



ANDRIES HERCULES PUTTER

POWER ELECTRONICS ENGINEER

DETAILED WORK EXPERIENCE

1987 - 1989

DETAILED WORK EXPERIENCE

National Service

After completing his M. Eng, Dr Putter had to undergo compulsory national service in the South African Defence Force for a period of two years. After completing his basic training in the Air Force, he was seconded to the Council for Scientific and Industrial Research (CSIR), where he first became a leader of a small group of engineers tasked with the development of an electric turret for an airborne defence platform. Subsequently Dr Putter obtained the rank of lieutenant and became the liaison officer between the Chief of Staff Logistics and the CSIR, being in charge of about 100 national service men seconded to the CSIR.

It was during his time at the CSIR that Dr Putter started with his D. Eng (1988).t

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ANDRIES HERCULES PUTTER

POWER ELECTRONICS ENGINEER

DETAILED WORK EXPERIENCE

1989 - 1993

DETAILED WORK EXPERIENCE

Advanced Technologies and Engineering (Pty) Ltd

Program Manager - Mining Locomotive Development

After completing his national service, Dr Putter still had bursary obligations with GEC, but he was approached by Advanced Technologies and Engineering (ATE) to join them. ATE was exclusively involved in the defence industry, and Dr Putter joined them to establish a business unit focussed on the local industry, in this case it was the mining industry.

The decision was to continue with the development of the electric drive for mine locomotives, and Dr Putter established a team of engineers that worked on this. It included power electronics engineers, embedded software development, and electric machine design. While at ATE Dr Putter continued with his D. Eng and completed it in 1992 while still at ATE. While working on the electric drive system for underground vehicles, Dr Putter developed a unique symmetrical snubber (already mentioned earlier) which led to one of the team members obtaining a doctorate on the analysis and design of this snubber and doing a comparative study between it and other snubbers of the time.

Dr Putter also worked on the development of the idea of the "open stator" inverter, which is aimed at overcoming the problems with low battery system voltage, which at the time was also not a well-known concept. There was no freely available analysis work available on the idea, and Dr Putter did extensive analysis and research, and produced original work that resulted in a patent. While at ATE, Dr Putter was also involved in the design of a PV inverter for Helios, which at the time was quite unique, there was no real renewable energy industry. The target market was Africa, with the aim of rural electrification. The design project was completed, but it did not go into full production, it was a product that was ahead of its time.

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DETAILED WORK EXPERIENCE

Advanced Technologies and Engineering (Pty) Ltd - continued

Program Manager - Mining Locomotive Development

Dr Putter also explored how the electric drive developed for the underground locomotive could be adapted to road vehicles, also an idea that was ahead of its time. The concept design included many of the ideas and concepts that today are used in electric road vehicles, such as wheel mounted electric motors. However, Dr Putter did later get the opportunity to develop a proto-type electric vehicle on a very small scale. While at ATE, Dr Putter was also exposed to the early UAV development, more specifically the development of a power supply with starter capabilities, a project that came back recently again from the same company now operating under a different name.

This project continued after Dr Putter left ATE, and this is a rather unique and challenging design, and at the time it could not be completed. It would allow the UAV to start without ground power and instead use its own on-board batteries, which is an advantage because it simplifies and makes launch operation safer.

Dr Putter stayed at ATE until mid-1993, when he left to form his own company.

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ANDRIES HERCULES PUTTER

POWER ELECTRONICS ENGINEER

DETAILED WORK EXPERIENCE

1993 - 2001

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DETAILED WORK EXPERIENCE

Self-employed

Engineering Consultant

Dr Putter left the employment of ATE to start his own consulting design business. His first client was Safronics, for which he worked on the development of their own variable speed drives.

During this period Dr Putter was also contracted as a consultant to Semikron (South Africa) and supported their clients with technical advice on the design of power electronics. Several of their clients were manufacturers of variable speed drives for mine locomotives and Dr Putter continued his involvement with the development of this technology.

Projects during this time

Further mine locomotive development work.

