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ENGINEERING
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M&M Post-Graduate Topics

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forward together
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Contents

Prof Anton Basson
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- **Research Field**
  Research field: Industry 4.0, cyber-physical systems, digital twins, and the integration of humans with digital environments
- **General Description of Research Field**
  CYBER-PHYSICAL SYSTEMS, DIGITAL TWINS, HOLONIC SYSTEMS The fourth industrial revolution, or Industry 4.0, is the current trend of automation and data exchange in manufacturing technologies and many other domains. The Industry 4.0 vision relies on technologies such as cyber-physical systems (CPSs), the Internet of Things (IoT) and cloud computing services. Our research focusses on the development of reality-reflecting architectures for CPSs – incorporating Digital Twins (DTs) – using principles of Holonic Systems. We consider the multi-domain implementation of four levels of CPSs: (1) Smart Connection Level: e.g. ingestion of physical system IoT data from sensor networks. (2) Data-to-Information Conversion Level: data processing from raw data to useful information. (3) Cyber Level: twin models (or Digital Twin) to simulate and analyse real-world systems. (4) Services Level: software services and Digital Twins to support decision making, e.g. monitoring, anomaly detection, data analytics for prediction, and visualization through augmented reality HUMAN-SYSTEM INTEGRATION (HSI) AND HUMAN CYBER-PHYSICAL SYSTEMS Industry 4.0 research has paid notable attention to automation systems, but South African enterprises will continue to rely heavily on people. We research the integration of humans into/with CPSs, both as task executors and decision makers, within Industry 4.0 environments. We aim to retain people's exceptional capabilities and overcome their limitations using digital technologies, for example by adapting control architectures and using enabling technology (e.g. collaborative robots, pose sensing, and virtual and augmented reality). CURRENT AND RECENT APPLICATION AREAS BMW: DTs of each vehicle built, supporting machine learning, cloudification, and the circular economy. Mediclinic: HSI in an emergency centre and DTs to improve patients' clinical pathways. Hortgro: DTs to manage a fruit treatment facility's information related to physical infrastructure and processes. Complex facilities: DTs to monitor/manage complex operations in, e.g., a university campus and a smart village. Mines: DTs and HSI to support integrated and worker-centric mining environments for improved safety, productivity and efficiency.

  Prof Basson and Dr Kruger co-supervise students in this research area. More information can be found at https://www.sun.ac.za/mad.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
HUMAN-SYSTEM INTEGRATION (HSI) AND HUMAN CYBER-PHYSICAL SYSTEMS South African (and worldwide) enterprises will continue to rely heavily on people in the midst of Industry 4.0. Our research integrates humans into/with cyber-physical systems (CPSs), both as task executors and decision makers. We aim to retain people's exceptional capabilities and overcome their limitations using digital technologies. Our research employs enabling technologies such as collaborative robots, pose sensing, and virtual and augmented reality. Our current industry partners include: Mediclinic and Western Cape Dept of Health, Mandela Mining Precinct, Hortgro (agricultural producers' organisation), Mintek Prof Basson and Dr Kruger co-supervise students in this research area. The Mechatronics, Automation and Design Research Group's website is at https://www.sun.ac.za/mad. Our research group of 15 students provides a supporting and stimulating environment. All students work with real-world applications. **Requirements:** We welcome students from any engineering background with a strong affinity for developing software for real-world applications.		✓	✓	✓
CYBER-PHYSICAL SYSTEMS, DIGITAL TWINS, HOLONIC SYSTEMS The fourth industrial revolution, or Industry 4.0, is the current trend of automation and data exchange in manufacturing technologies and many other domains. Our research relates to cyber-physical systems (CPSs), the use of the Internet of Things (IoT) and cloud computing services. Our research focusses on the development of Digital Twins (DTs), which are reality-reflecting architectures for CPSs updated in real time. The DTs are used for decision support and analysis. We develop software using the principles of Holonic Systems, Service Orientated Architectures (SOAs) and Microservices. Our DTs apply artificial intelligence (AI) including machine learning (ML) and expert systems. They are used for predictive maintenance, makings sense of Big Data, improving data integrity, circular economy decisions. Our current industry partners include: BMW, Gibela/Prasa, Mediclinic, Rand Water, PV systems supplier Prof Basson and Dr Kruger co-supervise students in this research area. The Mechatronics, Automation and Design Research Group's website is at https://www.sun.ac.za/mad. Our research group of 15 students provides a supporting and stimulating environment. All students work with real-world applications. **Requirements:** We welcome students from any engineering background with a strong affinity for developing software for real-world applications.		✓	✓	✓

Prof Deborah Blaine

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- **Research Field**
  Materials Engineering
- **General Description of Research Field**
  The majority of my research focuses on the link between manufacturing and processing procedures and the final properties of materials, working with the properties of materials to design functional materials that are fit for purpose. I particularly focus on powder metallurgy which includes a wide range of manufacturing processes, including additive manufacturing.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Sinter-based processing of metal powders Through on-going collaboration with Fraunhofer Institute in Germany (various branches), we continue to explore novel ways of manufacturing different materials by using metal powders. Once the powders have been formed into the required shape, they need to be sintered - sintering is the process whereby the individual metal powder particles bond together to form a network of solid metal by solid state diffusion at high temperatures. If you are interested in manufacturing processes and innovative ways of using them to create new and interesting materials and products, there are a range of different powder metal processes that can be explored. We would be writing research proposals to apply for funding so if you are interested in a research career, this would be a valuable opportunity to develop your grant writing skills. **Requirements:** BEng		✓		

Prof Corne Coetzee

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- **Research Field**
  Two fields of research are available: (1) Granular material modelling with applications in the mining and agricultural sectors, (2) Agricultural engineering focussing on packaging.
- **General Description of Research Field**
  (1) Granular material modelling: The Discrete Element Method (DEM) is a numerical method used to model granular materials and industrial processes. Mining applications include the calibration of material properties as well as the modelling of typical mining processes and bulk material handling such as the flow of ore on conveyor belts, transfer chutes and hoppers. The aim of such a study would be to optimise the process in terms of mass flow rates while limiting wear and spillage. Agricultural applications include the modelling of post-harvest handling to predict damage and bruising of fruit and vegetable as well as soil-tool interaction with the aim of improving implements such as ploughs and discs. Students with a mining bursary are welcome to propose a related topic which is of interest to them and the bursary provider and extend their stay in Stellenbosch rather than working in Middelburg or Secunda:-). This research is done in collaboration with researchers from Australia, the Netherlands and Germany, with opportunities for the student to visit one or more of our collaborators.

  (2) Agricultural engineering: Packaging (plastic bags, carton boxes, etc.) is used to protect fruit and vegetables during handling and transportation. However, the fruit need to be kept cooled while mechanical damage should be minimised. Boxes that are structurally strong will prevent any mechanical damage to the produce but might prevent proper cooling of the fruit and might be too expensive. On the other hand, a box which will allow the fruit to cool properly might be less expensive, but not able to prevent mechanical damage to the produce. The optimum design should be found which is inexpensive, provides sufficient structural protection and allow for proper cooling of the produce. Tools such as the Finite Element Method (FEM) and Computation Fluid Dynamics (CFD) are used and combined with experimental techniques. This research is done in close collaboration with various departments from Agricultural Sciences at Stellenbosch University.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Further development and application of the Material Point Method (MPM) The Finite Element Method (FEM) is a numerical method often used for structural analysis. FEM uses a mesh (elements and nodes) to discretise the material, and as the material deforms, so does the mesh. When the deformation becomes too large, and (some of) the elements too distorted, the whole approach collapses - the mathematics no longer applies, and a solution can not be obtained. To overcome this problem, special techniques such as re-meshing is required. Hower, for a 3D domain, this is not a trivial task. An alternative approach is to make use of a so-called "meshless" method. There are a number of meshless methods available, but we have focussed on the Material Point Method (MPM) over the last 20 years. MPM is a meshless finite element method capable of modelling very large deformation and is often used to model and analyse bulk (granular) material flow and soil mechanics. Although it has been shown that MPM can accurately model a large number of applications, it is still continuously being developed and improved. The aim of this project is to continue the development of MPM and to model unique applications, specifically in bulk solid handling and/or soil mechanics (geotechnical engineering). Interested students are encouraged to propose their own specific topic or application of interest. This topic requires an interest in solid mechanics, numerical modelling, FEM, and C++ programming, and is ideal for students in mechanical engineering and in civil engineering (geotechnical). For more details on MPM: https://en.wikipedia.org/wiki/Material_point_method Interestingly, MPM is also used by Walt Disney to model physics (such as snow) accurately in animation movies such as Frozen: https://www.disneyanimation.com/technology/matterhorn/ **Requirements:** Background in Finite Element Modelling is essential.		✓	✓	✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
The modelling of bulk granular materials using the Discrete Element Method (DEM) A granular material is defined as a collection of individual or discrete particles. The particles make contact with one another, resulting in the dissipation of energy, mainly through the action of friction. Examples of granular materials include sand, soil, mined ore, grains such as wheat and corn, powders, etc. These materials are abundant in nature, and also found in the mining, agricultural, food, and pharmaceutical industries where the term "bulk solid" is often used to describe the material. Equipment and machinery are used to handle, transport, convey, store, and process the materials. Examples include silos, hoppers, bins, conveyors, trucks, excavators, mixers, crushers, mills, ploughs, planters and seeders, harvesters, etc. The Discrete Element Method (DEM) is a software tool often used in modelling and analysing the behaviour of granular materials. DEM is also used as a design tool, to analyse the flow of the granular material and how it interacts with the equipment, in order to design better equipment, or to optimise it for a specific application and material. However, for the DEM model to be accurate, the user needs to specify the material properties as input parameters. The material properties are not readily available, and a process called "DEM calibration" should be followed for each material sample. We have been working on DEM calibration for the last 15 to 20 years and have successfully developed equipment and techniques for the calibration of non-cohesive materials. The aim of this project is to better understand the behaviour of cohesive (wet) materials, and to further develop a calibration process for these materials. This should then be validated using laboratory experiments. The project will include experimental work using our unique large scale conveyor test facility, shear testers, a newly developed centrifuge tester, etc. This project is ideal for a student interested in mining activities and/or agricultural engineering, laboratory test work, and numerical modelling. Commercial DEM software is used, and there is no need for programming. The balance between experimental (practical) work and numerical modelling can be adjusted to best suit the student's interests. Also, the applications investigated can be either aligned with the mining or the agricultural sector, depending on the student's interests. Students can also propose their own topic, as long as it includes a granular material of some sorts. For more information on our research group: https://blogs.sun.ac.za/gmrg/ **Requirements:** None		✓	✓	✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Analysing and improving the cooling inside a freight container South Africa's Citrus exports reached record-breaking numbers in 2020, shipping 146 million cartons, making it the second-largest citrus exporter in the world. An effective and efficient transport and distribution system is thus of utmost importance to utilise this fresh produce. Citrus fruits are mostly transported in freight (shipping) containers that have built-in cooling units; these types of containers are referred to as reefer containers (RC). Recently, the regulations and compliance rules regarding fresh produce exports have become much more stringent than in the past. These regulations are applicable to transport where temperatures are to be kept below 2°C. The RC's role is to maintain a safe temperature inside the container, which preserve fruit quality through the reduction of respiration rates. In the case of some niche markets, the container is also used to apply in-transit cooling to eradicate insect larvae, which may be seen as a pest by the importing market. These pests can cause containers to be rejected, leading to substantial financial losses and lost potential in food production. Optimisation of refrigerated container usage and cooling is thus a priority to the South African citrus industry, which would allow for more controlled cooling processes during shipping. The aim of this project is to analyse the cooling inside a loaded container, using experimental measurements and Computational Fluid Dynamics (CFD). Where possible, new aids and changes to the container should be proposed to achieve optimal and uniform cooling rates. This will not only preserve more of the produce, but also reduce the RC's energy consumption. This project is ideal for a student interested in agricultural engineering, experimental measurements (heat transfer and flow), and CFD modelling. This is not the first project on this topic undertaken by us, but is the continuation of a Master study, which will provide a very good background and starting point to the project proposed here. The project will be run in close collaboration with the Faculty of Agri Sciences (Stellenbosch, horticultural sciences). A student bursary for a Master and/or PhD student(s) is available from 2023 onwards. **Requirements:** Students would be required to follow the CFD postgraduate course if not already followed as an undergraduate course at Stellenbosch.		✓	✓	✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Improving the structural integrity of cartons used for the export of citrus Agriculture plays a significant role in the global economy with an average contribution of 4% to the GDP across the globe and even reaching contributions up to 25% to the GDP in developing countries (World Bank, 2022). In South Africa it was reported that agriculture contributed R 127 960 million (2.8%) to the national GDP (Statistics SA, 2021; Trading Economics, 2021). De Lange et al. (2015) investigated the impact of food waste on the GDP of South Africa for the year 2013. Their investigation showed that food waste was equal to 2.2% of the national GDP. This is a significant loss and shows that management and reduction of food waste can produce a positive growth in the agriculture sector of South Africa. Oelofse et al. (2021) determined that three main areas of manageable food waste occur. These areas include post-harvesting and storage, processing and manufacturing and distribution. These three areas contribute approximately 74% of food waste produced. The focus of this research project is on the structural integrity of corrugated paperboard cartons (boxes) and stacked pallet stability in the South African citrus industry. Industry experiences box failure which results in damage to the produce and ultimately a loss in food production and income. The existing box designs should be investigated and analysed in terms of box failure and pallet stability. When a box fails, the whole stacked pallet can become unstable and this results in more box failures and even a complete collapse. It is also experienced that stacked pallets become unstable during transportation due to the dynamic load conditions. This study should analyse the existing problems using laboratory and field experiments, and propose and analyse possible solutions. The department has a large testing facility where a complete stacked pallet can be laterally accelerated and the stability and loads acting on the boxes measured. Various other facilities such as box compression testing are also available, and this is a continuation of previous projects. The majority of the work would be experimental and hands-on, however, there is also the opportunity for numerical analysis using the Finite Element Method and/or the Discrete Element Method. This project is ideal for a student interested in agricultural engineering and experimental testing and measurement. **Requirements:** A knowledge of the Finite Element Method (FEM) is advantageous, but not a prerequisite.		✓	✓	✓

Mrs Liora Ginsberg

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- **Research Field**
  Biomedical engineering - Microcirculation flow pattern in the lymph
- **General Description of Research Field**
  The lymphatic system is an important biological system, with main functions of immunity and transportation of excess fluid from amongst the capillaries in the loose connective tissue into the vascular system. Much research has been conducted on the flow patterns of the circulatory system, into which the lymphatic system flows, however little has been attempted on the lymphatic system.

