AEROSPACE INDUSTRY SUPPORT INITIATIVE

IMPACT REPORT

2015/16

the dti
Department:
Trade and Industry
REPUBLIC OF SOUTH AFRICA

AISI
Aerospace Industry Support Initiative
an initiative of the dti

CSIR
our future through science

AN INITIATIVE OF THE DEPARTMENT OF TRADE AND INDUSTRY, MANAGED AND HOSTED BY THE CSIR

Cover image: The CAT 200 KS Small Gas Turbine Engine prototype, made possible with AISI support to place South Africa in the lead in terms of state-of-the-art micro gas turbines (see page 40).

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 facilitate 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.

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Hyperspectral Focal Plane and Mass Storage for a Space Imager

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UAV Short Range Datalink

Industrialisation of a Small Low Cost TEA CO_2 Laser

Feasibility of Natural Fibres in Aerospace Structures

Process Design of Titanium Fluidcell Forming

UHCF Design and Testing of High Strength Aerospace Materials

Process Design of CFRTP Joining Methods

Portable UAV Ground Station

UAS Antenna Solutions for Extended Communications Ranges

SKA PC Board Localisation

Supplier Development

Technology Transfer for SMME Development

Aviation Safety

Space

UAV Avionics

Targeted Skills Development

advanced manufacturing industries.

IFF Integrator Power Amplifier/Transmitter
Design and Manufacturing of Aerospace Fuel Tank Structures
Process Design and Validation of CFRTP Overlap Joining Methods
Localisation and Industrialisation of Insulation Blankets

Project Internships

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Capacity Building in Air, Space and Telecommunications Law
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Executive Summary

In presenting its Impact and Highlights Report for 2015/2016, the management of the Aerospace Industry Support Initiative (AISI) also extends its gratitude to AISI colleagues; AISI's host organisation, the CSIR; and its key stakeholder, the Department of Trade and Industry (the dti), as well as every organisation that supported and participated in the AISI's programmes during 2015/2016.

The AISI is in the privileged position of not only having an excellent overview of the South African aerospace and defence sector, but its work enables it to connect and share world-class, home-grown technology solutions with a myriad of companies – from small, medium and micro-sized enterprises (SMMEs), original equipment manufacturers (OEMs), international leaders in the sector, to South African higher education institutions, science councils, government departments and like-minded support programmes.

SOLUTION DRIVEN

Taking its strategic direction from government's objectives, the AISI, in collaboration with industry, aims to address industry challenges as identified and analysed in the sector development plan and the Industrial Policy Action Plan. These include:

- Limited participation of locally owned companies in key strategic technological areas;
- Insufficient diversification into export markets, product diversification (civil and commercial);
- Shortage of large development programmes to build technology and skills pipelines, and to accelerate knowledge transfer between the knowledge generating entities and industry;
- Risk of exclusion from the secondary markets due to the rising aerospace emerging market economies; and
- An insufficient skills pipeline and a loss of skills.

The Initiative strives to position the local aerospace and defence-related industry as a global leader in niche areas and accordingly, South African industry is encouraged to advance niche capabilities and technologies through industrialisation. Interdepartmental participation and collaboration forms a crucial part of realising this vision.

The need to grow the South African economy and create sustainable jobs remains urgent. The aerospace industry with its advanced manufacturing capability provides a very attractive opportunity in this regard.

Similarly, South Africa, with its extensive background in the aerospace industry along with its flexible and innovative engineering expertise, is ideally suited to realise this opportunity and establish itself as a reliable, cost-effective manufacturing partner.

FAR-REACHING IMPACT

As such, the AISI has a strong focus on impact to be achieved. It aims to achieve its objectives and measure impact in a number of areas, notably productivity improvement; market access; job creation and retention; supply chain development and redesign; identifying and sharing best operating practices; facilitating networking opportunities for industry; and SMME development.

A significant pillar of the AISI's strategy is its Supplier Development Programme that includes technology and skills transfer, as well as supplier development enablers such as an incentive scheme.

This scheme enables the inclusion and integration of suppliers which would otherwise not be able to participate in the industry. It is developing a sub-tier SMME manufacturing base for higher tier companies that supply components to original equipment manufacturers (pages 12 to 15 features examples of programme beneficiaries).

EXAMPLES OF WORK

The following pages give an overview of project highlights during the year. Projects have been structured in six self-explanatory focus areas: **supplier development**, **technology transfer for SMME development**, **aerospace safety**, **space**, **unmanned aerial vehicle avionics**, and **targeted skills development.**

While the featured projects are in varying stages of completion, a common denominator has been the realisation of growth for the industry, whether by increased product offerings or local and international income. The technical reports of each project are available on request.

