Impact Report

2018/19

the dti
Department:
Trade and Industry
REPUBLIC OF SOUTH AFRICA

CSIR
our future through science

An Initiative of the Department of Trade and Industry, managed and hosted by the CSIR

AISI Vision

To position South African aerospace and defence-related industry as a global leader, in niche areas, whilst ensuring effective interdepartmental participation and collaboration.

AISI Mission

To enhance the global competitiveness of the South African aerospace and defence industry by:

- Developing relevant industry focused capabilities and facilitating associated transfer of technology to industry
- Providing a platform for facilitating partnerships and collaboration amongst government, industry and academia, locally and internationally
- Identifying, developing, supporting and promoting the interests and capabilities of the South African aerospace and defence industry
- Accelerating the achievement of government strategic objectives including growth, employment and equity

Contents

1

Executive Summary

In presenting this Impact Report for 2018/19, the management of the Aerospace Industry Support Initiative (AISI) extends its gratitude to the AISI team; its main stakeholder, the Department of Trade and Industry (**the dti**); and the AISI's host organisation, the CSIR, as well as to every organisation that has supported and participated in the AISI's programmes during the 2018/19 financial year.

The dti, through its Advanced Manufacturing Chief Directorate, established the AISI to support the South African aerospace and defence industries to improve its competitiveness.

The AISI derives its strategic direction from government objectives such as the industrialisation of technologies, job creation and industry transformation. The AISI collaborates with other players in the National System of Innovation such as industry, government departments and academia to address aerospace industry challenges.

Technological advancements

Rapid technological advances, as well as increased globalisation, present significant challenges to small, medium and micro enterprises (SMMEs) in the South African aerospace industry. Substantial investment is required to keep abreast of technological developments such as additive manufacturing, the 4th industrial revolution, advanced materials including composites, and product refinement to match market needs. The AISI supports these SMMEs by 'de-risking' of technologies through technology transfer, validation and the provision of product development support to enhance local content. This gives the SMMEs access to new market opportunities and to technological advances that would otherwise be unattainable.

Technology roadmapping

During the 2018/19 financial year, the AISI carried out eight technology roadmapping workshops. The tool enabled the AISI to identify and support seven projects in the 2018/19 financial year. Positive feedback was received from the beneficiaries of this process. The process has also enhanced the AISI's understanding of the capabilities within the industry. The AISI is now able to match some of the SMMEs to required capabilities as needed.

AISI programmes

The AISI strives to ensure the competitiveness and sustainability of the local aerospace industry and executes its mandate through four main programmes, namely:

- Technology Based Supplier Development;
- Industry Development and Technology Support;
- Sector Strategic Support Initiatives; and
- Coordination, Promotion and Awareness.

Figure 1 shows the percentages invested by the AISI in the four programmes. The percentages are aligned with the current AISI priorities and with the strategic intent of its main stakeholder, **the dti**. 58% of the AISI's budget for the year was invested in Technology Based Supplier Development projects. These include technology enhancement, standards

and accreditation and supply chain improvement projects. The level of funding allocated to Technology Based Supplier Development in 2018/19 is not at the level initially planned as a result of funding that was allocated to the Commercial Aerospace Industrial Development Study (CAIDS) under Sector Strategic Support Initiatives. 21% of the budget was invested in Industry Development and Technology Support projects. 17% of the budget was invested in Sector Strategic Support Initiatives with the major portion of the investment allocated to the CAIDS. The remainder was invested in Coordination, Promotion and Awareness.

The AISI supported 16 projects under the Technology Based Supplier Development Programme and 9 projects through the Industry Development and Technology Support Programme. The Technology Based Supplier Development Programme will continue to be a significant pillar of the AISI.

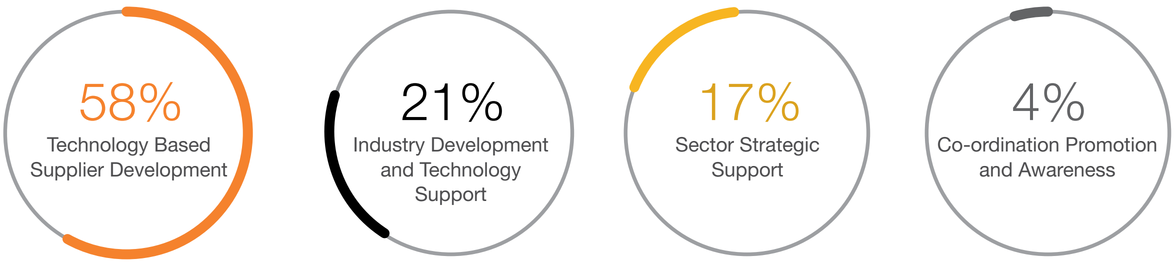
AISI impact

During the 2018/19 financial year, the AISI undertook 25 projects, benefiting 32 SMMEs directly and indirectly from AISI support. As a result of the AISI support, 18 jobs were created in the participating companies.

The projects supported during the 2018/19 financial year covered technology streams such as advanced materials and manufacturing, avionics, sensors, propulsion, space and aerostructures, which highlight the diversity of projects supported by the AISI.

This Impact Report provides narrative reports of the projects, based on interviews with beneficiaries, as well as information to enhance understanding of the nature of each project.

Figure 1: AISI budget breakdown by programme



2 Impact and Benefits

13

New or advanced manufacturing processes

16

Technology developments or advancements

31

SMMEs supported (direct and indirect)

54

People trained

18

Jobs created

150

Jobs retained

6

Export capacity achieved

4

Import substitution achieved

Facilitated access to national infrastructure – number of academic institutions and science councils involved

8

NB. Statistics have been sourced from project beneficiaries

3

PROGRAMME 1:

Technology Based Supplier Development

The AISI's Technology Based Supplier Development Programme provides enabling mechanisms to assist the industry in improving its competitiveness, productivity and quality management systems. This allows for optimisation of operations and procedures to ensure that the South African aerospace industry is able to integrate into global supply chains. The strategic focus remains on SMMEs with the objective to ensure industry transformation, and broadening of the economic base participating in the industry. The programme is made up of three interventions, namely:

- Technology Enhancement
  – Technology Transfer and Validation
- Standards and Accreditation
- Supply Chain Optimisation

High-level information regarding the Technology Based Supplier Development initiative is summarised in Table 1.

Table 1: Technology based supplier development impact summary

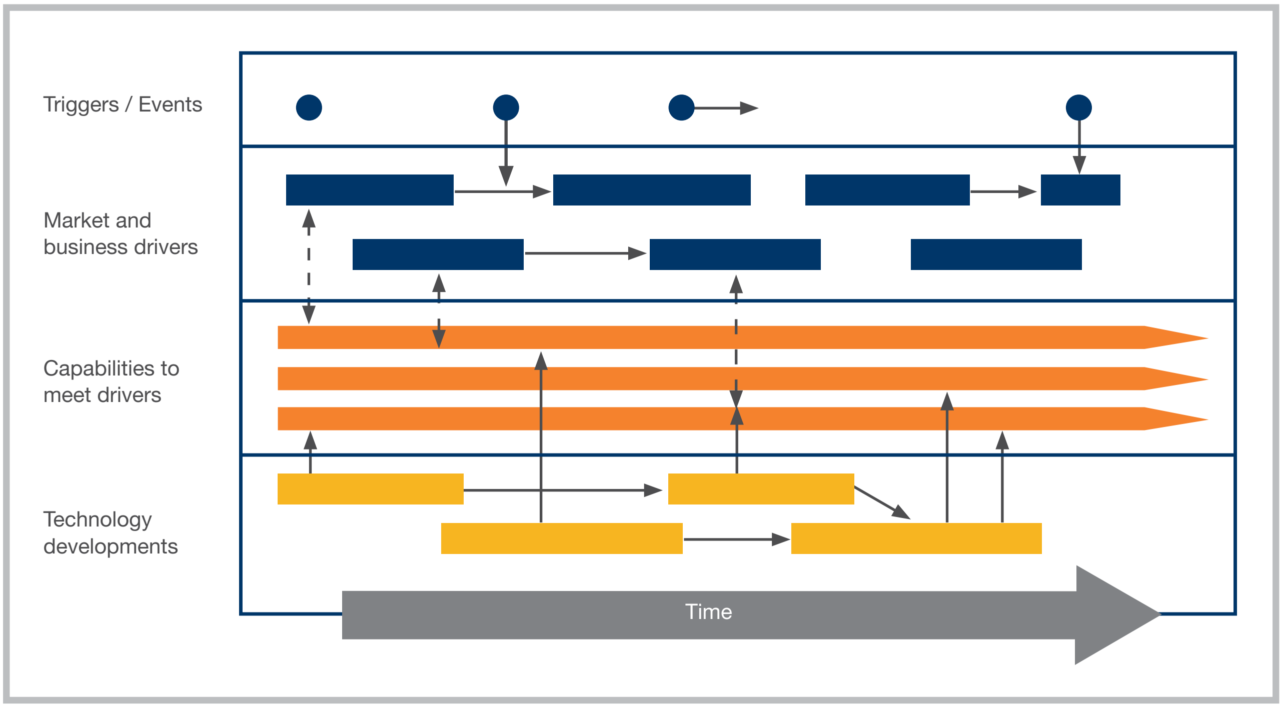
Programme Focus	Technology Enhancement, Standards and Accreditation, Supply Chain Optimisation
Predominant technology stream	Aerostructures, materials and manufacturing, & avionic/sensors
% AISI investment of project budget	58%
Number of projects undertaken	16
SMMEs supported	20

Resulting impact on industry	
Technology development / advancement	8
Manufacturing process	9
Number of jobs created or retained	150
Facilitated access to national infrastructure – number of academic institutions and science councils involved	5

Technology Roadmapping for Technology Enhancement

The AISI commenced the use of technology roadmapping as a tool for identifying projects during the 2017/18 financial year. During the 2018/19 financial year, the AISI carried out eight technology roadmapping workshops. The technology roadmaps were based on the Cambridge T-Plan methodology customised for AISI requirements.

Technology roadmapping is a critical technology management tool the AISI uses to identify sustainable projects that fit into the benefiting companies' strategies and technology plans. It also provides the companies, especially SMMEs, with a tool for them to communicate their technology plans in the short, medium and long term. This assists SMMEs with long-term technology planning and prevents over-reliance on a small number of customers. Identification of relevant technologies and new markets during technology roadmapping can help with diversification of SMMEs' customer base. The AISI uses this tool to build longer term partnerships with industry.



Some of the benefits of technology roadmapping include the following:

- Due to its structured and collaborative approach, technology roadmapping helps engender confidence in potential funders. This is one of the reasons why the AISI selected technology roadmapping as a tool for identifying and selecting projects.
- It is a flexible tool that is adaptable to the needs of any firm, organisation or sector. This is especially relevant in the case of SMMEs as the main beneficiaries of the AISI.
- The output of the roadmapping process is a visual representation which makes communication across the organisation and with external stakeholders easy. The beneficiaries are in a position to use the technology roadmaps for other purposes unrelated to the AISI, for example, when approaching other potential funders and stakeholders.
- Decision-making is consensus based and transparent and this contributes to technology buy-in within the company or organisation.
- The approach helps to align commercial and technology/technical strategy.
- Roadmaps assisted the AISI to identify collaboration opportunities among local industry.

Table 2: The participating companies in the 2018/19 financial year

Name of Company	Type	Technology Stream
LambdaG	SMME	Avionics, Surveillance and Sensors
Lantern Engineering	SMME	Avionics, Surveillance and Sensors
Shrike Marine	SMME	Avionics, Surveillance and Sensors
Thata Ubeke Manufacturing	SMME	Electronics and Defence
Cybicom Atlas Defence	SMME	Avionics, Surveillance and Sensors
Aerosud Aviation	Tier 1/2	Aerostructures
Jonker Sailplanes	OEM	Aerostructures
TraX Interconnect	SMME	Electronics

Benefiting organisations were identified through a 2018/19 Expression of Interest call advertised by the AISI. The technology roadmapping exercises were facilitated by the AISI with participation from the benefiting organisation as well as **the dti**.

Feedback from beneficiaries

The application of technology roadmapping for identifying projects has been a huge success for the AISI. Positive feedback was received from the beneficiaries of this process. The tool has also enabled the AISI to identify and support seven projects in the 2018/19 financial year. Technology roadmapping provides assurance to the AISI when supporting projects because there is a clear technology plan that is linked to market trends and drivers. The process has also enhanced the AISI's understanding of the capabilities within the industry; the AISI is now able to match some of the SMMEs to required capabilities as needed. The seven projects that were developed from the technology roadmapping exercises are included under the Technology Based Supplier Development section of this report.

Standards and Accreditation

Standards and accreditation are crucial for SMMEs to improve their competitiveness, open up new markets and increase their productivity, among other benefits. As part of the Technology Based Supplier Development Programme, the AISI offers support for implementation of relevant standards and accreditations for aerospace SMMEs. The AISI always supports SMMEs as needed with implementation of the following standards:

- AS/EN9100: Aerospace Quality Management System;
- ISO9001: 2015: Quality Management System; and
- ISO 14001: Environmental Management System.

SMMEs are also supported with the implementation of other standards, as deemed necessary.

Table 3: List of Companies for Standards and Accreditation

Company Name	Type of Support	Status
Shrike Marine	ISO9001:2015 gap analysis and implementation as part of phased approach to AS/EN9100	Completed
Daliff Precision Engineering	ASEN9100 Rev D Certification	Completed
Thata Ubeke Manufacturing	AS/EN9100 gap analysis and implementation	Completed
TiTamed	AS/EN9100 surveillance audit	Completed

COMPLETED PROJECTS

Residual stress reference sample

Residual Stress Distribution in Billets

Overcoming distortion problems in slender parts production through residual stress distribution

PROJECT AT A GLANCE

Aerosud Aviation undertook a project to investigate how best to assist a machining supplier overcome distortion problems when producing slender parts, which was resulting in higher production cost and longer lead time. Two methods were investigated. The first was to clamp the part between successive machining. The second method involved the use of nuclear diffraction to map residual stress in billets as well as simulation to determine the best depth at which to machine in the billet, and then machining the part at optimal depth in the billet. The outcome of the second method has helped the supplier to address the distortion problem in machining of slender parts.

Aerosud Aviation is an established leader in the South African aviation industry and a respected brand name in the competitive international marketplace. Aerosud has successfully secured a number of production contracts, mainly with Boeing and Airbus. Its parts supply is steadily growing to around 1.4 million per annum and beyond, which is a significant number, even by global standards.

Aerosud Aviation purchases various machined parts from a local machining supplier. This machining supplier is currently experiencing distortion problems, especially in slender parts. Slender parts, also known as thin-walled parts, offer light weight, material saving and compact structure. Distortion, however slight (<3mm), negatively affects supply as additional machining is needed to correct the distorted sections, with higher costs and longer production lead time. Failure to deliver parts to specification may jeopardise Aerosud Aviation's reputation as a reliable supplier.

"This was an untenable situation in the long run," explains Wouter Gerber, Research and Development Manager at Aerosud. "The specific part in question is the stow rack panel, and we needed to find a way to address this problem of recurrent distortion during the machining process." This part, which forms part of the interior of a plane to accommodate cabin baggage, is machined from 1050x460x30mm plate alloy billets produced at a foundry.

With support from the AISI, Aerosud Aviation set about to identify and develop a feasible way to solve this distortion problem and thereby minimise machining time and cost of slender parts. As a test case, a slender part with dimensions 26mm thick, 1000mm long and 400mm wide was used.

Gerber explains, "For the first method, the part was machined from a billet that was 35mm thick. We tried forceful correction of distortion by clamping between machining steps. The machining steps were also minimised and the part was machined as fast as possible.

"We found that this method was not successful as the part still distorted by 2.336mm."

Aerosud then partnered with the Nuclear Energy Corporation of South Africa (Necsa) to use neutron diffraction technologies to determine the residual stress distributions through the billets. Residual stress is an internal stress distribution, so it is not visible. Neutron diffraction, however, has unique deep penetration and three-dimensional mapping capability, and therefore could give a good idea of how residual stress is distributed.

Residual stress measurements were made over the complete surface volume of a 35mm-thick billet. Residual stress measurements were also made on a quarter of a billet that was 50mm thick, to compare its residual stress to that of the 35mm billet. Gerber says, "From all results we obtained after these measurements, the stress distribution can be best described as random. No general pattern can be identified."

Next, the outputs of the residual stress measurements from Necsa were used as inputs to Aerosud's stress analysis team, who was assisted by ESTEQ. By using the simulation software, MSC Marc/Mentat for finite element analysis, residual stress distributions were imposed over the billets and the machining process as well as the resultant distortion simulated. "This was the next step to figure out how to improve the machining process," Gerber says. "Using simulation meant that we could keep trying until we found a solution."

Various depth placement positions were simulated to find the depth placement (within the billet) that would result in minimal distortion.

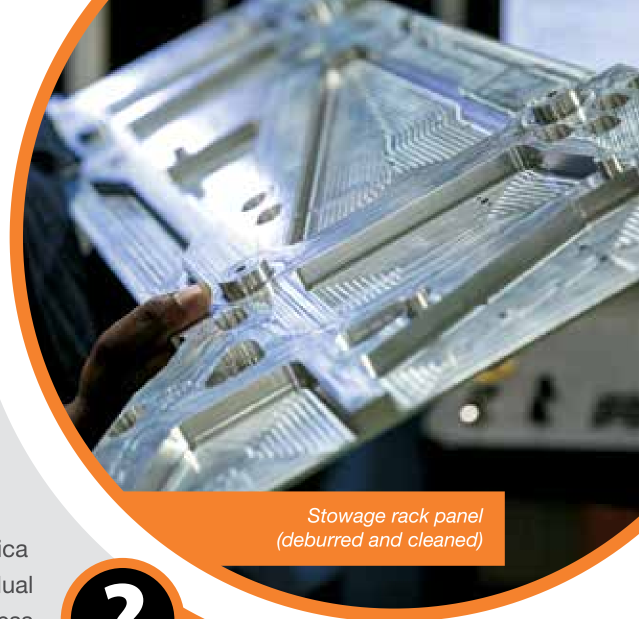
"With these simulation results as a guide, we started our second round of machining," Gerber explains. "It was all about determining the optimal placement of the machining within the billet. We used the same machining parameters as the first method."

The good news for Aerosud Aviation is that this second machining method proved to be more successful than the first method in minimising the distortion.

Gerber points out several other findings. "We were successful in integrating neutron diffraction residual stress measurements with MSC Marc/Mentat finite element analysis simulation. We also found that predicted finite element results and actual measured results from the machining trial were close."

He notes, however, that neutron diffraction measurement of residual stress is neither cost-effective nor fast enough to be used commercially. "We must find an alternative cost-effective and quick method," he says.

It does seem that Aerosud Aviation is well on the way, through ingenuity, sound research and development, and partnerships, to helping the machining supplier solve the distortion problem in producing slender parts.