  Parametric studies and numerical modelling of the micro-circulation of specific regions of the lymphatic system need to be conducted. The project takes place in the context on on-going final year projects and a PhD study.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Studies of lymph micro-circulation Study of the micro flow of the lymph in the lymphatic network. Use of CFD to model the micro flow movement of the lymph within a lymphatic segment / duct. **Requirements:** CFD		✓		
Comfort bed for premature babies Background: Kangaroo mother care is a method of care of premature infants. The method involves infants being carried, usually by the mother, with skin-to-skin contact. There is evidence that this method of care greatly helps in the development of the baby. The baby will be able to get warmth from the mother, feel her heart beat and breathing, hear her voice and of course cuddle on her body. However, this is not always possible immediately after birth. The mother may still be in recovery or she may be undergoing surgery. Problem: For premature babies born in rural hospitals, that need not go to a secondary or tertiary hospital, a comfort bed is needed that best approximate the experience the baby would have had with the mother. Additionally, the comfort bed should monitor the motion of the baby so that a warning can be given should the baby's condition deteriorate. **Requirements:** Design	✓			✓

Prof Jacomine Grobler
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- **Research Field**
  Algorithm development, optimisation and data science
- **General Description of Research Field**
  Optimisation algorithm development, data science, and machine learning applications for improved decision support.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Identification of tuberculosis in children through an analysis of x-ray images The clinical signs of tuberculosis in children differ from the clinical signs of tuberculosis in adults. A significant amount of research has been done in the identification of tuberculosis, but there is an opportunity for novel research in the detection of tuberculosis in children from x-ray images. A detailed literature review will need to be conducted to identify best practices in tuberculosis identification and image processing techniques already used in this context. Domain experts will also be consulted to obtain a better understanding of the indicators of tuberculosis in children. A dataset consisting of x-ray images will be obtained from Tygerberg Hospital. This dataset will be cleaned and analysed and used to train and test various image processing algorithms with the aim of identifying tuberculosis in the x-ray images. Finally, the results will be validated by domain experts. Other information: Thesis/dissertation to be co-supervised by Prof Pierre Goussard from Paediatrics and Child Health Possible funding available to cover tuition fees. **Requirements:** Previous background in data science and image processing Strong programming skills OR the willingness to develop these skills and background		✓	✓	✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Data analytics approach to predicting mortality in a neonatal intensive care unit There are various factors affecting the risk of mortality of neonates in a neonatal intensive care unit (NICU). The aim of this project is to investigate the use of data analytics for predicting this risk. A dataset with various features associated with risk factors is currently being collected at the Tygerberg Hospital NICU. The successful candidate for this topic will need to conduct an extensive literature review of the use of data analytics in the NICU environment. A rigorous process will then need to be undertaken to understand the dataset characteristics. The use of various predictive analytics algorithms such as neural networks and support vector machines, will then need to be investigated. Finally, the results will be validated by domain experts. Other information: Thesis/dissertation to be co-supervised by Prof Lizelle van Wyk from Paediatrics and Child Health Possible funding available to cover tuition fees. **Requirements:** Previous background in data science and image processing Strong programming skills OR the willingness to develop these skills and background		✓	✓	✓

Prof Jaap Hoffmann

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- **Research Field**
  Solar thermal energy
- **General Description of Research Field**
  Solar thermal energy is a source of clean energy for electricity generation, process heat and thermal comfort that is unfortunately only available while the sun is shining. Thermal energy storage in rock beds using air as heat transfer fluid provides a low cost solution to store energy harvested during the day for night-time use. The large size of rock bed thermal energy storage, and irregular nature of crushed rock particles means that much of previous research done on prismatic beds of spherical particles is inadequate to describe pressure drop and heat transfer through packed beds. Hydrogen fuel cells and electric vehicles are the most promising substitutes for petrol and diesel driven vehicles in a post fossil fuel work. Hydrogen vehicles offer ranges and refueling times like those achieved by internal combustion engines. Hydrogen is a form of chemical energy that can be stored indefinitely. On the downside, hydrogen infrastructure is lagging that of electricity distribution. Overall, the outlook for hydrogen as a replacement for petrol and diesel in the transport sector is positive provided that it can be produced competitively. The copper-chlorine cycle as the most promising of all the thermochemical cycles for hydrogen production. In this cycle, water (steam) first reacts with CuCl2 to form HCl, and the HCl is then split into H2 and CuCl in an electrolyzer. Splitting HCl requires only about a third of the electricity input of that of splitting H2O. To facilitate the chemical reactions and recycle chemicals, the cycle requires several heat inputs at different temperatures. Some reactions are exothermic, and the heat released can be internally recycled to reduce the overall heat requirement of the cycle.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Solar hydrogen generation using the Cu-Cl cycle The Cu-Cl cycle was developed and demonstrated by Ontario Tech in Canada. This cycle requires a heat source (about 530 °C) and electricity. Both requirements can be met by a molten salt concentrated solar power (CSP) plant. The challenge is to find a suitable configuration of CSP plant to serve both high and low (100 °C) temperature heat exchangers - molten salts typically solidifies at about 250 °C. The student must develop, validate, and integrate working models of a CSP plant and the Cu-Cl cycle. The models (s) should be able to predict the shut-down procedure required when the CSP plant is running low on (stored) thermal energy. Several of these plants might be situated around South Africa where there are sufficient solar and (fresh) water resources to run the plant, and the necessary infrastructure to transport the product to a point of export/end use. Site selection forms part of the project, as well as the economic feasibility of the project. The student will spend 3 - 6 months at Ontario Tech. **Requirements:** Solar Thermal Energy Systems 814 A strong background in thermofluids will be advantageous.			✓	✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Green hydrogen via CSP pathways Evaluate the technology pathway(s) required, the current and future levelized cost of green hydrogen, and South Africa's potential for producing green hydrogen via the Cu-Cl cycle **Requirements:** Solar Thermal Energy Systems 814		✓		✓
Solar still with a submerged absorber Interfacial evaporation in a solar still make effective use of the available sunlight as the bulk water remains cold, whilst evaporation happens only at the top of a membrane. The membrane wicks water to its upper surface. When using concentrated sunlight, the evaporation rate can exceed the transport rate of water through the membrane, leading tot dry-out. When this happens, evaporation stops. A submerged absorber can take advantage of a high surface temperature, whilst providing free access of water to the surface. The challenge is to develop a submerged membrane that mimics interfacial evaporation without any liquid flow restriction. **Requirements:** A solid background in undergraduate thermofluids subjects is required.	✓			
Turbulence modelling in porous media Flow through porous media is tortuous, and the presence of the solid matric causes additional turbulence production that is not present in flow through open channels. This turbulence helps to redistribute heat and momentum in a porous media. There are a few models in the literature to capture the extra turbulence production in the k-epsilon framework, but none (or few) for the k-omega turbulence models. Develop and validate (through the use of appropriate source terms) a model that can predict the extra turbulence dispersion in packed beds. Closure might be achieved on RANS, LES or DNS level. This project is expected to be mathematically intensive. **Requirements:** Numerical Fluid Dynamics 414/814 or equivalent		✓	✓	
Optimization of a packed bed thermal energy facility. Maximize bed utilization and minimize pumping cost for several discrete and continues design variables, such as number and size of inlets and outlets, bed length, bed height, particle size, etc. Since the flow is expected to be fully three dimensional, validated CFD model(s) of the bed (flow through porous media) is required. Existing models can be used/refined. The time scales for heat transfer and fluid flow is substantially different - the student must investigate ways to accommodate both in the same model, while keeping the simulation time down to levels that lend themselves to formal mathematical optimization. **Requirements:** Numerical Fluid Dynamics 414/814 or equivalent Advanced Design 814 or equivalent qualification in optimization A solid foundation in fluid dynamics and heat transfer will be advantageous		✓	✓	

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Climate control in a greenhouse using solar thermal energy For optimal crop growth, greenhouse temperatures and humidity must be kept within narrow bands. Harvested solar energy collected during the day can be released to raise night-time temperatures. The student should develop a thermal energy storage facility capable of preventing cold damage to crops, and evaluate its economic feasibility. **Requirements:** A working knowledge of CFD is recommended.	✓			

Mr Shival Indermun

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- **Research Field**
  Robotics and Biomedical Engineering
- **General Description of Research Field**
  My research focuses on the advancement of autonomous robotic visual navigation within hospital environments, with a primary objective of supporting healthcare professionals and enhancing patient care. The central theme of my work is the integration of diverse data sources to enable precise robotic perception and navigation in highly dynamic settings. By leveraging concepts from computer vision, SLAM (Simultaneous Localization and Mapping), data association, and semantic data extraction. Additionally, I am engaged in biomedical engineering research, specifically collaborating with orthopaedic surgeons to optimize surgical planning. This involves utilizing software such as 3Dslicer to segment crucial areas from patient CT or MRI scans, followed by 3D printing to create accurate anatomical models. The ultimate aim of this interdisciplinary research effort is to provide surgeons with valuable tools for pre-operative planning and potentially offer haptic feedback through these 3D models.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Optimizing sterilization techniques and parameters for ensuring structural integrity of 3D-printed patient-specific PLA orthopaedic models The utilization of 3D-printed patient-specific orthopaedic models for medical purposes requires rigorous sterilization procedures to be used as a reference during procedures. This research aims to address the challenge of sterilizing PLA-based 3D-printed models without causing deformation or melting. Dr Rudolph Venter, currently runs the AOTC 3D printing lab, where he segments and 3D prints patient cases for operational rehearsals. See current link - http://www.sunorthopaedics.com/3d-printing-lab.html The research is aimed at identifying the optimal sterilization approach and process conditions (post). The research aims to provide healthcare professionals with safe and sterilized 3D-printed models for preoperative planning, medical education, and research, expanding the applications of 3D printing in the medical field. **Requirements:** Given the interdisciplinary topic, students may be be required to work with the AOTC Lab in Tygerberg Hospital. Knowledge of FDM 3D printing is advantageous, but not a prerequisite.		✓		

Dr Marisa Klopper
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- **Research Field**
  Tuberculosis
- **General Description of Research Field**
  My studies involve epidemiology of drug-resistant tuberculosis, as well as diagnostic tools, molecular drug-resistance mechanisms and M. tuberculosis physiology. Culturing of mycobacteria is central to these studies.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
1. Declumping system for bacterial cultures Bacteria often form biofilms, or, as we call it in mycobacterial research, clumps*, which means that the bacteria stick to each other by producing extracellular glue consisting of sugars, proteins and fatty acids. This makes it difficult to conduct work where precise enumeration of the bacteria is necessary, for example infection studies, where we need to know how many bacteria we introduce into the culture, per mammalian cell (a.k.a. multiplicity of infection, or MOI). Clumps also make it difficult to quantify how much of a compound is metabolized or produced per bacterial cell, from one strain to a next. The current practice to get rid of clumps, is to either sonicate the bacterial culture (not very effective), or to go through a series of steps where the culture is forced through progressively smaller apertures. Typically, this entails "syringing" up and down several times, using different sized needles, followed by forced filtration or gravitational straining. This is more effective than sonication, but is very time-consuming and has a risk of needle-stick injury or other accidents such as spills. It also tends to result in large losses of bacterial matter. The aim of the project is to develop a safe, effective (i.t.o. processing time and of achieving single cells) way of declumping bacterial culture with minimal losses. Different approaches may be investigated, such as combining techniques, using different types and sizes of apertures/-pores, incorporating closed systems, automation, etc. *Technically, a biofilm adheres to a surface. In mycobacterial cultures, we see bunches of cells floating in the media as well. **Requirements:** Creative thinking.		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
2. Lossless optical density measurement of bacterial cultures Optical density (OD) measurements are typically used in bacterial culturing to monitor growth over time. However, it usually entails removing 1 ml of culture for every measurement. The volume is added to a non-sterile cuvette (high quality clear plastic) and placed in a spectrophotometer. Because the cuvette is typically not sterile, this volume cannot be replaced into the culture. Culturing is usually done in either 5ml (for starter cultures) or 20ml volumes, and the growth rate depends on the volume of culture, to some extent. Thus, every time an aliquot is removed to measure OD, the dynamics of growth may change. Further, there is a small risk of introducing contamination each time the culture flask is opened. The aim of the project is to devise a different way of measuring OD, to reduce risk of contamination, and to obviate the need for removing volumes of culture. **Requirements:** Basic knowledge of optics; creative thinking.		✓		

Prof Ryno Laubscher
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- **Research Field**
  Thermal-fluid dynamics
- **General Description of Research Field**
  Fundamental and applied research in combustion systems, heat exchangers and power cycles. Additionally my research focusses on the development of novel AI-based partial differential equation solvers for thermal-fluid problems.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Design of a sCO2 centrifugal compressor using mean line analysis and CFD Using 1D mean line analysis and CFD the objective of this project is to complete a preliminary design and validation study of centrifugal compressors for a sCO2 Brayton cycle. As an additional outcome the student should generate compressor maps for the design compressors which would be in future fed into cycle level models. **Requirements:** BEng Mechanical		✓		
Thermofluid network modelling of a sCO2 Brayton cycle shaft layout The aim of this project is to create a code for 1D mean line analysis, utilizing the thermofluid network modeling approach. The code will be used to design comprehensive system models for sCO2 compressors and turbines in a 50 MWe sCO2 Brayton cycle. By employing the simulation code and designing turbomachines, the student will explore different off-design scenarios, including turbine-compressor compatibility and the impact of inventory control on machine performance. **Requirements:** BEng Mechanical		✓		
A finite volume procedure for human cardiovascular system modelling In this project a 1D FVM network code will be developed by the student, which is capable of simulating blood flow through the systemic and pulmonary networks of the human cardiovascular system. The code should include the ability to simulate the fluid structure interaction between the arterial and venous walls and the blood flow. The newly developed 1D code will be validated using simplified artery/vein CFD models. **Requirements:** BEng Mechanical		✓		

Prof Craig McGregor

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- **Research Field**
  Solar thermal energy, green hydrogen
- **General Description of Research Field**
  Solar thermal Energy and Green Hydrogen research, focusing on:

  * techno-economic analysis * systems engineering and optimization * heliostat design and mechatronics * thermofluid design of solar receivers and thermal energy storage systems * industrial application of solar thermal heat * power cycle design for CSP and high temperature heat pumps

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Design and thermodynamic modelling of a compound piston steam expander for concentrating solar thermal applications. For several years, the Solar Thermal Energy Research Group has developed steam piston expansion (steam engine) technology optimized for application in concentrating solar power (CSP). This research culminated in 2022 when a previous student converted a Detroit diesel engine to run on compressed air and steam. This research topic expands this research by considering the application of compound (multi-stage) steam engines. Steam piston expanders offer advantages over steam turbines at smaller scales where turbines are costly, whilst compound engines offer higher cycle efficiencies than a single expansion cycle. The project has two primary focus areas: the Rankine cycle thermodynamic modeling and the mechanical design of a commercial-scale compound steam engine. The Rankine cycle thermodynamic model will enable the assessment of the system's performance across diverse conditions, ensuring optimal energy extraction from concentrated solar sources. The program's second facet delves into the mechanical realm, where the compound steam engine's crucial components are designed to enhance energy conversion efficiency and overall operational robustness. Practical application: The project offers a unique chance to develop energy modeling and design skills in a project that combines mechanical engineering with sustainable energy technology. **Requirements:** thermodynamics		✓	✓	