The examples of work illustrate a number of industry benefits.

For example, continuous cost reduction while maintaining world-class quality and safety standards is increasingly important to the aerospace sector. The AISI's work includes exploring manufacturing technologies that will allow it to reduce costs on existing and future materials and processes. Cost and weight reduction to promote

efficiency and ultimately achieve reduced cost is critical. Projects and the contribution to the aerospace and advanced manufacturing industries cover a broad spectrum – from process design of continuous fibre-reinforced thermoplastic joining methods to process design of titanium fluid-cell forming, and the design and testing of high strength aerospace materials.

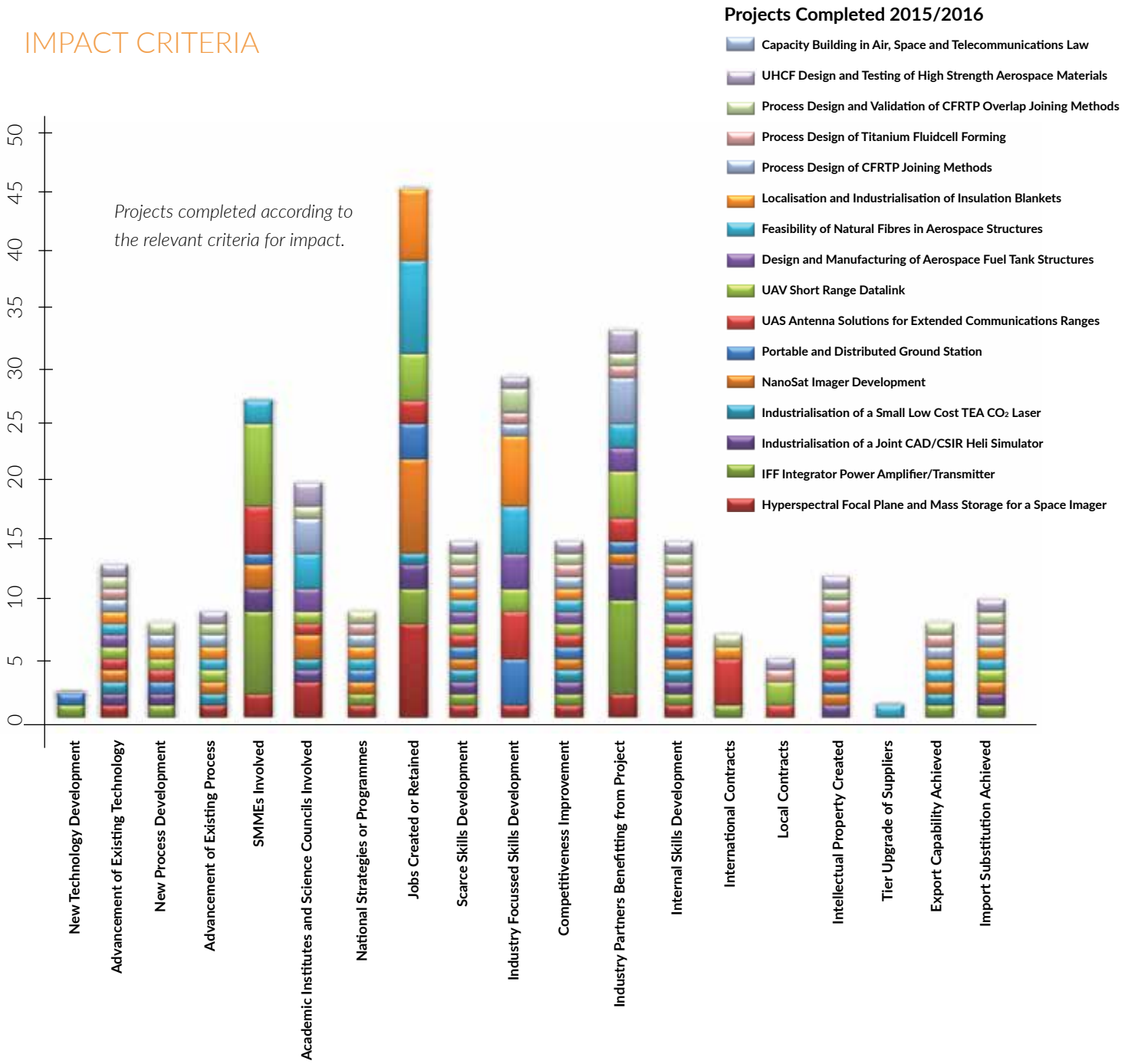
Another example of supplier development relates to work done in the area of fuel tank design. This, in particular, will drive innovation and industrialisation as well as facilitate a technology transfer . The project investigates the dynamic loading of fuel on aircraft systems and how to accurately predict these loads for design purposes. It considers an extensive range of large scale laboratory tests on realistic fuel tanks as well as the numerical simulation of the experiments.