Stowage rack panel (deburred and cleaned)

Technical terminology explained

Clamp: *A clamp is a fastening device used to hold or secure objects tightly to prevent movement or separation.*

FInite element analysis: *A computerised method for predicting how a product reacts to real-world forces and effects.*

Partners and collaborators

- Necsa
- Daliff Precision Engineering
- West Engineering

Highlights

- Solutions for distortion in production of slender parts
- Enhanced machining of slender parts
- Neutron diffraction measurement of residual stress
- Simulation of depth placement positions for machining

CONTACT

Wouter Gerber

w.gerber@aerosud.co.za

COMPLETED PROJECTS

Laser Shock Processing for Straightening of Machined Aluminium Spars

Using laser technology to correct distortion in aerospace components

PROJECT AT A GLANCE

Denel Aeronautics focused on a specific component, a machined aluminium spar, which is particularly prone to post-machining distortion (bending) and considered the development of laser shock processing (peening) as a technology to reverse this undesirable distortion. The work included extensive capability development in terms of process characterisation, process development, and infrastructure customisation to make successful implementation possible. It was also important to ensure that the laser shock processing did not alter the material; this was factored into the laser shock processing. When the laser shock processing was finally implemented to a recently scrapped machined component (spar), the shape of the component was modified to acceptable deviations.

Denel Aeronautics (DAe) manufactures a significant number of structural components for the global aerospace industry by precision machining of aluminium. One of the challenges of manufacturing thin-walled structures is the resulting post-machining distortion. A number of machined components are scrapped due to this distortion problem as the components fail the geometric tolerance specifications – they are out of shape and unusable.

The aluminium spar in question is a component in the winglet of a business jet, which takes the bending load. It is manufactured to tight tolerance, and is measured in percentages: less than 2% is acceptably 'in shape'; more than 2% is deemed 'out of shape' and will be scrapped. This distortion is thought to result from residual stress in the aluminium billets (semi-finished casting products), which are used in the machining process.

Through support from the AISI, DAe embarked on the process to see whether the laser shock processing technology could be used to straighten the spars that were found to be out of shape. DAe Chief Engineer Alcino Cardoso notes, "This is not a problem that can be bent straight by hand."

He emphasises, however, that neither material properties nor structural integrity could be compromised through this process. "We had to find the right range in which to use laser shock processing, so that we did not inflict more damage on the component," Cardoso states. Testing for fatigue damage was done to conform to the standard, ASTM E466-15.

Measuring distortion on a machined spar after laser shock processing

From left: Daniel Glaser, Preteshkumar Daya

Another challenge was the fact that each of the machined aluminium spars had a different distortion. A specialised jig (a type of custom-made tool used to control the location and/or motion of parts or other tools) was designed and manufactured. It includes a precision laser displacement sensor that can be positioned along the length of the component for in-process verification, and therefore effective handling of different distortion requirements during laser shock processing.

Three promising findings emanated from the project. First, the micro-structure of material was not damaged, as was shown by the images from a scanning electron microscope. Second, laser shock processing parameters (range) were identified, which would not make the material susceptible to breaking; and third, machine-induced distortions could be fixed within an acceptable level.

Cardoso points out, "Given stringent requirements placed on original equipment manufacturers, it was required by DAe to develop a detailed list of activities for aerostructural component forming by laser shock processing."

He concludes, "It would seem that this process has the potential for commercial application in aerospace. It's expensive, but then it would be used on high-value components. It would do away with scrapping, which is a big waste in material and productivity and a concern for manufacturers.

"This successful demonstration of the technology sets the stage for the following act, which is to certify and qualify the process according to the original equipment manufacturer's requirements."

It is clear that the demonstrated success of the laser shock processing has placed South Africa in the global spotlight with a reputation for a competency in this field. The AISI support directly impacts the global competitiveness of South Africa within the global aerospace manufacturing sector.

Technical terminology explained

Laser shock processing *acts as a precision hammer to provide highly engineered distortions into high-end components for high performance applications. The technology utilises a pulsed laser that improves metal fatigue life and damage tolerance.*

Residual stress *are locked-in stresses within a metal object.*

Partners and collaborators

- CSIR

Highlights

- Successful laser shock processing to straighten spars
- No damage to microstructure of material
- Definition of laser shock processing parameters
- Fixing of machine-induced distortions

CONTACT
Alcino Cardoso
Alcinoc@denelaero.co.za

COMPLETED PROJECTS

The CAT 120, CAT 250, CAT 400 turbines showcasing some of the capabilities at CAT

Small gas turbine to market

Local market niche

Made in South Africa: Jet engines in micro and small sizes

PROJECT AT A GLANCE

Cape Aerospace Technologies, an SMME based in Cape Town, completed the design, integration and manufacture of a 250N Micro Gas Turbine ahead of schedule. The work and developments on the 250N gas turbine progressed to the point of exceeding performance of similar engines on the market. During extensive experimental testing in the on-site laboratory, the 250N gas turbine produced a thrust of 257N. Cape Aerospace Technologies exhibited at the Africa Aerospace and Defence Airshow and Defence Exhibition in September 2018, which attracted interest from local and international clients. Following this promotional exercise, orders for the 250N gas turbine were received, and more orders have been placed.

Small gas turbines are much in demand by hobbyists for use in model aircraft, by sailplane manufacturers as the mechanical backup or range extender, and by the military for weapon systems. As there are no South African aerospace companies in this field, Cape Aerospace Technologies seized this local market niche to manufacture high-precision micro to small gas turbines. The company is proud to have concluded the development of the 250N Micro Gas Turbine, a type of jet engine, which is sought after by the defence industry.

Cape Aerospace Technologies' David Krige is passionate about his work. "My childhood dream was to fly," he says. While he has not yet realised this dream of human flight, he and co-founder Andre Baird run a small but thriving business established in 2013, manufacturing a range of gas turbines: 120N, 250N, 400N and larger turbines.

Cape Aerospace Technologies developed a roadmap for the developmental process which set out goals and milestones. Referring to the entire development on the 250N gas turbine, Krige explains, "It's been exacting and unforgiving work, with no shortcuts. Our decision to focus on quality means that we did everything in-house."

With support from the AISI, the 250N Micro Gas Turbine was taken from design to market through streamlining of, and verification during this developmental process.

But what stages did Krige and his team tackle in this journey to manufacture and assemble multiple intricate parts that make up the 250N? Stage 1 was strictly numerical design, utilising computational fluid dynamics and computer aided design computer programmes. "This is all about assembling parts on the computer in an optimised (best) environment to see how well they work together and where we can improve on our design," Krige points out. Turbomachinery engineering of this nature is a niche skill, and Krige is fortunate to have a good relationship with Stellenbosch University and the CSIR.

Stage 2 involved the use of computational fluid dynamics to match the compressor and turbine to determine whether the turbine could drive the compressor. This stage optimised the compressor and diffuser (to extract pressure) design to match the turbine characteristics.

By stage 3, things were starting to take shape. The final engine design and all components related to the newly designed gas turbine were assembled using computer aided design, and checked, after which they were manufactured. Once the manufactured parts had cleared the quality control checkpoint, they were assembled in the 250N turbine.

At stage 4, all experimental testing was done on the 250N gas turbine in the on-site laboratory, and experimental and numerical results were compared.

Stage 5 involved the upgrade of the previous turbine control unit and user interface, which were redesigned and reprogrammed with more features to make them more robust and easier to use. Enhanced aesthetics (good looks) were added to improve the user's experience.

Finally, stage 6 was concluded: the use of intelligent design and investigation of processes to streamline the design-to-manufacture process, to minimise the wastage of material and time.

Krige highlights some challenges encountered during this exciting innovative process. "The casting of the turbine wheels had to be done through vacuum-induced investment casting, a technology not readily available in South Africa at present. Hopefully this will change in the future as the CSIR is planning to bring this plant back into production and purchase the alloy.

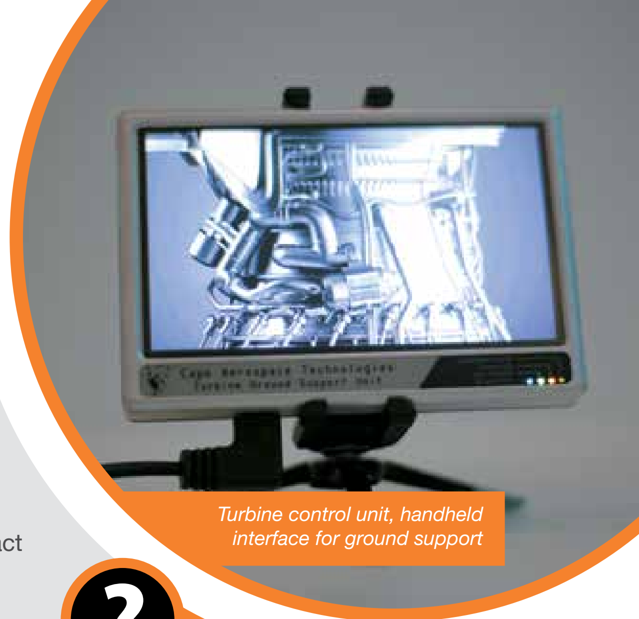
"We also learnt through experience that industrialisation for the market, which involved stages 5 and 6, is neither simple nor quick. We're still working on market readiness and will continue to market our products at upcoming trade shows in Brazil and London this year."

Through technical expertise, good planning and with the support of the AISI, Cape Aerospace Technologies is set to contribute to the aerospace sector in the Western Cape and take its place in the global aerospace market.

Technical terminology explained

The letter, N, *in the model name, denotes a unit of measure, the Newton (named for Sir Isaac Newton, famous physical scientist of the 17th and early 18th centuries). 1 Newton (N) is equal to the amount of force (thrust) required to accelerate a 1kg object at a rate of 1 metre per second, every second.*

Computational fluid dynamics *uses applied mathematics, physics and computational software to visualise how fluids (gases or liquids) flow and as well as how fluids affect objects as they flow past.*



Turbine control unit, handheld interface for ground support

Technical terminology explained

What's in a micro gas turbine?

The main parts of the micro gas turbine are the compressor; the diffuser (which extracts pressure); the combustion chamber; the nozzle guide vanes (for hot gas); the turbine wheel; the nozzle (providing thrust) and the engine housing. Bigger turbine engines have similar parts, as they work on the same principle to provide thrust.

Partners and collaborators

- Stellenbosch University
- CSIR

Highlights

- Development of the 250 N Micro Gas Turbine concluded
- Focus on quality through in-house manufacturing and assembly
- Orders received for the 250N gas turbine

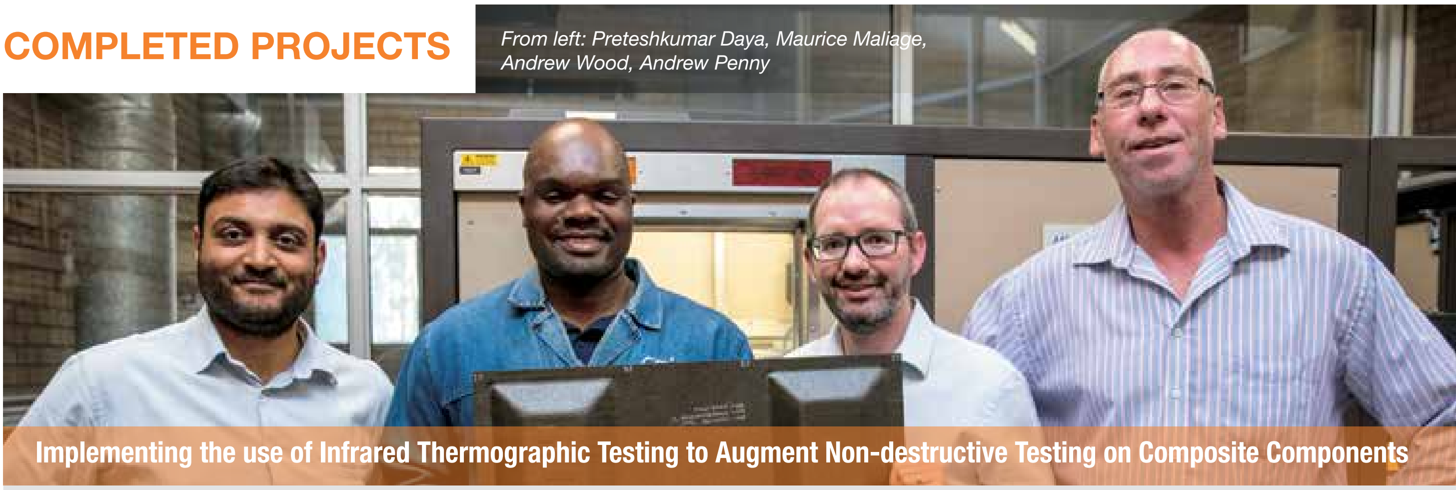
CONTACT

David Krige

david@capeaerospace.tech

COMPLETED PROJECTS

From left: Preteshkumar Daya, Maurice Maliage, Andrew Wood, Andrew Penny



Implementing the use of Infrared Thermographic Testing to Augment Non-destructive Testing on Composite Components

Identifying defects in aerospace composites using infrared thermography

PROJECT AT A GLANCE

Denel Aeronautics has proved the value and usefulness of a complementary non-destructive testing (NDT) technique, infrared thermography, to provide additional information on defects identified using other NDT technology in composite parts used in aircraft. The integrity of composite panels in aircraft is important for four reasons: safety of the aircraft and its passengers; the composite repair process; on-time delivery; and costs associated with the aforementioned factors. Infrared thermography was effective in pinpointing the precise location of identified defects on the inner or outer surface of a sandwich-construction panel. It is also effective when used on monolithic composite material. Based on these findings, the standard operating procedure for infrared thermography inspection (documenting all steps in the process), could be of great value to the aerospace and industrial manufacturing sectors.

As a tier one supplier to Airbus, Denel Aeronautics (DAe) is an advanced aerospace manufacturing organisation, supplying both metallic and composite components to the Airbus 400M final assembly line. This programme experienced challenges in identifying defects in honeycomb-type composite structures, with resultant expensive repairs and even scrapping of structural components. A clear business imperative exists to limit wastage and unnecessary spend, and to find out how to achieve this.

However, it is important to understand why composite parts are so important in aerospace. Weight is everything when it comes to heavier-than-air machines, and designers work continuously to improve lift-to-weight ratios. Composite materials have played a major part in weight reduction. They also have some remarkable properties: each type has different mechanical properties and is used in different areas of aircraft construction.

As part of its standard manufacturing process for some 120 specific A400M components, DAe uses two types of NDT methods: through-transmission ultrasonic testing (C-scan) for sandwich regions; and pulse-echo (A-scan or phase array) for monolithic parts. However, these technologies deliver, at best, indications of regions and depths at which defects occur, and do not help in identifying the type of defect.

DAe worked with the CSIR as the user of the infrared thermography technology to assess how well infrared thermography worked as a complementary NDT technology for quality production and reduction of scrapping in a real-life production context.

This was no mere plug and play exercise. DAe's Alcino Cardoso explains, "We put research milestones in place. This included understanding of relevant standards, training of staff, establishment of a test method, development of a standard operating procedure for use at DAe, determining of requirements for calibration reference panels, and planning and manufacturing of these panels. We also considered the limitations of the system on practical applications.

"Finally, we were able to identify main uses of the technology and potential cost savings." That is a short summary of a lot of work.

What are these undesirable defects that occur in composite materials? The text box lists some of these faults, all of which compromise the quality of the part in which they are found.

Honeycomb delamination	Monolithic delamination
Honeycomb disbond	Monolithic liquid ingress
Honeycomb inclusions	Monolithic inclusions
Nodal separation	Monolithic foreign object

To determine how well infrared thermography performed as a complementary NDT method in identifying these defects, panels identical to real parts were built at DAe, but with known defects incorporated.

Detailed results from the tests on these specimens were used in the research. At the same time, it was important to note both the efficacy and limitations of using infrared thermography.

Was it all worthwhile? Cardoso believes so. He says, "In the Denel context, the correct identification and location of the defects in honeycomb core structures provide considerable quality improvement, and cost and time savings. Rejection of defective components, which would otherwise not be detectable using conventional methods, is possible.

"This will contribute to improved efficiencies, productivity and on-time delivery. Infrared thermography also makes it possible to better classify and categorise defects, opening the way for DAe to work with Airbus on a qualification programme for parts supplied."

He notes that further industrialisation is needed and strongly believes in the potential of infrared thermography capabilities to benefit the entire South African composite industry.

Carbon fibre monolithic /sandwich test panel with built-in defects

Technical terminology explained

***Infrared thermography** detects infrared energy emitted from an object, converts it to temperature, and displays an image of temperature distribution.*

*A **sandwich composite** is a special form of a laminated composite comprising a combination of a core and a bonded skin or laminated on either side of the core.*

*A **monolithic composite** is a laminate made of only one type of material.*

Partners and collaborators

- CSIR

Highlights

- Infrared thermography for NDT
- Effective for sandwich composites and monolithic composites

CONTACT

Alcino Cardoso

Alcinoc@denelaero.co.za

PROJECTS IN PROGRESS

Machine vision

From left, standing: Moses Mbaimbai, Thabiso Mphuthi, Lerato Ramatsui, Petrus Nyathela
Sitting: Sandile Khumalo, Historina Hlanze, Dineo Hlongoane, Zelly Moropana, Benjamin Hlophe

PROJECT AT A GLANCE

The SmartCAM system is in the final stages of design and demonstration of the product. As far as possible, local suppliers of materials and components for this product have been used to ensure minimal importation. The design of this high-value optical system allows for customisation according to client specifications for a wide range of applications. With purchase orders already in place, Kutleng will move into industrialisation and seek local and international market opportunities for its novel product.

SmartCAM

SmartCAM system offers wide range of applications

A small camera system with a platform that is customisable to customer requirements and a range of applications, has neared the completion of the concept demonstrator. Kutleng Dynamic Electronic Systems, an SMME based in Randburg, received support from the AISI for the finalisation of this revolutionary new optical system. Benjamin Hlophe, Director of Technology Operations, says, “Kutleng is doing well because of the great assistance from the AISI programme.”

Hlophe’s prior industry experience of so-called ‘dumb’ cameras (with video functionality only) was the inspiration for the SmartCAM (i.e. smart camera). “Just as early single-purpose cell phones evolved to smart phones, so our SmartCAM has been developed to offer our customers the option to customise the product for particular applications,” he explains. Applications for the SmartCAM include environmental surveillance, agricultural monitoring and monitoring of urban areas, to name just a few.

Looking closer at SmartCAM, it becomes clear why this compact and neatly designed product packs such a punch. Each part of its design ensures significant value addition. It has a high-performance lens with a head enclosure for the lens and a printed circuit board, and an innovative electronic design for the processing printed circuit boards with a board enclosure. Commenting on its size, Hlophe says, “We followed the current engineering trend for miniaturisation with high functionality.”