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Modelling of the world's primary energy system to assess the role of green hydrogen This project offers an unparalleled opportunity to explore and dissect the intricate dynamics of global energy transformation, focusing on the prospect of a "hydrogen economy". As green hydrogen gains prominence as a potential energy carrier, this study delves into its viability for transporting renewable energy from resource-rich areas to energy-deficient regions. However, a compelling counterargument supports the supremacy of high-voltage direct current (HVDC) transmission due to its minimal energy losses. This study aims to illuminate the best path forward through analysis, technological assessment, and economic modelling. Undertaking this study, you will construct a panoramic view of the world's primary energy system. By developing a comprehensive energy production and consumption model using PyPSA (Python for Power System Analysis), you will gain a profound understanding of the interplay between renewable resources, energy generation, and consumption across the globe. This model will serve as the foundation for a rigorous technical and economic evaluation of two contrasting paradigms for energy transport: green hydrogen and HVDC transmission. Practical application: the study develops expertise in energy modelling, analysis, and economic evaluation, highly relevant to industries driving the renewable energy revolution; your findings could shape the energy policies of South Africa, influencing the transition to cleaner, more efficient energy systems. **Requirements:** Python programming skills a preference.		✓	✓	
Optimising Concentrating Solar Power Plant Siting in Southern Africa for Enhanced Industrial Integration. Sited in high-solar-resource regions of the Northern Cape, the current Concentrating Solar Power (CSP) plants in South Africa have faced challenges due to their geographical isolation. This study addresses this dilemma by exploring the feasibility of strategically locating CSP plants closer to major industrial hubs whilst balancing solar resource potential to optimise the siting of CSP plants in Southern Africa. The primary focus is maximising the integration with major industrial centres to facilitate improved maintenance accessibility, streamlined supply chains, and enhanced collaboration with expert resources by investigating the trade-offs between lower solar resource locations and proximity to industrial hubs. By considering factors such as energy output, transportation costs, and operational efficiency, the study will analyse the impact of CSP plant siting on maintenance services, spare and replacement parts availability, and access to international expertise, aiming for reduced downtime and increased cost-effectiveness. Practical application: Acquire insights highly relevant to energy companies, industries, and policymakers aiming to streamline energy logistics and contribute to solving a pressing challenge in the renewable energy sector, optimising CSP plant siting to align energy generation with industrial demands.		✓	✓	

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Requirements: none				
Fuel-fired augmentation of CSP plants in South Africa as back-up for poor solar days Given our excellent solar resources in South Africa, concentrating solar power (CSP) offers an excellent opportunity to address our current electricity supply constraints whilst establishing a significant manufacturing industry in the country. Because a CSP plant includes a significant amount of thermal energy storage it can dispatch power throughout the night. Even in the desert locations such as the Karoo of the Northern Cape where CSP plants are located, there are periods of overcast or cloudy weather that would interrupt generation. A CSP plant that includes a fuel-fired system that would be able to continue generating electricity during periods of low solar resource, making CSP a firm and dependable power source. This project will study the technical and economic aspects of such a fuel-fired augmentation of CSP. The project should consider biomass and fossil fuel sources and investigate the best power cycle configuration (direct integration through the addition of a fuel-fired boiler, or an integrated solar combined cycle mode obtained by adding an open cycle gas turbine to the existing steam Rankine cycle of the CSP plant). **Requirements:** thermodynamics	✓	✓		

Prof Josua Meyer
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- **Research Field**
  Heat transfer
- **General Description of Research Field**
  Heat transfer conveys energy from a high temperature to a lower temperature. The mechanisms of heat transfer are defined as conduction, radiation and convective. In convective heat transfer the heat transfer might be external forced convection, internal forced convection, or natural convection. Heat transfer has many applications and happens everywhere.

  The human body is constantly generating and/or rejecting heat by metabolic processes and exchanged with the environment and among internal organs by conduction, convection, evaporation, and radiation. Heat transfer is also one of the most important factors to consider when designing household appliances such as a heating and air-conditioning system, refrigerator, freezer, water heater, personal computer, mobile phone, TV, etc.

  Heat transfer also occurs in many other applications such as in car radiators, solar collectors, orbiting satellites, etc. However, one of the most important applications is in the generation of electricity which can happen in fossil fuel power plants, nuclear power plants or concentrating solar plants. The heat transfer during the generation of electricity happens in heat exchangers which normally has at least one passage through which a fluid flows. The passage geometry can be as simple such as a circular tube or it can have a very complex geometry with fins that not only enhances the heat transfer but induces flow rotation which reduces the size of the heat exchanger.

  For all these configurations empirical correlations are required for design and analyses purposes that can be used to estimate heat transfer rates. To develop thousands of empirical equations are not desirable as we first need to have a better understanding of the fundamentals and flow phenomena. Furthermore, different flow regimes (laminar, transitional or turbulent) normally each require its own empirical equations. Thus, to be able to understand complex heat transfer flow phenomena in complex geometries we must first understand what happens in simple geometries, such as in circular tubes.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Developing flow in smooth circular horizontal tubes with a uniform wall temperature; forced and mixed convection. Relevant to concentrated solar power (CSP) generation and heat transfer in blood vessels through human organs. A lot of work has been conducted in the field of heat transfer in circular tubes. Most of this work was limited to forced convection flow through horizontal tubes, and with fully developed flow. Thus implying that the flow was both hydrodynamically and thermally fully developed. However, forced convection occurs very rarely in practical applications. It only occurs for heat transfer in small tube diameters, low heat fluxes and for flow in zero gravity conditions. Therefore, if the heat transfer condition does not satisfy forced convection conditions the heat transfer phenomena would definitely and most probably result in mixed convection. However, no work has been done for mixed convection with a uniform wall temperature during developing conditions. The purpose of this study would therefore be to numerically investigate and compare with CFD in a circular tube developing flow for forced and mixed convection with a uniform wall temperature. **Requirements:** CFD		✓	✓	✓
Local and average heat transfer coefficients for developing single-phase laminar flow in horizontal circular tubes with a constant heat flux boundary condition. Wide range of Prandtl numbers. Relevance: concentrated solar power (CSP) generation and heat transfer in blood vessels through human organs. Correlations to calculate the local and average heat transfer coefficients for single-phase laminar flow in horizontal circular tubes with a constant heat flux are usually restricted to fully developed flow, high Prandtl numbers or constant fluid properties. Recently work has been conducted with water (see URL: 10.1016/j.ijheatmasstransfer.2017.10.070). The purpose of this study is to conduct a similar study, however, using CFD, and as working fluids air and glycol. The reason for air and glycol is that its Prandtl numbers are about an order of magnitude lower and higher than that of water. The equations that were developed in the previous study for water can therefore not be used for a wide range of Prandtl number applications. **Requirements:** CFD		✓	✓	✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Local and average heat transfer coefficients for developing single-phase laminar gas and glycol flow in horizontal circular tubes with a uniform temperature boundary condition. Relevant to concentrated solar power (CSP) generation and heat transfer in blood vessels through human organs. Correlations to calculate the local and average heat transfer coefficients for single-phase laminar flow in horizontal circular tubes with a uniform heat flux are usually restricted to fully developed flow, high Prandtl numbers or constant fluid properties. Recently work has been conducted with water (see URL: 10.1016/j.ijheatmasstransfer.2017.10.070). The purpose of this study is to conduct a similar study, however, using CFD, with air and glycol as working fluid. The reason for air and glycol is that its Prandtl numbers are about an order of magnitude lower and higher than that of water. The equations that were developed in the previous study for water can therefore not be used for a wide range of Prandtl number applications and were also developed for a constant heat flux boundary condition – not a uniform wall temperature. In this study a uniform heat flux needs to be used. **Requirements:** CFD		✓	✓	✓
Local and average heat transfer coefficients for developing single-phase laminar gas and glycol flow in horizontal circular tubes with a uniform heat flux boundary condition. Relevant to concentrated solar power (CSP) generation and heat transfer in blood vessels through human organs. Correlations to calculate the local and average heat transfer coefficients for single-phase laminar flow in horizontal circular tubes with a constant heat flux are usually restricted to fully developed flow, high Prandtl numbers or constant fluid properties. Recently work has been conducted with water (see URL: 10.1016/j.ijheatmasstransfer.2017.10.070). The purpose of this study is to conduct a similar study, however, using CFD, with and air and glycol as working fluid. The reason for air and glycol is that its Prandtl numbers are about an order of magnitude lower and higher than that of water. The equations that were developed in the previous study for water can therefore not be used for a wide range of Prandtl number applications and were also developed for a constant heat flux boundary condition – not a uniform wall temperature. In this study a uniform heat flux needs to be used. **Requirements:** CFD		✓	✓	✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Effect of surface roughness on internal laminar flow The effect of surface roughness on laminar, internal forced convection flows is often neglected. Experimental work indicated that surface roughness may augment heat transfer and influence the onset of transition. However, creating and measuring surface roughness inside small bore tubes is experimentally challenging. An alternative is to explore this phenomenon numerically. It is expected that the student study the effect of surface roughness on laminar flows numerically, and compare the results with experimental work by Prof. Josua Meyer and his group at the University of Pretoria. Results should be presented over a wide range of laminar flows; a typical Nusselt number vs Reynolds number plot for different surface roughnesses is required, similar to the Moody Chart but limited to the laminar regime. Sound skills in Heat Transfer and Fluid Mechanics is required, and students should benefit from taking these modules as part of their coursework. Prof Jaap Hoffmann will co-supervise the project. Prof Josua Meyer is currently with Stellenbosch University. **Requirements:** Numerical Fluid Dynamics, Advanced Heat Transfer, Advanced Fluid Mechanics		✓		

Mr Brian Moloi
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- **Research Field**
  Robotics and Power Engineering
- **General Description of Research Field**
  Crawlers and drones employed in boiler inspections today are incapable of navigating the complicated environment of the heating surface (economizer, reheater, and superheater). The snake robot inspired by adult snake can navigate complex situations and can be utilized for inspection purposes. The goal of this project is to build a snake robot capable of navigating cluttered/complex environments for inspection, search, and rescue missions.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Direction control of snake robot in cluttered environment The goal of this project is to develop a control law for a snake robot to follow an arbitrary path in cluttered/complex environments. **Requirements:** Interest in nonlinear control of mechanical systems.		✓		
Design a snake robot for cluttered environment The goal of this project is to build a snake robot capable of navigating cluttered/complex environments for inspection, search, and rescue missions. **Requirements:** Interest in nonlinear control of mechanical systems.		✓		
Automated system for boiler maintenance The goal of this project is to develop a system that will collect data on the boiler's condition and use that data to determine where the next inspection should occur. Coupled with the snake robot, the system will select the areas for the snake robot to investigate, analyze the findings, and then deliver the output to the User for approval. **Requirements:** knowledge in Material science and strength of material		✓		
Localization for boiler inspection snake robot The snake robot designed for boiler inspection will need to inspect predetermined places for material condition assessments. The snake robot localization solution is critical for ensuring that the inspection instrument takes measurements in the correct spot. This will be utilized subsequently to map the boiler state for analysis. **Requirements:** Interest in developing new sensor technology for future robotics.		✓		

Dr Melody Neaves
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- **Research Field**
  Materials Engineering
- **General Description of Research Field**
  Materials Engineering looks at material characterisation of new or rare materials using novel experimental techniques (such as small sample testing, or optical strain measurement techniques). It also involves the study of additively manufacturing alloys with the main focus being on Ti6Al4V and nickel superalloys produced through laser powder bed fusion processes. I also follow the chain of processing for materials including heat treatments, printing process parameter selection, powder characterisation methods. Power station piping research looks at studying damage of ex-service steel piping material subjected to creep at high temperatures and pressures.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Evaluating Digital Image Correlation Speckle Pattern Quality using Artificial Finite Element Based Displacement Fields This research project focuses on investigating the quality of a Digital Image Correlation (DIC) speckle pattern and developing a software tool that impose an artificial finite element (FE) based displacement field on an existing speckle pattern. Supervised by Dr. Melody Neaves and Prof. Gerhard Venter, the project aims to provide a ground truth displacement and/or strain field against which the DIC obtained results can be compared. This ground truth will be in the form of a FE based displacement field imposed on an existing speckle pattern. The comparison between the DIC results and the FE based ground truth can be used to compare the accuracy of different DIC software implementations, to evaluate the quality of a particular speckle pattern for a given DIC implementation and to compare different metrics used to evaluate the quality of a speckle pattern. The project involves software development in Python and physical experiments using DIC equipment in a laboratory environment. Digital Image Correlation (DIC) is an optical method used in structural mechanics to obtain accurate 2D and 3D measurements based on image changes. A crucial aspect of successful DIC application is the use of high-quality speckle patterns on the structure being analyzed. The quality of the speckle pattern directly impacts the accuracy of DIC results. Having a ground truth displacement field against which the DIC results can be compared is critical in evaluating the quality of a speckle pattern. In the completion of this project, the student will become familiar with the manipulation of digital images, DIC itself and the metrics used to evaluate the quality of a DIC speckle pattern. The student will develop a software tool to impose a finite element based displacement field on a speckle pattern and to compare the DIC produced results against the finite element based results. It is anticipated that a statistical analysis of the errors would be performed. **Requirements:** This project will require a significant component of software development in the Python programming language.		✓		✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Process Parameter Optimisation of Nickel Superalloys Produced via Laser Powder Bed Fusion The Materials Engineering Research Group (MATENG - https://www0.sun.ac.za/mateng/) is involved in the laser powder bed fusion (LPBF) of nickel-based superalloys for aerospace applications. This form of additive manufacturing (AM) involves the laser fusing of powder particles spread across a substrate in the pattern of a sliced segment of a full design. The process is repeated until the final part is printed. This process depends to a great extent on the LPBF machine parameters (such as laser power, scanning speed, hatch spacing, scanning strategy, etc.). Incorrect election of parameters results in high levels of porosity and cracking or distortion which would not be acceptable for flaw-sensitive aerospace applications. See this article for example literature on this topic: https://www.mdpi.com/1996- 944/15/16/5777/pdf. Furthermore, nickel-based superalloys are very expensive which necessitates the use of (for example) small-specimen testing methods combined with design-of-experiment software, such as Design Expert. This project will investigate the influence of various machine parameters as well as post-process heat treatments on the microstructure, porosity and mechanical properties of a LPBF-produced nickel-based superalloy. Small sample testing methods should be used as far as possible. **Requirements:** Candidate should have a strong interest in materials science and experimental work. Candidate should be comfortable with being organised and methodological.		✓		

Dr Brendon Nickerson
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- **Research Field**
  Vibration, modal analysis, data analytics, inverse problems
- **General Description of Research Field**
  The SA Agulhas II is a polar supply and research vessel, which has been scientifically instrumented for full-scale engineering measurements. Included in these measurements are propulsion shaft torque (strain) and vibration. For this ship, we are particularly interested in the propeller loading for the purposes of condition monitoring and operational insight.

  Ideally, the loads on the propeller blades would be determined through direct measurements made on the blades. However, direct measurements are not always feasible due to the risk of sensor damage and the difficulty of installation. The torque and thrust loads experienced by the propulsion shaft are therefore used to estimate the propeller loading through an inverse problem.