Dr Putter was appointed as an expert consultant for the mine loco accident that happened in 1992 at the Vaal Reefs gold mine in the Free State, South Africa. This was a turning moment in the mine loco industry, an uncontrolled mine loco fell down a shaft onto a lift cage carrying 102 people, and all of them perished. There was a commission of enquiry and Dr Putter was appointed by Anglo American to act as expert consultant to the legal team.

One of the consequences of the incident and the subsequent commission of enquiry was a complete review of safety procedures and the design of the safety systems on mine locomotives. As a result, Dr Putter developed the "no-power" brake system for these locomotives, and this resulted in a patent. The motivation for this development was that the accident was caused by an uncontrolled locomotive, and the operator, in an attempt to stop the locomotive, unplugged the battery bank. The result was that this disabled all the safety circuits on the locomotive because they were electrically powered from the battery. There was clearly a need for a system that operated without electrical power, and the "no-power" brake was developed. The concept was developed further by a company called Battery Electric, and this design and derivations of it is the de-facto standard on all mine locomotives.

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DETAILED WORK EXPERIENCE

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DETAILED WORK EXPERIENCE

Self-employed - continued

Engineering Consultant

Electric overhead cranes

Dr Putter also consulted for a company called MH Automation, which specialised in controls for electric motors used in overhead cranes in steel mills.

This is a rather unique and challenging environment and application.

The environmental conditions are extreme, with high levels of conductive dust and heat. Also, the application is rather unique, especially the hoist (vertical) motion controller, because the electric motor and its controller has to be able to operate in all four quadrants for extended periods of its operating cycle. Unlike a battery-operated vehicle that can dump the energy generated during braking into the battery, the crane controller cannot, and large resistor banks are used to dissipate this energy. This is wasteful and expensive, and both projects that Dr Putter worked on at MH Automation was aimed at eliminating these resistors. To appreciate the extent of this problem, consider that the resistors are often more expensive than the rest of the drive system, and quite often also much larger.

Dr Putter worked on the development of a new variable speed drive for DC operated cranes, which were still operated with electromechanical contactors. The goal was to replace them with more efficient solid-state power electronic controllers. The controller for the hoist motor proved to be a particular difficult problem to solve, while the travel (horizontal motion) controller was rather simple and very similar to the DC controllers used on mine locomotives.

Dr Putter also worked on a cyclo converter design for crane applications. The goal was to develop a low cost, robust controller for overhead cranes, that is capable of handling the high levels of generating power without resistors that is generated when the crane is lowering a load. For this project Dr Putter was one of the first users of FPGAs in South Africa, using FPGAs to implement the control algorithms for the cyclo converter switching, which had to be controlled very accurately and the computations had to be performed in parallel, which is best to be done using a FPGA.

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DETAILED WORK EXPERIENCE

Self-employed - continued

Engineering Consultant

Electric overhead cranes - continued

One of the challenging aspects of overhead crane drives is that the voltage is very polluted and as result the power electronics design becomes rather unique, and this also filters through to the control electronics. Dr Putter developed a unique concept of a flywheel, using the FPGA to implement it. The purpose of the flywheel was to provide a steady reference for the switching of the power switches used in the cyclo converter.

MH Automation used a unique, solid state circuit to trigger the power switches in their controllers (SCRs) and Dr Putter also gain a good understanding of this circuit, which was used in later designs.

High power magnetic transmitter

High power magnetic transmitters are used in the exploration of minerals, and Dr Putter worked on an airborne version of this technology for Anglo American. It involved various unique design aspects, including a special heat sink design that Dr Putter developed. The challenge is to produce high currents from a low voltage source, the load being a large area, low frequency pulse antenna.

Soft starter for electric motors.

While at MH Automation, Dr Putter developed a very compact and low-cost control electronics card for soft starters, which was put into limited production at MH Automation. The card only measured 60mm x 120mm and could be used for a wide range of soft starter power ratings. It used the active trigger module mentioned earlier, which was the main reason that the card size could be reduced so much. Dr Putter developed both the hardware and embedded software for the soft starter controller card.

