

Available Openings in 2012

Manufacturing and Operational Excellence

Post-docs, Doctoral and Masters Students

In the research field of Manufacturing and Operational Excellence, the following projects are available / expected to be available and are ready to sign on new postgraduate students and post-docs immediately, for program commencement in beginning 2012. Some of the projects can accept international applicants.

Laser-machining of Titanium alloys / biotribology of orthopaedic implants

This project investigates the machinability of Titanium alloy surfaces with lasers, for the purpose of reducing the wear of orthopaedic implants in-situ. The tasks to be carried out includes surface machining using lasers, the design and construction of an orthopaedic test stand for accelerated lifetime tests, and process modelling.

Research to be carried out includes

- analytical / numerical modelling of the heat transfer, laser machining and biotribological processes,
- experimental investigation of the heat transfer, laser machining and biotribological processes, and
- the integration of the uncovered knowledge into a new implant design.

Accepting applications for: **MSc and PhD students and Post-docs**

Water Quality Monitoring:

It is the objective of this project to develop a mobile diagnostic tool to investigate concentration levels of chemical trace elements as indicators of biological activity in-situ and real-time. Water samples commonly are taken, to measure the local concentration of constituents (i) NH₄, PO₄, NO₂, SiO₄ as indicators of possible biological activity, and (ii) urea as confirmation of biological activity. An on-site analysis of the samples often times is hindered or rendered impossible for a variety of reasons which predominantly are introduced by the modus operandi of the spectral analyser. The circuit of spectral analysers consists of a lamp which emits light in a broadband spectrum. This spectrum is then sent through the sample and the transmitted light is received by a detector which is placed on the other side (relative to the light-emitting lamp) of the sample holder. The performance of this analysis apparatus is impeded by two aspects, (i) the overall design not being rugged enough for mobile applications, and (ii) the lamp operation of the analyser.

Accepting applications for: **MSc and PhD students and Post-docs**

Laser micro-welding

Micro-welding suffers from post-welding sub-micron positioning inaccuracies; it is suspected that solidification dynamics in the melt pool distort the alignment of two objects relative to each other. This project analyses the achievable positioning accuracy experimentally and analytically.

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Research to be carried out includes

- analytical / numerical modelling of the heat transfer, laser melt pool and solidification dynamics, and
- experimental investigation of the heat transfer, laser machining and achievable accuracy and repeatability of the welding process

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Laser-welding of Magnesium

Light-weight design and construction is receiving considerable attention in the transport industries as a means to reduce fuel consumption and ultimately reduce the emission of CO₂. A material which draws increasing attention for designing and constructing vehicles is magnesium with a lower density (1.7 g/cm³) than Aluminium (2.7 g/cm³). Due to its volatile behaviour at high temperatures, thermal processing of magnesium is a technological challenge from the perspectives of process maintenance and control, safety, process stability and repeatability. Process stability is greatly affected by a plasma plume which is generated in the path of the incident laser beam, thereby attenuating the incident energy on the target surface. It is the goal of this project to carry out a baseline study of laser welding of Magnesium. The study will include an investigation of the energy transfer from the laser beam to the magnesium target material. An experimental and theoretical understanding of the energy transfer will focus on spectroscopic measurements of the plasma plume temperature. It is a further goal of this project to establish and validate a mathematical model of the energy transfer. Further studies will investigate the aerodynamic and gas dynamic effects in the plasma plume, to assess and calculate the plasma absorption coefficient.

Accepting applications for: **MSc and PhD students**

Operational Excellence in Health Care Service Delivery

This project will investigate the systemic impediments to optimization of public health care service delivery at two public hospitals in the Western Cape. The nature of the venues makes it possible to carry out a rare brownfield / greenfield comparison. The catchment area of the brownfield hospital, located in the "Cape Flats" in Metro Cape Town, comprises approximately one million people. The hospital is intended to act as a hub which overseas several spokes through different Community Health Centres. The greenfield hospital is built in the vicinity of the brownfield hospital; both hospitals are foreseen to operate side-by-side.