In terms of space-related projects, the AISI has succeeded in setting an architectural and component-based reference point to further develop the nanosat imager and realise a commercial off-the-shelf-based product that has been validated through system assembly, integration and testing. It has also demonstrated South Africa's capability to support nanosat missions by appropriately specifying, designing, procuring and adapting components for a new technology hyperspectral focal plane and mass storage for a space imager.

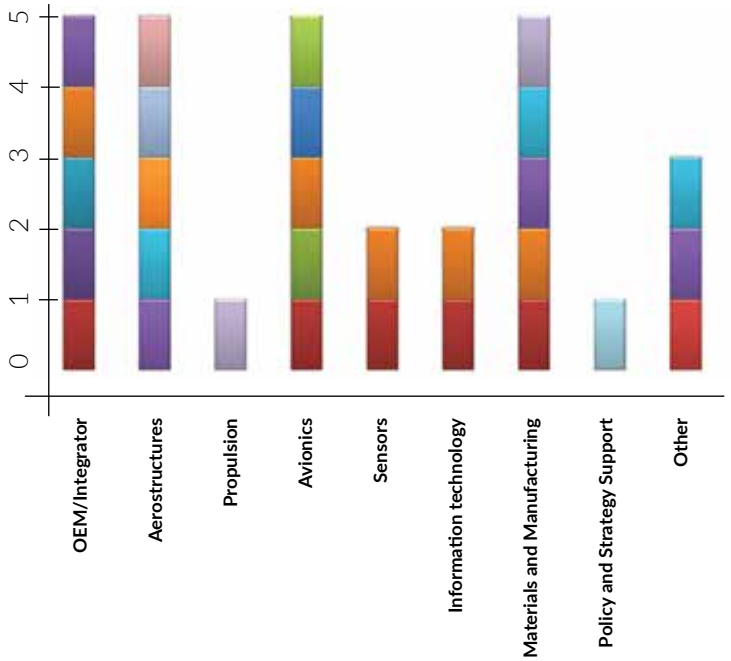
INDUSTRY IMPACT AT A GLANCE

During 2015/2016, the AISI's 23 projects benefitted 20 organisations of which 14 were SMMEs. The following graphs highlight the projects completed for the year under review, based on criteria for impact, technology streams and product market.

IMPACT CRITERIA



TECHNOLOGY STREAMS

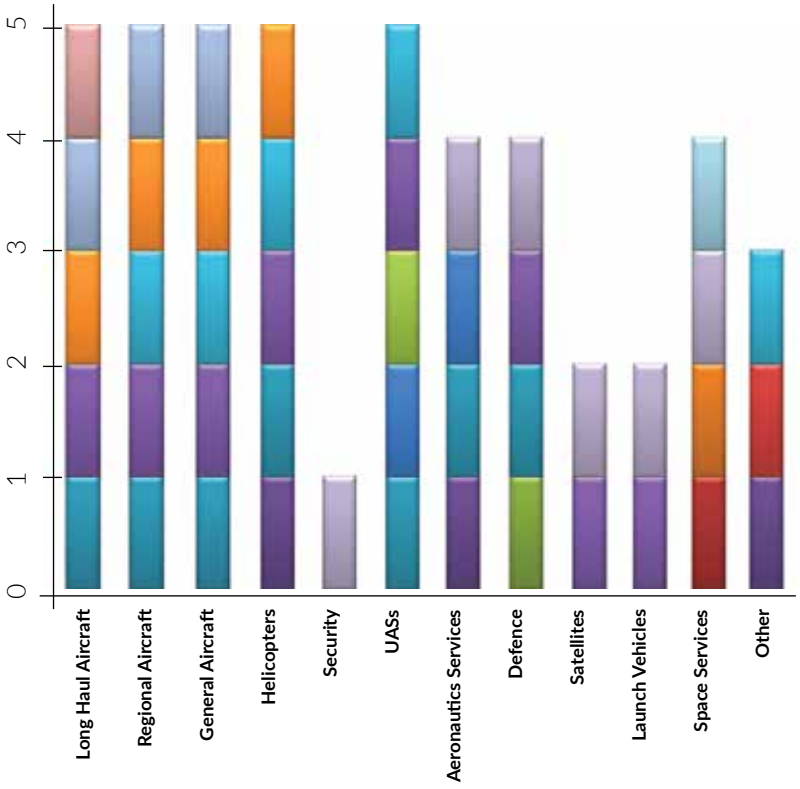


Projects completed according to technology streams.