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DETAILED WORK EXPERIENCE

1993 - 2001

DETAILED WORK EXPERIENCE

Self-employed - continued

Engineering Consultant

High frequency welding machine

Dr Putter developed a high power, high frequency welding machine, using microprocessor control. At the time microprocessors were only starting to enter into the control of power electronics. The complete design was done by Dr Putter, including the power electronics, embedded microprocessor controller hardware and software, the high power, high frequency transformer, the power electronics and the enclosure. The design of the transformer made use of multiple U cores, used in a similar fashion as laminations in normal transformers. At the time this was also a relatively new concept.

High frequency battery charger

Dr Putter developed a high power, high frequency battery charger, which made use of the internals of the welding machine mentioned above. This charger was for Enersys in France, which at the time brought out a rapid charge battery, which required a higher than normal power battery charger. The power rating was between 10kW and 20kW, which for the time was quite high for high frequency battery chargers.

Thyristor battery charger and battery monitor

Dr Putter developed a thyristor-based battery charger for the charging of forklift batteries, and a separate battery monitor. The battery monitor was used to monitor the charging and operation of the batteries. Dr putter designed the power electronics and microprocess-based controller (hardware and software). Dr Putter also developed the battery monitor microprocessor-based hardware and software.

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DETAILED WORK EXPERIENCE

Self-employed - continued

Engineering Consultant

Cable tester for Aberdare.

Dr Putter was approached to develop a cable tester for the newly designed XLPE cables by Aberdare. At the time, medium voltage cables mostly used paper insulation, but by using XLPE the size and cost of the insulation could be reduced. However, XLPE is prone to forming "water trees" which causes premature cable failure. This required that specific certification requirements have to be met, which included subjecting a cable sample to 500Hz and 19.1kV, for 3000 hours without interruption, which means that the equipment had to be very reliable. This required a rather unique piece of test equipment, that included a power supply capable of supplying the required power levels (between 200kVA and 300kVA), which was not available at the time.

Dr Putter developed and delivered a unique piece of power electronics to Aberdare, and that placed them in a position to be one of the first cable manufacturers globally to certify XLPE cables, and as a result they won a large contract for XLPE cable from China Power and Light Company.

Designing the inverter and its control for this application had some unique challenges, the load is essentially a capacitor, which means it has a very low impedance at the switching frequency of the inverter. Another problem was that an inductor was connected in parallel with the cable (capacitor) to reduce the reactive power rating. This, however, also creates a resonant circuit, which, at 19.1kV, 200kVA is no trivial matter. Dr Putter managed to resolve both issues successfully and the system worked for several years before it had to be maintained. The maintenance consisted of replacing the electrolytic capacitors and the power electronics. The unit was completed around 2001, and maintained in about 2007.

Dr Putter gained experience in the design of high-power single phase PWM inverters, as well as the design of low pass LC output filter for these inverters. Dr Putter also gained valuable insight in the operation of operating a PWM inverter into a capacitive load. Dr Putter designed the power electronics, embedded microprocessor-based controller, developed the embedded software and designed the step-up transformer that took the inverter output voltage to 19.1kV. It was a rather unique transformer design because of the medium voltage and relatively high frequency.

ANDRIES HERCULES PUTTER

POWER ELECTRONICS ENGINEER

DETAILED WORK EXPERIENCE

2002 - 2004

DETAILED WORK EXPERIENCE

Denel Dynamics

Facility Manager - Launch Control System for Umkhonto SAM

Dr Putter approached by Denel Dynamics to join them as facility manager for the Fire or Launch Control System of the Umkhonto surface to air missile. The missile is a hybrid heat seeking missile, with guidance from surface radar during the first part of its trajectory, and during final section of the trajectory it uses infra-red to home in on the target. The missile is meant for air defence against fighter and bomber aircraft.

