cognizance needs to be taken of the main drivers in the development of integrated academic-external stakeholder relations, namely: (a) The 'steering' of research priorities (at global, national, and system levels), (b) The increasing drive towards commercialization of academic research, and (c) The demand for an increased accountability of science (broadly defined). These drivers reflect, to a degree, realities such as: (a) The need for many different knowledge and skills sets to solve many of today's complex societal issues (e.g.

HIV/AIDS, Climate Change, Alternative Energy, Water Scarcity, Land Use, etc.); (b) The need for a broader funding model for R&D (and academic institutions in general); and (c) The increasing realization by society that they have as large a stake in academic R&D (and education) as the more traditional stakeholders (Government and Commerce). The degree to which InnoVenton has succeeded in establishing itself at this interface, thereby creating the type of dynamics that would allow the NMMU (or at least its SET sector) to progress towards a position of leadership is best judged by peers. The following is, however, offered as evidence of the progress made towards establishing this position:

a. The request by DST (2006) to host the "Downstream Chemicals Technology Station";
b. The hosting of the Microalgae to Energy project as a DST demonstration project;[1]
c. The support of DST and industry for the establishment of the Fuel Chemicals Platform within InnoVenton;[2]
d. The request by Sasol to establish an advanced competency in "Online process monitoring and control";[3]
e. Requests by industry stakeholders to provide in-house training to their staff;[4]
f. The request by several development agencies to participate in community development projects;[5]
g. The award of a SARChI chair (to be hosted within InnoVenton) in microfluidic bio/chemical processing;[6]
h. Invitation by the DST to display our fresh-water/energy/grow your own garden concept at COP-17;[7] and
i. Invitation (B Zeelie) as keynote speaker and panel member for bioenergy at the Bioenergy Africa Conference, Sandton Convention Centre, Johannesburg (March 2011).[8]

2. Mission

To offer a diverse range of quality educational opportunities that will make a critical and constructive contribution to regional, national and global sustainability.

To achieve our vision and mission, we will ensure that:

- Our values inform and define our institutional ethos and distinctive educational purpose and philosophy.
- We are committed to promoting equity of access and opportunities so as to give students the best chance of success in their pursuit of lifelong learning and diverse educational goals.
- We provide a vibrant, stimulating and richly diverse environment that enables staff and students to reach their full potential.
- We develop graduates and diplomats to be responsible global citizens capable of critical reasoning, innovation, and adaptability.
- We create and sustain an environment that encourages and supports a vibrant research, scholarship and innovation culture.
- We engage in mutually beneficial partnerships locally, nationally and globally to enhance

[1] Copy of funding letter from TIA included as Exhibit 1 in Attached portfolio; All other evidence available on request, including project scope and deliverables, and funding agreement between NMMU and TIA.
[2] Full fuels analysis and testing facility wholly funded from external funds (>R6 million) at InnoVenton's Gomery avenue site; ITS records of financial available on request.
[3] E-mail correspondence from Dr H Assumption (Sasol – University liaison for analytical science) available on request.
[4] Correspondence available on request.
[5] E-mail correspondence from different individuals re community development projects available on request.
[6] Written communication from NRF re SARChI Chairs award available on request.
[7] Photograph of Mr Lububalu Mafu explaining algae concept to the honorable Ms Naledi Pandor – Exhibit 2.
[8] E-mail correspondence re organization for speaker/panelist available on request.

social, economic, and ecological sustainability.

As stated above, InnoVenton is positioned on the interface between traditional "academia" and external stakeholders. As a result, its activities (in engagement and R&D) mostly deal with actual, real-life issues that are often too complex to be solved by a uni-disciplinary approach. In this environment, InnoVenton strives to function as an "integrated disciplinary" function within the Faculty of Science, not only in the undertaking of R&D/Engagement activities, but also the development of new "integrated disciplinary" degree/diploma programs (e.g. the Diploma in Chemical Process Technology). In this process we try and demonstrate that: (1) Integrated knowledge creation occurs within a context of "application" and this context describes the total environment in which scientific problems arise, methodologies are developed, outcomes are disseminated, and uses are defined; (2) Integrated knowledge creation is characterized by "integrated-disciplinarity" which may, or may not be derived from pre-existing disciplines and rarely contribute to the formation of new disciplines; (3) Integrated knowledge creation integrates both academic role players from different unrelated disciplines and non-academic participants, such as government, commerce and industry, and the public. It is therefore a combination of "integration" with a "participatory approach"; (4) Integrated knowledge creation requires novel forms of quality control, since "scientific peers" can no longer be readily identified as the knowledge creation process now comprise not only "producers" (of knowledge), but also "orchestrators", "brokers", "disseminators", and "users".
Thus, by fulfilling the function of an integrated disciplinary academic unit, InnoVenton (in a small way) addresses the overall NMMU mission by providing alternative academic options (undergraduate and post-graduate) that directly addresses the issue of higher education massification (i.e. the increase in the number of learner expectations). In so doing, it ensures a vibrant culture and atmosphere, both in R&D and in training programs due to the constant interplay between the academic pursuit, "real-life" issues and expectations.
In building out this integrated disciplinarity, InnoVenton strives to both build a staff compliment that incorporates different disciplines (e.g. Chemistry (B Zeelie, G Dugmore, S Gouws, etc.), Analytical Science (M Gouws, T Dokwana, N Mtwa, etc.), Geology (G Ritson); Statistics/Applied Mathematics (C Bosma), Law (O Lessing), Microbiology (M Esterhuizen-Londt), and Civil Engineering (J Barnard)) as well as taking on collaborative projects with disciplinary departments (e.g. Development of analytical sensors for False Codling moth infestation in Citrus – Biochemistry[9]; Acid mine water treatment – Geology[10]; Omega 3 production via microalgae – Biochemistry[11]), etc.

5.2. **Criteria 2: The intellectual endeavours contributed by the engagement activity.**

InnoVenton's engagement activities is firmly based on:

- What is has (Knowledge, Skills, Experience and Facilities);
- What it does (T & L and R&D).