Tellumat highly recommends the Aerospace Industry Support Initiative as a means to spur growth in the local industry and to provide competent, competitive South African solutions to the world market. It is Tellumat's recommendation that the AISI initiative should continue as it allows faster growth in the aerospace industry.

– Tellumat

PRODUCT MARKET

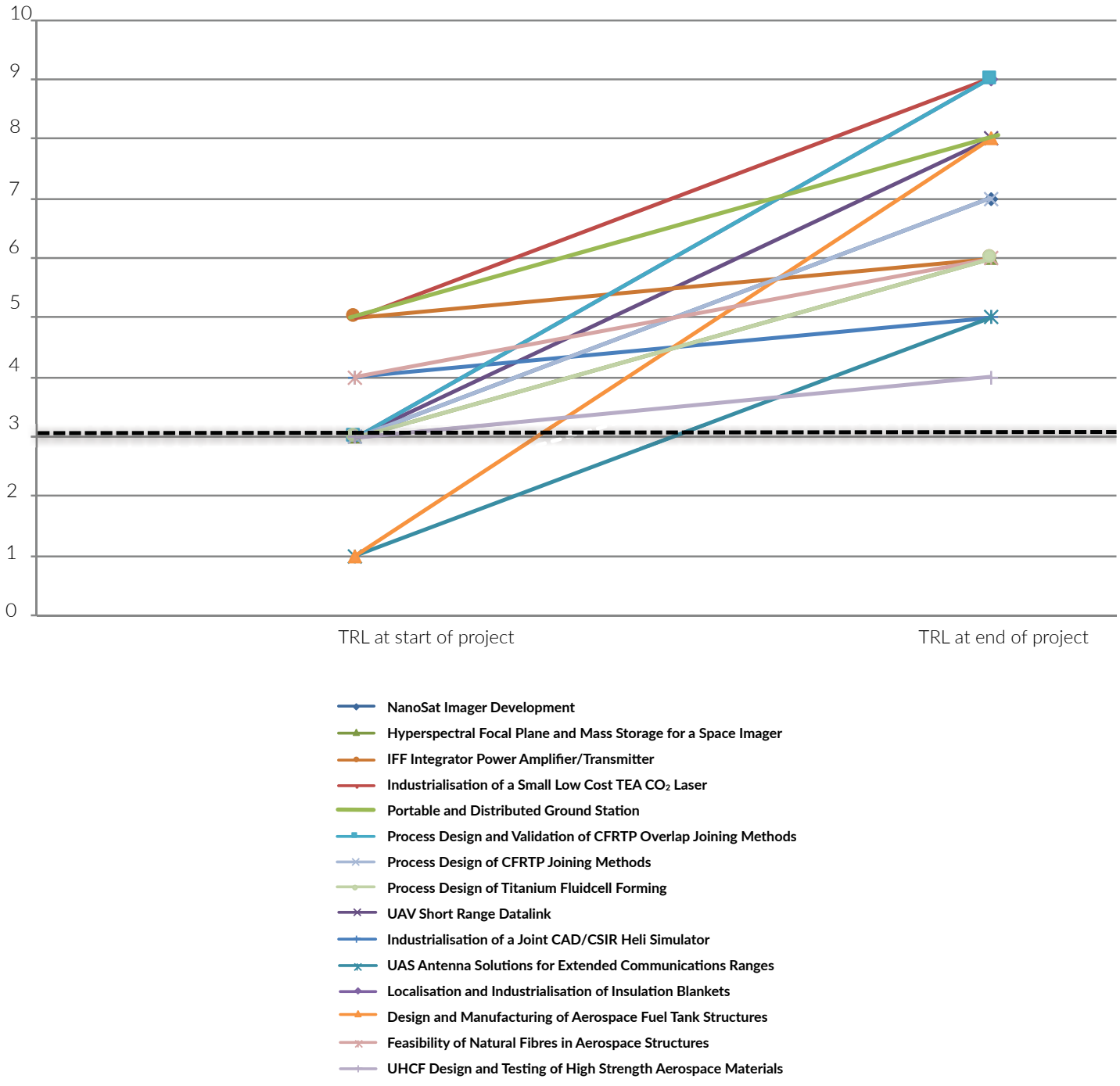


Projects completed according to product market.