C-Mount lens design

4 jobs created

Compact industrial intelligent camera

The design team of four people is committed to supporting the local supply chain, which has indirect socio-economic benefits. “We source local aluminium from Metal and Tool Trade for the mechanical enclosure. Prototyping was done at low cost by a local shared workshop and fabrication studio, Made In Workshop. TraX Interconnect in Cape Town supplies our high-performance printed circuit boards using sequential lamination technology for the integration platform. This means that the printed circuit boards must undergo multiple lamination cycles so that each set of drilled holes can be drilled, plated, and processed before all of the sub-laminations are put together. The assembly of the printed circuit boards is outsourced locally,” Hlophe confirms. TraX Interconnect had built this capability with previous support from the AISI.

The team is hands-on for all design challenges and is also committed to developing its own lens design capability, with support from an overseas expert to avoid possible infringement on patents. Polished glass for lenses is currently imported from the United Kingdom. “We’re learning as we go along and want to become independent of imports,” says Hlophe.

Industrialisation will require Kutleng to embark on scaling up. This will benefit companies associated with Kutleng but first requires financial outlay. It also involves international certification by the Japan Industrial Imaging Association for its lenses to confirm interoperability.

As part of its business model, Kutleng charges clients a fee to load software onto the encrypted platform. The company plans to target certain sectors, such as the automotive industry, where its product would become part of a value chain with benefits to local manufacturers and the potential for earnings from exports.

ARMSCOR was Kutleng’s very first customer and has remained a client. Hlophe says, “We’re fortunate to have purchase orders in place and are looking forward to taking our product through the industrialisation phase and growing our customer base.”

Partners and collaborators

- Metal and Tool Trade
- Made In Workshop
- TraX Interconnect

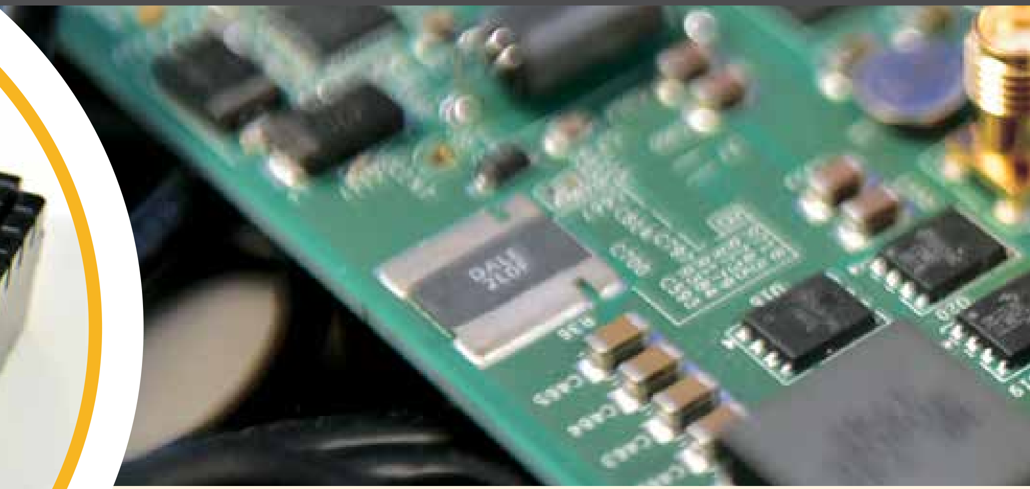
Highlights

- SmartCAM system in final stages of design and demonstration
- In line with current engineering trend for miniaturisation with high functionality
- Purchase orders in place

CONTACT
Benjamin Hlophe
info@kutleng.co.za

PROJECTS IN PROGRESS

Radio mechanical design



PROJECT AT A GLANCE

As a first step to technology localisation, Lantern Engineering has identified the need for capability to develop its in-house radio capability and a video-enabled radio (high data rate) for both the local and the international market. The company has spent time in recruiting two engineers with appropriate skills and with matching passion and a willingness to learn, as part of its plan to train and retain capability in this technology. Development kits for design and demonstration are used before the design is engineered into the hardware design for the customer. By using modern, cloud-based tools and techniques, Lantern Engineering keeps its business operation controlled and lean, while exploiting its capability in radio and video processing to meet market needs.

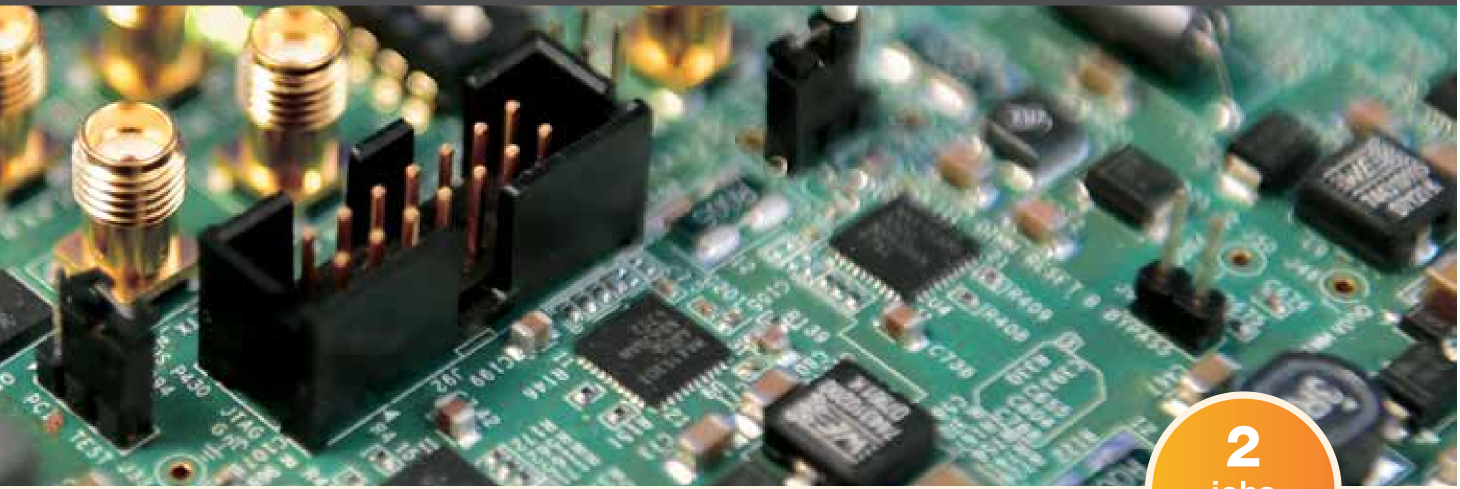
Lantern Technology Localisation

Ramping up local capability for radio and video processing technology

Communication equipment is essential to aerospace operations and the capability to develop radio and video processing technology to specification is a strategic advantage to South Africa. In the context of the slowdown in South Africa's industry, Lantern Engineering's technology localisation project aims to recruit, train and retain capability in this technology.

Application of radio and video technology is critical when using unmanned aerial vehicles (drones) in sectors such as agriculture and for security cameras. Ghaazim Rylands, who heads up business development and sales at Lantern Engineering, explains, "Drones are used in agriculture to monitor crops in fields and real-time video in this case must be made available to the farmer. So, we plan around factors such as line of sight to a ground station. In another application, we assist security companies with the technology and products required for private radio and video communication from security cameras."

Lantern Engineering regards people as central to its capability in radio and video processing technology. Key skills in-house underpin its ability to win business opportunities. Chris Williams, responsible for technology and products at Lantern Engineering, says, "We need to



2
jobs
created

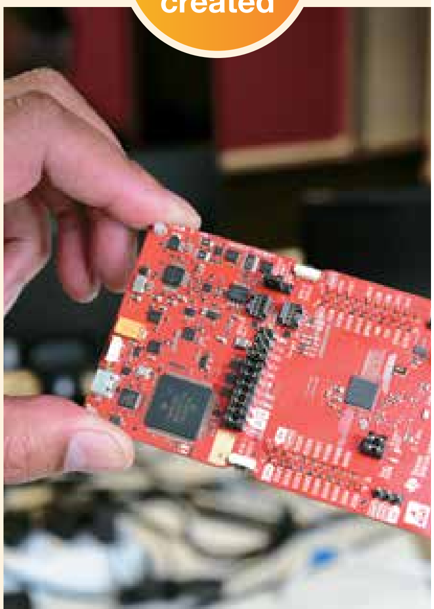
invest in new technology to meet the appetite of the market. Our first step has been to find and employ young energetic staff who enjoy learning and immersing themselves in fast-paced commercial technology."

After an extensive process, Lantern Engineering recruited two people from the pool of South African applicants, whose profiles, experience and skills sets match its business intent. As permanently employed engineers, Joshua Tatenda Mfiri, an MSc graduate with two years' work experience and Taariq Hassan, a BEng graduate with five years' work experience, commenced work on 1 March 2019. Both have demonstrated a passion for work and learning.

With these new colleagues on board, Lantern Engineering is making good strides in creating an in-house radio capability and developing a video-enabled radio (high data rate). Shareef Hoosain whose focus at Lantern Engineering is Programs, sets out the process going forward, "We use development kits for our designs, based on customers' requirements, as a de-risking exercise. Demonstrations are done with these kits and once we've converged on a baseline, we engineer or customise the design into a product that meets our customers' requirements."

Lantern Engineering has used Enterprise Architect to retain control of the requirements baseline of its design process. Hoosain explains, "This helps us to be both creative and run a controlled and lean process, which is extremely efficient and cost-effective."

From left: Christopher Williams, Ghaazim Rylands, Andrew Mangezi, Joshua Mfiri, Shareef Hoosain, Taariq Hassan (absent)



Texas instruments sub 1GHz and 2.4GHz development kit

Highlights

- Recruit, train and retain capability
- Matching of profiles, experience and skills sets to business intent

CONTACT
Shareef Hoosain
shoosain@lanterneng.com

PROJECTS IN PROGRESS

JS3 Serial Number 65 being weighed as part of the final procedures before test flight

Tsepho Malebo

PROJECT AT A GLANCE

Jonker Sailplanes is adding a new sailplane model, the JS2-24, to its product portfolio. The South African sailplane company lost podium position to the new German sailplane, the EB29R, in the Open Class of the 2018 World Gliding Championships in the Czech Republic. This 'latest kid on the block', designed by Binder Flugzeugbau, has a wingspan of 28m. Based on its aerodynamic team's preliminary performance calculations, Jonker Sailplanes is convinced that its JS2-24, with new technology applied on a 24m wingspan, will beat the EB29R.

24m Wingspan Open Class JS

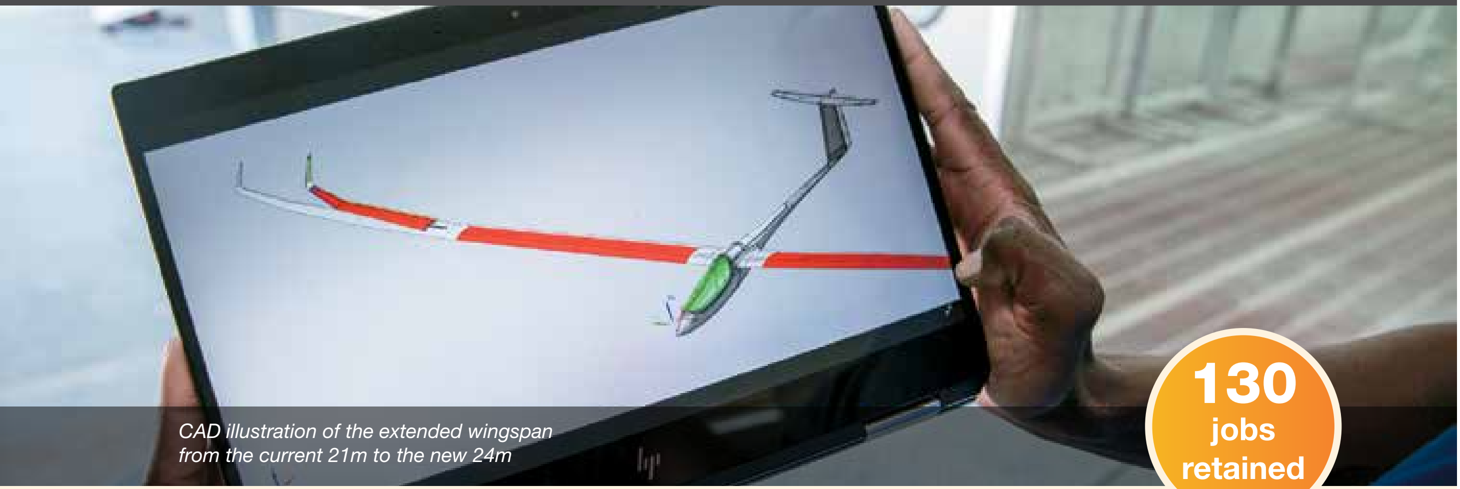
Jonker Sailplanes: Getting back to best in class

For many years, Jonker Sailplanes has had an unassailable market position as the only manufacturer of sailplanes outside Germany. Its sailplanes are rated as the best in the world and in demand for recreational purposes. They are sought-after products, flown by leading pilots from Germany, Denmark, France, Great Britain, the Netherlands, Czech Republic, Poland, Hungary, New Zealand, South Africa and the United States of America.

In the 2018 World Gliding Championships, the EB29R took the top three positions in the Open Class, pushing the JS1C-21 off podium. Uys Jonker, Chief Executive Officer of Jonker Sailplanes says, "Since then, we have received lots of requests from clients to develop a sailplane to match this competitor."

During the AISI roadmapping exercise for Jonker Sailplanes, the JS2-24 was identified for its local and international potential. The decision to add the JS2-24 to its portfolio to regain its market position has been boosted by support from the AISI for three years.

Advantages for Jonker Sailplanes in this project include the capabilities of its formidable design team, Dr Johan Bosman and Dr Attie Jonker, whose approach is to focus first on numerical modelling before using computer aided design for structural development. In addition, the well-established design and production facility in Potchefstroom has lower costs than its overseas competitors.


CAD illustration of the extended wingspan from the current 21m to the new 24m

130 jobs retained

As a start, the Jonker Sailplanes design team used its expertise to model and optimise the envisaged sailplane design by factoring in the variables of wingspan, twisting of wings and structure strength.

Using the Jonker Sailplanes numerical model, various parameters were used to interrogate different design options and the resulting effect on performance. Bosman explains, "Of particular interest for sailplane efficiency is speed versus rate of descent for a particular wingspan length and structural design. We regard the favourable modelling result for JS2-24 as a reliable indicator of superior performance for this new Jonker Sailplanes product."

The team has identified 24m as the optimal wingspan for the new product (hence the designation, JS2-24) and is confident that predictions will match performance. As the project progresses, the Jonker Sailplanes team will consider additional design aspects in year 1, such as detailed structural design, mould and tooling development, wing control system design, and composite tooling manufacturing. Years 2-3 are earmarked for industrialisation and certification.

Consistent brand promises are among Jonker Sailplanes' strongest selling points and with passion for excellence, it is clear that the team will put the JS2-24 back on the Open Class podium in the near future.

Technical terminology explained

Composites: *A composite material is made by combining two or more materials.*

Computer aided design: *A computer technology that designs a product and documents the design process.*

Numerical modelling: *A computer model that is designed to simulate and reproduce aerodynamic effects, in this case on a sailplane.*

Technical terminology explained

Tooling: *Manufacturing components and machines needed for production.*

Sailplane: *An unpowered aircraft, using naturally occurring currents of rising air in the atmosphere to remain airborne. Also known as a glider.*

Wingspan: *The distance from one wingtip to the other wingtip.*

Partners and collaborators

- OnTrack Technologies
- North-West University

Highlights

- New sailplane model in product portfolio
- Favourable modelling result for JS2-24
- Optimal wingspan of 24m

CONTACT

Uys Jonker
uys@js1.co.za

PROJECTS IN PROGRESS

Development component

From left: Wayne Wiid, Nick Swardt, Wouter Gerber, Jim Sepahane

PROJECT AT A GLANCE

Aerosud Aviation is developing a manufacturing execution system as part of a software platform to be integrated with a rotational moulding machine and installed at Pioneer Plastics (Pty) Ltd. The system will produce polymer components to specified quality. Pioneer Plastics has built a facility to accommodate this machine. The combination of state-of-the-art equipment and sophisticated communication infrastructure has advantages for both parties. It gives Pioneer Plastics a competitive edge in the market, while Aerosud will be able to communicate directly with Pioneer Plastics' production process to ensure that its complex polymer aerospace components, based on its cellular core technology, reach the global aerospace market as planned.

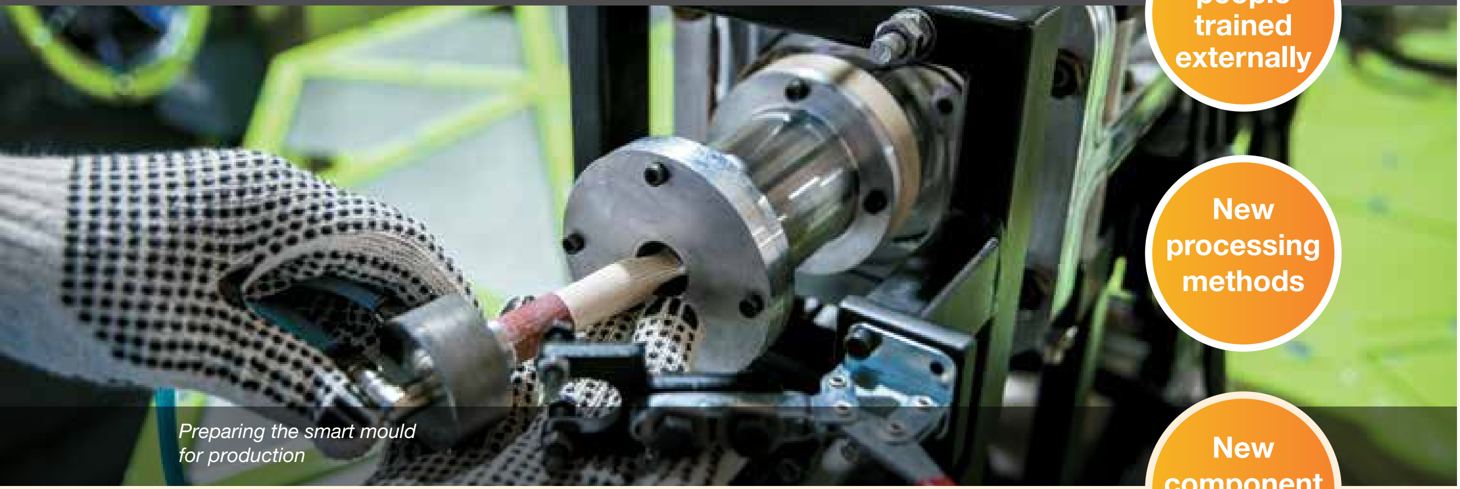
Strategic supplier development: Rotational Moulding

Strategic investment in equipment and software platform for polymer aerospace components

Aerosud Aviation, a South African aerospace supplier into the global supply chain, has teamed up with Tshwane-based Pioneer Plastics (Pty) Ltd, a leader in rotor moulding manufacturing. This strategic partnership has primarily two aims: to build the capacity at Pioneer Plastics in the production of polymer aerospace components for Aerosud; and to create a system for both parties to achieve scheduling in real-time for seamless prioritised production.