As already suggested in prior text, we regard engagement as integration with participation: Thus engagement could either result in the transfer of "technology" from NMMU to the external world, or vice versa. InnoVenton strives to fulfil this gateway within the Faculty of Science to allow both the outflow and inflow of good practice, knowledge and skills. We first refer to engagement activities directed externally of the NMMU:
The following specific technological capabilities that InnoVenton has allows it to "engage" with the external world:

- Chemical production platform: The chemical production platform at InnoVenton includes

[9] Full research proposal by Ms Rachel van der Walt is available on request.
[10] Full research proposal by Thakane Ntholi is available on request.
[11] Full research proposal by Ms Diana Kimono is available on request.

its kilo-laboratory and its small production platforms laboratory. These facilities are unique and are the only example of such facilities at a university on the African continent and allow InnoVenton to practice chemical technology at the gap between "laboratory" and "commercial production". As a result, these facilities are in high demand for participatory projects of which the following are illustrative examples (please note that most of the work below is subject to confidentiality agreements and this information should therefore not be divulged to external parties):

a. Production of a new candidate fuel additive;
b. Production of synthetic jet fuel;
c. Development and evaluation of a process for the production of inulin (dietary supplement and probiotic);
d. Development and evaluation of a continuous electrochemical corrosion protection process;
e. Development of a small production platform for methylisocyanate;
f. Electrochemical production of tert-butylhydroquinone (anti-oxidant);
g. Continuous cyclization of citronellal in Eucalyptus citriodora oil;
h. Evaluation of coal clean burning catalyst;

- Fuel chemicals testing platform: This new facility, constructed and equipped with support from the DoE, Sasol, DST, and TIA, will really only start attracting interest once the proposed regulations for the blending of biofuels into the national fuel pool (currently before Parliament) has come into effect. Nevertheless, the facility brings a unique capability to InnoVenton in that it not only expands its analytical testing capabilities, but also allows it to undertake fuel chemicals and product development work as the testing of such products can now be performed on-site using the latest technology and internationally accepted practice. An example of this is the production of synthetic jet fuel[14] in InnoVenton's chemical production platform which required the product to consistently meet a specified flash point and which could be continuously verified as the product was being produced. In addition, the facility will also be used to support the development of SMEs and SMMEs in the biofuels industry.[12]

- Chemical analysis platform: This platform is probably the single most active platform in our engagement activities, and serves as a first point of contact with the needs/developments in the industrial sector. During 2011 the demand for analysis and testing support from the industry sector were mainly for: Water analysis (~24%); Car parts and plastics (tests for fugitive emissions and substances of concern ~ 28%); Coolants and complex fluids (6%); Food analysis (10%); Raw materials tests (10%); Effluent and sludge (14%); Soil (4%); and Clothing and textiles (4%). In this process, 268 external stakeholders were provided with a substantial value-add service, analysing and testing over 1600 different samples (with many tests per sample).[13]

- Microalgae cultivation platform: The microalgae cultivation platform comprise an area of approximately 500 m^2 on InnoVenton's Gomery Avenue site, and is the only large-scale photo-bioreactor (PBR) facility for microalgae cultivation in the RSA. It mainly serves as test-bed for the development of commercial cultivation systems, including the development of cultivation systems, harvesting systems and processing systems. At present InnoVenton runs a demonstration project for the Department of Science and Technology and funded through the TIA[1] (late generation biofuels) in the facility, as well as two projects in collaboration with Eskom (clean coal technology[14] and bio-oil production[15]). As part of this initiative, InnoVenton has developed a concept microalgae

[12] Project scope documentation for Tsolo Biofuels available on request.
[13] Full ITS records of transactions for 2011, and all individual analysis and testing reports available on request.
[14] Eskom task order available on request.
[15] Eskom task order available on request.

cultivation – clean water recovery – biogas for energy – bio-fertiliser for gardening system which has been displayed at the COP 17 conference in Durban during December 2011[7]. This system has also attracted interest from the Northern Cape Government (to possibly support their "Grow your own garden" project'[5]), and the German Consul to South Africa[16] (to try and establish collaboration with BASF in Germany, ourselves, and the Eastern Cape Government).

In terms of "What we do", the above discourse already gave examples of the research activities of InnoVenton in relation to its engagement mandate. In terms of the imbedded know-how, InnoVenton provides training and problem solving services to its stakeholder community. Training for external stakeholders currently focusses on chemometrics and applied statistics (focussing mainly on product and process development). These courses are often presented in-house for stakeholders[4] and are done in accordance with the NMMU's SLP policies and procedures. All InnoVenton's SLP's are registered and are subject to internal audit.[17] Internally InnoVenton also provides training in chemometrics to NMMU staff and students[18] and is particularly well attended by staff/students from the Faculty of Engineering and from the Dept. of Biochemistry and Microbiology. In addition, InnoVenton has, in analogy to the international guidelines for Good Laboratory Practice and Good Manufacturing Practice, developed a course for Masters and Doctoral students in "Good Research Practice".[19] This course is open to any post-graduate student from the Faculty of Science and is presented every first semester. It comprises several talks/workshops on topics that include: The scientific method; Scientific communication (reading, writing and presentation); Record keeping; Chemometrics (Experimental design); and Validation (Equipment, methods and sampling). Several individuals act as presenters, including the Dean of the Faculty who leads the session on publication writing. In this way, InnoVenton strives to transfer good practice from the stakeholder community back into the NMMU.

The knowledge contribution resulting from the engagement activities ranges from new intellectual property (patents)[20], company specific knowledge[21], artefacts[22], publications[23], conference proceedings[24], trained manpower[25], and dissertations and theses[26].
Creativity and innovation contributions can be judged from (a) the level of intellectual property generation, and (b) the nature of artefacts created. During the time period January – December 2011, two patent applications were completed and submitted[28], one of which is an international PCT Patent Application. While not strictly evaluated for RSA patents, international patents require that inventions must comply with three general requirements, namely (i) It must be new / novel; (ii) It must be non-obvious; and (iii) It must be useful. The artefacts referred to include, for example, the first ever agglomerates of coal and micro-algae (subject of the PCT patent), and a micro-structured electrochemical reactor. As an aside, all InnoVenton students attend a three-day