Projects Completed 2015/2016

- Capacity Building in Air, Space and Telecommunications Law
- UHCF Design and Testing of High Strength Aerospace Materials
- Process Design and Validation of CFRTP Overlap Joining Methods
- Process Design of Titanium Fluidcell Forming
- Process Design of CFRTP Joining Methods
- Localisation and Industrialisation of Insulation Blankets
- Feasibility of Natural Fibres in Aerospace Structures
- Design and Manufacturing of Aerospace Fuel Tank Structures
- UAV Short Range Datalink
- UAS Antenna Solutions for Extended Communications Ranges
- Portable and Distributed Ground Station
- NanoSat Imager Development
- Industrialisation of a Small Low Cost TEA CO_2 Laser
- Industrialisation of a Joint CAD/CSIR Heli Simulator
- IFF Integrator Power Amplifier/Transmitter
- Hyperspectral Focal Plane and Mass Storage for a Space Imager

TECHNOLOGY READINESS LEVELS



The figure illustrates the increase in the technology readiness levels of the completed projects. In all instances the projects showed a marked increase in readiness levels.

** The picture graphic on pages 9 and 10 gives a snapshot of AISI-supported projects featured in this report and their contribution to the aerospace and advanced manufacturing industries.*

Supplier Development

Man must rise above the Earth – to the top of the atmosphere and beyond – for only thus will he fully understand the world in which he lives.

– Socrates

The AISI's enabling mechanisms assist industry to improve its competitiveness, productivity and quality management systems and in doing so, optimise its operations and procedures to ensure South African industry integration into global supply chains. Technology and skills transfer, as well as a supplier development incentive scheme, enables participation in the economic sector, which, under normal circumstances, would not have been possible for sub-tier SMMEs. In particular, the suppliers of Aerosud Aviation and Denel Aerostructures have been integrated into local supply chains. Economic benefits derived through supplier development projects include competitiveness improvement, productivity improvement, improved lead times, improved quality, cost savings, compliance to environmental standards, improved delivery performance, increased customer satisfaction and job creation and retention.

Projects addressing these objectives include:

- Supplier development enabler for SMMEs
- Supply chain improvement and optimisation interventions
- Design and manufacturing of aerospace fuel tank structures
- Feasibility of natural fibres in aerospace structures
- Localisation and industrialisation of insulation blankets
- Process design of continuous fibre-reinforced thermoplastic joining methods
- Process design and validation of CFRTP overlap joining methods
- Process design of titanium fluid-cell forming
- Ultra-high cycle fatigue (UHCF) design and testing of high strength aerospace materials

Supplier development enabler for SMMEs

Supplier development is a key focus area of the AISI's strategy to ensure industry transformation and to broaden the economic base participating in the industry – improving the competitiveness of the whole sector. Two pillars of the Supplier Development Programme are technology and skills transfer, and supplier development enablers. An incentive scheme is one such enabler. This scheme enables the inclusion and integration of suppliers which would otherwise not be able to participate in the industry. It is developing a sub-tier SMME manufacturing base for higher tier companies that supply components to original equipment manufacturers. The AISI utilised two higher tier integrators, Aerosud Aviation and Denel Aerostructures, to pass on development opportunities to their suppliers.

Denel Aerostructures

THE BENEFICIARIES: CLIFFS'WAY AEROSPACE, DALIFF PRECISION ENGINEERING, MICROMAX, AND T&T ENGINEERING

Denel Aerostructures' goal was to assist these SMMEs to become internationally self-sustainable companies to the first and second tier suppliers in the aerospace industry by, among others, achieving and maintaining internationally recognised accreditations to increase its contribution.

Both *Cliffs'way Aerospace* and *Daliff Precision Engineering* focus on the production and assembly of machined components produced to tight tolerances in a range of materials. These companies have a competitive range of modern CNC precision milling and turning equipment, and state-of-the-art manufacturing control software. The bulk of their work is in aerospace, mainly the production of airframe components for Denel Aerostructures, who is a supplier to Airbus for the A400M military transport.