Denel Dynamics was busy with delivery of systems to the South African Navy and they also received an order from another customer. Dr Putter was responsible for overseeing the completion of the development and delivery to the South African Navy, and start the project the second customer.

The team included various internal specialists, including digital hardware designers, software development (both embedded and computer based), RF electronics as well as guidance, control and navigation engineers. External contractors were also used for the software development and test equipment development.

Dr Putter had to interface with the clients, the team of internal specialists and the external contractors. Dr Putter successfully delivered the systems to the South African Navy, and started the project for the second customer.

During this project Dr Putter had to resolve specific problems regarding EMI design of the fire control equipment, as well as co-ordinating software development between different sub-contractors.

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ANDRIES HERCULES PUTTER

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DETAILED WORK EXPERIENCE

2004 - 2006

2006 - 2007

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DETAILED WORK EXPERIENCE

CBi Electric

Chief Engineer - Standard Products

While at Denel Dynamics, Dr Putter was approached by CBi Electric to join them as Chief Engineer of their standard products. CBi is a local manufacturer of circuit breakers, and this included a range of standard circuit breakers, which was the mainstay of the business for many years. The work involved working closely with the production department, which is a high-volume production plant. This in its own brings its own unique challenges. There were some inherent problems in the design of the circuit breaker which had to be overcome.

Dr Putter was also responsible for the failure analysis and reporting on field failures.

Dr Putter explored the possibility of an electronic circuit breaker while at CBi, where the electromechanical mechanism would be replaced with electronics. This aspect of circuit breakers has continued and today there are some experimental, very high-power examples being developed in Europe. At the time the research was in its infancy, and the basic concepts and value proposition had to be developed.

While at CBi, Dr Putter was approached by CBi to develop a range of soft starter for them. At the time they were the agents for Mitsubishi Electric variable speed drives, and they did not have access to soft starters.

Self-employed

Engineering Consultant

Dr Putter left the employ of CBi to establish a business that designed and manufactured soft starters for CBi. There was not a big enough local demand for soft starters to sustain the business, and it was terminated in 2007.

During this time Dr Putter also did the design of battery chargers for the mining industry.

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POWER ELECTRONICS ENGINEER

DETAILED WORK EXPERIENCE

2007 - 2008

DETAILED WORK EXPERIENCE

Neotel

Infrastructure Manager

Dr Putter joined the newly formed telecoms company Neotel, that was tasked with the development CDMA and fibre telco network in South Africa. Dr Putter was responsible for developing the electrical infrastructure and suppliers. Dr Putter developed the Integrated Power System (IPS), a rather unique concept at the time. The IPS moved the assembly and testing of the electrical equipment off-site, away from the sensitive telco equipment, into the factory where it could be mass produced and tested. The complete integrated IPS units are delivered and installed on site with minimum disruption and exposure of the telco equipment.

This IPS concept was very successful and accelerated the roll-out of the new network and saved time and money. This system continued to be used for many years at Neotel.

Dr Putter was responsible for introducing the new concept, designing it and collaborating with sub-contractors to get it developed and put into production. Several hundred of IPS units were manufactured, until the network roll-out was completed.

Dr Putter gained skills in the design of power systems for telecommunications installations, including Diesel Generators as back-up power combined with UPS, as well as low voltage DC power supply design with battery back-up.

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ANDRIES HERCULES PUTTER

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DETAILED WORK EXPERIENCE

2008- 2010

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DETAILED WORK EXPERIENCE

Clearline

Design consultant

Dr Putter joined Clearline where the concept of the Integrated Power System was developed further, and it included the development of a solid-state selector switch, that allowed the power in a telco site to be routed using software. Dr Putter's work on the IPS led to the development of renewable energy solutions for telco network operators, which was just beginning to be explored by them at the time.

At the time it was already realized that batteries are essential to renewable energy systems, but that these batteries are relatively expensive and they do not last long, increasing the life cycle cost of these systems to levels that makes it difficult to motivate their use, despite the environmental benefits.