[16] E-mail correspondence from the German Consul, Mr Hans-Werner Bussmann available on request.
[17] Audit report available on request.
[18] Example of NMMU advert shown as Exhibit 4.
[19] Course contents and schedule for 2012 attached as Exhibit 5. All presentations on different topics available on request.
[20] G Dugmore and B Zeelie, Carbonaceous fines beneficiation using micro-algae and related processes, PCT/IB2011/001884, August 2011. J Barnard, G Dugmore, and B Zeelie, System and process for the cultivation of microalgae, RSA Patent application, 2011/8, August 2011.
[21] Report for Thembalathu Coal available on request.
[22] Various artefacts, including AAFC electrochemical cell, Sasol jet fuel samples, Eskom briquettes etc.
[23] Characterization of Base Metal Catalysts with Platinum to Reduce PGM Content in a PEM Electrolyzer Cell." N. Gojela & S. Gouws. Analytical Letters, Volume 44, Issue 11, 2011, 1996-2004.
[24] Bioenergy World Africa 2011 Conference, Ben Zeelie: Case study entitled "The pilot scale mass production of micro-algae biomass at NMMU" and a panel session named "Is the future of biofuels in algae?", (30 - 31 March 2011, Johannesburg).
[25] Details provided in Annexure 1.
[26] Details provided in Annexure 1.

workshop on creativity and innovation (presented by Prof B Zeelie) so as to stimulate creativity and innovation within R&D and problem solving endeavours.
With regards to ethics, InnoVenton has introduced several initiatives to guide students and participating stakeholders through the complex regulatory environment that governs chemical products and chemical manufacturing activities. For example, all researchers (staff, students, and external scientists making using of InnoVenton facilities) must comply with InnoVenton record keeping procedures. The in-house designed and managed electronic notebook system has been designed in accordance with ISO 9000 and patent law guidelines so as to ensure safeguarding of sensitive information and to maintain "trail of evidence". All individuals are trained in the use of the notebook system, and InnoVenton has installed a dedicated server (within NMMU's computer department) for storage of all original data. In addition, InnoVenton is the only academic entity at RSA universities that provide formal training in chemical regulations, including details of such acts as the Occupational Health and Safety Act, The Hazardous Substances Act, The Medicines and Related Substances Act, The Foodstuffs, Cosmetics and Disinfectants Act, The Agricultural Products Act, and the Consumer Protection Act.

5.3. **Criteria 3: Communication and dissemination of knowledge and expertise.**

Within the various engagement activities within InnoVenton, different forms of communication approaches are followed, depending on the nature of the engagement. As example, when the need (of the stakeholder) is some form of certificate showing compliance of a product with some specification, the communication can be as simple as the certificate. In cases where actual knowledge and skills needs to be transferred, the process is considerably more complex and usually involves several direct interactions with the stakeholder in face-to-face situations. In general, however, communication and dissemination of knowledge starts at the very first contact with the stakeholder as this first contact is usually critical in determining the success, or otherwise, of the engagement activity. This usually involves developing a detailed understanding of the stakeholder's actual need as in many cases the request for support (e.g. type of test) from the stakeholder may not lead to a satisfactory outcome for the stakeholder. These initial engagement interactions are in most cases used to develop a formal "Scope of Work"[27] in which the need or problem is detailed and the research hypothesis (even in cases where the research may just be testing) is provided (together with standard components that include literature review, work plans, etc). The "Scope of Work" is signed by both parties and is also used by the NMMU's Technology Transfer Office for contractual purposes. During the actual work phase, further communication and dissemination may occur, for example stakeholder representatives may participate in the actual work, either at the stakeholder's premises, or within InnoVenton facilities. This ensures on-going feedback, as well as on-going and direct technology transfer. Upon completion of work, a final report[28] is prepared in which the stated hypothesis is evaluated against the data obtained during the project. This, together with recommendations, is usually provided in a face-to-face meeting with the stakeholder upon which further dissemination and transfer of knowledge and skills may occur – depending upon the agreed-upon actions. As example, in the case of the inulin project, final recommendations are currently being followed up by on-site scale-up and training of personnel – a process that is usually carried out over several sessions, each of which could last several days.
Reflection on engagement activities (both individual activities and holistically as key KPA within the organization) creates the link between knowledge generation, participation and understanding the need for participation, and the impact of the engagement. Within InnoVenton, reflection on engagement activities is carried out at different levels and using different mechanisms. These mechanisms include: (a) Direct reflection with stakeholder/s (e.g. through formal working groups)[29]; (b) Formal measurement and analysis activities[30, 31]; (c) Strategic planning exercises;

[27] Various examples of formal "Scope of Work" documents are available on request.
[28] Various examples of Stakeholder reports are available on request.
[29] The Eskom algae working group involving researchers from Eskom, various universities, and other participating industries is an example.

(d) Formal reports (Advisory Board, Entity, Stakeholder); and (e) Academic discourse[32, 32]. Direct reflection with stakeholders often lead to further action – an example being the investment by Sasol Fuels Research (R3.0 million) in upgrading the NMMU's fuel analysis and testing capability. In this particular case, the need for wider participation (Government and industry) were realised and resulted in a further ~R3 million investment by the DST (through TIA)[33] and the participatory development of a new qualification aimed at addressing a specific skills shortage in South Africa (Diploma in Chemical Process Technology)[34]. Formal measurement activities include the measurement of the economic impact on stakeholder businesses and or job creation/retention and formal benchmarking (carried out by an external company on behalf of the DST). Inputs received from measurement/benchmarking exercises are used to develop InnoVenton strategic plans, which then are used for the development of annual business plans. These plans are formally discussed and approved at Board meetings and performance against these plans is formally measured against a Board-approved scorecard. Academic discourse activities normally refer to the presentation of specific strategies[32, 40] at relevant academic conferences.

5.4. **Criteria 4: The strategic importance of the role performed by the individual/team**.

As stated elsewhere, InnoVenton currently hosts one of two Technology Stations at the NMMU. This Department of Science and Technology initiative aims to create support for SMEs in targeted business sectors and for this purpose they provide funding to (a) improve capacity and facilities within the NMMU, and (b) subsidize development/support costs for SMEs and SMMEs on a sliding scale. The decision of what projects are to be supported, the level of subsidization, and the management of the finances are handled entirely within the institute. This process is formalized through various structures and activities that include the institute's monthly leadership team meetings and quarterly management committee meetings. Brief descriptions of the types of support projects that have been undertaken by InnoVenton during 2011 is given in Annexure 1 and should give a reasonable idea of the strategic importance of these engagement activities.

The analytical and testing services provided to external customers play an important role in the economic activity of these companies as the alternative is either using laboratories in Cape Town or Johannesburg with long turn-over periods on test work, or making substantial investments to acquire their own capabilities (equipment and expertise).