The brand-new rotational moulding machine, which recently arrived ahead of schedule from Italy-based company, Persico, will be used for production.

The question is, of course, how will Aerosud and Pioneer Plastics leverage the immediate advantages of this strategic investment. Initially, it has been all about getting hold of the right machine and local expertise. Wouter Gerber, Research and Development Manager



Preparing the smart mould for production

5 people trained externally

New processing methods

New component design

at Aerosud explains, "Aerosud bought the machine from Persico, which has been delivered to Pioneer Plastics and will be commissioned shortly. Pioneer Plastics, in turn, prepared the building to house this machine as a production facility and will receive training in the use of the machine."

The secret to successful production is the so-called manufacturing execution system that comprises coding the software and a computer interface, as part of a software platform with connectivity between the two partners. Gerber points out, "With support from the AISI, we're creating this system to turn the facility at Pioneer Plastics into a virtual cell in Aerosud's manufacturing activities.

"The prime advantage of this manufacturing execution system is to have real-time oversight of production, and to plan and prioritise our production requirements (components and delivery times) according to our business schedules. Pioneer Plastics will find itself operating in an integrated environment, allowing it to be interconnected to companies such as ours."

The SMART rotational moulding machine installation at Pioneer Plastics is the first of its kind in the southern hemisphere. This works to Aerosud's advantage as it stands to benefit from these technical enhancements and the streamlined production process. In addition, Pioneer Plastics has a route to new markets to complement its deep understanding of plastic moulding.

Another advantage of this strategic supplier development project is that it fits perfectly into the Aerosud technology roadmap, developed in 2018 with the AISI. This framework promotes in-depth development in the longer term of focused technologies and capacity. Gerber says, "The value of our technology roadmap lies in its background and motivation."

It is an exciting time for both Aerosud and Pioneer Plastics. "Through careful planning, individually and collectively, and Persico's willingness to expedite the order and delivery of the machine, this project is ahead of our milestones. We're making the dominoes fall!" he confirms.

Persico smart rotational moulding machine with test moulds

Partners and collaborators

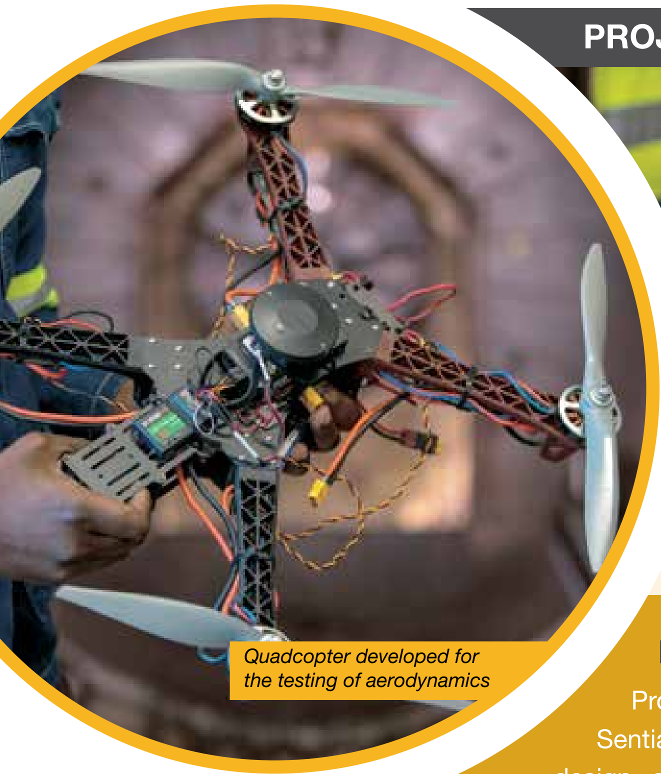
- Persico
- Pioneer Plastics

Highlights

- Capacity building in rotational moulding at Pioneer Plastics for production of polymer aerospace components
- Pioneer Plastics to become virtual cell in Aerosud's manufacturing activities
- New component design and manufacturing possibilities

CONTACT
Wouter Gerber
w.gerber@aerosud.co.za

PROJECTS IN PROGRESS



Quadcopter developed for the testing of aerodynamics

A 1/5 scale prototype aircraft used to validate the fixed wing performance of the UAV

PROJECT AT A GLANCE

Proceptworks (Pty) Ltd's aeronautical team working on the Sentian unmanned aerial vehicle (UAV) made further technical design, optimisation and development enhancements to the original design and parameters and decided on a hybrid system for better airborne performance. The minimum takeoff weight was reduced, and a generator identified and purchased. A small-scale model for testing was designed and components purchased. Advice from AMT Composites helped the team to find the optimal method of building the plug, moulds and the airframe. The company's electronic engineering team used the component layout diagram of the Sentian model in the component layout of the small-scale model. Success on the configuration of the transmitter/flight controller and constraints in terms of current delivery capacity of batteries on high torque motors were identified.

Sentian UAV

Sentian: Introducing a new locally made UAV

Four friends, Dalumuzi Dube, Edmund Moyo, Ishmael Chiremba and Nigel Nkundhande, with strong personal ties and a shared passion for technology in the service of humanity, came up with the idea of building this aircraft "from scratch" and named it Sentian. In its current shape, this modular UAV has a wingspan (tip to tip) of 5m, is 3m long and runs on 95 octane fuel (petrol). It is designed to be flown by a drone pilot or in autonomous mode. With the past support of the University of Johannesburg – Chiremba is an alumnus – and support from the AISI, these ambitious youth are well immersed in this project.

The name, Sentian, was chosen deliberately to evoke the concept, sentience, which is the capacity to feel, perceive or experience subjectively. Dube explains, "This project is the best fit for our interest and skills. We want to build this technology to support and help all forms of sustainable life, particularly in South Africa. We think of it as a drone for good."

The Proceptworks team has an ambitious list of potential applications for the Sentian UAV, such as monitoring of railway lines, crop spraying, surveillance of wildlife, and survival at sea. Each of these applications will have its own requirements for Sentian in terms of payload and

4 jobs created

range. Battery life and weight of the vehicle are critical in this regard and the design team is grappling with the right combination of critical parts and fuel to make flights of 12 hours possible.

The team is fortunate to have access to the wind tunnel at the University of the Witwatersrand (Wits). Nkundhande says, “The results we obtain will be compared with results from the computational fluid dynamics, and we’ll see how this affects the computer aided design process. Iteration is the name of this game, until we get it as close to perfect as possible.”

Once industrialisation is underway, the plan is to build one UAV a month. “This will be our moment when we prove the viability of the local drone manufacturing industry,” says Dube. “The industry is young and we’re keen to play our part in it. Spin-off industries, such as battery suppliers, will benefit.”

The Proceptworks team is grateful for advice and input received, particularly from Wits lecturer, Michael Boer. Dube says, “It helps that both Nigel and I studied at the Wits School of Mechanical, Industrial & Aeronautical Engineering.” ResearchGate, the social networking site for scientists and researchers to share papers, ask and answer questions, and find collaborators, has connected the team with other experts.

From left: Nigel Nkundhlande, Ishmael Chiremba, Dalumuzi Dube, Edmund Moyo

A 1/5 scale prototype aircraft to be used to validate the fixed wing performance of the UAV

Partners and collaborators

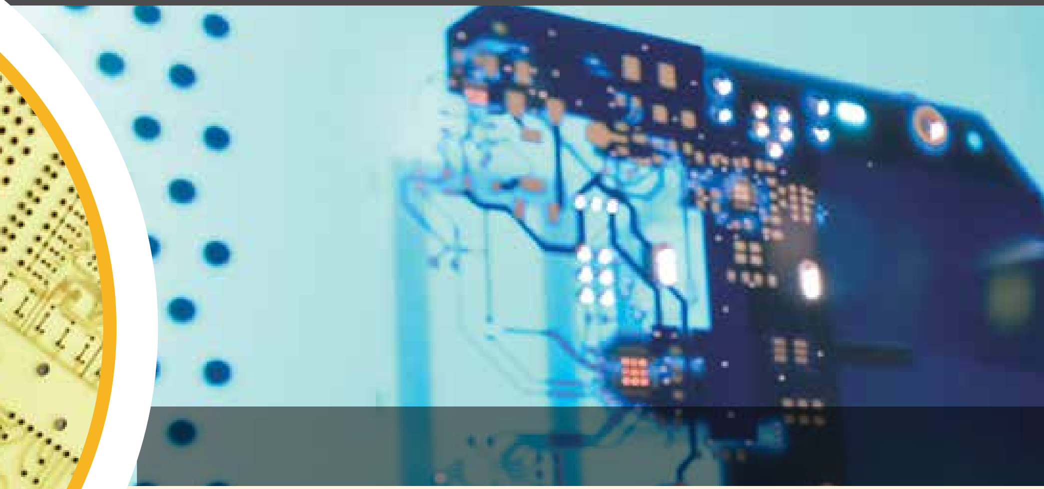
- University of the Witwatersrand
- University of Johannesburg
- AMT Composites
- Triwave Technologies (Mr Larry Sheer)

Highlights

- A drone for good
- Designed for flight by drone pilot or in autonomous mode
- Potential applications: monitoring of railway lines, crop spraying, surveillance of wildlife, and survival at sea

CONTACT
Dalumuzi Dube
muzie@proceptworks.com

PROJECTS IN PROGRESS



Eugene Dolweni examining some of the printed circuit boards

PROJECT AT A GLANCE

TraX Interconnect (Pty) Ltd has selected the appropriate equipment best suited to its processes, factory capacity and capability requirements to address the challenge of multilayer printed circuit board manufacturing, particularly the need to fill so-called blind vertical interconnect access (vias). As the equipment required is custom built to order, with lead times of up to six months, it was critically important to order the equipment at the outset of the project to meet the project completion date. Operating and environmental requirements were also used as criteria against which to evaluate the selected equipment.

Resin-filled Via

Enhanced manufacturing for multilayer printed circuit boards

During a workshop with the AISI as part of a roadmapping exercise for TraX Interconnect, the relevance of multilayer printed circuit boards for the aerospace industry was emphasised. TraX Interconnect identified a skills gap and an equipment gap in the resin filling of vias; both these gaps have become stumbling blocks to manufacturing multilayer printed circuit boards.

Subsequently, TraX Interconnect submitted a proposal to the AISI for the acquisition of a machine to fill vias with resin. The proposal was successful.

More about multilayers and vias

Multilayer printed circuit boards have more than two layers; in some cases, 18 layers can be stacked up in a sandwich formation. The weight and space benefits of multilayers are especially valuable for aerospace printed circuit boards. With previous support from the AISI, TraX Interconnect has built the capability to supply printed circuit boards to meet local demand, replacing the prior need of local clients to source such circuit boards offshore. TraX Interconnect has been introduced to a

In process inspection of printed circuit boards

Local production of multi-layer printed circuit boards

number of clients through the AISI network, thus creating an environment for an emerging industrial ecosystem.

Vias are the copper-plated holes in the printed circuit board, which allow the layers to connect. Blind and buried vias are used to connect between layers of a printed circuit board where space is at a premium. A blind via connects an outer layer to one or more inner layers but does not go through the entire board.

Ever-shrinking component pads has meant that vias need to be placed inside the component pads due to space constraints. The problem with this is that solder pastes wicks into these via holes during component assembly, causing bad solder joints. This problem is overcome by filling the vias with resin. Daniel Dock, Managing Director of TraX Interconnect explains, “This is a known problem in manufacturing circuit boards with ball grid array components, for which a solution exists. We were keen to look into getting the best equipment for resin filling of blind vias to increase our capability and competitiveness.”

Finding the best machine for the job

“Through the support of the AISI, we were able to identify the best equipment for resin filling of vias, the MASS VHF300 V machine, which will fit our processing needs and can process our largest factory panels of 18” by 12” in size,” Dock confirms. “This machine is available with vacuum to fill blind vias.”

With all the preplanning and specifications in place, the order has gone out timeously. TraX Interconnect is looking to execute this project by the project completion date. Once the machine arrives, it will be commissioned.

Dock comments, “This additional equipment and skills will help us scale up our offerings to meet our customers’ expectations as identified by our customer audits.”

Eugene Dolweni examining some of the printed circuit boards

Highlights

- Enhanced capacity to produce multilayer printed circuit board manufacturing
- Equipment for filling so-called blind vertical interconnect access on order

CONTACT

Daniel Dock

daniel@trax.co.za

PROJECTS IN PROGRESS

Vernon Davids CEO of LambdaG alongside Melissa Boonzaaier Davids (Project Manager)

PROJECT AT A GLANCE

LambdaG is working on microwave components for satellite communication. These components work at the K (18-26 GHz) and Ka (26-40 GHz) frequency bands. To date, the individual components of an antenna feed system were designed separately using a computational electromagnetic tool. Technology demonstrators of three types of waveguide components (horn antennas, a septum polariser and filters) were produced by Metal Heart, a local SMME, using additive manufacturing. These parts are being tested, and the results will be fed back into the design process of a complete antenna feed sub-assembly.

3D-printed Microwave Sub-assemblies

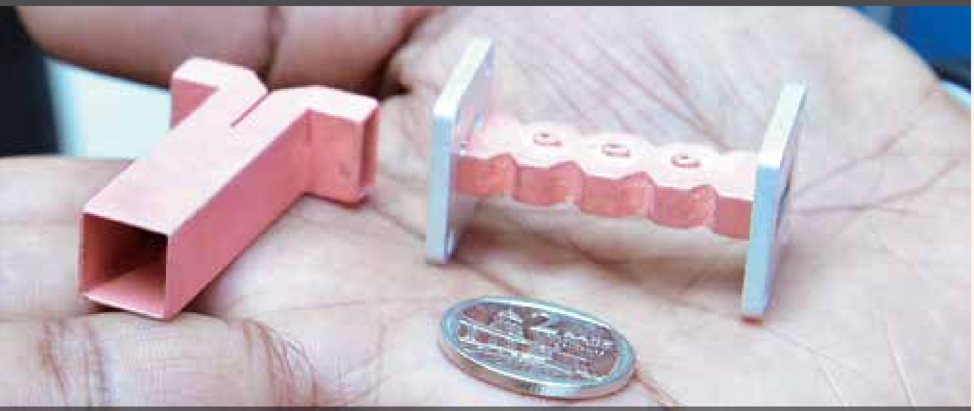
Improving antenna design for space communication

Developments in the space sector point to the requirement for low-weight, cost-effective and higher performing radio frequency communication components. The trend towards smaller spacecraft goes hand in hand with high performance needs.

For Vernon Davids, the CEO of LambdaG, a new SMME that spun out from NewSpace Systems through AISI, and which is currently incubated by NewSpace Systems, the lure of this market opportunity was irresistible. He is an antenna and radio frequency engineer by training, with industry experience in antenna development. He is also a doctoral student at the Cape Peninsula University of Technology, through the French South African Institute of Technology, with current scientific interests in integrated solar panel antennas and reconfigurable antennas for small satellites.

“Several factors played in my favour. I took the leap into entrepreneurship by establishing my company in June 2018, with marketing support and mentorship by NewSpace Systems. At the same time, the AISI technology roadmapping exercise was underway, which helped me by highlighting the potential value of a start-up such as LambdaG in the South African aerospace sector.

“So, one of my first tasks as an entrepreneur was to use the technology roadmap as a guideline and submit



A 3D-printed K/Ka-band stepped septum polariser and bandpass filter

a proposal to the AISI to design and build communication components for satellites. It was successful and has allowed me to start year 1 of the project, with two more years to go."

NewSpace Systems had previously worked on waveguides operating at X (8-12 GHz) and Ku (12-18 GHz) bands using additive manufacturing. "It has become clear that maturing this technology at higher frequency bands is now needed for current satellite communication systems," Davids confirms.

Davids' initial designs comprised several horns, with different radiation characteristics, connected to a septum polariser (responsible for converting linear polarised waves into circular polarised waves and vice versa) and different filters for downlink (Ka-band) suppression and uplink (K-band) reception.

Taking the designs to prototype production by additive manufacturing, a technique that allows complex parts to be built by adding layer on layer, has been a significant next step. Metal Heart, an SMME with capability in additive manufacturing, is assisting Davids in this part of the project.

Assembled components are being tested in an anechoic chamber. "As the name implies, no electromagnetic waves bounce off the walls. Results from testing are valuable in helping to refine the designs and characterise the additive manufacturing and post-processing steps at these frequency bands," he explains.

His ultimate goal is to produce by additive manufacturing the complete antenna feed (horn, septum polariser and filters) as a unit, although another two years of hard work on the project remain. He is greatly encouraged by the interest and support from the aerospace and defence sectors. "I've had access to experience and knowledge, which has been great. I'm also looking forward to interacting with the Centre for High Performance Computing, where I hope to access high-speed computing to accelerate electromagnetic modelling and design."

Technical terminology explained

*An **antenna** is a device used to transmit or receive signals.*

***GHz** stands for gigahertz, a unit of measure for electromagnetic wave frequencies.*

*The **X** (8-12 GHz), **Ku** (12-18 GHz), **K** (18-26 GHz) and **Ka** (26-40 GHz) bands are considered to be in the microwave frequency range. Compare this to the Global Positioning System, which uses the L-band frequency band (1-2 GHz).*

***Frequency** of a wave refers to the number of full wavelengths that pass by a given point in space every second.*

*A **waveguide** is a device for transferring electromagnetic energy from one place to another in satellites and radar transmitters.*

Partners and collaborators

- Cape Peninsula University of Technology
- Metal Heart
- NewSpace Systems

Highlights

- Separate design of individual components of antenna feed system using a computational electromagnetic tool
- Designs taken to prototype production by additive manufacturing
- Interest and support from the aerospace and defence sectors

CONTACT

Vernon Davids

vernon.davids@lambdag.com

PROJECTS IN PROGRESS

From left: Mr. Rudi Glathaar [senior Design Engineer] and Ms. Riddhi Maharaj [Materials Engineer] who were chiefly responsible for the FLIA project with inputs from Mr. James Barrington-Brown [CEO] and Mr. Nico Calitz [Design Engineer]

Newspace materials engineer Riddhi Maharaj and CEO James Barrington-Brown examines one of the new components

PROJECT AT A GLANCE

NewSpace Systems has successfully built and tested a fluid loop inertial actuator known as a FLIA for use as an alternative to reaction wheels in attitude control actuation. By accelerating the liquid through pumping, a torque vector can be generated, thereby conserving angular momentum; this was successfully demonstrated. Phase 1 of the project was completed successfully in 2018. A mathematical sizing model was developed for the FLIA for sizing the FLIA design parameters based on customers' satellite size and mission requirements. A single-axis (one-dimensional) FLIA was built, using commercial off-the-shelf components, and demonstrated. An air-bearing table for test and verification of the FLIA was also developed and demonstrated. Phase 2 has commenced, which involves a three-dimensional implementation of the FLIA, materials selection and a thermal management interface.