Following an 18-month intensive training and skills transfer period through a Denel Aerostructures initiative, supported by Airbus, Cliffs'way Aerospace and Daliff Precision Engineering were granted Airbus approval. This enables the SMMEs to compete globally. With Denel Aerostructures' assistance, they also improved and increased their machining capability. It is only through enhancing their own capability that they can support Denel Aerostructures' growth strategy – ultimately benefiting the South African aerospace industry.

Since becoming approved Airbus suppliers, Cliffs'way Aerospace and Daliff Precision Engineering are seen as workbench extensions of Denel Aerostructures. One of the major benefits of the project to these SMMEs has been improved and increased control of economic batch quantity and better capacity planning as well as an improved capability for on-time delivery.

MicroMax is a supplier of advanced machined metallic parts and supply a number of companies in the Denel Group. MicroMax's core business is in the aerospace and defence industry as it machines airframe components for Denel Aerostructures.

The SMME is ISO 9001 certified, but some of Denel Aerostructures' recent contracts and its own objectives required an upgrade to AS/EN 9100. Denel Aerostructures assisted MicroMax with some improvements and new processes. These include facility assessment and recommendations; review and approval of records for inventory management; and review of material handling and management in terms of AS/EN 9120.

Denel Aerostructures initiated a supplier development project with a number of SMMEs that showed potential for sustainability and growth in the aerospace industry as well as the potential for skills and technology development. Denel Aerostructures partnered with these companies as they required support in achieving the relevant approvals to become legitimate international players in this market.

– Denel Aerostructures

Benefits realised for MicroMax include improved logistics of issuing material per order; delivery of full order batch; improved stock management; and robust and industry-compliant controls.

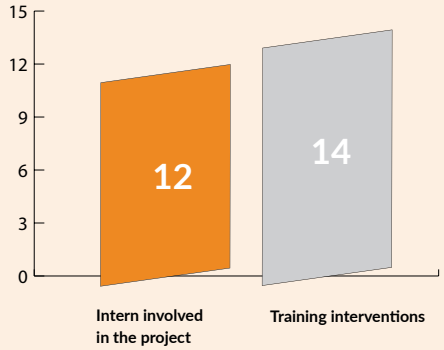
T&T Engineering is a precision component manufacturer that was identified following the annual ABSA Enterprise and Supplier Development Expo. It was also awarded the Alstom Base Board Duct Project for 20 train sets with an option for a further 600 train sets, following a competitive tender process.

Denel Aerostructures helped the SMME with improvements and new processes. Certification and OEM approvals were sought for Denel Aerostructures, ISO 9001:2008, Transnet and Eskom. Key actions targeted specific improvements in the areas of quality, industrialisation, first article inspection, tooling design, turnkey solution support, support with delivery performance schedule, and financial management.

T&T Engineering realised improved and increased control of economic batch quantity; better capacity planning; and improved capability for on-time delivery. Its ISO 9001 has earmarked the company for further AS/EN 9100 accreditation. An additional benefit from the project is an established track record in the aluminium machining and subsequent aerospace industry.

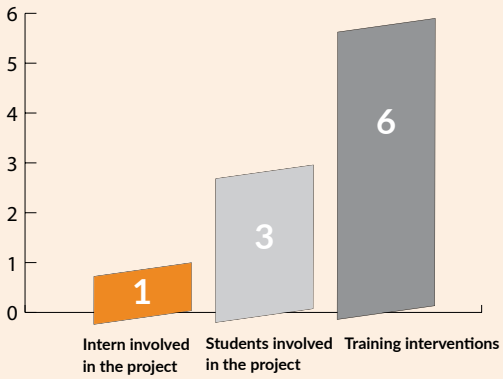
In numbers:

CLIFFS'WAY AEROSPACE



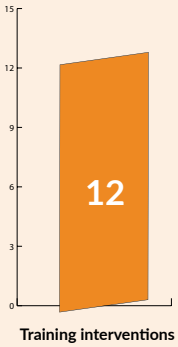
50% Black transformation of the workforce

DALIFF PRECISION ENGINEERING



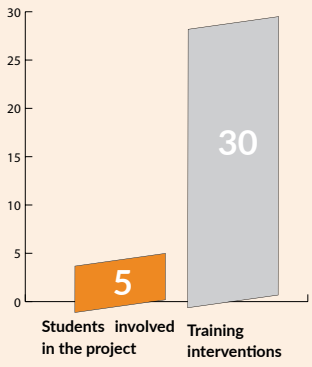
83% Black transformation of the workforce