In terms of training, the strongest evidence of the importance of the type of training being done by InnoVenton comes from the on-going request by external and internal demand[35] for such training. Customers for such training include NECSA, Sasol, Karbochem, Lifelab, Adcock Ingram, Engelhard, BASF, Hereaus Chemicals, Willard Batteries, Coega Development Corporation, Department of Water Affairs and Forestry, Bodene, NMMU (Department of Biochemistry and Microbiology), and others.

5.5. **Criteria 5: The extent to which the engagement activities are acknowledged / recognized.**

Recognition for InnoVenton's engagement activities and acknowledgement of its expertise has

[30] The accompanying letter from our 2011 customer survey is shown as Exhibit 6. The responses and analysis thereof is available on request.

[31] Benchmarking report available on request.

[32] "Development of a Professional Science Master's Degree as Technology Transfer Tool and Training for Economic Growth", B Zeelie, 1st All Africa Technology Diffusion Conference, Johannesburg, June 2006; World Petroleum Congress, (December 2011, Doha, Qatar).

[33] ITS records of funding received available on request.

[34] An extract from the competency profile for a chemical process technician/operator is shown in Exhibit 7.

[35] E-mail from Ms Ruby-Ann Levendal to the DVC: R&E regarding sponsorship for specific training – Exhibit 8.

come from a variety of sources over a number of years, including:

1. The awarding of a Technology Station to the Institute;
2. Request to lead one of four major research programs within the Centre of Excellence in Catalysis;
3. Invitations as keynote speaker at academic conferences on topics related to our engagement activities[36];
4. Requests to act as expert analysts for DST projects;
5. Awarding of a SARChI chair in InnoVenton;
6. Awarding of a DST Demonstration Project to InnoVenton;
7. Finalist for NSTF award: Research for Innovation by a team or individual through an organization.
8. Request for international collaboration – Warwick University, University of Mainz.

5.6. **Criteria 6: The integration of engagement into the core academic functions**.

The integration of engagement into teaching and learning as well as research and scholarship will be illustrated on the hand of the development of the master's degree (M Tech) in product and process development. This program was developed specifically to enhance the technical skills levels (in the said field) through collaborative engagement through said program. Typical post-graduate training (at the master's degree level) is essentially aimed at training students in the principles of "academic" (long-term) research. The needs of technical industry is however significantly different and is driven essentially by the demands of the market place and by competitive issues. Also, career enhancement opportunities for persons in the technical environment, especially if such an environment does not provide opportunities for long-term, basic research in a corporate R&D environment, are often limited. For such persons the typical post-graduate master's degree program (leading on to PhD studies) is not attractive and they are left with the option of starting traditional MBA training with the view to switch career paths from technical to managerial. Unfortunately this does not promote and stimulate technology development as the best people are basically forced to leave the technical environment in order to enhance their careers.

In order to address some of the issues mentioned above, the structured master's degree program was introduced as an alternative to the traditional post-graduate, research based qualification, as well as to provide an alternative to the traditional MBA qualification for persons working in the chemical and allied industries sector. The following were specific objectives in the design of the program:

- To create a study opportunity towards a Master's Degree for individuals looking to improve their qualifications in the field of technology (a Technical "MBA");
- To create a mechanism whereby firms that lack their own R&D facilities could have access to:
  - Modern research facilities (Product and process development, accredited analytical facilities, etc).
  - Networks (Providing access to subject specialist knowledge nationally and internationally).
  - Mechanical and Chemical Engineering support.
  - Financial support for qualifying projects and firms.
- To create a mechanism whereby companies that have clearly identified opportunities, but do not have the human resources to carry out development projects, could link the firm's opportunity to student manpower. Many students looking to undertake post-graduate studies would be willing to undertake dedicated industrial projects, particularly if such projects can result in the creation of new business and job opportunities.
- To create a mechanism whereby technology transfer from the program to the industry can occur in a seamless manner that involves the simultaneous transfer of the

[36] Copy of conference website showing keynote speaker names – Exhibit 9.

technology and the trained manpower.
During 2011, 2 students graduated with master's degrees from the said program (one from Epol feeds in KZN and one from Aspen Pharmacare), which brings the total number of individuals trained through this specific intervention to about 20.
Apart from the master's degree discussed above, InnoVenton has also introduced a BSc Hons degree in Formulation Science (to address the lack of specific training in new product development in the RSA) and the Diploma in Chemical Process Technology (training of chemical process operators and technologists). In addition, during 2011, InnoVenton also undertook the development of a competency profile for an analyst in collaboration with its stakeholders in the petrochemical and pharmaceutical industries. This competency profile, together with a proposed program syllabus, has been provided to the Department of Chemistry to allow them to re-curriculate the existing Diploma in Analytical Chemistry into a Diploma in Analytical Science.

5.7. **Criteria 7: In the case of engagement through research and scholarship, the information referred to under Assessment Criteria (Criteria 7), where applicable needs to be provided**.

We will address this criterion on the hand of the "Microalgae to Energy" project. Due to space restrictions, the following brief summary cannot give justice to a project of this nature and scale as it involves several disciplines (agriculture, botany, microbiology, chemistry, physics, mathematics and statistics, chemical and civil engineering, etc.) and role players (NMMU, UCT, CSIR, UNW, Eskom, DST, Anglo American, NetEnergy, Bluecrane Development Agency, and more).

Issues: While most researchers globally agree that microalgae have the potential to significantly contribute to the world's energy demand, no actual commercial example exists despite the massive amount of work already done on microalgae. To identify the critical issues that hinder the exploitation of microalgae as energy source, a literature review and sensitivity analysis was carried out on all the aspects that influence cultivation, harvesting and utilization of the microalgae biomass. This was used to formulate a comprehensive research and development strategy (first proposed to PlantBio – now incorporated into the TIA) and later directly to the DST who approved supporting the project as a demonstration project. The following lists the key issues that form part of the overall program:

1. Increasing the aerial productivity of microalgae cultivation systems;
2. Decreasing the operational costs for microalgae cultivation systems;
3. Decreasing or eliminating the need for nutrient fertilisers which competes directly with food production;
4. Improving the energy balance around microalgae cultivation, harvesting and conversion (amount of energy in versus the amount of energy out);
5. Identifying the critical properties of microalgae that determines its value as energy crop;
6. Developing a viable, low energy route from biomass to energy carrier; and
7. Identifying and exploiting potential synergies between microalgae biomass and fossil fuels.