  There exists potential for the further development and implementation of inverse models for the estimation of propeller loads. This includes, but is not limited to: 1. Further increases in efficiency of various models 2. Further development/refinement of models 3. Integration of models into operational decision making on board vessels

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Development of inverse models for the estimation of propeller loads Topic includes further research and development into existing inverse models for the estimation of propeller loads. This will be supported through full-scale measurements on board the SA Agulhas II. Historical data is available, with the potential for further data capture during upcoming voyages. **Requirements:** Students should have a general interest in conducting engineering measurements, working with large datasets, and numerical modelling. Background in vibration theory is beneficial for the understanding of existing inverse models.		✓		

Dr Michael Owen

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- **Research Field**
  Heat transfer, thermodynamics, fluid mechanics
- **General Description of Research Field**
  Overall my research aims to contribute to sustainable production, use and manipulation of thermal energy. I make use of a combination of experimental, numerical (typically by means of CFD) and analytical methods to investigate thermodynamic cycles, thermal energy systems and components at a number of levels including high level feasibility analysis, system testing and analysis and component-level testing and simulation. There is a strong focus on industrial heat exchangers and cooling towers in particular (dry, wet and hybrid), as these systems directly affect thermal power plant efficiency (fossil-fuelled, nuclear and renewable) and have a direct influence on the energy/water nexus.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Uniformity index as a universal air-cooled condenser fan performance metric Mechanical draft direct dry cooling systems (typically referred to as air-cooled condensers or ACCs) are widely employed in thermal power plants where they offer considerable water savings relative to evaporative cooling towers. ACCs employ an array of axial flow fans whose operation is sensitive to distorted inflow conditions caused by ambient wind. CFD simulations are frequently used to interrogate wind effects on ACC fans but their accuracy is often questioned due to limitations in the implicit fan models. A recent CFD study identified a strong correlation between the uniformity of the flow at the fan inlet and the fan volumetric performance and dynamic blade loading (as expected), both important fan performance metrics. The form of this correlation has subsequently been verified through inspection of on-site measurements taken at an operating ACC fan. This study will attempt to enhance our understanding and better quantify the relationship between fan inlet flow uniformity (quantified by means of a uniformity index) and the two fan performance metrics of interest using laboratory scale experiments. A secondary objective is to interrogate whether the prediction of uniformity index in CFD is sensitive to the type of fan model used. With the combination of this information we hope to determine if CFD based ACC wind effect analysis can be uncoupled from the fan model such that accurate and reliable results can be generated at reduced computational cost. **Requirements:** Experience with CFD and experimental work is recommended.		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Reduced-order modelling of air-cooled condenser performance under windy conditions Air-cooled condensers (ACCs) are a direct dry cooling technology that significantly reduces the water footprint of thermal power generation. These systems are widely used in concentrating solar power (CSP) plants since these plants are typically built in arid regions with high solar resource but limited water availability. The performance of the condenser direclty impacts the thermal efficiency of the power plant (by influencing the turbine back pressure) and is thus a critical (but often overlooked) component in the power cycle. The majority of ACCs are mechanical draft systems where air flow is driven by large axial fans. As an alternative, natural draft systems use bouyancy as the motive force and thus eliminate the need for fans (thus offering benefits in terms of net power output). There is currently only one natural draft ACC at a CSP in the world (Khi Solar 1, Upington South Africa), and the relative performance and costs (compared to mechanical draft systems) are not well understood. Ultimately, our aim is to conduct a direct comparison of mechanical and natural draft ACCs for application in CSP based on life-cycle cost. This comparison requires an understanding of how these two systems would perform over a typical meteorological year in a representative location (taking into account ambient conditions including temperture and wind). In this project, we will develop a reduced order model of the performance of a mechanical draft ACC (using CFD simulations to generate training data) as a function of both ambient temperature and wind. This model will be applied in the overarching comparitive study mentioned previously. **Requirements:** The project requires the student to have completed, or to do, a CFD module (or have relevant experience with CFD). ANSYS FLUENT is the preferred software.		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Axial fan operation in hybrid cooling towers Mechanical draft hybrid cooling towers combine wet (evaporative) and dry cooling to provide compact and effective industrial cooling solutions in demanding operating environments. A typical hybrid cooling tower is an induced draft system with an axial flow fan drawing air through a counterflow wet cooling section and a cross-flow air-cooled heat exchanger (located between the wet cooling section and the fan). Louvers are used to control the air flow through the air-cooled heat exchanger to (a) assist with plume abatement (by reducing the relative humidity of the exhaust air), and (b) reduce water consumption by providing some dry cooling capacity. Because of this variable air flow nature, the operating conditions experienced by the fans are complex (multiple duty points, non-uniform inlet velocity profiles) and the fans are exposed to non-ideal operating conditions, notably in terms of dynamic blade loading and associated vibrations and fan component fatigue. This project involves the numerical simulation of a hybrid cooling tower using computational fluid dynamics. The objective of the work is to quantify the nature of the operating conditions experienced by the axial flow fan for different cooling tower operation modes. The project will be co-supervised by Dr Jacques Muiyser (Howden Netherlands). **Requirements:** The project requires the student to have completed, or to do, a CFD module (or have relevant experience with CFD). ANSYS FLUENT is the preferred software.		✓		
Thermal comfort in South African subsidy housing The South African government has a subsidy housing programme (formerly known as the "RDP" programme) which provides housing to low-income families. The programme is driven by the quantity of houses delivered, rather than on delivering quality buildings. A key aspect of building quality is thermal comfort and buildings that are thermally uncomfortable will fall short of providing the quality-of-life improvements intended with the subsidy housing programme. Surveys of subsidy housing occupants have revealed that people experience the buildings as uncomfortable, and previous simulation work has provided preliminary quantification of the extent of the thermal discomfort. In this project our aim is to extend the work that has already been done to (a) properly and rigorously quantify the thermal comfort in a typical subsidy home, (b) identify possible low-cost improvements and quantify their impact (including cost-benefit characteristics) and (c) provide detailed guidelines regarding improved subsidy house construction specifications. The scope of the work can be adjusted to accomodate both a Research MEng thesis (preferred) or Structured MEng project. **Requirements:** N/A	✓	✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Solar-aided power generation in the South African context: "greening" our coal South Africa's energy supply is highly dependent on its fleet of coal-fired power plants, with over eighty percent of electricity demand being met with this fossil-fuel energy source. Considering that we will remain dependant on our coal power plants for several decades, the question arises as to how we can reduce the environmental footprint of our coal power or leverage the infrastructure at our coal stations to bring renewable energy online quickly and at lower cost? Solar-aided power generation (SAPG) is a hybridized approach in which solar thermal energy is incorporated into existing thermal power plants to improve the overall performance of the plant. Studies have considered using solar thermal heat for feedwater heating in coal-fired (Rankine cycle) plants to reduce the extraction of steam from the turbines for this purpose. In this way, the efficiency benefits of feedwater heating are realized while the steam flow through the turbines remains higher and thus (a) the turbine power output is greater for the same fuel consumption; or (b) the same power output can be achieved with lower fuel consumption. At the same time, the solar thermal energy is effectively converted to electricity but via the higher thermal efficiency of the coal-fired plant and at lower cost since it uses the existing power block and transmission infrastructure. Previous work on this topic at Stellenbosch University identified SAPG as an attractive option for the South African context. The work was however based on several simplifying assumptions and more work is required to better understand the techno-economic feasibility of this concept. This study aims to develop a more detailed thermodynamic model capable of simulating the performance of a SAPG plant under varying operating conditions (e.g. varying solar resource, ambient conditions and part load operation) and incorporating thermal energy storage. The study aims to answer the question of whether SAPG can and should be considered in South Africa. The project will be co-supervised by myself and Prof. Ryno Laubscher. **Requirements:** A strong grounding in fundamental heat transfer and thermodynamics at undergraduate level is required.	✓	✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Simulation of high flow nasal cannula ventilation in infants and children High flow nasal cannula therapy is a non-invasive respiratory therapy that involves delivering humidified respiratory gas (typically rich in O2) to a patient's nasal cavity via a nasal cannula. The therapy improves breathing efficiency but the high flow rates make it relatively expensive and the exact mechanisms through which it works are not well understood. A better understanding of fluid mechanics associated with the therapy has the potential to realize more effective treatment and reduced costs, particularly for therapy in infants and children where there is little literature available. High flow oxygen therapy through nasal cannula (HFNC) is a commonly used method of respiratory support for patients with respiratory failure. Heated, humidified air is blended with oxygen and delivered at high flow rates via a nasal interface. The therapy improves breathing efficiency but the high flow rates make it relatively expensive and the exact mechanisms through which it works are not well understood. Studies of the use of HFNC compared to standard nasal oxygen in infants and children have conflicting results and further analysis is required to refine the use of HFNC. This project involves the numerical simulation (using an appropriate computational fluid dynamics tool) of HFNC in infants and children. A numerical model must be developed and validated against published information (e.g. positive end-expiratory pressure measurements from model-based studies). The model will be used to conduct a parametric analysis which aims to contribute to the understanding of the mechanisms through which the therapy works and to identifying optimal operating parameters. The project will be co-supervised by Dr Andre Gie, a Paediatric Pulmonologist at Stellenbosch University. **Requirements:** This project will suit a candidate with a mechanical engineering background since it is heavily reliant on an understanding of fluid mechanics. CFD will be used as the primary tool in this work and the student should have completed a relevant CFD module (or must complete such a module in the first semester of the MEng programme).		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Simulation of cooling fan blade loading spectra using CFD Large, industrial cooling fans operating in air-cooled condensers are often subjected to distorted inlet air flow conditions due to side winds. These operating conditions result in dynamic blade loads that can potentially lead to the failure of fan blades or blade connection bolts, especially if there is resonance of the fan blades. Past work has quantified the effect of the wind on the magnitude of the dynamic blade loads, but have not included an analysis of the accompanying dynamic load spectra that may lead to resonance. The goal of this study will therefore be to determine the influence of the wind on the magnitude of these dynamic loads as well as the frequency content thereof using CFD. It is expected that steady simulations using implicit fan models can be used to determine the cyclical forces on the fan blades. The influence of wind gusts will require transient modelling and will not initially form part of the project scope. This project will be co-supervised by Dr Jacques Muiyser (Howden Netherlands). **Requirements:** This is a multidisciplinary project requiring the application of both CFD and structural dynamics. The student must complete relevant post-graduate modules in CFD and Adanced Dynamics (or have previous relevant experience).		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
An assessment of the feasibility, energy and water saving potential of sea water air conditioning in South Africa: Building climate control (HVAC) is responsible for approximately 10% of global energy consumption and considerable efforts are needed to reduce the energy footprint of this activity. The cooling loop of a typical building air conditioning system makes use of chilled water supplied by a refrigeration cycle (typically referred to as a chiller). The heat sink in these chillers is typically an evaporative cooling tower and the maximum COP is thus is constrained by the ambient wetbulb temperature. In addition, since heat transfer in the cooling tower is predominantly due to evaporation, the water footprint of building cooling is considerable. Sea water air conditioning (SWAC) systems make use of the ocean as the heat sink and, if the ocean temperatures are favourable, either remove the need for a chiller entirely or offer lower sink temperatures and thus higher chiller COP (reduced energy consumption for the same cooling load). In addition, evaporation in the cooling tower is replaced by sensible heat transfer to sea water and fresh water consumption is eliminated. SWAC is used in many developed parts of the world already (e.g. Stockholm, Sweden, is almost entirely sea-water cooled). A preliminary analysis of SWAC for a commercial building in Cape Town predicted a 50% decrease in energy consumption and the elimination of 1500 kg/hr of fresh water consumption (for a specific operating point). The potential of SWAC to contribute to more sustainable building operation in South Africa is thus significant and extremely important to energy and water security in our country. This aims to develop a tool that can be used to determine the feasibility, energy and water saving potential of SWAC for South Africa (taking into account the diverse climate and ocean conditions along our coastline). The project will be co-supervised by Dr James Joubert (Sustainability Engineer, Ecolution Consulting). The scope of the project can be adjusted to be a MEng (research) thesis or MEng (structured) project. **Requirements:** N/A	✓	✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Tunable PCM-boosted particle storage for NextGen CSP: a techno-economic assessment Concentrated Solar Power (CSP) plants convert solar energy to high quality (temperature) heat to drive a thermal power cycle (e.g. the Brayton and / or Rankine cycle). CSP plants typically use a thermal energy storage (TES) system (currently molten salt storage is most comment, T 560 deg C) as a means of managing the transient heat input, providing extended generation (i.e. after sunset) and dispatchability (e.g. energy is stored during the day and dispatched in the evening to service peak demand). The next generation of CSP plants will operate at higher temperatures (700 deg C) to power innovative power cycles (e.g. the supercritical CO2 Brayton cycle) to acheive higher efficiencies. New TES solutions are required to support these NextGen CSP plants. A candidate solution involves the use of ovaline particles as the heat transfer fluid and TES medium. This system operates in a similar way to molten salt but at higher temperature. Unfortunately, while cheaper than molten salt and able to handle the higher temperatures, the particles have a lower specific storage capacity and thus TES enhancement is required. A research consortium (consisting of partners from France, Belgium, Spain, the UK and South Africa) is considering the use of a Zinc-allow phase change material (PCM) as a TES booster in the context of the partical-based CSP system. Stellenbosch University will contribute to the techno-economic feasibility assessment of the PCM TES boost concept through this project (in collaboration with CNRS-PROMES, France). At this stage, funding is being applied for via an EU grant. Should the application be successful, the project will go ahead with full project funding - including a student bursary. **Requirements:** N/A		✓	✓	✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Electric vehicle thermal system modelling and investigation of heat recovery opportunities Electric vehicles (EVs) are a key contributor in the global move towards cleaner energy and transport systems. One of the major obstacles faced by EVs is limited driving range. Unlike in internal combustion engine vehicles, heat is not "freely" available (in large quantities) in EVs and power consumption for heating can have a significant impact on range (e.g. Horrein et al. (2017) report up to 30% reduction in range due to cabin heating in cold conditions). This project aims to address this issue through the development of an EV thermal system model which can be used to develop and analyse concepts for scavenging heat (e.g. from the drive train, battery or fuel cell) and reducing parasitic power consumption for heating. This project will be conducted in close collaboration with, and funding (bursary) from, a commercial company involved in designing vehicles for the American market (design offices in Cape Town, South Africa). Prof Gerhard Venter will be a co-supervisor. L. Horrein, A. Bouscayrol, W. Lhomme and C. Dépature, "Impact of Heating System on the Range of an Electric Vehicle," in IEEE Transactions on Vehicular Technology, vol. 66, no. 6, pp. 4668-4677, June 2017, doi: 10.1109/TVT.2016.2615095. **Requirements:** The topic will require numerical thermo-fluid network simulation, programming (typically in Python) and the application of optimization techniques.		✓		✓
The technoeconomic feasibility of reversible heat pump storage in industrial process heat systems Industrial process heat accounts for approximately 20% of South Africa's total energy consumption (200 TWh of energy per annum). The vast majority of this energy is supplied by fossil fuels (mostly coal but also including heavy fuel oil and gas) and the carbon footprint of industrial process heat in South Africa is thus enormous. Reducing fossil fuel use through waste heat recovery (e.g. using heat pumps) and renewable energy (e.g. solar thermal energy) has considerable potential to reduce our national greenhouse gas emissions. This project will consider the feasibility of using novel high temperature heat pumps (capable of achieving 200 deg C at high COP) in combination with solar thermal energy technologies and thermal energy storage as a strategy for decarbonization of industrial process heat in South Africa. The project forms part of a larger study involving an international consortium of research partners, predominantly from Europe, and including Stellenbosch University and Greenline Africa as African partners. At this stage, funding is being applied for via an EU grant. Should the application be successful, the project will go ahead with full project funding - including a student bursary. **Requirements:** N/A		✓		✓