MICROMAX



50% Black transformation of the workforce

T&T ENGINEERING



90% Black transformation of the workforce

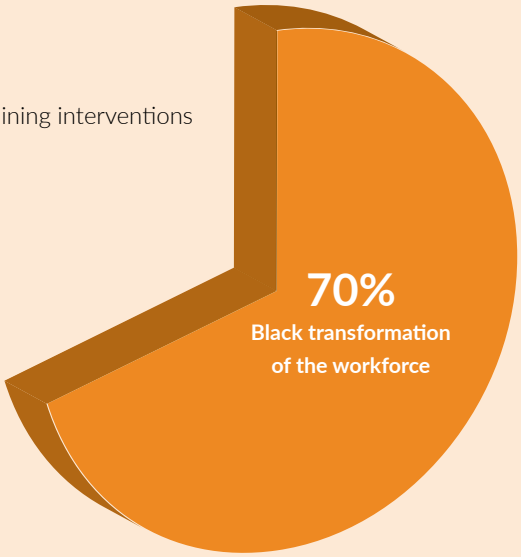
Aerosud Aviation

COMPUMACH ENGINEERING

Compumach, a manufacturer of precision computer numeric control (CNC) machined components since 2004, was the first SMME that Aerosud Aviation supported as a development partner. Since this early alliance, Compumach has achieved ISO9001 and EN9100 approvals. Aerosud Aviation Aviation assisted Compumach through the transfer of technology as well as improving its throughput to ensure that it remains competitive and increase its market share year-on-year. Compumach's improved and increased throughput has resulted in increased sales to Aerosud Aviation Aviation as well as attracted new programmes from the support industry.

In numbers:

2 Training interventions



TI-TAMED

Ti-TAMED is a manufacturing company established in 1996. It specialises in high-precision engineering with materials such as titanium, stainless steel, invar (a nickel-iron alloy), nitronic, aluminium and high-performance polymers..

Ti-TAMED served as a development partner with Aerosud Aviation on specialised part manufacture. This led to an increased business volume and subsequent development of Ti-TAMED as an aerospace supplier. Aerosud Aviation assisted the SMME to increase its business opportunities through the transfer of technology as well as improving throughput. Further interaction with Ti-TAMED in the area of process improvement and the transfer of machining best practices as well as an improved and reduced coordinate measuring machine (CMM) process, will create the required capacity for further growth.

The SMME has been able to manufacture some critical components which allow other companies in South Africa to assemble and export technology. The introduction of geometric dimensioning and tolerancing (GD&T) CMM processes by Aerosud Aviation has improved CMM capability and throughput.

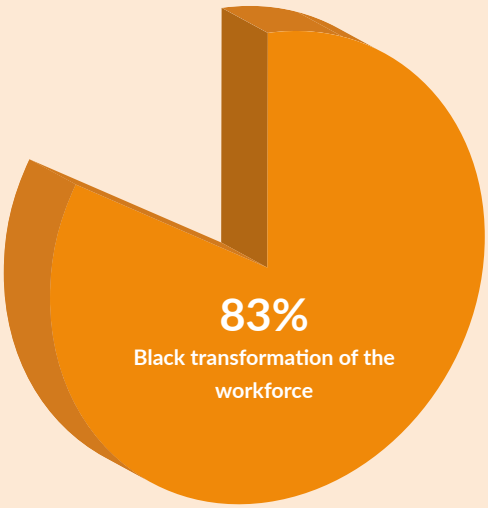
To date, the company has manufactured approximately 181 different parts for Aerosud Aviation – from turning to milling. On the more complex parts, 5-axis CMM measuring was provided.