Fluid Loop Inertial Actuator

Device for satellite attitude control under development

Satellite attitude control is critical for a satellite's successful mission. On-board equipment, such as communication antennas, solar panels and cameras must be accurately pointed in a certain direction.

Through attitude control, the satellite's orientation is adjusted and controlled. Attitude control is set in motion by actuation, which typically happens through reaction wheels.

It is a well-known fact that moving mechanical parts in space are a problem. "Mechanisms in the space environment are a bad idea," says CEO James Barrington-Brown. "We started looking at options for the replacement of current technology and with support from the AISI, we believe we have found a novel solution."

This project is the result of the technology roadmapping session organised by the AISI for NewSpace Systems. Within the context of prioritised capabilities, technologies and solutions, the development of fluid (or liquid) inertial actuator technology was identified as a medium-term high priority.

Accelerating fluid in a tube by pumping has delivered the desired result: a torque vector is generated, thereby conserving angular momentum for actuation of attitude control. "So, it works as well as a rotating solid mass such as a reaction wheel for attitude control actuation," explains Barrington-Brown. "The big bonus is that there are no moving parts, other than the fluid, and it's very flexible."

Flexibility is a particularly desirable quality in this product, given the different sizes and shapes of satellites. “The tube for the fluid is flexible and we can use it in a number of different ways, for example, as a single circular loop, a square loop or even as multi-loops to increase performance.”

Barrington-Brown notes, “The FLIA assembled on our in-house developed set-up is a demonstration model. It will not be flight qualified, but it will be flyable. We’ll use this to check our design parameters; this will lead into the test set-up for verifying and characterising deliverables for the next phases.”

A Master’s student from the University of Cape Town worked at NewSpace Systems to develop a mathematical model for use in design and marketing. “We’re able to use the Excel spreadsheet with its input and output sections to give estimates, based on customer requirements, for the size and performance of the FLIA,” Barrington-Brown says. “We also use the model to optimise design.”

The mechanical and electrical design of the fluid loop was done using readily available components. A fluid with a high density and low viscosity was selected for the loop, to keep the tube diameter within limits and still have angular momentum storage capacity.

A so-called air-bearing table for the testing of the FLIA was also developed using some imported components. It is a low-friction platform with 360 degrees of movement round the vertical axis and approximately 17 degrees of movement on the horizontal axes.

How successful was the testing of the different FLIA configurations, which included all mechanical parts, all electrical parts and all components of the air-bearing table? “Promising,” answers Barrington-Brown. “There were small errors between calculated and measured results, and we understand how they happened and how to fix them.”

Phase 2 of the project, which commenced early in 2019, focuses on the three-dimensional implementation of FLIA, to be demonstrated on the air-bearing table. This design process had the notable addition of the multi-loop rings for the fluid.

The second aspect to be investigated in Phase 2 was certain material requirements for the flight-ready model of the fluid inertial actuator. Barrington-Brown notes, “Based on this, we’ll select materials for piping and liquid.”

The development of the interface between a FLIA and a thermal (heat) management system is the third aspect. “This is another very neat potential benefit of this technology,” confirms Barrington-Brown. “It will allow good heat distribution throughout the spacecraft, reducing stress on the components and therefore extending the lifetime.”

“At the end of Phase 2, we’ll have done all the work for Phase 3, which will focus on commercialising this product.”

By all indications, FLIA is set to take its rightful place in three years’ time as a novel, low-cost, reliable and flexible space system for satellites.

A novel momentum wheel – the FLIA will transform how satellite orientation is controlled in space

Technical terminology explained

Actuation: *Putting into action.*

Angular momentum: *The quantity of rotation.*

FLIA: *Fluid loop inertial actuator.*

Reaction wheels: *Momentum wheels used to stabilise satellites.*

Torque vector: *Torque denotes turning force. A vector denotes both size and direction of this force.*

Partners and collaborators

- Kline Engineering
- TraX Interconnect
- University of Cape Town

Highlights

- Development of fluid inertial actuator technology
- Flexibility of product
- Development of mathematical model for design and marketing
- Interface between FLIA and a thermal management system

CONTACT

James Barrington-Brown
jbb@newspacesystems.com

4

PROGRAMME 2:

Industry Development and Technology Support

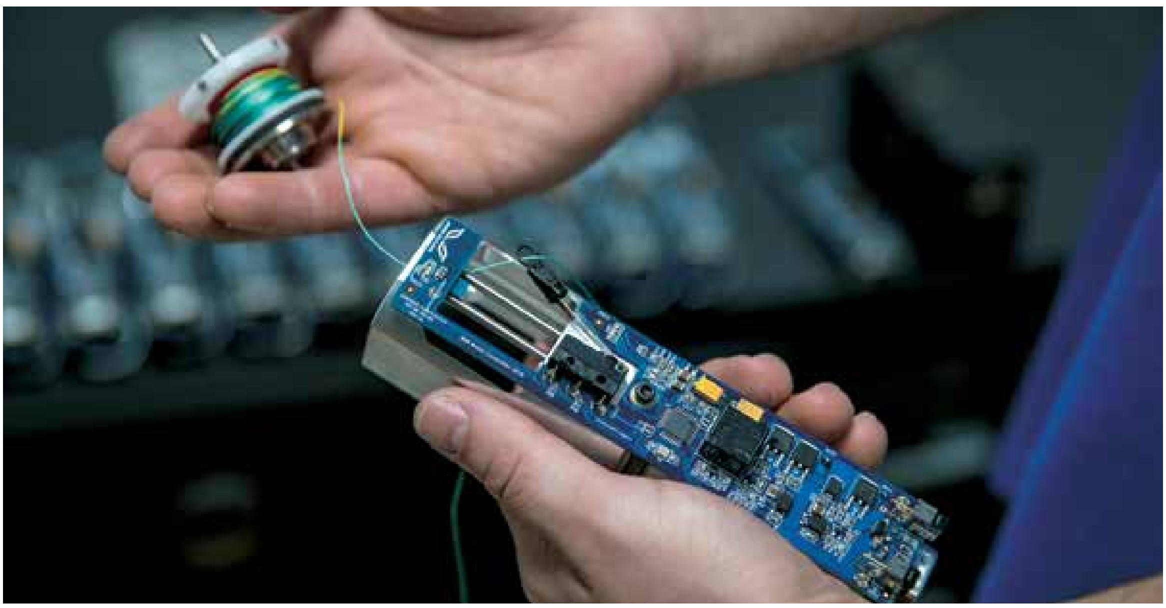
The aerospace industry continues to demand lighter, more compact, more durable and more efficient products. Production innovation has become far more dependent on supplier innovation, and such innovation increasingly results in longer-term strategic supply agreements to assure supply and differentiation in products.

By taking a strategic and optimised approach to engineering and manufacturing, medium-sized manufacturers will reap the benefits, as aerospace companies look for niche suppliers to help expand their supply chains.

Original equipment manufacturers (OEMs) and SMMEs must therefore take cognisance of and implement innovative technologies and manufacturing processes being developed in the global aerospace industry to reap benefits.

During the 2018/19 financial year, nine projects were supported as part of the Industry Development and Technology Support intervention. Narrative reports on the projects and their high-level impact appear in the next section.

High level information regarding the Industry Development and Technology Support initiative is summarised in Table 4 on the right.



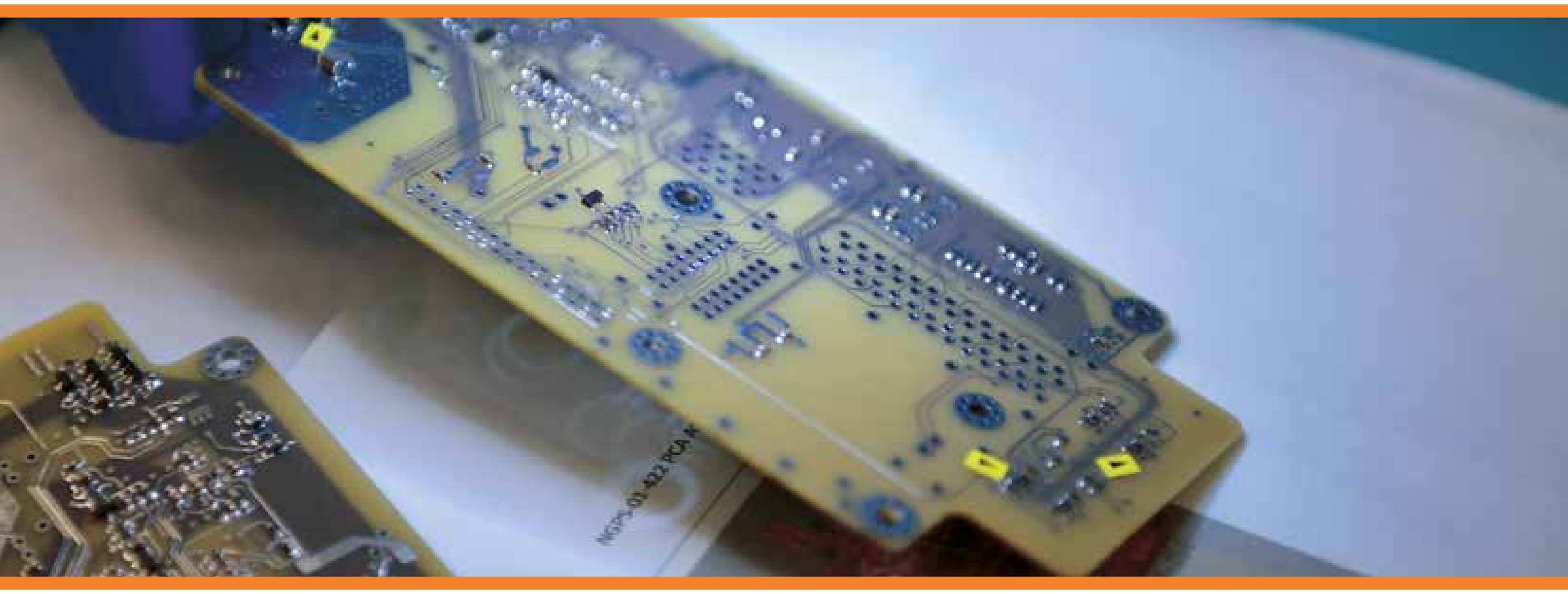
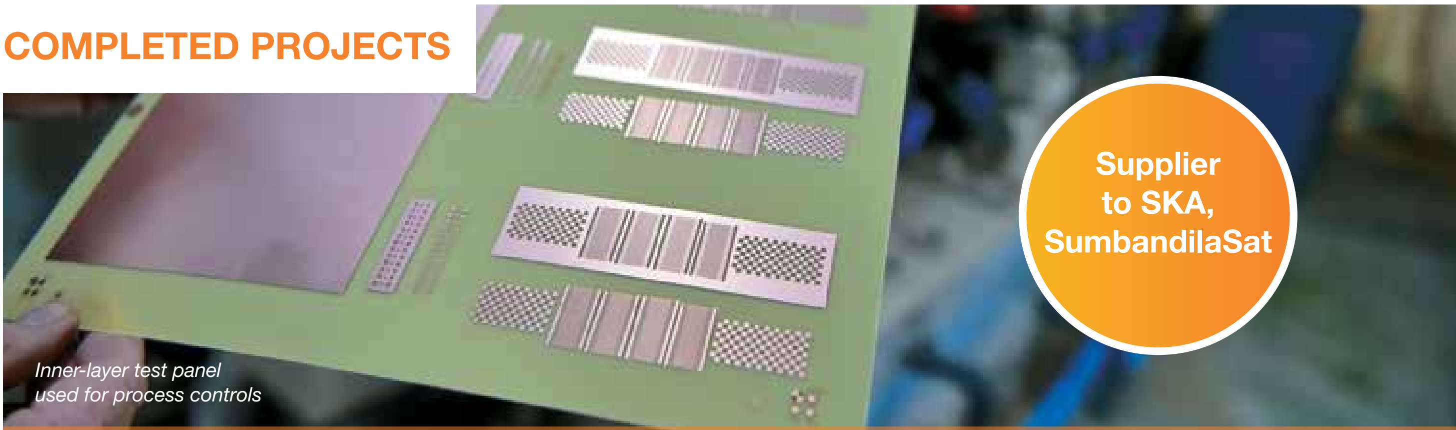


Table 4: Industry development and technology support impact summary

Programme Focus Industry Development and Technology Support	
Predominant technology stream Materials and manufacturing and avionic/sensors	
% AISI investment of project budget	21%
Number of projects undertaken	9
SMMEs supported directly and indirectly	11

Resulting impact on industry	
Technology development / advancement	8
Manufacturing process	4
Number of jobs created or retained	18
Facilitated access to national infrastructure – number of academic institutions and science councils involved	3

COMPLETED PROJECTS



Inner-layer test panel used for process controls

Adhesion Technology of Copper Surface for High-Frequency Printed Circuit Boards

Advanced adhesion technology introduced for high frequency printed circuit boards production

PROJECT AT A GLANCE

TraX Interconnect (Pty) Ltd has replaced the current black oxide adhesion-promoting treatments, with a MEC etch process (a chemical process) using a purpose-built processing line. This new surface treatment provides sufficient adhesion (sticking) for soldermask but leaves the copper surface as smooth as possible. This is the better process for printed circuit boards used in radar, aerospace and military applications where controlled impedance and high frequencies are critical factors. In high frequency applications, controlled impedance helps to ensure that signals are not degraded as they route around a printed circuit board.

TraX Interconnect (Pty) Ltd supplies many aerospace customers in South Africa with both technical support and printed circuit boards. However, like other South African designers and manufacturers in the aerospace sector, TraX Interconnect was forced to look offshore for printed circuit board fabricators to make high frequency boards.

With support from the AISI, TraX Interconnect has met this challenge head-on. One of the technology adjustments has been the selection of a chemical adhesion promotion process best suited to TraX Interconnect's processes and objectives. The processing equipment has been installed in its factory.

But will this 'making-it-stick-properly' solution be the only technology improvement to underpin the company's ability to supply its targeted markets, which require printed circuit boards for radio frequency, radar and aerospace application?

The answer is no, and so we need to consider how TraX Interconnect has been able to position itself in this high-tech niche market. With further support from the Department of Science and Innovation's Technology Localisation Implementation Unit, TraX Interconnect made a significant investment in its capability to supply printed circuit boards (as specified) to the Meerkat radio telescope for the Square Kilometre Array project. Managing Director Daniel Dock explains, "This support gave us the impetus to improve our production capability and the confidence we needed to work with our clients." These are Cobham Satcom (suppliers of a range of phased array antennas to Boeing and Airbus) as well as Saab Grintek Defence and Reutech, to name a few.

Its investments in a direct imaging machine, the plating shop and inspection equipment have stood TraX Interconnect in good stead. "We're in a great place," confirms Dock. "We made a strategic decision to downsize and keep our capabilities on par with our competition."

So why are circuit boards for radio frequency and high-speed digital circuits so tricky to produce? The answer lies in their design, which includes specific track shapes, and in the materials used, such as the very smooth copper foils for better signal transmission and radio frequency performance.

The production process of the circuit boards must not compromise or alter the impedance of these tracks.

"Part of the process requires the adhesion of a soldermask to cover the copper traces of the circuit, which do not require soldering," explains Dock. "In the past, we made the polymer soldermask stick by abrading or scrubbing the surface. However, we found that this process played havoc with the impedance of the tracks."

The next step was to find an adhesion process that did not scratch. Using a chemical to promote adhesion offered the best solution to keep the impedance of the tracks unaltered. An exhaustive investigation to match what TraX Interconnect knew would meet its needs best, was followed by a call for proposals. Dock confirms, "The MEC V-bond process we're now using effectively replaces two processes. It was also relatively simple to get going. No disappointments and only minor adjustments."

Several other benefits to producing these boards have been noted. TraX Interconnect is now able to work with smooth copper profile laminates and advanced radio frequency materials while maintaining the electrical performance that the higher cost of these laminates demand. There have been fewer remakes, which means productivity improvement. More work for existing customers is in the offing. In addition, the V-bond line is a suitable adhesion promotor for multi-layer bonding.

Dock gives much of the credit for the smooth implementation of the V-bond process to Takunda Kondo, a chemical engineer and University of Cape Town graduate, who is the laboratory manager at TraX Interconnect. Dock says, "She has been an asset to the company since she joined us."

Dock is confident that TraX Interconnect's capability in producing high frequency printed circuit boards will slowly but surely see the start of repatriating work that is currently manufactured offshore. This, he says, will in turn bolster the South African marketplace and help to ensure the survival of small high-tech companies.

Achievements and interactions

- *TraX manufactured the printed circuit boards for the CPUT CubeSat project that was launched late in 2018.*
- *TraX was a supplier to Sunspace who launched the SumbandilaSat.*
- *TraX works closely with education institutions such as the universities of Stellenbosch, Cape Town and Pretoria, and the Cape Peninsula University of Technology by hosting open days for students, assisting with advice on project boards and providing technical advice.*
- *TraX manufactured printed circuit boards for the Square Kilometre Array project.*
- *PCBs manufactured in South Africa were used in the CERN Hadron Collider project in Switzerland.*

From left: Daniel Dock, Eugene Dolweni, Edmund Geldenhuys, Anita Adonis, Desiree Williams, Edith Benjamin

Technical terminology explained

***Soldermask** is an electrically non-conductive protective layer over the copper traces that make up the electronic circuit of a printed circuit board.*

***Impedance** is a measure of how much the circuit impedes or obstructs the flow of electrical current.*

Highlights

- Selection of chemical adhesion promotion process
- Production of circuit boards for radio frequency and high-speed digital circuits
- Productivity improvement
- More work possible for existing customers

Media

In conversation with Daniel Dock, TraX Interconnect: How technology ramp-up can save the PCB industry

https://www.ee.co.za/article/technology-ramp-saved-pcb-industry.html

CONTACT

Daniel Dock
daniel@trax.co.za

COMPLETED PROJECTS

Wing cleaning winders installed in a JS3 glider

Cost savings through import replacement

In-flight Wing Cleaning System

Locally produced winders for in-flight wing cleaning systems of sailplanes

PROJECT AT A GLANCE

Jonker Sailplanes is producing an in-flight leading edge wing cleaning system for sailplanes to remove contamination by insects. The sophisticated product, dubbed the CuttingEdge BugWiperWinder, has a significant market advantage with various operational modes, adjustable for different wingspans. Bug wiper controller units come in pairs (right and left) and are installed in the cockpit. Integrated with the set of blade wipers, this bug wiper controller system is easy for the pilot to operate. Localisation of this product has resulted in significant cost savings as well as import substitution and export opportunities throughout the world.

The aerodynamic shape of the laminar wings on a sailplane results in a thin boundary layer with very little drag. Insect contamination on the leading edge of wings impairs the laminar design and can result in loss of performance of up to 20%.