Hypotheses: The proposed research plan is based upon several research hypotheses, including:

1. Biomass accumulation rates can be significantly enhanced by removing the focus on lipid (hence biodiesel) production;
2. Biomass accumulation rates can be enhanced by increasing the number of cells exposed to light on a given area by means of suitable reactor design and operation;
3. Operational costs during microalgae cultivation can be significantly reduced by removing the need for biomass drying;
4. The need for nutrients can be reduced or eliminated through recovery and recycling of nutrients in a suitable biomass conversion route;
5. Microalgae cultivation can be used to produce clean drinking water from otherwise non-potable water sources, thereby improving the energy balance around microalgae cultivation;

6. Direct biomass liquefaction can provide a viable liquid fuel at substantially positive energy balances;
7. The high carbon to hydrogen ratio in microalgae biomass can synergise the use of coal in several ways, providing a low risk, low cost route to energy whilst significantly improving the environmental impact of coal mining and utilization.

Methodology: The overall project is constructed into several work packages, each of which has several sub-projects and hypotheses. Advanced chemometric techniques are used for the design of experiments and the analyses of data in order to test sub-hypotheses. These designs are made especially complicated due to the fact that most cultivation experiments are a mixture of a designed experiment and an observation experiment (since we do not have day-to-day control over the environmental conditions).

Data collection: All the work contained within the different work packages are managed through InnoVenton's dedicated server to which different researchers across the country has been given access. In this way, different researchers can follow the day-today progress on work of direct interest to them. Raw and analysed data are stored directly onto our server which provides several security features. Actual data collection makes extensive use of sensor equipment for real-time data gathering whilst data analysis utilizes several specialised software packages such as Statistica, Design Expert, and MATLAB.

Reporting and dissemination of results: Reporting of progress and findings is extensive and involves (1) quarterly reports to DST/TIA and (2) bi-monthly to the Eskom algae working group (two different reports for two specific projects). All these reports are standardised and include details of equipment and experimental procedure validation. To date we have filed two patent applications with several more under consideration. Publication of results in the open literature has deliberately been postponed until the establishment of a national steering committee (DST request) for the overall project (the first meeting of said steering committee is scheduled for June 2012).

NMMU alignment: The overall project is fully aligned to the NMMU's vision and mission, particularly in terms of sustainable development (see elsewhere for COP 17 participation) and focus on renewable energy.

6. Contacts

Provide the names and details of internal and external stakeholders/partners that can be contacted.

Internal Contacts:

1. Prof A Leitch (Dean: Faculty of Science; Chairperson: Advisory Board for InnoVenton)
2. Ms J Barnett (Director: Technology Transfer and Support; Member: Advisory Board, InnoVenton)

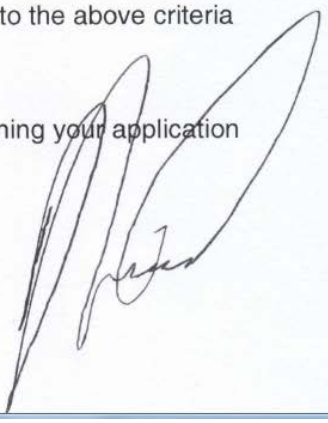
External Contacts:

1. Dr Robin Drennan (Director of Research: Wits University; Member: Advisory Board, InnoVenton)
2. Prof Jack Fletcher (HOD: Department of Chemical Engineering, UCT; Member: Advisory Board, InnoVenton)

7. Attach a Portfolio of evidence and supporting documents linked to the above criteria Attached.

8. Please confirm that all the information provided is correct by signing your application

Name: Ben Zeelie Signature:



Annexure 1: Summary Table of Activities: January – December 2011

KPA: Research and Development			
Stakeholder	**Description of Engagement**	**Number of Activities**	**Benefits**
DST	Demonstration Project: Microalgae to energy	The project comprise the following main foci: 1. Microalgae cultivation 2. Microalgae harvesting 3. Fresh water recovery 4. Direct liquefaction of microalgae biomass 5. Coal fines beneficiation using microalgae biomass Apart from the above, seven student research projects were also supported through this project	1. Establishment of large-scale microalgae cultivation facility for demonstration and research purposes 2. Longer term R&D funding for NMMU 3. Collaborative projects with other stakeholders
Eskom	Development of clean coal technologies	Bi-monthly reporting on progress and bi-annual algae working group meetings with Eskom and other stakeholders	Potential commercial roll-out of in-house developed technology
Eskom	Development of liquid fuels from microalgae	Bi-monthly reporting on progress and bi-annual algae working group meetings with Eskom and other stakeholders	Potential commercial roll-out of in-house developed technology
Anglo American	Carbon dioxide capture and emissions reduction through microalgae technologies	Initial techno-economic evaluation for an independent power station	Potential commercial roll-out of in-house developed technology
Centre of Excellence in Catalysis	Small Volume Chemicals production via micro-structured reactors and small production platforms: Development of policy and measurement tools for service rendering activities within Centre	Five post-graduate student projects supported through activities	Collaboration with nine RSA universities

KPA: Teaching and Learning			
Stakeholder	**Description of Engagement**	**Number of Activities**	**Benefits**
DST	Provision of learnership opportunities for newly graduated students	The following seven students were accommodated: S Mbambi (Ms); S Warren (Ms); V Mamani (Ms); P Mdloldlongi (Ms); V Maqanda (Ms); N Celu (Ms); T Share (Mr)	Allowed students to achieve valuable work experience
NMMU / Industry	Development of the Diploma in Chemical Process Technology	1. Development of competency profile; 2. Development of course syllabus; 3. Development of module contents and outcomes; 4. Form 1 completion for approval by NMMU structures; 5. Submission documents to DoE and SAQA; 6. Presentation of the development and course at the World Petroleum Congress, Doha, Qatar	1. Approval obtained from DoE for the presentation of the only course of its nature in Africa; 2. Long-term agreement between PetroSA and NMMU re provision of scholarships for said program 3. Strengthening of case for Project Mtombo to be housed at Coega.
NMMU / Industry	Development of a competency profile and draft programme: Diploma in Analytical Science	1. Development of competency profile; 2. Development of course syllabus	Carryover of engagement activities to other academic structures within NMMU
Sasol	Formulation Science project: Development of a butemin/rubber composite using recycled tyres	One employee - graduated April 2012	Skills transfer; Improved workforce
Autosafety	Formulation Science project: Development and optimization of a one-pot clear coat formulation	One employee - graduated April 2012	Skills transfer; Improved workforce
Improchem	Formulation Science project: Development of a High Stress Polymer formulation	One employee - graduated April 2012	Skills transfer; Improved workforce
Aspen Pharmacare	Formulation Science project: Optimization of tableting process	One employee - graduated April 2012	Skills transfer; Improved workforce