Prof Willie Perold

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- **Research Field**
  Biosensors
- **General Description of Research Field**
  The Sensor Applications & Nano-Devices (SAND) research group focusses on the development of sensing devices applicable to human disease (cancer, HIV, TB, Covid, etc.), plant disease, animal disease and water and soil pollution. The sensors are fabricated in the nanotechnology-laboratory at Electrical & Electronic Engineering. The research is multidisciplinary by nature.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Development of a membrane-based extreme optical transmission (EOT) device for nucleic acid based testing Extreme optical transmission has recently been shown to be an extremely versatile and sensitive sensing technique for biosensing applications. Various methods of manufacturing such sensors exist, although none are currently economically viable. This project would focus on development and optimization of a membrane-based manufacturing method for such sensors that can be implemented on large-scale. Co-supervision: Prof Anna-Mart Engelbrecht (Physiological Sciences) Collaboration: Joint Institute for Nuclear Research (JINR), industry **Requirements:** Image processing, multiphysics simulation and optimization. Testing and evaluation.		✓		
Developement of a whole-blood fluorescence spectroscopy device with application to point-of-care blood testing More than ever before, the COVID epiemic has made the need for fast, simple and cost-effective point-of-care or household testing processes abuntantly clear. The rise of non-communicable and lifestyle-related diseases has also introduced the need for easily accessible testing. This project would continue development of a test methodology and device to evaluate a patient's inflammatory state and provide information about their health status. The device would make use of whole-blood fluorescence spectroscopy, and focus on building a small and low-cost prototype and also implementing machine-learning processes to better interpret and understand the results from such a test. Co-supervision: Prof Resia Pretorius (Physiological Sciences) **Requirements:** Rapid prototyping, image processing, micro manufacturing, machine learning		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Development of a microbead-based test for diagnosis of infant TB Meningitis TB Meningitis is a largely overlooked threat in developing countries, especially in South Africa. The disease usually goes unnoticed until treatment is no longer useful, and very few testing methods currently exist to address this problem. This project would develop a handheld microbead-based assay to detect and quantify biomarkers associated with TBm in resource constrained settings like South Africa. Co-supervision: Prof Novel Chegou (Immunology Research Group, Tygerberg) **Requirements:** Image processing, machine learning, fluid mechanics, microfluidics		✓		
Development of a multi-bounce spectroscopy device for disease detection and treatment monitoring Fluorescence spectroscopy is a versatile, non-invasive and non-destructive analysis method that has been effectively used to perform a very wide variety of biological tests. However, the required electronics and software for very sensitive measurements can be prohibitively expensive. A potential solution to this is o perform multi-bounce spectroscopy, where the light beam passes through the sample multiple times to enhance the sensitivity of measurements. This project would develop a prototype of such a device to evaluate the method for application to biosensor designs. Co-supervision: Prof Resia Pretorius (Physiological Sciences) **Requirements:** Fundamental physics, micro manufacturing, image processing.		✓		
Detection and separation of circulating tumor cells using microfluidic methods Noncommunicable diseases are becoming more and more prevalent, especially in aging populations. The need for effective methods of diagnosing these diseases is also rising, and much effort is being put towards low-cost microfluidic methods of automating normally labour-intensive tests. This project would develop a device for the detection of circulating tumor cells using state-of-the-art microfluidic methods and simulation models. Co-supervision: Prof Anna-Mart Engelbrecht (Physiological Sciences) **Requirements:** High-frequency electronics, multiphysics simulation and modelling, optimization, micro manufacturing		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Integration of potentiostat measurements with lab-on-chip applications The development of cartridge-based diagnostics and lab-on-chip systems is revolutionizing healthcare diagnostics by reducing the time necessary to develop tests, perform tests and eliminating the need for operators to be involved. However, one of the current shortcomings is that many assays are still qualitative in nature, or involve expensive optical systems for quantification. This project would focus on implementing a low-cost potentiostat in a lab-on-chip format, using state of the art lithography and SLA 3D printing systems. Co-supervision: Physiological Sciences **Requirements:** Electrochemistry, integrated development, modelling and simulation using COMSOL multiphysics, lithography and additive manufacturing.		✓		
Development of an innovative microfluidic lateral flow assay Lateral-flow assays are the gold standard for home and rapid testing. However, their use is limited to tests where qualitative results are good enough, which disqualifies them from the greater majority of applications. Recent advances in microfluidics has made it possible to replace the basic material of which LFAs are made to make them easier to fabricate, and also open up new avenues for changing their output mechanism to become quantitative in nature. This project would focus on laying the groundwork for such a device, and develop a proof-of-concept implementation of a fully-microfluidic quantitative lateral flow assay. Co-supervision: Physiological Sciences or Immunolgy Research Group (Tygerberg) **Requirements:** Lithography and additive manufacturing, Multiphysics simulation/CFD, machine vision, analog electronics		✓		
Development of an Organ-on-Chip lung or neuron model Organ-on-chip systems are becoming indispensable in the search for new and novel drugs and treatment regimes, especially in non-communicable diseases. this project would focus on the development of a novel organ-on-chip system for neural or lung models, using state of the art lithography and manufacturing techniques. C-supervision: Dr Sanjeev Rambharose (Physiological Sciences) **Requirements:** Multiphysics simulation, machine vision, manufacturing systems, cell culturing and physiological models		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Miniature Surface Plasmon Resonance (SPR) with Digital Micromirror Device (DMD) technology Surface plasmon resonance (SPR) is a very powerful biosensing technique with applications in every field of pharmaceutical and medical testing. However, until now SPR machines have been large and bulky due to the optical systems involved. New developments in the field of MEMS and optics has made it possible to miniaturize many of the components necessary for an SPR system, and some work has been done to develop portable versions of the technology. This project would focus on developing such a portable SPR sensing platform for biosensor applications at the point-of-care (PoC). Co-supervision: Dr Gurthwin Bosman (Physics) **Requirements:** Optics/physics, integrated development, multiphysics simulation		✓		
Development of a COMSOL model of ZnO nanowire biosensors Zinc Oxide is a versatile piezoelectric material with promising applications in biosensor development and other fields. Specifically, Zinc Oxide nanowires have been successfully used as biosensors, but their function and optimal use is not yet fully understood. This project would focus on developing a COMSOL multiphysics model of a nanowire-based sensor to better understand the existing sensors and their limitations/strengths/weaknesses. Co-supervision: Prof Leon Dicks (Microbiology) **Requirements:** Multiphysics simulation, electrochemistry		✓		
Development of a spatial PCR prototype for rapid nucleic acid based tesing Nucleic acid-based diagnostics are fast becoming indispensable in the effective diagnosis of diseases of all kinds. Of particular interest is cancer and viral infections, that can be very difficult to detect without sensitive PCR processes that are difficult to implement in a household or resource-constrained setting. This project would develop a compact and energy efficient PCR platform for the detection of such targets, using spatial thermal cycling techniques, moving the sample inside microfluidic chambers between stationary temperature zones. Co-supervision: Medical Physiology (Tygerberg) or Physiological Sciences **Requirements:** Control systems, automation, image processing and microprocessor development		✓		

Dr Hannes Pretorius

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- **Research Field**
  Thermofluids & Solar Energy
- **General Description of Research Field**
  Dry cooling systems for power generation applications; Axial flow fan performance; Heat transfer analysis from PV panels; Floating solar PV power generation; Thermo-economic evaluation on CSP / PV power plants

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Heat dissipation factors for bi-facial PV modules in open-rack and building-attached configuration Solar power generation using Photovoltaic (PV) power plants have seen a dramatic rise in popularity in recent years. Large PV plants continue to be constructed all around the world, including South Africa. Due to the continually decreasing price of PV panels and the relative construction simplicity of such power plants, it is expected that they will remain competitive in the medium to long term. The efficiency of PV modules is negatively affected by an increase in operating temperature of the module. To predict power output accurately, it is important that the heat dissipation from the PV module is accurately modelled. PV simulation models exist which typically employ empirical heat dissipation factors obtained from open-racked mono-facial module experiments. Little research is available on what these factors are for bi-facial PV panels in open-rack and building-attached (BAPV) configuration. This study will experimentally determine heat dissipation factors for mono- and bi-facial PV panels in open-rack and BAPV configuration. The commercial simulation tool PVSyst will be used to simulate the annual performance of a simple system with these newly obtained heat dissipation factors, and comparisons made to predictions with default inputs. The study will also aim to establish which relative angle maximizes annual power output. **Requirements:** Strong interest and performance in Thermo-fluid modules. This topic will be focused on experimental work.	✓			

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Natural draft direct dry heat rejection system for a supercritical CO2 power cycle Global research interest into supercritical CO2 power cycles is increasing, due to their superior efficiencies and reduced component size requirements. These cycles, linked to concentrated solar power applications represent a modern evolution to sustainable and efficient power production. The sCO2 cycle needs a heat rejection system to dissipate heat loads from the pre-cooler and intercooler heat exchangers to the environment. To further enhance cycle efficiency and promote sustainability, a heat rejection system with low parasitic power- and no water consumption requirements would be very beneficial. This study investigates the performance characteristics of a natural draft direct dry heat rejection system for the pre-cooler and intercooler heat loads of a sCO2 power cycle, linked to a 50 MWe solar CSP plant. The investigation uses 1D methods to size the heat rejection system, after which co-simulation of the 1D model and a 3D computational fluid dynamics model is employed to evaluate the performance of the system under varying ambient temperature and wind conditions. This project is co-supervised by Prof Ryno Laubscher. (Note: This project has been allocated to a student for 2024) **Requirements:** Strong interest and performance in Thermo-fluids modules. Computational Fluid Dynamics.		✓		

Dr Sanjeev Rambharose

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- **Research Field**
  Nanotechnology, drug delivery, physiology
- **General Description of Research Field**
  Physiological characteristics of diseases bring about both challenges and opportunities for targeted drug delivery. Novel engineered strategies are being increasingly used for the design of advanced drug delivery systems. The research group works at the interface of physiology, biochemistry, pharmaceutics and nanotechnology. The focus of the research group is to harness the characteristics of physiological systems to tailor precision drug delivery systems for both communicable and non-communicable diseases.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Development of a Nano-Integrated Transdermal (NIT) Drug Delivery System for Antiretroviral Drug and NeuroAIDS Therapy The development of an innovative nano- integrated transdermal (NIT) Drug Delivery Systems (DDS) as a medicinal product is capable of delivering either single or multiple ARV drugs simultaneously, as is required for HIV and AIDS drug therapy, via the skin is desired to overcome current limitations. Transdermal NIT preparations have the potential to improve bioavailability of various ARV drugs, decrease dosages required, decrease cost of therapeutics and reduce drug side effects. Specifically engineered DDS can allow targeted, controlled drug release which can decreases frequency of administration. These innovative DDS can therefore enhance therapeutic effects, compliance and adherence. **Requirements:** Physiological systems	✓	✓	✓	

Prof Kristiaan Schreve

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- **Research Field**
  Machine vision; Biomedical Engineering
- **General Description of Research Field**
  I am interested in applications and basic research related to machine vision in industrial and biomedical engineering environments. My main focus is on dimensional measurements and accuracy prediction in 3D applications using cameras (e.g. quality control, reverse engineering, diagnostics, etc.), however the field is also related to applications in robot navigation.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Integrated Length and Weight Measurement for Infants A crucial activity in nutrition surveillance is growth monitoring and promotion to timeously identify and treat children who are malnourished or at risk for malnutrition. Malnutrition, specifically stunting is much more than a physical condition. Stunting is when a child plots more than 2 standard deviations below the WHO Child Growth Standards' median. The nutritional status of infants is directly linked to their anthropometrical data, specifically weight and length. In a previous study, a device was built that integrates these two measurements and allows for the digital recording of the data and plotting on a growth chart. The current device is in a prototype stage. For effective use by clinicians, the device needs to be redesigned for usability and robustness. Firstly, the principal components of the device need to be packaged robustly. The measurement process must be stream lined so that it can be done fast and accurately. The data recording (including age, ID, clinician, photo's, etc.) must be automated as much as possible keeping in mind the clinical setting. Fail safes need to be built into the device to prevent incorrect recording of data. **Requirements:** Python programming experience. CAD modelling.	✓			

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Smart pill box TB (tuberculosis) and chronic diseases are very prevalent in rural South Africa. Successful treatment of such diseases is dependent on patient's taking their prescribed medication on a regular basis. In the case of TB, for example, this can lead to bacteria becoming immune to existing medicine with serious consequences for the patient and high cost to the country. We need a smart pill box that can assist a patient to correctly take the medication at the prescribed times. The device must record the removal of medication (thereby assuming that the patient is taking the medication), it must remind the patient when prescriptions must be renewed or when a clinic visit is required. It must also be able to measure and record at least one key secondary symptom (vital sign) to assist in tracking the patient's progress. The AURUM Institute of Health has a related device that is distributed in South Africa: https://tbdigitaladherence.org/technologies/smart-pill-box/, but this device does not have all the functionality required. For a first iteration of this product, it will be acceptable to focus on one prevalent disease, such as TB or diabetes. **Requirements:** Python programming. CAD modelling. Raspberry Pi experience.	✓			
Anti-rotation device for patients lying in traction Patients with femur fractures in some rural hospitals wait a very long time for surgery, some times up to 6 weeks. During this time, the patient lies in traction and it is not unusual that the fracture heals during this time. With current traction systems it is not always possible to prevent rotation of the foot, which means that the fracture can heal in the wrong orientation. To some extent, Thomas splints (e.g. https://emed.ie/Procedures/Thomas_Splint.php) can help in these instances, but there are some practical problems with their use, e.g. many different sizes are required for different sized patients. Some patients also refuse to wear them. A low cost anti-rotation device is needed that can be incorporated into existing traction systems in typical South African rural hospitals. It also requires a low cost weight system. **Requirements:** CAD modelling.	✓			

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Design of a low-cost intraosseous needle In many parts of the world, a high number of deaths among small children and babies result from dehydration that can be prevented with suitable fluid resuscitation treatment (https://www.rch.org.au/clinicalguide/guideline_index/intraosseous_access/). An intraosseous needle, inserted into the tibia or distal femur, is typically needed for this treatment. These needles currently can cost more than R2000 (https://be-safe.co.za/product/nio-intraosseous-needle/). Compared to the cost of a typical syringe needle of less than R1, this is very expensive. Although syringe needles can be used for this procedure, there are a number of detractors. The long bevel of the typical needle means that it must be inserted deep into the bone. If it is inserted too deep, especially in small children, one can drill through the bone, and if it is not inserted deep enough, the fluid will leak. A bone marrow biopsy needle is an alternative solution. This needle is too long for the fluid resuscitation treatment, because it is not easy to fasten to the skin to hold the needle in place for several hours while administering the fluid. A possible design alternative is a needle with a threaded shaft (https://patents.google.com/patent/EP0490517A1/en). Making the needle strong enough to penetrate the bone, having an appropriate bevel for this procedure, and making the needle thin enough to minimise the impact of the procedure, cost, and manufacturing are some of the major design considerations making this a very challenging project. In this project, a needle must be designed, manufactured and tested. **Requirements:** n/a	✓	✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Low cost, do-it-yourself, below knee prosthesis There is a dire need for access to prosthetics in South Africa. In the Western Cape alone, it is estimated that there are 1000+ lower limb amputations annually. The main causes of these are firstly diabetes, peripheral vascular disease and secondly trauma due to road accidents. It is not unusual for patients to wait 2 years or longer for a prosthetic limb, many patients are excluded due to strict criteria being applied in the public health system. High costs involved in the production of prosthetics necessitate the application of these criteria so that only small portion of amputees with the highest fitness level and those close to the relevant facilities can access this benefit. There can also be considerable delays, of up to several months, between the initial fitment to the provision of the prosthesis. This can result in the prothesis not fitting any more. After provision of the prothesis, patients typically require several weeks of assistance from clinicians such as physiotherapists. In this research a low cost, do-it-yourself solution is proposed in combination to self-help video training aids if the patient cannot get access to a therapist. The solution should give the patient at least some use of the amputated leg to the extent that they can walk with limited use or without a walking aid. There are several design challenges: the materials should be readily obtainable and of low cost, the design must as far as possible be manufacturable with basic "handyman" tools, a load bearing attachment for the prothesis to the leg is needed and a foot with rotatable or flexible angle is needed that makes walking on level and inclined surfaces possible. As a first phase of the project, existing approaches to below knee prosthetics must be researched, preferably in terms of the main functions of the prosthetic. The ideal of DIY prosthetics is not new. One example is: https://www.dezeen.com/2019/09/06/diy-prosthetics-guide-desiree-riny/ **Requirements:** To be determined	✓	✓		

Dr Willie Smit
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- **Research Field**
  Robotics and Control in Concentrated Solar Power Plants
- **General Description of Research Field**
  The Solar Thermal Energy Research Group (STERG) is researching environmentally friendly and sustainable solar thermal technologies. In particular, we are looking at concentrated solar power (CSP) plants. We think that multi-copters and ground-based robots can provide services to plant operators.