Although clouds of insects are not generally a major problem in South Africa, pilots must be aware of this factor, particularly in the northern hemisphere, as it may severely affect flying performance. According to European pilots, insects are normally a big problem over forests and in the vicinity of swamps.

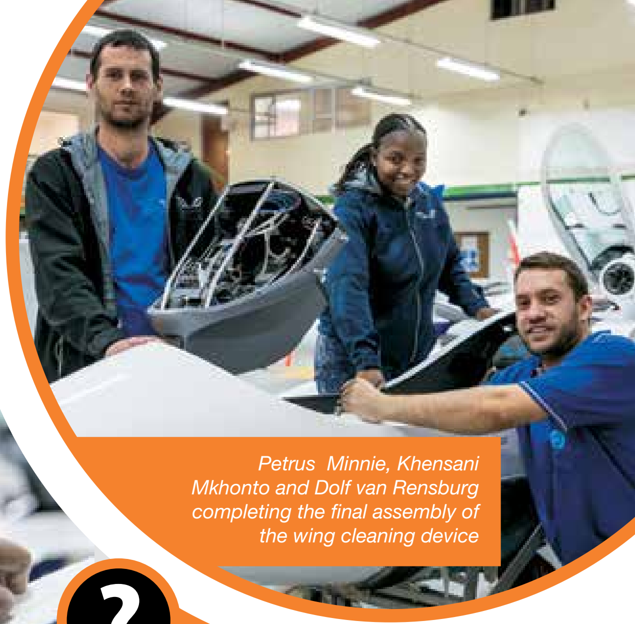
The locally produced bug wiper controller was designed by aerospace design organisation OnTrack Technologies (Pty) Ltd. Units are now being supplied to Jonker Sailplanes for installation in the JS series of gliders and are also available to other aviation companies worldwide.

Uys Jonker of Jonker Sailplanes explains how the bug wiper controller system came about, “It’s a clever unit with logic programmed into the system. We use it with the fully retractable wing cleaning wipers that we produce, which were also developed in collaboration with our partner, OnTrack Technologies. We believe that we have a winner.”

Prior to this development, the only viable system had to be imported. Production delays and high costs of imports had a negative affected on Jonker Sailplanes, and product limitations affected the reliability of the operation, resulting in many pilots losing bug wiper cleaners in flight. These factors prompted Jonker Sailplanes to investigate the design and manufacture of a localised product.

To speed up the design process, OnTrack Technologies followed an iterative design methodology. This repetitive process resulted in implementing designs or prototypes, gathering feedback and refining the design. As a result, five concept designs were undertaken, and after testing

Khensani Mkhonto installing the wing cleaning devices at JS final assembly.



Petrus Minnie, Khensani Mkhonto and Dolf van Rensburg completing the final assembly of the wing cleaning device

of each new concept, improvements were made, based on results and feedback.

Concept 5 delivered a number of promising operating outcomes for the bug wiper controller: greater reliability; possibility to change switch direction; different wing selection; automatic cleaning; electronic braking; soft stop and turn around. In addition, satisfactory levels of stowed away current (to reset to the correct state); maximum operating current (to switch off current to prevent fire from occurring and to specify the circuit breaker size); and a pre-identified maximum pulling force were achieved. During the flight test (between 110 and 140 km/h), the wing was cleaned a total of eight times.

Jonker confirms, "We're satisfied with the results of testing on this final concept and we gave the go-ahead to OnTrack Technologies to initiate full production." Pilot production delivered 10 units, and manufacturing has been set at two units a week. Bug wiper controllers therefore no longer need to be imported.

To date, several bug wiper controller units (sets of two) have been delivered to Jonker Sailplanes' customers worldwide who are pleased with the product.

Technical terminology explained

Drag: *The aerodynamic force that opposes the sailplane's motion.*

Iterative design: *A process of continual improvement.*

Laminar flow: *The smooth flow of air over a wing.*

Prototype: *A first or preliminary version.*

Technical terminology explained

Boundary layer: *The thin layer of air in contact with the wing.*

Circuit breaker: *An automatic device for stopping the flow of current in an electric circuit as a safety measure.*

Electric current: *Rate of flow of electric charge past a point or region.*

Partners and collaborators

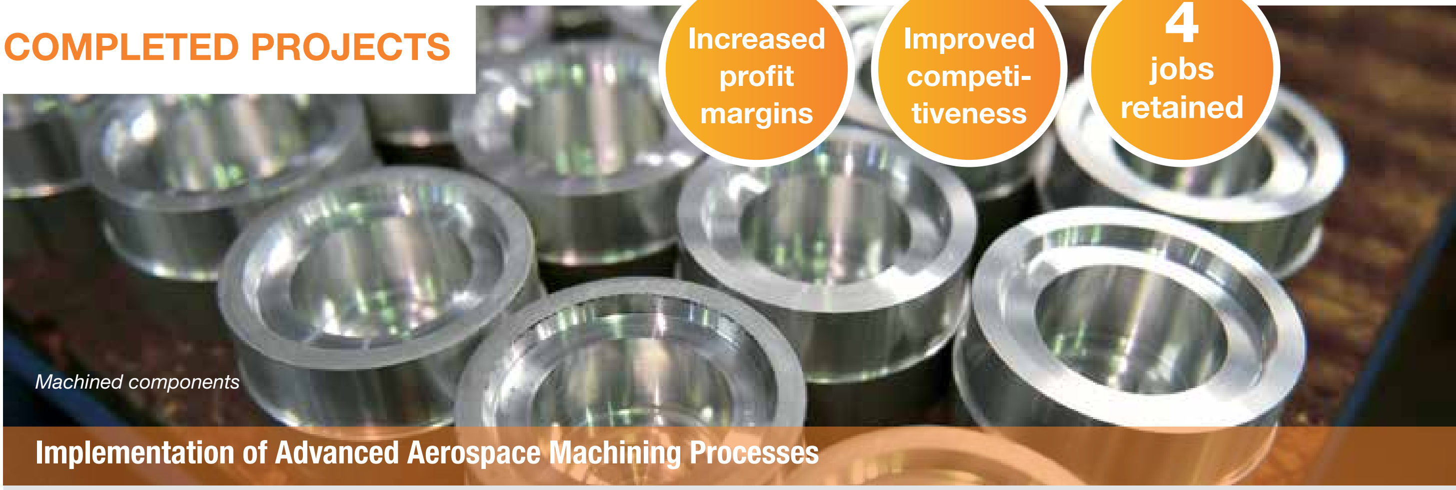
- OnTrack Technologies
- North West University
- Telemetric Data (Pty) Ltd

Highlights

- Export of locally produced bug wiper controller units
- Manufacture of two units a week
- Good reception by Jonker Sailplanes' customers

CONTACT
Uys Jonker
uys@js1.co.za

COMPLETED PROJECTS



Machined components

Implementation of Advanced Aerospace Machining Processes

Improved advanced machining processes result in SMME productivity gains

PROJECT AT A GLANCE

Daliff Precision Engineering (Pty) Ltd has implemented advanced processes for aerospace manufacturing within the company. Through scientific analysis, gaps were identified in the production process, and interventions were planned and implemented at different levels. Affirmed by Chairman Rowland Chute as a "thorough intervention, which has helped our company to become globally significant through the introduction of sophistication", the implemented improvements have demonstrated their practical use. This has freed up capacity in the company to perform more work and has increased profit margins within monthly machined components. The project is part of the journey of continuous improvement in the company.

To remain relevant in the aerospace sector, increased competitiveness is essential. By ensuring the appropriate capacity and quicker turnaround time, it is possible for locally based SMMEs such as Daliff Precision Engineering (Daliff) to participate in the global supply chain. Rowland Chute, Chairman at Daliff, notes, "Both our delivery and pricing have improved, which is helping us to lift our game in this competitive sector."

With support from the AISI, an advanced aerospace machining specialist was able to work with Daliff on this project. Christiaan van Schalkwyk, Daliff's Managing Director, says, "We realised that variables such as machines, programming software and cutters should all be at an optimal standard to achieve our goal of output efficiency."

After an initial assessment, the company was identified as being at a basic level with regards to current machining processes, while staff had a limited knowledge as far as practical machining capabilities were concerned. The gap analysis undertaken was valuable as it pinpointed useful processes in each department to be changed (to a lesser or greater degree).

The gap analysis also evaluated machining processes and methods, particularly how these were implemented and utilised within the company.

So how was this fixed? Tellingly, Daliff was fully immersed during this six-month project and involved a range of staff in this process improvement: the managing director; the engineering director; the

From left: Rashied Combrink, Elino Busch, Marius Maas, Leandra Carelse, Christiaan van Schalkwyk, Mbuzeli Lubisi, Jarrod Law, Jacques Botha, Wiseman Ntabeni

production manager; numerical control programmers; the tool manager; the tool setters; the computer numerical control setters and operators; and the quality assurance members. This range of staff received the same theory and practical knowledge through each level of complexity in the process. This ensured that staff in the company improved and progressed together and on the same knowledge platform.

So, while detailed objectives were set out to be achieved to address technical gaps (in some cases, the company switched to different tools to cut out recurrent design problems), it is important to note that the implementation happened at different levels and that success was achieved at different levels.

Van Schalkwyk believes that there were two critical success factors in the project, "The aerospace machining specialist involved achieved innovation through a combination of deep knowledge of machining technology and the ability to do research and development. This knowledge was transferred to Daliff at all levels.

"The second factor has been wholehearted acceptance by Daliff staff of this improvement process. In this case, seeing was believing. Practical outcomes were tangible, and this reinforced a deep understanding of the value of these new ideas." The necessary insight and change in thinking have helped the company enter new niche markets.

As a measure of how successful this improvement process has been, Daliff is proud to share that it has achieved a productivity improvement of 40%. Van Schalkwyk says, "We've implemented the methodology on 69 of our 400 aerospace parts, with the result that our production has improved for our clients. We'll keep on applying this strategy to other parts for different clients.

"And best of all, our competitive prices allow us to put in competitive quotes. In short, this process improvement is a significant enabler for our strategic export drive by enhancing our capability and helping us to bring down our prices."

There's more good news for Daliff as a result of this intervention. Its newly established advanced manufacturing capability lays the foundation for the next step – digital manufacturing. "We've brought factors together which are conducive to operating as part of the 4th industrial revolution. In this paradigm, there is less human intervention, with more control and more stable output," Van Schalkwyk confirms.

It is hats off to Daliff which, in partnership with the AISI, has upped its game as a supplier of aerospace parts into the global supply chain and has set its sights on a bright future as part of the 4th industrial revolution.

Media

Approach, not technology, key to success in advanced manufacturing

https://www.engineeringnews.co.za/article/approach-not-technology-the-foundation-of-advanced-manufacturing-2019-06-14/searchString:rowland+chute

Engineering News, 14 June 2019

Partners and collaborators

- University of Stellenbosch

Highlights

- Improved productivity
- Better delivery and pricing
- Staff involvement in process improvement
- Knowledge transfer to staff
- Acceptance by staff of improvement process

Benefiting organisations

- Denel Aeronautics
- Aerosud
- Iscar

CONTACT

Christiaan van Schalkwyk
christiaan@daliff.co.za

COMPLETED PROJECTS

The NewSpace Stellar Gyro is set to disrupt the traditional Star Tracker market by offering a unique, cost effective alternative

Stellar Gyro Flight Readiness

Novel attitude control gyroscope available for satellites

PROJECT AT A GLANCE

NewSpace Systems has overseen the development and manufacture of an operational, flight-ready stellar gyroscope solution, based on the technology development supported by the AISI in 2016. The complete re-evaluation of the original design identified those aspects of the design, which were unsuitable for the space environment, and focused on improving them. This resulted in a smaller, more flexible printed circuit board, a revised camera design and a revised mechanical structure. Features that worked well or were unique were retained. The project resulted in a stellar gyro that is efficient and robust, as well as an integrated attitude control system (which includes the stellar gyro), which is suitable for a range of satellites.

Satellites must take precise measurements from their place in orbit around the Earth. Satellites must also be stabilised so that they do not wobble. Stabilising a satellite is attitude control and the attitude of a satellite is its orientation in space. Attitude determines what a satellite looks at: which way its cameras are facing, and the angle the satellite makes with the object it is orbiting.

To stabilise a satellite, the satellite must have a system that keeps it moving accurately through its orbit. NewSpace Systems developed the stellar gyroscope product as a star camera solution for attitude control during a satellite's eclipse period in orbit (when the sun is hidden by the Earth). "We found a way to orientate the satellite by using video footage of the stars," explains CEO James Barrington-Brown. "By taking continual video footage of the stars, it has been possible to calculate back to find the best fit between images. That way we can feed back information to the control system to correct the attitude of the satellite."

The original stellar gyro hardware was more than adequate for proof of concept and basic functional testing, but it did not have the robustness and reliability required to survive launch and for in-orbit operation. So, taking into consideration market feedback, current research and its ambitions to target the rapidly growing satellite constellation market with an improved product, NewSpace Systems undertook significant improvements to, and rework of the original design. This was the initial phase of this project supported by the AISI.

How was the stellar gyro improved? "We decided to do a complete rework of the stellar gyro hardware," explains Nico Calitz, the Design Engineer assigned to the project. "We focused on a smaller, more flexible printed circuit board, a revised camera design and a revised mechanical structure. We kept those features that had favourable characteristics and performance or were unique. We also added a support structure."

The most striking difference in the new product is the size, which is now 37X36X49mm (nearly five times smaller than the prototype), and its cube-like shape, which means it can be easily mounted within the satellite.

To manage cost on the camera, NewSpace Systems decided to use a commercial off-the-shelf lens with high performance. It partnered with Space Advisory Company (a co-subsidiary of the Space Commercial Services Aerospace Group) for optical design and verification. “This partnership was ideal for our employees to develop optical skillsets,” Barrington-Brown says. The locally developed camera hardware, from development supported by a previous AISI project, demonstrated that its detection capability exceeds the original requirement.

The image sensor used on the original stellar gyro design was retained as it ticked all the technical boxes to capture data while moving and came from a manufacturer whose products have been proven in space.

Reengineering the electronics allowed NewSpace Systems to move towards a printed circuit board compact stack arrangement, with numerous advantages. Quite significant is the inclusion of a micro-electromechanical systems gyroscope module. “By using sophisticated algorithms, we can combine this technology with that of the stellar gyroscope for an integrated ‘best of both worlds’ solution,” notes Barrington-Brown.

The support structure of aerospace aluminium for the stellar gyro was redesigned for robustness and the main camera module in this structure was made compatible with a large variety of lenses.

Outgassing (gaseous release or discharge in space) is known to be detrimental to optical systems in space. The stellar gyro was constructed using approved low outgassing materials, or materials post-processed to reduce the rate of outgassing or to mitigate its effects. Finally, the NewSpace Systems team worked on algorithms for stellar gyro solutions.

As part of its business intent to target satellites ranging from CubeSats to high-profile surveillance and communication constellations of satellite, NewSpace Systems developed the stellar gyro as part of an integrated attitude determination and control system. This modular unit allows the satellite owner to put the various subsystems anywhere on the satellite, coupled to the main attitude control system board through a series of cable harnesses designed to suit customer requirements. The main board comes with the stellar gyro module, a magnetometer, sun sensors, magnetic actuators, a GPS module and a micro-electromechanical systems gyroscope. It will be manufactured to flight standards and will be offered at subsidised cost to a spacecraft committed to a launch opportunity to give it space heritage.

Barrington-Brown is optimistic about market access and uptake, “The stellar gyro technology is innovative, and when flight proven, will be an entirely new way of sensing and controlling the attitude of a satellite. The technology is specifically optimised for the new generation of communications constellations.”

Newspace design engineer Nico Calitz examines one of the optical components manufactured by the company

Technical terminology explained

Actuator: *An actuator is a component of a machine that is responsible for moving and controlling a mechanism or system.*

Attitude: *The orientation and position of a satellite. All satellites have attitude control devices to control their pitch, roll and yaw (movement in three dimensions).*

Gyroscope: *A device that accurately measures rotation to help determine orientation.*

Magnetometer: *A device that measures the local magnetic field.*

Magnetorquer: *An actuator, controlled by the host system, used for satellite attitude control and activating torque for alignment of the satellite.*

Highlights

- Star camera solution for attitude control
- Complete rework of the stellar gyro hardware
- Five times smaller than prototype
- Optimised for new generation of communications constellations

CONTACT

James Barrington-Brown
jbb@newspacesystems.com

COMPLETED PROJECTS

From left: Wynand Mogoiwa, Nico Ntaolang, Andru de Beer, Johann Mostert (Project Leader), Gielie Coetzee, Gerhard Kruger, Tobie Hanekom

Local Canopy Production for Sailplanes

Localising production of sailplane canopies

Import replacement

PROJECT AT A GLANCE

Canopies manufactured to specification for the Jonker Sailplanes are currently imported at a high cost from European suppliers, as there is no local manufacturer. As Jonker Sailplanes contributes 40 sailplanes to the global total of 300 sailplanes manufactured per year, there is a strong cost-savings imperative to establish a sustainable, local supply. OnTrack Technologies finalised a manufacturing process based on wet draping of Plexiglass® canopies, as well as the design and setting up of equipment to manufacture complex-shape sailplane canopies. Once fully industrialised, the facilities will manufacture one canopy per week.

The transparent enclosure over the cockpit of a sailplane is the canopy, which is made of either Plexiglass® or Perspex®. Canopies protect the pilot and provide visibility but are notoriously difficult to manufacture. The complex shape of a canopy with curvature in two axes (it looks like a plump, outsized teardrop cut in half lengthwise) must be optically sound and distortion-free, to allow the pilot to see through it properly while flying.

OnTrack Technologies identified the appropriate facilities and components needed to produce canopies for Jonker Sailplanes. While equipment, materials and methods are easy to acquire, the skill lies in the way they are used to produce a flaw-free canopy from a Plexiglas® acrylic sheet. This sheet becomes soft and pliable when heated and retains its shape when it cools.

So firstly, an air oven with forced air circulation (like that in a bread oven) was purchased for heating of the Plexiglas® sheet at an optimal and carefully controlled temperature setting.

Next, the requirements for the composite draping mould, into which the heated Plexiglas® sheet is inserted, were finalised.

Finally, the draping rig to hold the draping mould with the heated Plexiglas® sheet, was built to accommodate the forming process with cables and clamps.

Making canopies locally was always seen as a doable undertaking; however, OnTrack Technologies put in place a very thorough plan to ensure proper understanding of requirements. Johann Mostert of OnTrack Technologies says, “Our aim was to achieve a significant milestone in terms of the development of the manufacturing process and we believe we are at a 95% success rating.”

JS canopy plug finishing process in progress
From left: Wynand Mogoiwa, Nico Ntaolang

Johann Mostert – Inspection of the canopy on a completed JS glider

No less than eight pilot runs were attempted during which the heated sheet from the oven was laid over the flannel-covered mould and pulled into shape with clamps and rigs.

"All the pilot runs failed. This was apparent when we removed the canopy from the mould," says Mostert. "We do, however, know exactly what went wrong with each attempt and we know how to correct these problems going forward."