Aspen Pharmacare	M Tech: Chemistry (Product and Process Development): 1. An evaluation of UPLC technology for the simultaneous analysis of actives in a multi-active drug; 2. A comparison between Fourier Transform Infra-Red (FTIR), Near Infra-Red (NIR), & Raman Spectroscopy (RS) techniques & their application in a pharmaceutical manufacturing analytical laboratory;.	One employee - graduated April 2012; two others in progress	Skills transfer; Improved workforce
Epol Feeds	M Tech: Chemistry (Product and Process Development): Quantitative evaluation of starch determination in feed samples using near infra-red reflectance	One employee - graduated April 2012	Skills transfer; Improved workforce
Eveready Batteries	M Tech: Chemistry (Product and Process Development): Optimization of battery electrolyte formulation	In progress	Skills transfer; Improved workforce

NMMU: Department of Chemistry	MSc/M Tech students registered as Chemistry Department students: 1. T Dokwana (Analysis of complex oils using multi-dimensional gas chromatography; 2. W Koorts (Scoping of a Commercial Micro Reformer for the production of Hydrogen); 3. G Kauffmann (Hydrothermal liquefaction of Scenedesmus in a continuous reactor system); 4. F Akwi (Creation of a clay burner to be used to vaporize an insect repellent containing PMD as an active ingredient.); 5. D Charlie (Hydrothermal co-liquefaction of microalgae biomass and coal.); 6. L Brooks (The synthesis of bromochloromethane using phase transfer catalyst); 7. L Mafu (Beneficiation of glycerol from bio-algae); 8. R Mohammed (Electro catalysis Characterization of fuel cells.); 9. K Mkwentane (The development & optimization of a chemical formulation that facilitates the process of removing synthetic braids from ethnic hair). MSc students in the Department of Biochemistry and Microbiology: 1. D Kimono (Optimization of omega 3 production in a mixed microalgae culture; 2. R van der Walt (Identification of volatile emissions associated with FCM-infested citrus fruit). PhD/D Tech students in the Department of Chemistry: 1. B Mpuhlu (Oxidative dehydrogenation of cyclohexane in micro-structured reactors - Graduated); 2. U Guyo (Synthesis of new plasticizer molecules for sensitive applications); 3. C Barnard (Investigation of the source of foaming in microalgae cultivation systems); 4. S Nongauza (Direct liquefaction of microalgae - effect of co-solvents); 5. L Mcingana (The Catalytic Upgrading, Characterization and Separation of Crude Liquefaction Reactor Oil from Scenedesmus Micro-Alga Species).

KPA: Services and Engagement			
Stakeholder	**Description of Engagement**	**Number of Activities**	**Benefits**
Analytical and Testing			
157 Stakeholders in total, including Industries, NMMU, and CSIR	Analytical and testing support in the following categories: • Water analysis (~24%) • Car parts and plastics (tests for fugitive emissions and substances of concern ~ 28%) • Coolants and complex fluids (6%) • Food analysis (10%) • Raw materials tests (10%) • Effluent and sludge (14%) • Soil (4%) • Clothing and textiles (4%).	The total number of invoices raised on ITS for 2011 was 653 (1652 samples analysed) with a monetary value of ~R1.6 million	1. First contact point for industries into InnoVenton; 2. Expert support provided to support economic activities and market growth
Clean Tech Africa (East London)	1. Development of a small production platform for methylisocyanate production. 2. Evaluation of glyphosate production at CTA's East London facilities	Large multi-year technology station projects	1. Methylisocyanate is a valuable chemical for the synthesis of plant protection chemicals but is highly toxic. The project aims to develop a production device that would eliminate the need for handling and storage of the MIC, thereby eliminating the need for excessive safety measures. 2. CTA owns significant infrastructure at its production facility in East London that is currently not operational. This project has evaluated the potential to produce glyphosate, the world's largest herbicide, in said facilities.

Chicory SA (Alexandria)	Development of a process for the extraction and purification of inulin.	Large multi-year technology station project	Inulin is a valuable dietary supplement and pro-biotic that is imported in significant amounts into SA. The project aims to develop and implement a local technology that would significantly enhance the viability of chicory farming, and that would replace all imported inulin.
Omnia	Purification of process waste water.	Exploratory technology station project	Omnia is one of South Africa's largest fertilizer producers and generates huge volumes of waste waters that are nutrient rich and is problematic to dispose. The project investigated the viability of using microalgae to remove excess nutrients from the waste water to allow disposal into natural water streams.
African Floralush/Illuba	Ongoing support to the preservation of plant material company (NMMU spin-out company)	Ongoing technology station support	The company produces preserved flowers (mainly roses) for the local and export market and requires technical input from time to time.
AAFC (Richards Bay)	Evaluation and development of an electrochemical process for the production of a food antioxidant.	Exploratory technology station project	AAFC is a production company in Richards Bay (KZN) that produces mainly anti-oxidants. The current project aims to assist the said company to adopt NMMU-developed IP and know-how to produce several anti-oxidants by means of electrochemical processes. The project involves collaboration from the Department of Chemistry (Prof E Ferg) and the University of Mainz (Prof H Loewe).
Confidential	Electrochemical corrosion protection	Large multi-year technology station project	The company uses specific metals in its production processes to protect equipment from corrosive environments. These metals are reduced over time and the project aims to use an electrochemical process to sustain the levels of protective metals in the system.