  Here is a good video that gives an overview of the state-of-the-art CSP plant: https://youtu.be/QW42wBthN2A

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Locating a drone close to a parabolic trough Parabolic troughs concentrate solar rays onto a central tube. The tube contains oil that heats up to close to 400 'C. The heated oil is used to generate steam which powers a turbine. The mirrors need to be cleaned every few days. It should be easy for a drone to automatically clean the mirrors. This project aims to develop a system with which the drone can accurately locate itself inside the parabolic trough. The system might use ultrasonic sensors, cameras, laser range finders and so on. **Requirements:** Good programming skills.		✓		
The control of a novel quadcopter configuration for long flight times A master's student designed and built a drone with a novel configuration. The new quadcopter can fly for more than an hour. The dynamics of the quadcopter have not been fully analysed. As a result, the control system is not as stable and robust as one would like. This research topic aims to analyse the quadcopter's dynamics and implement and test a better control system for it. The main tasks of the project will be to: - Model the quadcopter in Simscape (mostly done by a final-year student) - Develop a controller in Simscape - Implement the controller on on the Pixhawk autopilot - Test the performance of the physical drone **Requirements:** Good programming skills.		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Measuring the optical quality of a heliostat A heliostat is a mirror that tracks the sun. It reflects and focuses sunlight onto a receiver hundreds of meters away from the heliostat. The heliostat's shape must be very precise; otherwise, some of the solar rays are not reflected onto the receiver but miss it completely. Concentrated solar power plant operators would like to know the exact shape of each heliostat. We have been working on the problem of measuring the shape of the heliostat in the field. Our solution is to use a drone to take photographs of known objects as they are reflected in the mirror. Using the basic law of reflection, we believe it is possible to determine the heliostat's exact shape. This project will investigate this approach. The plant operators in South Africa are excited about this idea and will allow us to test it at their plants. **Requirements:** Good programming skills.		✓		

Mnr Wayne Swart
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- **Research Field**
  Biomedical Engineering
- **General Description of Research Field**
  Biomedical engineering encompasses many fields of research, including biomechanics predominantly for orthopaedic applications, implant design, prosthetics, diagnostic devices and technology that supports therapeutic applications. The Biomedical Engineering Research Group (BERG) have strong ties with various practitioners at Tygerberg campus, most notably in the fields of orthopaedics and psychiatry. We also strive for continual industry engagement with various companies with different specialties.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Instrumentation of Illizarov Frame Illizarov frames are frequently used to fix tibial fractures and facilitate bone healing at the fracture site. Healing of these fractures requires an optimal fixture of the fractured ends relative to one another in order to allow relative displacement between the fixed ends and facilitate the generation of the healing tissue. That is, if the fractured ends are fixed too rigidly in close proximity to each other or if the fracture ends are fixed with too much clearance relative to one another, the healing process does not occur correctly. Literature, based on in-vitro test data, suggests that there is an optimal relative displacement range that leads to a faster healing. An instrumented Illizarov frame that can accurately estimate the relative displacement within the fracture will provide surgeons with valuable feedback on the potential efficacy for the given frame setup in any clinical setting. The objectives of this project are to instrument an Illizarov frame and to validate fracture displacement estimations through load frame testing. The frame needs to be instrumented in such a manner that data can be collected outside of a laboratory context, i.e. the instrumentation can be done on an Illizarov frame fixed to a patient. The instrumentation should be able to accurately estimate the relative bone displacement at the fracture site based on measurements and known heal strike force data. Validation will require a rigorous experimental design process including the creation of a representative model of the surrounding tissue and a thorough experimental procedure that can be used to relate the measurements to the actual relative displacement at the fracture site. Any candidate for this project will require a background in Mechanical or Mechatronic Engineering and should be comfortable multi-disciplinary applications. This project forms part of a collaborative research effort with the Advanced Orthopaedic Training Centre at Tygerberg campus and may require the candidate to visit Tygerberg campus to discuss and experience the clinical nature of the aimed applications. As such, the candidate will be expected to conduct themselves in a respectful and professional manner. **Requirements:** Mechanical / Mechatronic Engineering degree.		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Modelling the Behaviour of an Illizarov Frame under Load This topic will investigate the behaviour of an Illizarov frame under load. An Illizarov frame is an external fixation used in orthopaedic surgery to treat broken or damaged bones of the arm or leg. It is often used to treat complex fractures. This project will be co-supervised by Mr Wayne Swart and Prof Gerhard Venter and will involve the development of a finite element model of the Illizarov frame and appropriate bone segments that the frame is attached to. The material properties of the frame and bone segments will be obtained from experiments and/or literature. Both linear and non-linear finite element models will be investigated and will be validated through the use published data as well as physical experiments. Understanding the behaviour of these frames under load is important. These frames are designed to allow limited axial movement in the fracture to help promote bone growth. However, lateral movements and rotations should be constrained. Understanding how these frames behave under load will aid the orthopaedic surgeon in the design and attachment of the device to obtain optimal bone growth. This project will start by considering only axial loads, but will eventually be extended to also include loads experienced while walking, eg during heel strike. This project forms part of a collaborative research effort with the Advanced Orthopaedic Training Centre at Tygerberg campus and may require the candidate to visit Tygerberg campus to discuss and experience the clinical nature of the aimed applications. As such, the candidate will be expected to conduct themselves in a respectful and professional manner. **Requirements:** Finite element modelling. The student should have completed the Finite Element Methods 414 module (or similar) or should be willing to take this module in the first year of the MEng study. Some Python programming will most likely also be required.		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Exploring the use of Virtual Reality Based Visualization for pain management in burn care Although some studies suggest that virtual reality (VR) serves as a useful addition to burn wound pain management techniques, it is not yet fully understood whether VR simply serves as a distraction or if it affects pain perception. The purpose of this project will be to investigate the affect of VR in pain management through the design of an experimental procedure and the associated stimulation and monitoring equipment, which will include a finely controlled temperature stimulus device as well as ambient temperature sensing. Furthermore, a measuring technique to quantify subject reflex response to the stimulus in terms of time and acuteness of physical motion will have to be designed and developed. The VR stimulus will be delivered by means of a commercial VR system; however, some digital environmental design will be required. A background in temperature measurement and control as well as electronic design is highly recommended to any candidate for this project. This project will require the student to design a controlled electrically driven device and therefor the candidate should be comfortable with electronic applications. A background in electronics and measurement will be an advantage. Additionally, some control theory may have to be applied in the design. This project forms part of a collaborative research effort with the Department of Psychiatry at Tygerberg campus and may require the candidate to visit Tygerberg campus to discuss and experience the clinical nature of the aimed applications. As such, the candidate will be expected to conduct themselves in a respectful and professional manner. **Requirements:** A background in driving electronics, measurement and control will be beneficial. Some programming background (predominantly C based applications) will be beneficial.	✓			

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Olfactory stimulus for augmented VR anxiety treatment The purpose of this project is to determine the efficacy of olfactory stimulation as a fear enhancement tool during the use of VR (virtual reality) exposure therapy procedures. VR has proven to be a useful tool for exposure therapy purposes in anxiety conditions (Freitas et al., 2021). Olfactory enhanced VR treatment could be relevant in treatment procedures for anxiety and related disorders. The primary objective of the project will be to develop, test and validate an olfactory stimulus device that can accurately control smell intensity and guarantee quick response times in smell dissipation after delivery. This will require a rigorous test methodology to ensure a high confidence that the desired stimulus intensity is being achieved. The secondary objectives will be to investigate the effect of olfactory stimulus in VR environments in terms of subject response; and the development of a closed-loop control system for anxiety level stimulus using heartrate variability and EDA (electrodermal activity) response. This project will require the student to design an electromechanical device and therefor the candidate should be comfortable with multi-disciplinary applications. A background in electronics and measurement will be an advantage. Additionally, some control theory may have to be applied in the design. This project forms part of a collaborative research effort with the Department of Psychiatry at Tygerberg campus and may require the candidate to visit Tygerberg campus to discuss and experience the clinical nature of the aimed applications. As such, the candidate will be expected to conduct themselves in a respectful and professional manner. Freitas, J.R.S., Velosa, V.H.S., Abreu, L.T.N., Jardim, R.L., Santos, J.A.V., Peres, B., Campos, P.F., 2021. Virtual Reality Exposure Treatment in Phobias: a Systematic Review. Psychiatr. Q. 92, 1685–1710. https://doi.org/10.1007/s11126-021-09935-6 **Requirements:** Some electronics and measurement background will be beneficial. Some programming background (predominantly C based applications) will be beneficial.	✓			

Prof Gerhard Venter
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- **Research Field**
  Computational (structural) mechanics with focus on structural analysis and numerical design optimization and related technologies
- **General Description of Research Field**
  My research typically deals with complex finite element analyses combined with structural and/or multi-disciplinary optimization. These techniques are applied to a wide range of interesting topics, typically driven by and in collaboration with an industry partner. Currently my group does some work in load reconstruction of real world forces on complex structures, material characterization using inverse modelling, optimum design and investigation into the fatigue life of welded and bolted connections in high strength steels and DIC related topics.