Mostert is enthusiastic about the project outputs. "It was important for us to assist Jonker Sailplanes to find a manufacturing solution to achieve import substitution. We know that we have learnt a lot through trial and error, and we're now in the position to check and refine the manufacturing process for sailplane canopies."

"The savings in money and time by building locally promises to be significant and therefore a boost to Jonker Sailplanes' marketing objectives."

Mostert lists the next items to be addressed. "We'll put together specifications and guidelines for the production process to ensure the quality of these products. This is an important part of industrialisation.

"The next step to achieving successful import substitution will be to ensure that the canopy is included when Jonker Sailplanes certifies its products through the European Union Aviation Safety Agency."

JS Canopy 1:3 scale model

Technical terminology explained

Mould: *A shape used to form a product, in this case, a polymer.*

Wet draping: *An established method to produce complex shapes of polymers.*

Partners and collaborators

- The Airplane Factory

Highlights

- Manufacturing solution for import substitution
- Cost-savings imperative to establish sustainable, local supply
- Specifications and guidelines for production process

CONTACT

Johann Mostert
johann@js1.co.za

COMPLETED PROJECTS

Trainee pilot training on the firefighting Helicopter Flight Trainer upgrade

Helicopter Flight Trainer Firefighting Upgrade

Simulated firefighting training for helicopter pilots upgraded

10 jobs retained

PROJECT AT A GLANCE

Cybicom Atlas Defence (CAD) has added a firefighting training module through a software upgrade to the existing helicopter flight trainer simulator, which was developed jointly with the CSIR. The instructor module developed for the fixed wing flight trainer was also integrated into the helicopter flight trainer, thereby increasing local content of the product and lowering costs. By including additional development, CAD has created a simulation-based firefighting training facility, which is a unique product in the global market.

The ongoing drought in the Western Cape and recurrent fires, and a resulting increase in aerial firefighting operations have highlighted the need for the training of helicopter pilots. Malcolm Behrens, Managing Director of CAD, says, "We have noted with concern the heavy toll on the Western Cape of the extreme weather and the destruction brought about by wildfires, which flare up under these conditions.

"As part of our commitment to help address this dire socio-economic and environmental situation, we have put our expertise towards a much-needed training tool for helicopter pilots who do firefighting under these conditions. We are thankful to the AISI for supporting this project."

Aerial firefighting (use of aircraft and other aerial resources) is one of the ways to combat wildfires. The types of aircraft used include fixed-wing aircraft and helicopters. Fixed-wing aircraft are used as spotter planes to observe, analyse and predict fire behaviour, and to supply all relevant parties with updated information. Helicopters use buckets of up to 1 000 litres to transport water to the fire line to douse fire.

Behrens says, "During a workshop with Working on Fire, we received confirmation that training for helicopter pilots working in aerial firefighting was urgently needed. No simulation-based firefighting training facilities exist in South Africa." He adds that simulation-based training products in the US, Europe and South America are not sophisticated.

Helicopter pilots who are unfamiliar with the tasks of filling, transporting and emptying fire-fighting buckets, must learn how to handle these tasks in a simulated environment. They must also have simulated exposure to the conditions to which they will be exposed while flying.

"CAD has responded to this training need by adding a firefighting training module to the existing helicopter flight rescue trainer simulator. In addition, the instructor module developed for the fixed wing flight trainer has been integrated into the helicopter flight rescue trainer, thereby reducing production costs."

In line with requirements identified, changes were made to the basic helicopter flight trainer. This allows the user to set locations, select helicopter models, alter environmental and weather conditions and induce (deliberately bring about) helicopter faults.

Users of the fire and rescue helicopter flight trainer can select helicopter type and associated helicopter firefighting equipment. They can also set location and size of a fire on the map. The simulator will give them the feel of flying a helicopter during firefighting, particularly the effects on the aerodynamics of carrying a water bucket. The simulator displays a fire accurately and allows the fire to interact with its environment. Finally, the simulator estimates the location and amount of water used in dousing the fire and adapts the blaze accordingly.

Behrens highlights novel aspects of these enhanced features, "One of the major changes to the helicopter flight rescue trainer is the fire propagation model which shows how a fire can be expected to spread, given its location and terrain, and the prevalent weather, more specifically the wind direction and speed. Terrain and weather are the two key features on which the model depends for its computations and prediction of the spread of the fire."

The second major change to the helicopter flight rescue trainer is the updated instructor module. The instructor uses a touch screen on a tablet and scenarios for training can be selected from the following: training mode (fire-fighting, regular helicopter flight training, deck landing); airport; helicopter; fire type (forest fire, airport fire); and selection of weather and time of day.

Behind this description of this world-class simulation system for helicopter firefighting training, lies expert selection of various tools used to make this upgrade happen. Presagis Vega Prime visualisation generates realistic fire and smoke effects on the ground and in the air. This is a complete three-dimensional visualisation software development toolkit for the creation and deployment of accurate and visually rich simulation. Presagis HeliSIM flight simulation software gives the user the bumpy ride into a fire-affected area. This software is the industry standard for creating high-fidelity, high-quality flight dynamic simulations.

An initial training exercise was designed around the Camp Pendleton Central Business District simulation, allowing for fires near the airport involving buildings and vegetation.

This world-class simulation solution for the training of helicopter pilots engaged in firefighting is a first for South Africa and is an opportunity to create a new market niche. The next major development step for the product will be to achieve formal accreditation for flight training. Behrens says, "Our promotional and marketing activities are targeting potential customers world-wide and we are eager to engage with them."

Media

CYBICOM and the CSIR add fire-fighting module to helicopter simulator

http://cadefence.com/news-CSIR-helicopter-simulator.html

From left: Darcy Ocker, Jason Suter, Basheer Benjamin, Anda Mbejeni and Lihle Tabata

More about Working on Fire

Working on Fire is an Expanded Public Works Programme aimed at providing work opportunities to young men and women. The programme resides under and is funded by the Department of Environmental Affairs. Working on Fire Aviation is a trusted supplier of aerial firefighting services to key roleplayers within the wildland firefighting industry in South Africa.

https://workingonfire.org

Partners and collaborators

- CSIR
- South African Navy
- Working on Fire

Highlights

- World-class simulation solution for training of helicopter pilots engaged in firefighting
- Inclusion of fire propagation model
- Updated instructor module

CONTACT

Malcolm Behrens

malcolm@cybicom.com

PROJECTS IN PROGRESS

Technical team from left: George Moodley – Production Director, Richard Schulz – Marketing Director, Prince Khalala – Assembly Technician, Shrivar Ramjeewan – Engineering Technician, Jean Paul Kabulu – Quality Assurance and Raymond Bakker – Technical Director

George Moodley – ADEPT engine assembly in progress

PROJECT AT A GLANCE

ADEPT Airmotive has taken initial steps to start the manufacture of its aviation engine. Initially, casting technology was incubated at the University of Johannesburg's Metal Casting Technology Station. Benchmark non-destructive testing (NDT) of the development castings was performed at Stellenbosch University's computed tomography (CT) scanner facility. Based on these results, casting process improvements will be made for production castings. Data from the University of Johannesburg's Metal Casting Technology Station have been used for computer aided design models for analysis and simulation.

ADEPT Advanced Casting

Award-winning aviation engine enters initial manufacturing phase

ADEPT Manufacturing (Pty) Ltd was established to create manufacturing capacity for the commercialisation of the ADEPT Airmotive aircraft engine technology. The first prototype flew in 2010 and subsequently the engine received a number of South African and international awards. Airmotive Technology holds the intellectual property for this multi-fuel engine that can fly on aviation fuel, unleaded automotive fuel (petrol) or biofuel.

Raymond Bakker, Chief Operating Officer/Technical Director of ADEPT Airmotive, comments, "With the support of the AISI, we have embarked on the journey to manufacture this advanced aviation engine.

"One of the critical elements in this value chain is the need for high-quality aluminium castings for components such as cylinder heads and engine blocks. The production of castings must be repeatable and measurable, and manufactured to high-quality standards."

ADEPT Airmotive has worked closely with partners on this project, notably the CSIR's Light Metals research group with its experience of aluminium castings and Aerosud Holdings with its experience of supply chain development, aerospace standards, and manufacturing systems. Casting technology was incubated at the University of Johannesburg's Metal Casting Technology Station and many lessons learnt during the process.

On the recommendation and support of the AISI, ADEPT Airmotive undertook benchmark NDT of the develop-ment castings at Stellenbosch University's CT scanner facility. "This preparatory testing was important as we needed to consider and understand the extent of quality and specification deficiencies when compared to the three-dimensional files supplied," explains Bakker. Scanning was done according to the standard practice for the systematic assessment of the internal structure of a material or assembly using CT technology.

The scans of two heads and two blocks were done and images examined for evidence of porosity, voids and geometric variance. Deviations (pores and voids) were found in the blocks that were examined; the heads had fewer pores and little deviation. These deficiencies occur during solidification during the casting process and may also be associated with certain design traits. Bakker confirms, "We've noted these anomalies and are now able to make meaningful casting process improvements for our production castings." Deviations in castings must be within specification to avoid compromising the quality of the casting and ultimately the functioning of the engine.

These are all the necessary steps on the industrialisation journey. "If we are to meet the demand for aviation engines in the export market, we need to make sure that a cast product of high quality is available for series production," he notes.

Another technology trick up Bakker's sleeve in the journey towards manufacturing has been the generation of computer aided design models for analysis and simulation. "We were able to use every detail from the data recorded during development at the University of Johannesburg's Metal Casting Technology Station," he says. "Our next step was simulation based on these datasets which has allowed us to do further analysis, as well as evaluating and optimising the casting design for better outcomes from our casting process."

This step appears to be part of a natural progression and a satisfying techno-logy exercise as it allows the team to move productively and purposefully towards refinement and confirmation of design and associated data. These inputs will be used in the next phases of the manufacturing process.

Bakker is looking forward to the next phases, "We have a great design, we have valuable partnerships, and we know that the market is beckoning."

Award-winning aviation engine

Manu-facturing capacity develop-ment

Awards

- *SABS Design Award*
- *International Autodesk Inventor of the Year Award*
- *Mail & Guardian Greening the Future Award*
- *Vision 2030 Driver for Change Award*

Technical terminology explained

Block: *An engine block is the structure that contains the cylinders, and other parts, of an internal combustion engine.*

Computed tomography: *This scan makes use of computer-processed combinations of many X-ray measurements taken from different angles to produce cross-sectional images of specific areas of a scanned object, allowing the user to see inside the object without cutting. The technology is the same as that used for medical imaging.*

Head: *The cylinder head (often informally abbreviated to just head) sits above the cylinders on top of the cylinder block, and houses the valves, camshafts and coolant passages of an engine.*

Partners and collaborators

- Aerosud Holdings
- Ametex
- ANDTc
- Central University of Technology
- CSIR
- Stellenbosch University
- University of Johannesburg

Highlights

- Journey to manufacture advanced aviation engine underway
- Incubation of casting technology
- Benchmark NDT of development castings
- Computer aided design models for analysis and simulation

CONTACT

Raymond Bakker
raymond@adeptairmotive.com

PROJECTS IN PROGRESS

A nano-satellite space imager from the Space Commercial Services' product range

From left: Stephen Tillemans, Lodwick Rikhotso, Heinrich Fuchs, Kobus Heyneke, Marcello Bartolini, Jan Botha, Smuts Louw

PROJECT AT A GLANCE

As part of Space Commercial Services' COR475 project to establish a novel, next generation spacecraft electrical power system (EPS), the design for the EPS Nano Power Control Unit's printed circuit boards and mechanical components have been completed. During the printed circuit boards' layout design stage, it became evident that not only one but three printed circuit boards would be required to achieve its ambitious power density and form-factor (shape), which have been stacked into a unique and innovative housing. The housing therefore provides a thermally and structurally sound solution that accommodates sufficient thermal (heat) relief required by its through-put power performance. Thermal, vibration and radiation testing are to be performed to verify and qualify its design as fit for purpose and where necessary, identify aspects where engineering change is required to reach qualification status.

COR475: Electrical Power System Nano Power Control Unit

Next generation technology for spacecraft power systems

Trends in the space industry are moving towards smaller, lighter, long-life (five years and more), high-performance satellites commonly referred to as 'next generation', which are typically destined for satellite constellations. These satellites pose significant pricing advantages in terms of production and launch costs for a wide range of applications. However, power system technology that is proven to satisfy longer lifespans, stringent power requirements, within highly constrained shapes and sizes (defined in engineering terminology as form-factor), has lagged these trends.

The COR475 project envisages a flexible electrical power system that is scalable in terms of size, power handling (modular power capacity), cost and reliability. Its high reliability is achieved through design know-how of flight heritage design. It offers configurable redundancy (backup systems) and a system that undergoes reliability screening through a system engineering process that also includes functional and environmental qualification campaigns.

The brainchild of Marcello Bartolini, Head of Engineering at the Space Advisory Company, this innovation fills a gap in the market with its advantages of being both modular and scalable for use on a range of satellites starting at nanosatellite (including cubesat form-factors) weighing as little as 4kg, typically through to minisatellites of up to 500kg. He says, "We are able to tap into a wealth of know-how acquired over many years from individuals within the company. The concept also fits perfectly into our technology roadmap, drawn up together with the AISI. We also know that there is no other comparable capability in power systems locally."

The first building block of this electrical power system is the nano power control unit, the COR475. (The other two blocks of the electrical power system are the solar regulator module and the power distribution module.) The design of the power control unit is split across three printed circuit boards assembled sandwich-style and joined with connectors in a mechanical housing, providing a clean and aesthetic design, with dimensions of the average domestic wireless router. The boards are assembled by an external manufacturer.

The nano power control unit has now reached its prototype stage, one of the milestones on the project roadmap. The next step is to functionally verify operation and then test it by simulating the space environment in which it will function. Verifying its broad set of product requirements, which includes full functional performance, remote operability and robustness of design, is critical for the qualification of the product. It must stand up to extreme temperature testing (both hot and cold as it will be used on satellites in orbit from the sun-lit side to the dark side of the Earth); vibration testing (it is a rough ride into space!); and radiation testing. The latter is done through a somewhat surprising collaboration with the Agricultural Research Council's Infruitec. The irradiation facilities for sterilising fruit flies are being used to bombard the electronics of the prototype; the resultant damage (so-called degradation) is measured until the part fails.

Once testing has been completed, the test report goes into a critical design and part-qualification review. Bartolini says, "It's back to the drawing board. We will review any failures to remedy them and establish a baseline for a reproducible product, ready for the marketplace.

"Once we have a functional prototype, the next step is industrialisation. I believe this electrical power system is one of the best technology innovations to fill an existing market gap.

"We are very grateful for the support from the AISI. Through this intervention, skills have been retained and products are being prepared for the market."

By including existing company-designed components that have been used in space, the COR475 project will add the highly desirable quality of heritage ("Has it flown in space?") to the final product. Smuts Louw, Business Development Manager, says, "We're confident that we'll have a solid potential customer base, both locally and internationally."

A prototype enclosure for the power control unit

The heart of the matter

The project name, 'COR', means 'heart'. The product represents the heart of the power system, since it will regulate the flow of power centrally as a hub to the power system and satellite as a whole. The specific version of this product will be 'COR475', meaning it is a heart that can provide up to 475 Watts of output power.

Partners and collaborators

- Barracuda
- Infruitec

Highlights

- Scalable electrical power system in terms of size, power handling (modular power capacity), cost and reliability
- For use on a range of satellites starting at nanosatellite (4kg), through to minisatellites (up to 500kg)

CONTACT

Smuts Louw

smuts@spaceadvisory.com

PROJECTS IN PROGRESS

Measurement of one of the static test specimens

A static test specimen produced by additive manufacturing

PROJECT AT A GLANCE

Denel Aeronautics believes in the promise of additive manufacturing for the aerospace industry. The aim of this project is to build skills in producing aluminium aerospace parts through additive manufacturing. This project started by identifying parts in a local helicopter against the requirements for production by additive manufacturing. Through simulation, six parts are being optimised based on mass and displacement or natural frequency. Metal Heart produced aluminium test pieces and will eventually produce one of the optimised parts through additive manufacturing; the SMME has achieved significant exposure to the production of aerospace parts.

Design, Optimisation and Characterisation of Aluminium Aerospace Parts Produced by Additive Manufacturing

Local capacity building in additive manufacturing of aluminium aerospace parts

Additive manufacturing is a process by which material is added, typically layer by layer, to produce a product rather than removing material from a solid piece. It is possible to design, optimise, manufacture and characterise superior aerospace parts to be produced this way, for installation on aircraft. It has many advantages, of which two are relevant for this project.

The first is the so-called high build-to-fly ratio, so that only the material needed for the part is used and very little material is wasted. The second advantage lies in the intriguing statement, ‘complexity is for free’. Complex parts, which are difficult to manufacture by conventional means, can be produced using the additive manufacturing process.

However, not all aerospace parts are suitable for additive manufacturing. From 14 helicopter parts identified as possible candidates, the team narrowed the selection down to six parts to be evaluated against set requirements. “We decided to focus on optimising all six parts to identify the one most suited for additive manufacturing,” explains Denel Aeronautics’ (DAe) Stefan Rassmann. “This had the advantage of involving more people in the optimisation process of parts as part of capacity building.”

From left: Walter Fransman, Niël Agenbag, Andrew Wood, Stefan Rassmann, and Andrew Allcock

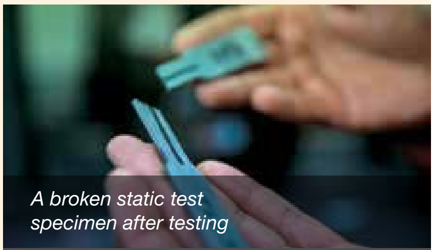
In a separate but related part of the project, Metal Heart, a local SMME, produced two different types of aluminium test pieces to characterise the material and the additive manufacturing process (Metal Heart will also eventually produce the selected optimised part). Some of the first batch of test specimens were found to have cracked after manufacturing and stress-relieving. “We believe the specimens cracked due to suboptimal support design and redesign was done to address this problem,” says DAe’s Niël Agenbag.

The specimens were intended to undergo a heat treatment which is normally necessary to improve the properties of aluminium components; however, excessive distortion of the specimens resulted during quenching and the heat treatment had to be abandoned. The next step was to use non-destructive testing (NDT) (specifically phased array scanning which uses ultrasonics) to test specimens.

To determine the strength of the material, static tests, when test pieces are pulled until they break, or fatigue tests, when test pieces are repeatedly pulled (at lower loads) until they break, were performed.

The South African Nuclear Energy Corporation is also a collaborator on the project with two technologies: X-ray tomography and neutron diffraction. Additive manufacturing allows for the production of parts with complex shapes, which means that common techniques for NDT are not capable of verifying their inner quality. Using X-ray diffraction, however, a digital model of a part can be created from X-ray scans which can be used to identify defects. Neutron diffraction is being used to quantify residual stresses and these will then be compared against predictions made using computer simulations.