This project will generate and disseminate new knowledge in the field of health care service delivery in the public health care sector. This is an area of almost chronic underperformance in South Africa and a source of dissatisfaction of the majority of the population. It is not uncommon for patients to arrive at public hospitals early morning, only to be told to go home and come back the next day after waiting for an entire day, without being seen by a physician. Preliminary research results in the public health care sector in the Western Cape have identified a number of root causes for poor health care service delivery and a wealth of locally available expertise and knowledge which can be harvested and shared. Effective and efficient health care service delivery to the communities in the hospital's catchment area is hindered severely by the absence of a cohesive structure, exchange of communications and lessons learned, means of visualizing problems and attempted solutions, and agreed metrics to describe the problems and their magnitude.

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Applications, visualization tools and metrics have been tried and tested in the UK, USA, Australia and other locations. The common denominators of the identified references are

- the adaptation of lessons learned in the same service sector in other locations, to the authors' local needs,
- the need for a collective stakeholder buy-in to transform a high-risk / low reliability hospital into a low -risk / high reliability service provider,
- the mission-critical training of employees regarding the purpose of the organization and the processes which support this purpose, and
- the need to shift the traditional departmental perspective of how a patient is handed over between medical department “silos” (vertical perspective) to a patient-centred view of the patient's flow through the hospital (horizontal perspective).

The research questions for this project are stated as follows:

What resources, protocols, processes and infrastructures must be implemented between the hub and the spokes to facilitate sustainable service delivery and operations between hub and spokes and between spokes?

What benefits can be gained from a coordinated approach based on existing engineering / business perspective principles and knowledge?

How can the lessons learned and best practices of local communities be identified, utilized by and communicated between all parties?

Accepting applications for: **MSc and PhD students and Post-docs**

NGOs as a Complex Systems

Globally operating NGOs are interested in assessing the performance and effectiveness of their service delivery. This proposed project treats an existing international NGO project as a complex system; it then identifies and analyses delivery against defined metrics, and includes process modelling.

Accepting applications for: **PhD students and Post-docs**

Machine Design for Seasonal Equipment Manufacturer

This project investigates the hurdles and limitations to competitiveness, identifies technical and operational fields of performance improvements, and develops innovative technical and operational improvements to domestic manufacture of farming equipment in South Africa. These fields include, but are not limited to, spray painting, belt drives for fertilizer feed, in-the-field metrology, and operational improvements through employee further qualifications.

This project addresses shortcomings of current farming equipment design and manufacturing. Manufacturing strategies as they are employed today are not globally competitive and as a result, market shares of South African manufactured machinery have been lost. In order to regain such market shares, innovative products satisfying market needs with increased operating ranges and effective delivery and harvesting mechanisms are required so that manufactured products are competitive on the world market.

This project identifies a number of farming machinery which need to be redesigned and upgraded to satisfy market demands. Such a redesign requires (i) an innovative approach to extend machine capabilities such as operating range of machinery, handling of different fertilizer types, and usage of several front-end tools by one set of farming equipment, and (ii) an integrative mindset between all departments in the factory, from order-taking to machinery delivery.

The objective of this project therefore is to design and build innovative farming equipment. In order to improve the competitiveness of products made in South Africa, it is necessary to comprehensively improve the functionality of the manufactured machinery, reduce an identified bottleneck in the current production setup, and to create an inclusive work culture of improving responsiveness to a customer with highly seasonal demands.

Research therefore focuses on machine design, drive systems, complex systems design, and operational excellence, pooling locally available knowledge to create a sustainable manufacturing environment, and to graduate MSc and PhD engineers trained in complex systems design. These MSc and PhD graduates have the potential to form a nucleus of professional engineers capable of making manufacturing operations environmentally compliant. Further, post-docs are offered a hands-on opportunity to practice and polish their expertise in complex systems design on an industrial project. It is hoped that the post-docs will consider an academic career in engineering design which traditionally is a discipline which is very difficult to fill. This project therefore has a clear capacity building intention.

Accepting applications for: **MSc and PhD students and Post-docs**

If you are interested in either of these opportunities, please feel free to contact Associate Prof. F.-J. Kahlen at

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