  Most of my research projects have some finite element, some meta-modelling (machine learning) and some optimization components associated with it. The vast majority of the topics requires programming, typically in Python. An interest in these fields, or at least a willingness to learn, is thus a requirement for potential students.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Open Source Camera Calibration Software for Digital Image Correlation This research project aims to develop an open source camera calibration software for Digital Image Correlation (DIC) in structural mechanics. Supervised by Prof Kristiaan Schreve and Prof Gerhard Venter, the project explores camera calibration options and investigates the design of physical objects for the calibration process. Extensive programming in Python will be required to create a software solution, freely available for independent use or for integration into existing DIC software. Digital Image Correlation is a non-contact optical method to accurately provide 2D and 3D measurements based on changes in a series of images. Within the structural mechanics field, DIC is used to provide 2D and 3D full-field displacement and strain data. Two dimensional data is obtained from a single camera, while stereo DIC (using more than one camera) is used to provide 3D data. At the Department of Mechanical and Mechatronic Engineering at Stellenbosch University, an open source DIC software was recently developed under the supervision of Prof Gerhard Venter. Prof Kristiaan Schreve has an extensive background in digital vision and using digital images to obtain 2D and 3D measurement data. A key point in successfully obtaining measurement or tracking data from digital images, is the calibration of the cameras used to obtain the images. This project will focus on camera calibration and will provide a comprehensive, open source set of instructions, design specifications and software to address camera calibration needs within the context of performing high accuracy measurements. The propagation of the measurement uncertainties from the calibration object through the camera parameters to the measurements to determine whether or not the method can provide sufficient accuracy and sensitivity to DIC measurements. The project will have a large programming component and the Python programming language will be used. **Requirements:** Familiarity with Python programming or at the very least a willingness to learn Python programming.		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Computational Design of Novel Soft Sensors This proposed Master's project focuses on the computational design of novel soft sensors. Inspired by biological systems, soft sensors have gained significant attention due to their ability to conform to complex shapes and interact with delicate and irregular surfaces. They find applications in various fields, including robotics, healthcare, and wearable technology. However, designing soft sensors with desired sensing properties and performance remains challenging. The project aims to address this challenge by employing numerical optimization techniques and finite element analysis (FEA) to design and optimize novel soft sensors computationally. The project will begin by characterizing existing soft sensor materials' mechanical and sensing properties through experimental testing and literature review. Using this knowledge, a computational framework will be developed to simulate soft sensor designs' mechanical behaviour and sensing response. FEA will be utilized to model the deformation and strain distribution of the soft sensor under different loading conditions. Advanced optimization algorithms will be employed to find optimal sensor designs based on specific performance criteria, such as sensitivity, resolution, and robustness. Additionally, machine learning techniques can be integrated into the design process to assist in exploring a vast design space and accelerate the optimization process. This may involve training machine learning models using datasets generated from FEA simulations and experimental data, enabling sensor performance prediction for untested designs. The outcomes of this project will contribute to developing novel soft sensors with enhanced sensing capabilities and performance characteristics. The optimized designs can find applications in robotic manipulation, human-machine interaction, and healthcare monitoring. Moreover, the computational design approach will offer a cost-effective and efficient way to explore and iterate soft sensor designs, facilitating advancements in soft robotics and wearable technology. This project will be co-supervised by Prof Martin Venter and Prof Gerhard Venter. **Requirements:** None		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Modeling the Behavior of an Illizarov Frame under Load This topic will investigate the behavior of an Ilizarov frame under load. An Ilizarov frame is an external fixation used in orthopedic surgery to treat broken or damaged bones of the arm or leg. It is often used to treat complex fractures. This project will be co-supervised by Mr Wayne Swart and Prof Gerhard Venter and will involve the development of a finite element model of the Ilizarov frame and appropriate bone segments that the frame is attached to. The material properties of the frame and bone segments will be obtained from experiments and/or literature. Both linear and non-linear finite element models will be investigated and will be validated through the use published data as well as physical experiments. Understanding the behavior of these frames under load is important. These frames are designed to allow limited axial movement in the fracture to help promote bone growth. However, lateral movements and rotations should be constrained. Understanding how these frames behave under load will aid the orthopedic surgeon in the design and attachment of the device to obtain optimal bone growth. This project will start by considering only axial loads, but will eventually be extended to also include loads experienced while walking, eg during heel strike. **Requirements:** Finite element modeling. The student should have completed the Finite Element Methods 414 module (or similar), or should be willing to take this module in the first year of the MEng study. Some Python programming will most likely also be required.		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Development of a Bone Growth Model for Finite Element Analysis This proposed Master's project aims to develop a bone growth model for finite element analysis (FEA). Bone growth is crucial in orthopaedic applications, such as fracture healing, bone remodelling, and implant design. Understanding the complex process of bone growth and its interaction with mechanical stimuli is essential for improving clinical outcomes and optimizing implant performance. The project will begin by reviewing existing literature on bone growth mechanisms and their relationship with mechanical factors. Based on this knowledge, a mathematical model will be developed to simulate bone growth patterns. The model will consider various factors, including cellular activities, mechanical loading, and biochemical signalling, to capture the dynamic nature of bone growth accurately. The developed bone growth model will be integrated into FEA simulations to predict the mechanical behaviour of bone structures during the growth process. This will enable the evaluation of the effects of bone growth on the mechanical integrity and performance of orthopaedic implants or structures. Moreover, the model will facilitate the exploration of optimal implant designs that promote proper bone growth and enhance long-term implant success rates. The outcomes of this project will contribute to advancing the understanding of bone growth mechanisms and their implications for orthopaedic applications. When integrated into FEA, the developed bone growth model will provide a powerful tool for orthopaedic engineers to optimize implant designs, predict the mechanical performance of bone structures during growth, and enhance patient outcomes regarding implant longevity and functional restoration. This project will be co-supervised by Prof Martin Venter and Prof Gerhard Venter. **Requirements:** None		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Evaluation and Optimization of Speckle Pattern Quality in Digital Image Correlation This research project focuses on investigating metrics used to evaluate speckle pattern quality in Digital Image Correlation (DIC) and developing a software tool for generating artificial speckle patterns. Supervised by Dr. Melody Neaves and Prof. Gerhard Venter, the project aims to understand the limitations and applicability of existing metrics through an anti-optimization process. The outcomes include a speckle pattern generation software, a deeper understanding of current metrics, the potential for a new metric, and a reference optimum speckle pattern. The project involves software development in Python and physical experiments using DIC equipment in a laboratory environment. Digital Image Correlation (DIC) is an optical method used in structural mechanics to obtain accurate 2D and 3D measurements based on image changes. A crucial aspect of successful DIC application is the use of high-quality speckle patterns on the structure being analyzed. The quality of the speckle pattern directly impacts the accuracy of DIC results. Understanding the limitations and applicability of existing metrics for evaluating speckle pattern quality is vital. Additionally, having an optimized speckle pattern as a reference can be a valuable tool. This project aims to investigate currently available metrics for evaluating speckle pattern quality in DIC. The student will become familiar with these metrics and implement them in a software environment. Furthermore, the student will develop a software tool to generate artificial speckle patterns on a computer. Anti-optimization techniques will be applied to generate artificial speckle patterns that highlight differences in the current metrics. This process will lead to a better understanding of the limitations and applicability of the metrics. This project will require a significant component of software development in the Python programming language. **Requirements:** Familiarity with Python programming or at the very least a willingness to learn Python programming.		✓		✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Thermal Analysis of Passenger Train Wheel Disc Brakes Gibela was established in 2013, initially as a ring-fenced company for the execution of the Passenger Rail Agency of South Africa's (Prasa) rolling-stock fleet-renewal programme. Gibela currently employs disk brakes on the passenger trains that they manufacture and maintain. These brakes consists of five segments that are assembled into a single brake disc. The reasons for considering a segmented disk is (1) to simply maintenance (the discs can be replaced without the need to first press the wheels from the axle) and (2) the disc exhibits better cooling between brake cycles. These segmented disks are expensive to manufacture and maintain. In addition, Gibela has changed the brake blending of the trains to incorporate regenerative braking. As a result the segmented brakes are currently used mostly as emergency brakes while the train is stationary or during infrequent emergency braking situations. The wear on the disks is thus minimal and the disks lasts longer than the wheels themselves. This study will investigate if a simpler cheaper, solid disk is a viable alternative that should be considered. The advantages and disadvantages of a solid disk over the current segmented approach should be investigated. This will involve finite element thermal and structural modeling of the brake as well as considering maintenance issues and costs associated with the different options. **Requirements:** Finite element modeling. The student should have completed the Finite Element Methods 414 module (or similar), or should be willing to take this module in the first year of the MEng study. Some Python programming will most likely also be required.		✓		✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Evaluating Digital Image Correlation Speckle Pattern Quality using Artificial Finite Element Based Displacement Fields This research project focuses on investigating the quality of a Digital Image Correlation (DIC) speckle pattern and developing a software tool that impose an artificial finite element (FE) based displacement field on an existing speckle pattern. Supervised by Dr. Melody Neaves and Prof. Gerhard Venter, the project aims to provide a ground truth displacement and/or strain field against which the DIC obtained results can be compared. This ground truth will be in the form of a FE based displacement field imposed on an existing speckle pattern. The comparison between the DIC results and the FE based ground truth can be used to compare the accuracy of different DIC software implementations, to evaluate the quality of a particular speckle pattern for a given DIC implementation and to compare different metrics used to evaluate the quality of a speckle pattern. The project involves software development in Python and physical experiments using DIC equipment in a laboratory environment. Digital Image Correlation (DIC) is an optical method used in structural mechanics to obtain accurate 2D and 3D measurements based on image changes. A crucial aspect of successful DIC application is the use of high-quality speckle patterns on the structure being analyzed. The quality of the speckle pattern directly impacts the accuracy of DIC results. Having a ground truth displacement field against which the DIC results can be compared is critical in evaluating the quality of a speckle pattern. In the completion of this project, the student will become familiar with the manipulation of digital images, DIC itself and the metrics used to evaluate the quality of a DIC speckle pattern. The student will develop a software tool to impose a finite element based displacement field on a speckle pattern and to compare the DIC produced results against the finite element based results. It is anticipated that a statistical analysis of the errors would be performed. **Requirements:** This project will require a significant component of software development in the Python programming language.		✓		✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Characterizing Friction Losses in a Bicycle Drive Train The MOD group recently developed an experimental setup for measuring losses in a bicycle drive train. This setup can measure friction losses in bearings, the chain under full tension and the complete drive train under full load. From a practical perspective, the full tension load is preferred, but it is not clear how to relate this data to the full load test which better approximates the real life use of the drive train. This project will be a follow up project that will concentrate on two aspects to better understand this relationship: 1. Fine tuning of the current setup to obtain the most accurate data possible. This will involve small design changes that should be incorporated into the current design where necessary 2. Analytic and numerical modelling of the drive train to better understand the losses in each of the different tests. This will be a major new thrust for this project 3. Validation of the these analytical and numerical models against the experimental setup The goal would be to use the analytic and numerical models as a basis for better understanding the correlation between the full tension and full load tests. This will be a major contribution to industry which currently does not have a clear means of making this correlation. This project will include a practical design aspect, experimental work as well as programming in the Python programming language. Numerical modelling will be done using the rigid body dynamics code Adams. **Requirements:** Python programming, numerical simulation, experimental work		✓		✓
Several Topics in Commerical Truck Design and Manufactoring The MOD group has a long standing collaboration with a commercial company that is involved in designing commercial trucks for the American market. The design office is located in South Africa and sponsors multiple topics in this general area each year. These projects come with partial or full funding plus a job commitment after completion of the studies. The new topics for 2024 have not been released yet, but past topics included: 1. Structural optimization of chassis components 2. Load recovery from experimental strain gauge data 3. Fatigue testing of welding connections in high strength steel and of bolted connections in high strength steel 4. CFD simulation and aerodynamic optimization of trucks 5. Digital vision applications for self driving trucks The 2024 topics will be released shortly and one can expect topics in these same general areas. **Requirements:** General these topis require numerical simulation, some programming (typically in Python) and the application of optimization techniques		✓		✓

Prof Martin Venter

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- **Research Field**
  Generative Design, Machine Learning, Material Modelling, Soft Robots and Inflatables
- **General Description of Research Field**
  I am interested in computational methods as part of the design process. This allows us to share the burden of making design decisions that can become complex, like biologically inspired artificial creatures and inflatable structures. Over the past few years, I have been exploring the potential applications of compliant and selectively reinforced materials in the fields of pressure-rigidised structures and soft robotics. In addition, our research group is interested in combining powerful non-linear simulation tools, such as finite element methods, with the ever more important field of machine learning in a modern generative design approach.

  This is a multidisciplinary field taking elements from several computational fields. Researchers in this area will develop non-linear finite element methods, numerical design optimisation, programming and machine learning skills. Much of what we do requires insightful experiment planning in tandem with advanced tools to deal with large volumes of data. This new field is open to exploration, which can be both challenging and rewarding.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Design pipeline for soft robots At present, the rate at which researchers can evaluate new designs restricts much of the development of soft robots. To assess a design, a full prototype must be fabricated and tested. Although several research groups use numerical simulations of soft robots, the simulations are typically used for design validation or insight. They play no active role in the design process. This research will attempt to create a robust generic workflow for generating and verifying new numerical models to make meaningful progress towards a digital twin for soft robots. Research Questions: 1. What tools are suitable for generating arbitrary soft robot geometries? 2. What processes result in the successful simulation of a soft robot? 3. How can the performance of a generalised simulation of a soft robot be verified? **Requirements:** Must complete FEM by the end of the first six months. Must enjoy programming.		✓		✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Development of a Bone Growth Model for Finite Element Analysis This proposed Master's project aims to develop a bone growth model for finite element analysis (FEA). Bone growth is crucial in orthopaedic applications, such as fracture healing, bone remodelling, and implant design. Understanding the complex process of bone growth and its interaction with mechanical stimuli is essential for improving clinical outcomes and optimizing implant performance. The project will review existing literature on bone growth mechanisms and their relationship with mechanical factors. Based on this knowledge, a mathematical model will be developed to simulate bone growth patterns. The model will consider various factors, including cellular activities, mechanical loading, and biochemical signalling, to capture the dynamic nature of bone growth accurately. The developed bone growth model will be integrated into FEA simulations to predict the mechanical behaviour of bone structures during the growth process. This will enable the evaluation of the effects of bone growth on the mechanical integrity and performance of orthopaedic implants or structures. Moreover, the model will facilitate the exploration of optimal implant designs that promote proper bone growth and enhance long-term implant success rates. The outcomes of this project will contribute to advancing the understanding of bone growth mechanisms and their implications for orthopaedic applications. When integrated into FEA, the developed bone growth model will provide a powerful tool for orthopaedic engineers to optimize implant designs, predict the mechanical performance of bone structures during growth, and enhance patient outcomes regarding implant longevity and functional restoration. **Requirements:** An interest in programming and must complete introduction to FEM in the first 6 months.		✓	✓	

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Shape Control of Inflated Structures through Selective Reinforcement This proposed Master's project aims to investigate the shape control of inflated structures through selective reinforcement. Inflatable structures offer numerous advantages, such as lightweight, deployability, and adaptability, making them suitable for aerospace, architecture, and robotics applications. However, achieving precise shape control and stability in inflated structures remains challenging. The project will focus on developing a novel approach to selectively reinforce inflatable structures to achieve desired shapes and enhance structural stability. The project will comprehensively review existing literature on inflatable structures and reinforcement techniques. This will provide insights into the state-of-the-art methodologies and identify gaps for further exploration. Based on the review, a computational framework will be developed to model the behaviour of inflatable structures and predict their deformation under various loading conditions. Finite element analysis (FEA) will be utilized to simulate the inflation process and analyze the structural response. The framework will also incorporate optimization algorithms to determine reinforcements' optimal distribution and orientation. Selective reinforcement techniques, such as embedding fibres or attaching rigid elements to specific regions of the inflatable structure, will be explored to achieve the desired shape control. The optimization algorithms will consider material properties, geometric constraints, and load requirements to find the most efficient reinforcement strategy. The outcomes of this project will contribute to advancements in shape control and stability of inflatable structures. The proposed selective reinforcement techniques will enable the design of structures with enhanced performance characteristics, improved load-bearing capacity, and precise shape control. The findings can have significant applications in aerospace engineering, where lightweight and deployable structures with tailored shapes are crucial for space missions, aircraft design, and inflatable habitats. **Requirements:** Complete the intro to FEM in the first six months.		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Soft Robot Poise Control This proposed Master's project focuses on developing poise control strategies for soft robots. Soft robots, characterized by their compliant and deformable structures, offer unique capabilities such as adaptability, dexterity, and safe human-robot interaction. However, achieving stable and controlled posture or poise control in soft robots remains challenging. The project addresses this challenge by exploring novel approaches to achieve precise poise control in soft robots. The project will begin with an in-depth study of soft robots' mechanics and control principles, considering material properties, actuation mechanisms, and sensor integration. Based on this knowledge, a computational framework will be developed to model the behaviour of soft robots and simulate their dynamic response. Finite element analysis (FEA) or multi-body dynamics simulations will capture the complex deformation and interactions within the soft robot's structure. Control strategies, such as model predictive control, feedback control, or bio-inspired control, will be investigated to achieve poise control in soft robots. These strategies may involve real-time sensing of the robot's posture using sensors, such as accelerometers or strain sensors, and appropriate actuation mechanisms to induce controlled deformations. To optimize the poise control performance, machine learning algorithms can train models and improve the robot's ability to adapt to different environments and tasks. Reinforcement learning or evolutionary algorithms can enhance the soft robot's poise control capabilities through iterative learning and optimization. The outcomes of this project will contribute to advancements in poise control for soft robots, enabling them to achieve stable and controlled postures in various applications, such as soft robotic manipulation, locomotion, and human-robot interaction. The developed control strategies can enhance the robot's ability to perform complex tasks with precision, versatility, and improved safety in unstructured and dynamic environments. **Requirements:** Complete the intro to FEM in the first six months.		✓	✓	