The optimised part has not been printed yet, but results on the test pieces are promising. Agenbag says, “We’re confident that we’ll be in a position to use aerospace aluminium for additive manufacturing by next year this time.”



A broken static test specimen after testing

Partners and collaborators

- Metal Heart
- The South African Nuclear Energy Corporation
- CSIR

Highlights

- Optimisation of six helicopter parts
- Capacity building
- Defect detection by X-ray scans
- Printing by Metal Heart of two test pieces
- Promising results on test pieces

CONTACT

Stefan Rassmann

Stefan.Rassmann@denel.co.za

5

PROGRAMME 3:

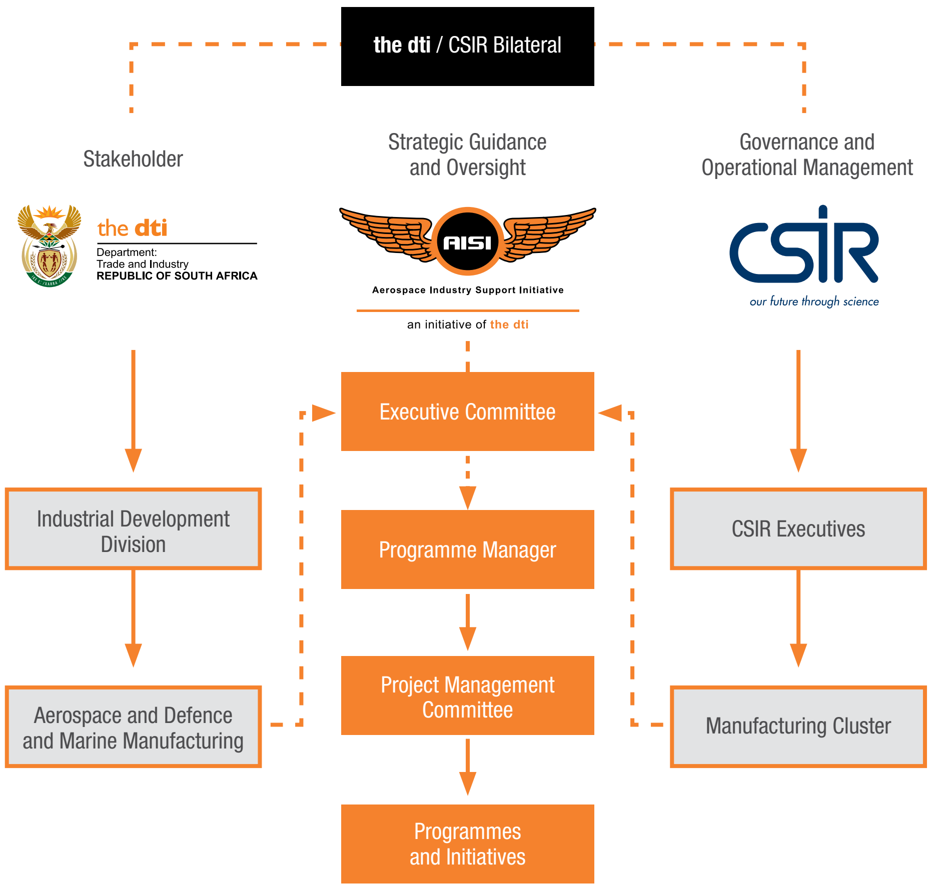
Sector Strategic Support Initiatives

Sector Strategic Support Initiatives creates a platform for industry to facilitate interactions which under normal circumstances would not be possible, allowing industry, academia and government to engage with potential clients, partners and thought leaders. The AISI utilises existing outlets to enhance the presence of the South African aerospace and defence industry, which enables both local and international role players to gain an understanding of the value proposition and competence offered in the country.

The Joint Aerospace Steering Committee (JASC) was established to provide strategic guidance and positioning to the local aerospace and defence industry. The focus of this programme is firstly the hosting of the JASC and its secretariat, and secondly, the hosting and implementation of projects on behalf of the JASC, and as guided by Industrial Policy Action Plan (IPAP). These projects are technology advancement projects with the specific aim of addressing technology gaps in strategic areas, as identified by the JASC, its subcommittees, or defined in IPAP.

6 AISI Governance

The AISI is a government-funded industry support initiative of **the dti**, hosted at the CSIR, and fully complies with the Public Finance Management Act and the Preferential Procurement Policy Framework Act. The AISI operates within the procedural framework of the CSIR, and reports to the AISI Management Committee on a quarterly basis. The AISI also reports to **the dti**, specifically data and statistics.



7 Summary of Organisations benefiting from AISI Support

Organisation Name	Organisation Type	B-BBEE Level	Certification	Project Name
MAIN INDUSTRY BENEFICIARIES (CONTRACTED ORGANISATIONS)				
ADEPT Manufacturing	SMME	2	None	• Non-Destructive Testing (NDT) Phase I • ADEPT Advanced Casting – Phase II (Collectively ADEPT Advanced Casting)
Aerosud Aviation	OEM	4	• EN 9100 Rev D • EASA POA (Part 21G) • Nadcap Heat treatment • Nadcap Chemical Processing • Nadcap Composites • Nadcap Welding	• Residual Stress Distribution in Billets • Strategic Supplier Development: Rotational Moulding
Cape Aerospace Technologies	SMME	4	None	• Small Gas Turbine to Market
Cybicom Atlas Defence	SMME	2	IPC	• Helicopter Flight Trainer Firefighting Upgrade
Daliff Precision Engineering	SMME	2	• ISO 9001 • AS/EN 9100	• Implementation of Advanced Aerospace Machining Processes
Denel Aeronautics	OEM	4	• ISO 9001 • 18001 • AS9100 • BV	• Design, Optimisation and Characterisation of Aluminium Aerospace Parts Produced by Additive Manufacturing • Implementing the use of Infrared Thermographic Testing to Augment Non-destructive Testing on Composite Components • Laser Shock Processing for Straightening of Machined Aluminium Spars

Organisation Name	Organisation Type	B-BBEE Level	Certification	Project Name
Jonker Sailplanes	SMME	7	• ACAA Type certificate for S1 'Revelation' all variants • EASA Type certification for JS-MD Variants	• 24m Wingspan Open Class JS • In-flight Wing Cleaning System
Kutleng Dynamic Electronic Systems	SMME	1	None	• SmartCAM
LambdaG	SMME	2	None	• 3D-printed Microwave Sub-Assemblies
Lantern Engineering	SMME	1	None	• Lantern Technology Localisation
NewSpace Systems	SMME	4	ISO 14644-1	• Fluid Inertial Actuator Commercialisation – Phase I and II • Stellar Gyro Flight Readiness
OnTrack Technologies	SMME	4	None	• Local Canopy Production for Sailplanes
Proceptworks	SMME	2	None	• Sentian UAV
Space Advisory Company	SMME	4	None	• COR475 Electrical Power System Nano PCU
TraX Interconnect	SMME	2	ISO 9001	• Adhesion Technology of Copper Surface for High Frequency Printed Circuit Boards • Resin-Filled Via

8

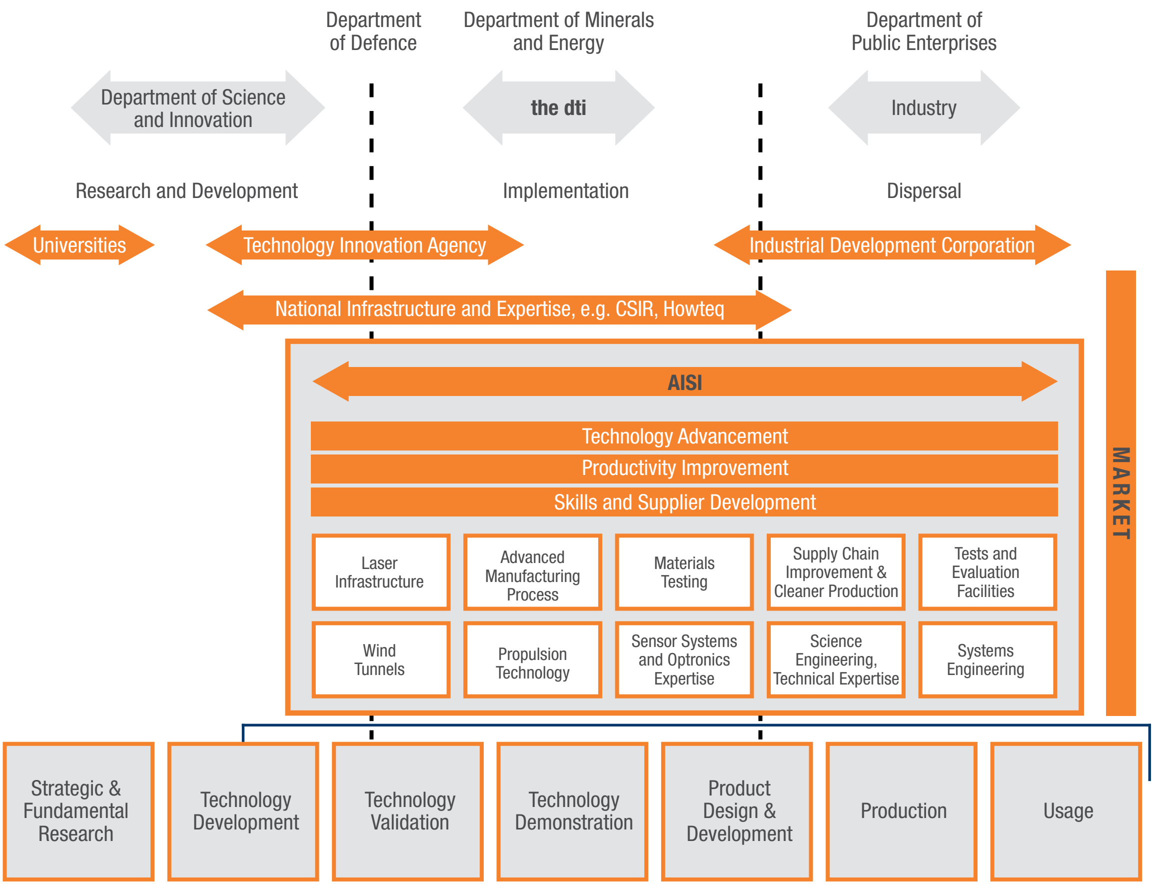
Industry Partners and Collaborators

Organisation Name	Project Name
Albatross Fly c.o.o Kusanii Composites Nisa Composites OnTrack Technologies	24m Wingspan Open Class JS
Multifractal Semiconductor Stellenbosch University University of Pretoria Metal Heart Central University of Technology	3D-printed Microwave Sub-Assemblies
Airmotive Technology Aerosud ANDTc University of Johannesburg Central University of Technology CSIR Stellenbosch University	ADEPT Advanced Casting
Metal Heart Necsa University of Pretoria University of the Witwatersrand	Design, Optimisation and Characterisation of Aluminium Aerospace Parts Produced by Additive Manufacturing
Barracuda Holdings NewSpace Systems ARC Infruitec Nietvoorbij SCS-Space	COR475 Electrical Power System nano PCU
Kline Engineering TraX Interconnect University of Cape Town	Fluid Inertial Actuator Commercialisation – Phase I and II
WOF CSIR	Helicopter Flight Trainer Firefighting Upgrade
Aerosud Aviation Airbus Denel Aeronautics Stellenbosch University	Implementation of Advanced Aerospace Machining Processes
CSIR	Implementing the use of Infrared Thermographic Testing to Augment Non-destructive Testing on Composite Components

Organisation Name	Project Name
OnTrack Technologies Telemetric Data	In-flight Wing Cleaning System
TraX Interconnect Daliff Precision Engineering Isithuba Training Centre Zyteq TIA Adaptronics AMTL	Lantern Technology Localisation
Eskom Research Testing and Development University of the Witwatersrand CSIR	Laser Shock Processing for Straightening of Machined Aluminium Spars
The Airplane Factory	Local Canopy Production for Sailplanes
Daliff Precision Engineering ESTEQ Necsa West Engineering	Residual Stress Distribution in Billets
Lantern Engineering	Resin-Filled Via
Resolution Circle University of the Witwatersrand University of Johannesburg	Sentian UAV
Escape Gauges GRW SBB Machine Tools Stellenbosch University CSIR	Small Gas Turbine to Market
ARMSCOR SARAO CSIR	SmartCAM
Pioneer Plastics North-West University	Strategic Supplier Development: Rotational Moulding

9 AISI Value Proposition

The Aerospace Industry Support Initiative (AISI) assists the aerospace and defence-related industry with technology-based supplier development and the industrialisation of relevant technologies and products. Through this, the AISI will assist industry to verify that technologies and products are technically feasible and thus commercially viable. The value proposition of the AISI in relation to additional players in the aerospace sector is illustrated below.



10 Acknowledgements

The AISI was established by the Department of Trade and Industry (**the dti**) in 2006, and has received continuous support through **the dti's** Industrial Development Division. South Africa's aerospace and defence-related industry has benefitted significantly from this support. During the compilation of the 2018/19 Impact Report, the AISI received positive feedback directly from the benefitting organisations, expressing their sincerest gratitude to **the dti** for establishing the initiative and its support.

The AISI wishes to acknowledge **the dti** team under the exemplary leadership of Ms Nokwanda Fipaza, who is supported by Mr Phemelo Mokumo, Ms Amanda Nosengela and Ms Fikiswa Ngqakayi.

The aerospace industry in South Africa is a close-knit community with various role-players in the South African National System of Innovation all contributing to the growth and success of the industry. The projects that the AISI undertook during the 2018/19 financial year were as a result of the combined contributions of various stakeholders. Under the guidance and leadership of the Joint Aerospace Steering Committee, the AISI was able to engage with National Government, industry and industry associations, and academia, leading to more impactful outcomes that were achieved.

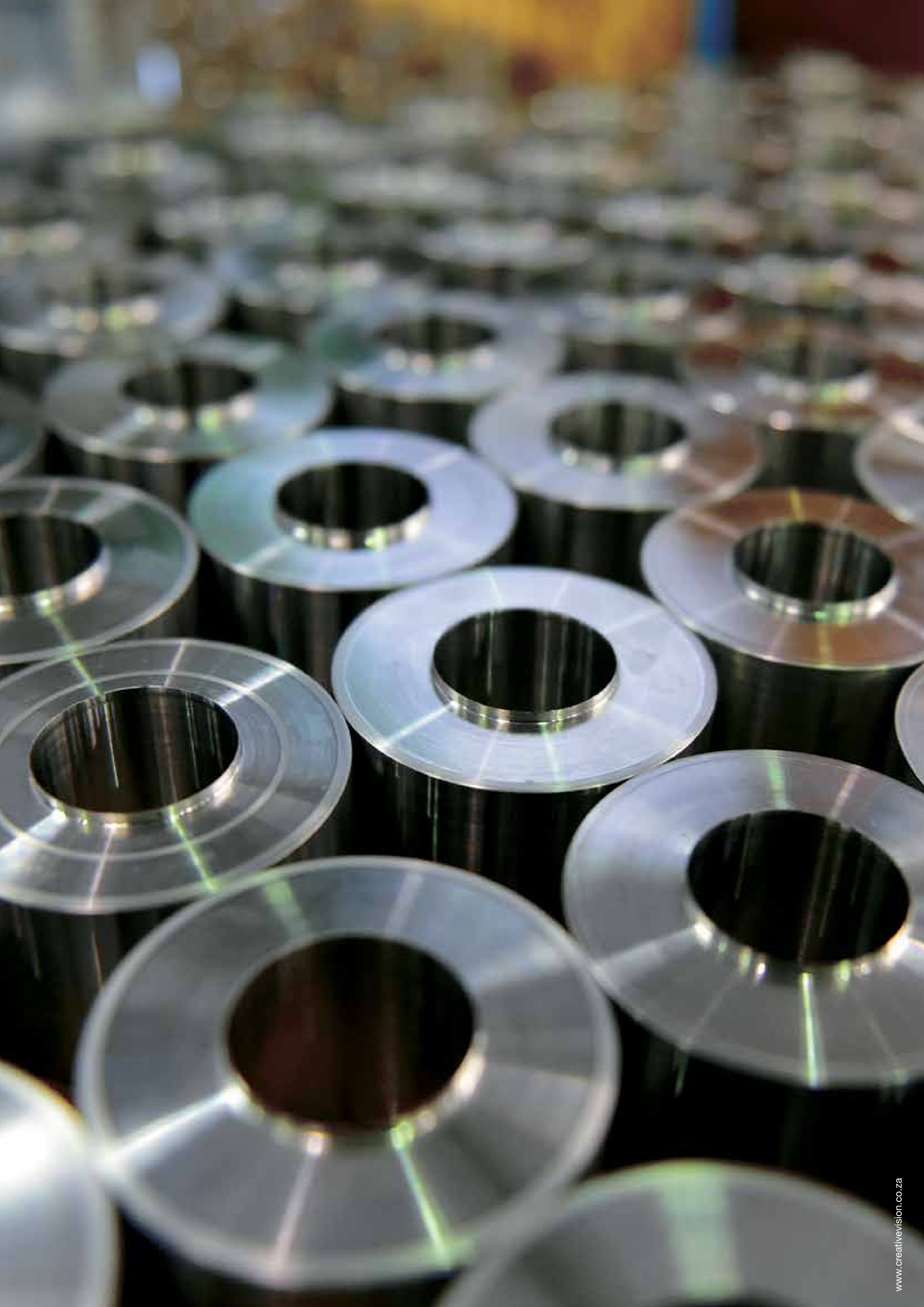
The AISI wishes to acknowledge the various stakeholders across multiple technology streams with which it works, and is grateful for the continued support and constructive feedback provided, which ensures that the offerings of the AISI are directed towards achieving the desired impact.

The AISI team is acknowledged for their hard work and commitment in diligently pursuing the achievement of the AISI mandate. The success of the initiative is a testament to the team's dedication to making a meaningful impact in the local aerospace industry.

Lastly, an acknowledgement to Chakana Consulting for the professional service provided in the compilation of this 2018/19 Impact Report.

11 Abbreviations

AISI	Aerospace Industry Support Initiative
ARC	Agricultural Research Council
CAD	Cybicom Atlas Defence
CAIDS	Commercial Aerospace Industrial Development Study
CT	Computed tomography
DAe	Denel Aeronautics
EASA	European Union Aviation Safety Agency
EPS	Electrical power system
FLIA	Fluid loop inertial actuator
GPS	Global Positioning System
IPAP	Industrial Policy Action Plan
JASC	Joint Aerospace Steering Committee
Necsa	Nuclear Energy Corporation of South Africa
NDT	Non-destructing testing
OEM	Original equipment manufacturer
SMME	Small, medium and micro enterprises
the dti	Department of Trade and Industry
UAV	Unmanned aerial vehicle
Via	Vertical interconnect access
Wits	University of the Witwatersrand



www.creativevision.co.za

www.aisi.co.za