This led Dr Putter to develop the idea of a quad or multi battery system, a very simple battery management system that increase the warranty and life expectancy of batteries, for example, in the case of the quad battery implementation of the concept, it increased the warranty and life expectancy four-fold.

The quad battery system was patented and deployed successfully. While at Clearline, Dr Putter also developed a retrofit single-phase soft starter for air conditioners. At the time inverter air conditioners were still too expensive, and the telco operators had to find a way to reduce the starting current of the air conditioners on site. This is quite a big problem, because many of the rural sites operated from Diesel Generators, and this meant that the Diesel Generator had to be sized for the high starting current, which is a waste. By using the soft starter, the Diesel Generator could be made smaller, resulting in capex savings. Several hundred of these were produced and installed in the Neotel network.

Dr Putter also designed a solid-state power supply selector switch, that was capable of selecting between various power sources, and it was put into production and deployed at Neotel.

ANDRIES HERCULES PUTTER

POWER ELECTRONICS ENGINEER

DETAILED WORK EXPERIENCE

2010 - 2015

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DETAILED WORK EXPERIENCE

Self-employed

Engineering Consultant

Dr Putter left Clearline and entered into a royalty arrangement with Megatron Federal. The relationship started with their interest in the quad battery system, and using it for MTN. They deployed several of these systems in the MTN network.

Dr Putter developed a Diesel Generator Optimization system for Megatron Federal as well. This system uses batteries to keep the loading on the Diesel Generator constant, thereby reducing the fuel and operational costs by as much as 60%. The development work involved using the Durathon Sodium Metal Hydride batteries from GE in the US. Dr Putter worked closely with GE on this project, and many of these systems were sold to MTN.

The Durathon batteries were also used to develop a version of the quad battery system for MTN that they used on their telco sites. This product is also being used by the South African Railways or Transnet. GE has since terminated the production of the Durathon batteries. While working with Megatron, Dr Putter also worked extensively on multilevel inverter design, seeing that there is a market developing for inverters in the back-up power and renewable energy markets. Dr Putter established a relationship with Mitsubishi Electric Europe, and they were interested in this technology.

Dr Putter used this technology to develop a medium voltage cable tester for Aberdare Cables in Port Elizabeth, replacing the unit that was done in 2002 mentioned earlier. This project gave Dr Putter the opportunity to develop a high power, multilevel inverter, and also improve the cable tester aspect. The result is a cable tester that is cheaper and smaller than the current technology. Dr Putter registered and worked for four years on a PhD at the University of the Witwatersrand, but could unfortunately not complete it due to restrictions on IP ownership. This involved extensive research and analysis on multilevel inverters, with the objective of using this to develop products for Mitsubishi Electric Europe.

Dr Putter also worked extensively on energy systems modelling, including financial analysis and trade-off between various power sources.

Dr Putter also developed a comprehensive simulation model for grid battery storage (shift and shave) with the objective of using the Durathon batteries in such applications.

ANDRIES HERCULES PUTTER

POWER ELECTRONICS ENGINEER

DETAILED WORK EXPERIENCE

2016 - 2018

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DETAILED WORK EXPERIENCE

ArioGenix

Chief Technical Officer

In 2016 ArioGenix bought shares in the business that Dr Putter operated, with the objective of developing the inverter technology further for Mitsubishi Electric Europe. This included a range of soft starters for induction machines.

A complete range of soft starters were developed and launched into the European market by Mitsubishi Electric Europe, including a very small DIN rail mounted version. The design of a range of "high starting torque" soft starters was also investigated, specifically for the market where four quadrant control is required. It would offer a cheap alternative to variable speed drives. For example, this concept would be for fixed speed applications where the induction machine had to brake regeneratively, pumping the power back into the grid. This can be done with a variable speed drive, but it is rather expensive to do.