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Design and Development of a Drop Foot Prosthetic This proposed Master's project focuses on designing and developing a drop foot prosthetic. Drop foot is a gait abnormality characterized by the inability to lift the front part of the foot, leading to difficulties in walking and an increased risk of tripping or falling. Prosthetic devices offer a solution by supporting and assisting individuals with drop foot to regain a more natural and functional gait. The project aims to design and develop an innovative drop foot prosthetic that addresses individuals with this condition's specific needs and challenges. The design process will involve the following: A comprehensive review of existing prosthetic devices. Biomechanical analysis of the gait cycle. Consultation with healthcare professionals and potential end-users. Based on the gathered knowledge, a prototype of the drop foot prosthetic will be developed using advanced design tools and manufacturing techniques. The prosthetic will incorporate mechanisms to assist with foot dorsiflexion during the swing phase of the gait cycle and provide stability during the stance phase. The design will also consider comfort, adjustability, and ease of use. The performance and functionality of the drop foot prosthetic will be evaluated through biomechanical testing and user trials. Feedback from individuals with drop foot and healthcare professionals will be incorporated into the iterative design process to optimize the prosthetic's effectiveness and user satisfaction. The outcomes of this project will contribute to the advancement of drop foot prosthetics, providing individuals with improved mobility, stability, and quality of life. The designed prosthetic can offer a cost-effective and accessible solution for those experiencing drop foot, facilitating their daily activities and reducing the risk of falls. The project also opens opportunities for further research and development in assistive technologies and rehabilitation engineering. **Requirements:** Complete the intro to FEM in the first six months.		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Alternative Solar Panel Backing Structure This proposed Master's project focuses on exploring and developing an alternative backing structure for solar panels. Traditional solar panels commonly utilize rigid and heavy materials, such as glass or aluminium, as their backing structure. However, these conventional materials need to be revised regarding cost, weight, and installation flexibility. The project aims to investigate and propose an alternative backing structure that overcomes the limitations of conventional materials while maintaining the required mechanical support and durability for solar panels. The alternative structure will be designed to enhance the efficiency, performance, and sustainability of solar energy systems. The project will begin by reviewing existing materials and structures used in solar panel backings and innovative approaches in other industries. Potential alternatives, such as lightweight composites, flexible polymers, or hybrid materials, will be considered. Based on the review, a computational analysis and modelling framework will be developed to simulate and assess the proposed alternative backing structure's mechanical properties and structural behaviour. Finite element analysis (FEA) or other suitable numerical methods will be employed to evaluate the design's structural integrity, thermal performance, and reliability. The project will involve prototyping and experimental validation to verify the performance of the alternative backing structure. Physical testing will be conducted to assess its mechanical strength, resistance to environmental conditions, and compatibility with solar panel components. The outcomes of this project will contribute to the advancement of solar panel technology by providing a more efficient, lightweight, and cost-effective alternative for the backing structure. The proposed alternative can potentially improve the overall efficiency of solar energy systems, reduce installation costs, and facilitate the integration of solar panels into a wider range of applications, including portable and flexible solar panels. Additionally, the project aligns with the growing emphasis on sustainable materials and green energy technologies. **Requirements:** Complete the intro to FEM in the first six months.		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Physics-Informed Neural Network for Silicone Simulation Modeling This proposed Master's project focuses on developing and applying a physics-informed neural network (PINN) for silicone simulation modelling. Silicone materials are widely used in various engineering applications, including soft robotics, biomedical devices, and elastomer-based structures. Accurate modelling and simulation of silicone behaviour are crucial for design optimization, material selection, and performance prediction. The project aims to leverage the power of neural networks and incorporate physics-based constraints to develop a PINN that can accurately simulate the mechanical behaviour of silicone materials. The PINN will be trained using available experimental data, finite element analysis (FEA) results, and the underlying physics governing silicone deformation. The project will begin by collecting experimental data on silicone material properties, including stress-strain relationships, strain rate sensitivity, and temperature effects. The collected data will serve as the training dataset for the PINN. The PINN architecture will be designed to incorporate physical laws and governing equations, such as the hyperelastic material model, to enforce constraints on the network's predictions. This physics-informed approach will ensure the neural network produces physically meaningful and accurate simulations. The trained PINN will be validated against independent experimental data and FEA results to assess its predictive capability and generalization to unseen scenarios. Sensitivity analyses will also be conducted to evaluate the influence of different input parameters on the silicone simulation results. The outcomes of this project will contribute to advancing the modelling and simulation of silicone materials using a physics-informed neural network approach. The developed PINN can be a powerful tool for engineers and researchers working with silicone materials, enabling efficient and accurate simulations for design optimization, virtual prototyping, and performance prediction. The project also bridges the gap between data-driven machine-learning techniques and physics-based models, offering a novel approach for simulating the behaviour of complex materials. **Requirements:** Complete the intro to FEM in the first six months.		✓		

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Computational Design of Novel Soft Sensors This proposed Master's project focuses on the computational design of novel soft sensors. Inspired by biological systems, soft sensors have gained significant attention due to their ability to conform to complex shapes and interact with delicate and irregular surfaces. They find applications in various fields, including robotics, healthcare, and wearable technology. However, designing soft sensors with desired sensing properties and performance remains challenging. The project aims to address this challenge by employing numerical optimization techniques and finite element analysis (FEA) to design and optimize novel soft sensors computationally. The project will begin by characterizing existing soft sensor materials' mechanical and sensing properties through experimental testing and literature review. Using this knowledge, a computational framework will be developed to simulate soft sensor designs' mechanical behaviour and sensing response. FEA will be utilized to model the deformation and strain distribution of the soft sensor under different loading conditions. Advanced optimization algorithms will be employed to find optimal sensor designs based on specific performance criteria, such as sensitivity, resolution, and robustness. Additionally, machine learning techniques can be integrated into the design process to assist in exploring a vast design space and accelerate the optimization process. This may involve training machine learning models using datasets generated from FEA simulations and experimental data, enabling sensor performance prediction for untested designs. The outcomes of this project will contribute to developing novel soft sensors with enhanced sensing capabilities and performance characteristics. The optimized designs can find applications in robotic manipulation, human-machine interaction, and healthcare monitoring. Moreover, the computational design approach will offer a cost-effective and efficient way to explore and iterate soft sensor designs, facilitating advancements in soft robotics and wearable technology. **Requirements:** Complete the intro to FEM in the first six months.		✓		

Dr Andie de Villiers

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- **Research Field**
  Computational Mechanics
- **General Description of Research Field**
  This field involves the modelling and simulation of mechanical problems. The field comprises of three parts: modelling, numerical implementation and computational implementation. The appropriate equations and boundary conditions need to be identified/developed to capture the physics of a system. It is often difficult to find analytical solutions for these problems, and numerical methods such as the finite element method is used to solve the equations. These problems can not be solved by hand and should be solved computationally. Depending on the problem at hand commercial software may or may not be useful.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
A peridynamic model of skin Skin is a living material. Not only is the material properties anisotropic and incompressible but it is also influenced by the environment and changes over time. Peridynamics is a non-local continuum mechanics framework originally developed to overcome challenges that classical continuum mechanics encounter when modelling discontinuities, such as cracks, as well as long-range forces. The aim of this project is to develop a peridynamic model of the skin and find suitable peridynamic material parameters. **Requirements:** Students should have a background in solid mechanics and a love for mathematics and programming.		✓	✓	✓

Dr Johan van der Merwe

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- **Research Field**
  Data-informed preoperative planning and endoprosthesis design.
- **General Description of Research Field**
  Conventional implant systems may result in suboptimal patient outcomes due to a mismatch between implant geometry and pathological anatomy. This could be caused by misrepresentation of the target population, or severe defects outside of the original system's design scope, requiring modification.

  Patient-specific solutions are an attractive alternative due to the capabilities afforded by additive manufacturing. However, the development of patient-specific devices is a multidisciplinary and iterative process that requires extensive effort on the part of various stakeholders. This could lead to increased expense and delays in treatment within an already resource constrained healthcare system. Ideally, the benefits associated with standardized implant systems such as economy of scale, logistical efficiency, and quality control, should be pursued where possible.

  Therefore, this research follows a data-informed approach to implant design and preoperative planning, to enable targeted standardization of implant systems and design processes, and predictive automatization of patient-specific solutions. Applications in orthopedic and maxillofacial surgery include fixation, large defect reconstruction and joint replacement.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Internal fixation implant analysis and design Applications considered for this project include fixation plates, pins, and screws for various anatomies. The scope may vary based on prior art as well as student background. Possible activities include needs identification via ethnographic research, market assessment and stakeholder engagement; Research questions and hypotheses must be developed, followed by data collection for morphological shape analyses and comparison to available implant geometry; Implant geometries must be proposed based on the findings and optimized for form and function; Verification will be done via simulation and experimental testing. **Requirements:** Students must have sufficient scientific or engineering background for further study at a postgraduate level in one or more of the following: statistics, scientific programming, machine learning, digital image processing, numerical simulation, and optimization.		✓	✓	

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Functional implants for large bone defect reconstruction The focus for this project is the generation of engineered and additively manufactured lattice structures for large bone defect reconstruction. Applications include various anatomies but will most likely focus on the femur and mandible. After initial needs identification and data collection, lattice geometries must be selected, and implant fixation features incorporated into a functional design. Numerical optimization and simulation must be performed, along with experimental validation. Extended scope would include design customization, automatization, and early failure prediction. **Requirements:** Students must have sufficient scientific or engineering background for further study at a postgraduate level in one or more of the following: statistics, scientific programming, machine learning, digital image processing, numerical simulation, and optimization.		✓	✓	
Design of patient-specific joint replacements This project investigates the design of patient-specific joint replacement implants, such as for the mandible or shoulder, after needs identification and analysis of prior art and current challenges. Research questions and hypotheses must be developed, followed by data collection for morphological shape analysis in conjunction with biomechanical simulation and motion capture. The resulting database must be used to inform patient-specific implant design, possibly in conjunction with modular or standard components. Experimental verification will involve kinematic and wear testing. Project scope may vary based on prior art as well as student background. **Requirements:** Students must have sufficient scientific or engineering background for further study at a postgraduate level in one or more of the following: statistics, scientific programming, machine learning, digital image processing, numerical simulation, and optimization.		✓	✓	
Data-informed bone models for preoperative planning and surgical navigation This project is concerned with the generation of 3D patient-specific or patient-matched bone models for use in preoperative planning and surgical navigation. Potential applications include surgery for hip dysplasia and ankle fractures. Data collection will occur after needs identification, and methods for matching or fitting models to individual patients must be investigated. Solutions may involve digital image processing, statistical learning, and automated 3D model registration. Verification will occur via simulated test cases. **Requirements:** Students must have sufficient scientific or engineering background for further study at a postgraduate level in one or more of the following: statistics, scientific programming, machine learning, digital image processing, numerical simulation, and optimization.		✓	✓	

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Design and development of a drop foot prosthetic This project focuses on designing and developing a cost-effective drop foot prosthetic. Prosthetic devices mitigate gait abnormalities and the associated the risk of tripping or falling, by facilitating a more normal gait. The design process will involve a review of existing devices, consultation with healthcare professionals and potential end users, biomechanical testing and analysis of the gait cycle, and the development and testing of a prototype. **Requirements:** Students must have sufficient scientific or engineering background for further study at a postgraduate level in one or more of the following: statistics, scientific programming, machine learning, digital image processing, numerical simulation, and optimization.		✓	✓	
Development of titanium antibiotic eluding devices Bone-related infection is treated via surgical removal of the affected tissue. Custom, lattice-based titanium implants allow management of the resulting dead space, are load bearing, and facilitate bone in-growth such as via the delivery of bone matrix proteins to the defect site. However, once an implant is in place, treatment of post-surgical infection remains a challenge. To this end, an ideal implant would additionally enable the delivery of local antibiotics, with the flexibility to change treatment regimes depending on extended cultures. Therefore, the aim of this study is to develop an antibiotic eluding device design method, intended to form part of custom, lattice-based titanium implants. Research questions would include how to achieve the ideal configuration for the desired antibiotic elution, the effect of gravity and biokinetics on drug elution, and the investigation of implant coatings to drive an osmotic gradient and prevent biofilm formation. The envisioned study would make use of fluid simulation in porous media with possible particle tracking. Once verified in vitro, the simulation may be used to model antibiotic elution under various conditions and device configurations. Finally, animal models may be used to validate combined implant and elution devices. This project is done in collaboration with industry and clinical partners. **Requirements:** Material science, fluid dynamics, scientific programming, design.		✓	✓	✓

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- **Research Field**
  Turbomachinery
- **General Description of Research Field**
  1) The use of direct dry-cooling in power generation systems is a means of ensuring sustainable water usage. The efficient, low noise, operation of the axial flow fans that form part of such an air-cooled system is essential for a well-performing system. These research topics (topics 1, 2 and 3) focus on the design, testing and analysis of axial flow fans for these systems. 2) The use of micro gas turbines (MGTs) for the propulsion of aerial vehicles or solar thermal power applications hold specific advantages. The topic is related to the development of a turboshaft micro gas turbine.

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Improving the performance of the 24 ft. installed MinwaterCSP axial flow fan. The project will specifically focus on modelling and accurately measuring the performance of the 24 ft MinwaterCSP axial flow fan. Existing work has focused on the measurement and modelling of this fan's performance under both stable and unstable conditions. The idea is to expand this work in order to improve the fan's performance under various operating conditions. The possible improvements will be modelled in CFD and implemented in the large diameter fan.. **Requirements:** CFD		✓		✓
Reducing the noise signature of a large diameter axial flow cooling fan. Existing work has focused on the measurement and modelling of the noise emitted by a large diameter cooling fan. This project will now attempt to reduce the noise characteristics of such a fan by altering the blade configuration of the fan, without replacing the fan blades. Modifications must therefore be made in the form of attachments added to the fan blade. The work will involve intensive experimental evaluation, as well as numerical modelling of the flow around the fan blades. **Requirements:** CFD	✓	✓		✓

Topics	MEng Struct	MEng Resrch	PhD	Potential Funding
Developing a mixed flow compressor for a micro gas turbine An existing micro gas turbine engine is equipped with a centrifugal compressor and diffuser stage. Existing work has looed at replacing the centrifugal compressor with a mixed flow design that promises to improve the performance of the gas turbine. The purpose of this work will be to complete the current mixed flow design and to oversee the manufacture of the entire compressor stage, for installation in an existing gas turbine platform. The work will require significant co-operation with outside companies. **Requirements:** CFD, thermofluids 344, strong CAD skills		✓		
Improving the performance of a solarised micro gas turbine The performance of an existing micro gas turbine needs to be improved. A New impeller and diffuser has been design for the gas generator component and needs to be manufactured and tested on the gas turbine. The power turbine has to be replaced with a smaller, more realistically sized unit and a concept for an actual generator has to be developed. The system was developed to originally operated under solarised conditions but is currently being converted for research on hydrogen combustion. This work will be done in conjunction with the PhD student currently working on the system. **Requirements:** CFD, good CAD skills		✓		
Sudden expansion pressure loss and recovery in fans Collaborative Project with UKZN UKZN Contact: Prof G Snedden In ventilation fans the fan blading sits in an annulus with the hub forming a barrel inside a duct. Once the motor barrel terminates there is effectively a sudden expansion of an annulus into a duct. The frictionless Carnot-Borda assumption is often used to account for losses and the static pressure recovery in this sudden expansion, however Carnot-Borda was intended for small to large pipe sudden expansions and is, as stated, frictionless. The aim of this work is to develop a validated correlation for the losses in fan arrangement. This correlation should account for variation in: • Fan velocity • Duct diameter ratio • Changes in inlet swirl • Changes in hub to tip velocity profile Note: Funding from Industry partners/THRIP to be applied for but not yet assured. **Requirements:** CFD		✓		✓
The development of a 30 kW turboshaft micro gas turbine. An existing project has developed the methodology for the design of a 30 kW turboshaft micro gas turbine. This project will continue this work by developing an actual gas turbine engine. Once completed, the engine will be tested and its performance verified. **Requirements:** CFD, thermofluids 344		✓		✓