P Clark/Malawi Dept of Agriculture	Development of a combined distillation/chemical reaction process	Multi-year technology station project	The individual has established a rural development program in Malawi in collaboration with the Malawi Dept of Agriculture to grow and harvest Eucalyptus citriodora. The leaves of the plant is harvest and the oil extracted by steam distillation. The oil is then send to the UK for chemical processing. The project aims to combine the chemical processing step with the distillation step so as to allow both steps to be carried out on site in Malawi. Part of the project is carried out by Walter Bohringer at UCT.
Themba Fireside	Evaluation of coal combustion catalyst	Theoretical evaluation of catalyst system	Themba Fireside produce and markets a coal combustion aid and has been requested by international customers to provide them with the theoretical explanation of their system. The project involved developing the chemical explanation (reactions and stoichiometric calculations) to provide to such customers.
Joseph Kgamphu Mashigoane	Evaluation of DDAC production in South Africa	Technology Station project	The project aims to evaluate production of DDAC in the RSA using raw materials available at Sasol. The project involves route selection, testing (lab-scale), scale up (kilo lab) and technology transfer.

Portfolio of (selected) evidence

Exhibit 1: Copy of funding approval for Microalgae to Energy project

technology innovation
A G E N C Y

Head Office: Unit 5 & 16 • Enterprise Building • 6 Mark Shuttleworth Street • The Innovation Hub • Brummeria • 0087
Regional Offices: Gauteng • KwaZulu Natal • Western Cape • Eastern Cape • **Website:** www.tia.org.za

Jacqueline Barnett
NMMU Summerstrand Campus (North), Gardham Ave
Summerstrand, Port Elizabeth,
6001

09 January 2011

Dear Jacqueline

RE: REQUEST FOR FUNDING – MICROALGAE BIOMASS TO BIO-FUELS PROJECT

The Executive Committee of the Technology Innovation Agency ("TIA") has approved your application for funding to the maximum of R4, 665,320. 00 subject to the following:

- The project must be carried out within the University and not at the company (Zalgen Pty). No costs related to management of the company being established are to be funded at this stage.
- The costs related to commercialization and salaries must be reviewed to ensure that they are tied in with the achievement of milestones.

Yours sincerely

Olympus Manthata
General Manager: Expert Services - TIA Central Office

Exhibit 2: Mr Lububalo Mafu of InnoVenton explaining InnoVenton's microalgae-freshwater-energy-grow your own garden concept to the Honorable Minister Naledi Pandor and Mr Somila Xosa of DST at the COP-17 conference (Durban December 2011).

Exhibit 3: Copy of first page of Project initiation form: Jet fuel distillation

Confidential

Exhibit 4: NMMU internal advert for InnoVenton Short Course

Dear Colleagues and Students

"The possibilities of spreadsheets are generally underestimated. By employing the data analysis functions, you can increase your understanding of your data and subsequently improve decision-making."

The 4 day short course entitled "**Data Analysis with Excel for Analysts, Scientists and Engineers**" will be presented by InnoVenton, Nelson Mandela Metropolitan University, Port Elizabeth from Monday 10 to Thursday 13 October 2011.

Who should attend?

- Persons who want to improve their data manipulation with Excel
- Persons involved with the analysis and summarizing of data
- Researchers in all disciplines where data generation, analysis and interpretation are essential
- Individuals who want to improve their skills and marketability

Course objectives

After completion of the course the student will be able to obtain, interpret and apply:

- Descriptive statistics
- Inferential statistics: confidence intervals, t-tests and ANOVA
- Bivariate regression models
- Multivariate regression models
- Mixture designs
- Two level factorial designs
- Central composite designs

with the aid of the spreadsheet program Excel

Structure

- The course emphasis is on the interpretation of statistical results rather than on the calculation thereof
- Each participant will be assigned to a computer and will analyze real and relevant data sets under the guidance of the lecturer
- The spreadsheet programme Excel will be used (please note that the student needs to have a working knowledge of Excel)
- The students are evaluated by completing a test on the work covered

The course information, general short course information and an application form are hereby included.

Exhibit 5: Good Research Practice Course Schedule

InnoVenton

Nelson Mandela Metropolitan University
for tomorrow

NMMU Institute for Chemical Technology and Downstream Chemicals Technology Station

GOOD RESEARCH PRACTICE - 2012 LECTURE SERIES

	Lecture Title	Lecturer	Date	Time	Venue
1	Introduction to Research	Prof Ben Zeelie	Friday 16 March	09:00 – 11:00	A101C
2	The Scientific Method (1)	Mr Coos Bosma	Friday 23 March	09:00 – 11:00	A204A
3	The Scientific Method (2)	Mr Coos Bosma	Tuesday 27 March	09:00 – 11:00	A204A
4	Research Communication - General writing	Prof Ben Zeelie	Tuesday 17 April	09:00 – 11:00	A101C
5	Research Communication - Research Proposal	Dr Gary Dugmore	Monday 28 May	09:00 – 11:00	AW
6	Research Communication - Reading	Dr Gary Dugmore	Wednesday 30 May	14:00 – 16:00	AW
7	Research Communication – Lab Notebook	Dr Gary Dugmore	Thursday 31 May	09:00 – 11:00	AW
8	Research Communication – Oral Presentations	Prof Ben Zeelie	Tuesday 5 June	09:00 – 11:00	A101C
9	Experimental Systems Validation	Gary Dugmore	Thursday 7 June	09:00 – 11:00	A101C
10	Analytical Instrumentation Validation	Ms Cecilia Saunders	Friday 15 June	09:00 – 11:00	AW
11	Analytical Method Validation	Mr Coos Bosma	Monday 18 June	09:00 – 11:00	A204A
12	Experimental Design	Mr Coos Bosma	Wednesday 20 June	09:00 – 11:00	A204A
13	Data Analysis	Mr Coos Bosma	Friday 22 June	09:00 – 11:00	A204A
14	Thesis Writing - Introduction/Literature Review	Prof Ben Zeelie	Tuesday 24 July	09:00 – 11:00	A101C
15	Thesis writing – Experimental Details	Prof Ben Zeelie	Thursday 26 July	09:00 – 11:00	A101C
16	Thesis writing – Results and Discussion	Prof Ben Zeelie	Tuesday 31 July	09:00 – 11:00	A101C
17	Writing a Publication	Prof Andrew Leitch	Wednesday 1 August	09:00 – 11:00	AW

- **AW: Adriaan Wiechers Library (A201), North Campus**
- **A101C: Prof Zeelie's office, North Campus**
- **A204A: Mr Coos Bosma's office, North Campus**
- **Students, you will find all course material on the N – Notebook drive in folder "1. GRP Research Help Centre"**
- **Enquiries: Margriet Bosma, telephone 041 504 3613 / 3281, margriet.bosma@nmmu.ac.za**

Exhibit 6: Customer survey letter – 2011

Dear Customer,

Would you please complete the following survey in order to help us fulfill the requirements of ISO 17025 and SANAS for 2011? In doing so, you will enable us to provide an improved service to you.