During the time at ArioGenix, Dr Putter continued to work extensively on multilevel inverters, and several new concept designs were done. This included a unique concept where the PV panels were the inverter is operated without DC link capacitors, making use of the unique characteristics of the PV panel VI curve. The concept was designed, built and tested at a power rating about 100kW, it was tested at various power ratings. The benefit of this design is a reduction in cost and size. An integrated DC power system was also developed for the telecoms industry, and several of these were sold to Neotel. This included custom power electronics and remote monitoring and control.

Dr Putter continued to work on the modelling of energy and battery storage systems, including a comprehensive proposal for on-demand grid stabilization system where battery systems are used in conjunction with Generators. This was for Mitsubishi Electric Europe, and for the UK market. They were looking for very large battery storage solutions that supported the grid when the grid frequency dropped, the battery storage systems had to support the grid in the time that it took to start, synchronise and ramp up a bank of generators.

ANDRIES HERCULES PUTTER

POWER ELECTRONICS ENGINEER

DETAILED WORK EXPERIENCE

2016 - 2018

DETAILED WORK EXPERIENCE

ArioGenix - continued

Chief Technical Officer

Dr Putter also explored the use of power factor correction in conjunction with grid tied renewable energy systems. The problem with current grid ties PV systems is that the PV system supplies the majority of the active power to the load, leaving the utility grid with supplying the reactive power. This means that the grid will be presented with an increasing lower and lower power factor is more and more grid tied PV systems are connected. To counter this, it is necessary to introduce power factor correction at the load, preventing the grid from becoming more and more reactive.

While at ArioGenix Dr Putter developed an electric controller/grid interface for low speed hydro turbines in Ireland via Mitsubishi Electric Europe. While at ArioGenix (2017), Dr Putter developed a micro-grid specification for Eskom. The specification includes battery storage, Diesel Generator integration and an optional grid connection. Also included in the specification is the monitoring and control system.

Further aspects such a service extension package for the Diesel Generators were also considered and developed further. This can be combined with the Diesel Generator Optimization system that was developed by Dr Putter, and mentioned earlier. The quad or multi battery management system mentioned earlier is also an option for micro grids that can be used in microgrids to extend the battery warranty and life expectancy. These are value adds to the microgrid design that can reduce the life cycle costing.

Dr Putter was also responsible for developing a comprehensive proposal for a micro grid project for the ECOWAS countries via Mitsubishi Electric. A further proposal for Mitsubishi Electric Europe was developed for the UK Capacity Market, which comprised a very large, rapid response battery storage system to support grid during the start-up time of generators in response to increased demand.

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ANDRIES HERCULES PUTTER

POWER ELECTRONICS ENGINEER

DETAILED WORK EXPERIENCE

2018 - PRESENT

DETAILED WORK EXPERIENCE

Self-employed

Engineering Consultant

Dr Putter left ArioGenix to continue on his own. Subsequently Dr Putter was contracted to develop a power supply for a UAV (project mentioned earlier) which he did successfully. This design was done within very strict product price constraints, and the design had to make use of freely available, low cost components. This is quite difficult to achieve for such a demanding application, but Dr Putter achieved this.

During the development Dr Putter worked with other specialists in the team, including software developers, printed circuit board design and test engineers, as well as the rest of the UAV development team. Dr Putter also worked with a mechanical engineer on the finite element design of the heat sink. The final product performance is very close to the predicted results in all aspects, including the thermal design.

Dr Putter made extensive use of LTSpice for the simulation of the power supply, and the simulated results correlated well with the experimental results. Usually, switch mode power supplies produce high levels of EMI, but in this design this aspect was completely managed from the start (which is usually not the case), and the final design is well within EMI requirements.

Dr Putter is currently involved in research on high power pulse power electromagnetic radiation for a local defence company. This work includes fundamental research into non-sinusoidal electromagnetics and high-power pulse generation. This work includes magnetic flux compression, and a provisional patent was filed on a new, re-usable flux compressor. Dr Putter has done extensive research on flux compression and non-sinusoidal electromagnetic radiation. This project is ongoing.

Dr Putter also developed two products for the consumer market in the renewable energy space, the Power Buddy and the Powa Buggy.

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