We value your opinion and we would therefore appreciate it if you would honestly answer the questions below.

Kind Regards

Dr Melissa Gouws (Quality coordinator) and Mrs Cecilia Saunders (Technical/Quality Manager)

General information

Company name: ……
Is your company rated as a SM(M)E* (Small, Medium (and Micro) Enterprises)? Yes: ……. No: …….

How long have you made use of the service of InnoVenton Analytical? ……. years /……. months

How frequent do you make use of the service of InnoVenton Analytical? …… per year / …….. per month

SM(M)E* (Small, Medium (and Micro) Enterprises

* SARS has several descriptions for small businesses; there are several definitions utilised for different purposes:

- For Amnesty purposes, a small business is any business with a turnover of up to R10m;
- For Income Tax purposes (Section 12E), a Small Business Corporation (SBC) is defined as a business having a turnover of less than R14m, over and above other qualifying criteria;
- For Capital Gains Tax, a Small and Medium Enterprise (SME) is described as a business having total net assets of under R5m.

The Department of Trade and Industry (DTI) classifies SMEs in the following way:

- Small establishments 20 – 49 employees,
- Medium-sized establishments 50 – 199 employees.

Exhibit 7: Extract from Chemical process technician/operator competency profile

Competency Model Overview

The following diagram illustrates the draft competency model for a Process Technician/Operator as a layered pyramid with seven main competency fields.

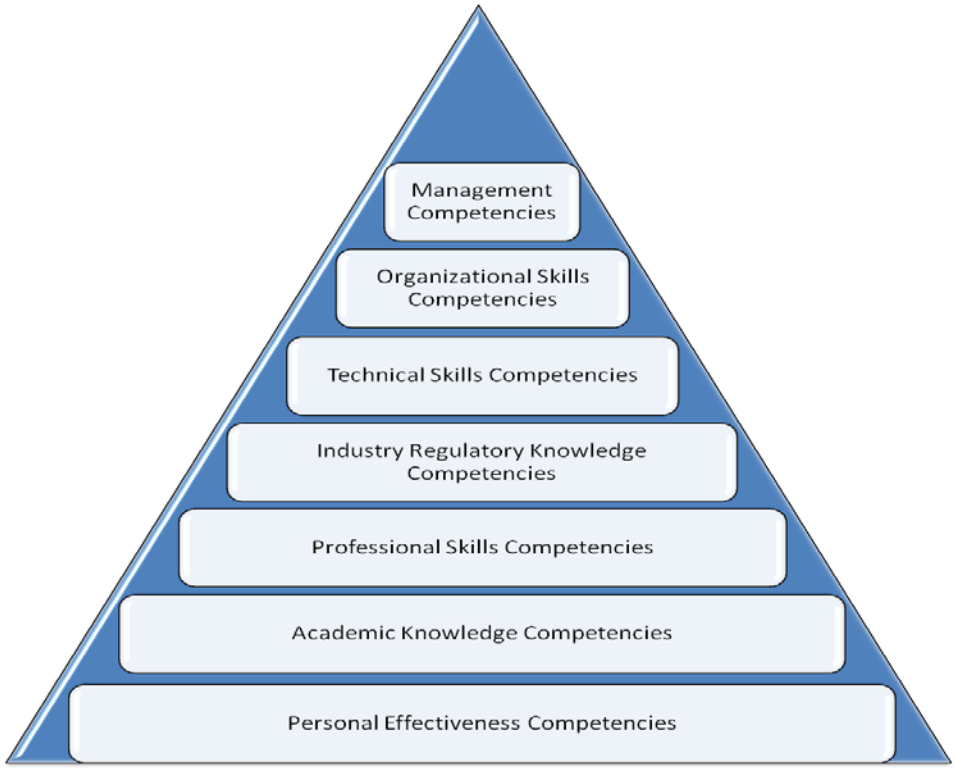


Exhibit 8: Internal NMMU request for InnoVenton training

From: Levendal, Ruby-Ann (Mrs) (Summerstrand Campus South)
To: Mayekiso, Thoko (Prof) (Summerstrand Campus South)
Sent: Fri Aug 06 12:30:21 2010
Subject: FW: Proposed presentation: Short course "Applied Biostatistics with Excel"

Hello Thoko, I spoke to you on Wednesday about this course. The discounted cost is R1 500 per person. Below is the communication from Innoventon.

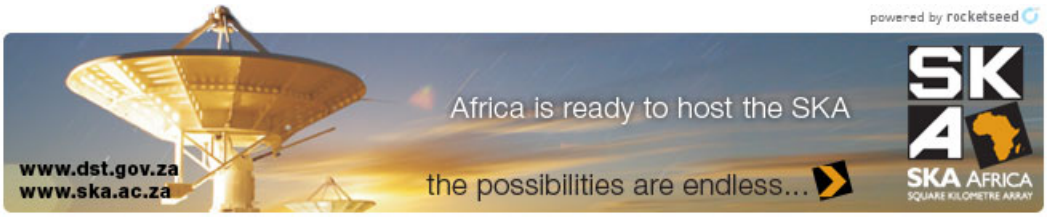
As indicated to you, I attended the course for chemical analysts and engineers, and found it very insightful and helpful. I had indicated that our research group would like to attend the Applied Biostats course being presented, but do not have sufficient funding for all of us to go (12 in total).

Stats courses are not part of the M&D research programmes across all faculties. Perhaps it can become part of a standard capacity building programme for all M & D students? There is even a module on experimental design (which I attended), in which the presenter mentioned examples of PG students coming to him after having conducted 1-2 years experimentation, when he could have assisted them in designing their experiment to get the most information by conducted the minimum amount of experiments. This would have other implications on optimizing resource utilization.

Regards
Ruby-Ann Levendal
Director Transformation (Monitoring and Evaluation)

Exhibit 9: Conference website showing invited speaker names

Exhibit 10: E-mail request for project analysis – DST



Dear Ben

This doc is confidential - please treat as such.

I have my on views on this but let me hear yours.

Regards

Somila Xosa
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Fax: +27 (0) 86 681 0221
Mob: + 27 (0) 82 944 0004
Email: somila.xosa@dst.gov.za