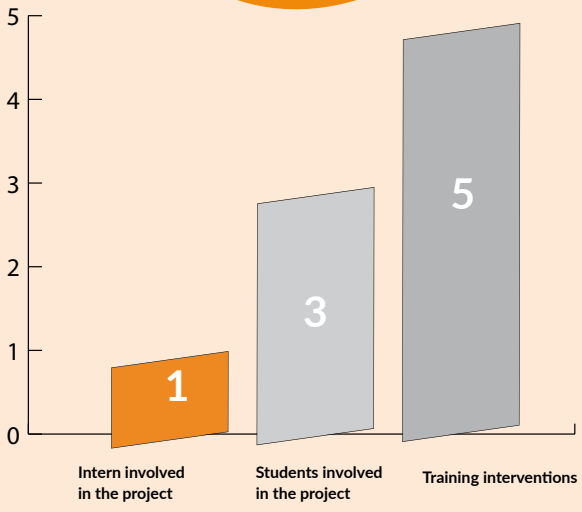
DALIFF PRECISION ENGINEERING

Aerosud Aviation assisted Daliff by advancing an existing capability/process at the SMME. As an SMME, Daliff relies on receiving work packages from higher tier suppliers such as Aerosud Aviation. Aerosud Aviation's ability to secure international contracts, however, depends on its South African supply chain's capacity and capability to meet the manufacturing demands. Capacity includes time; equipment; machining envelope dimensions; production support processes; special processes regarding, for example, original equipment manufacturers' approvals; and price.

With Aerosud Aviation's assistance, Daliff has been able to improve and increase its machining capability. The company also followed an intensive 18-month training and skills transfer period, enabling Daliff to compete globally and form part of Airbus' supply chain. Airbus' approval was as a direct consequence of the Aerosud Aviation-supported continual improvement programme over the past eight years. Since becoming an approved Airbus supplier, Daliff has also been able to supply quotations to UK/European Tier 1 suppliers.

In numbers:





Aerosud Aviation's objective is to focus on a small group of SMMEs and develop them to ensure that their business grows in line with the local aerospace industry.

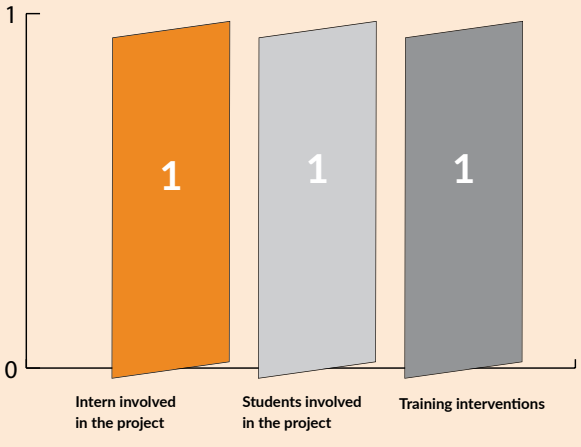
- Aerosud Aviation

WEST ENGINEERING

West Engineering is the most recent of Aerosud Aviation's machining SMMEs. The willingness of West Engineering to embrace Aerosud Aviation and the aerospace industry's stringent regulations and technology requirements, has led to a solid working relationship. Due to the increasing volume of machined parts required by Aerosud Aviation and the necessity for reduced lead times, Aerosud Aviation requires suppliers such as West Engineering to be developed to a standard where increased volumes, work complexity and technology transfer can be realised.

Aerosud Aviation has recently introduced GD&T CMM training as well as the Aerosud Aviation Shop Floor Data Collection priority management system with extraordinary results. Further development has led to West Engineering achieving ISO 9001 status and the SMME is now poised for AS/EN 9100 accreditation.

In numbers:



Supply chain improvement and optimisation interventions

The CSIR is implementing optimisation interventions in industry for the AISI through its Supplier Development Programme by working on various projects to investigate, analyse and improve the supply chains of aerospace and defence industry stakeholders in South Africa. Sinjana Engineering, a black-owned SMME, is one such company requiring help with its production planning and quality management systems.

THE PROJECT IN MORE DETAIL

Sinjana Engineering was established in 2000. It specialises in precision machining driven by customer requirements. The company manufactures components from ferrous, non-ferrous and non-metallic materials using precision equipment and tools. Tight tolerances and high surface finish are achieved consistently both from manual and computer numeric control (CNC) machines. The company is ISO 9001:2008 accredited.

A needs analysis showed that three areas required interventions. In the end, two areas were prioritised. Firstly, the company lacked a production planning system. The challenge was that of unstructured work where the ability to plan, schedule and control production activities is deficient. This results in poor resource allocation, poor capacity planning and poor scheduling and control. As a result, the company has high operating costs. Planning and control is required to manage the ongoing activities of production so as to satisfy customer demand.

Subsequent to studying the processes and operations to better understand the process flow and how the processes are interrelated, it was discovered that the company's quality management system needed to be revised and updated as it lacked quality improvement tools.

These tools include documents for data collection, tools for data analysis and tools to be used for quality improvement. For quality improvements to take place there must be a quality plan in place as well as control measures to meet customer needs.

This project aimed to develop a production planning system that will consist of planning and scheduling, line balancing, Kaizen – a business philosophy of continuous improvement, and inventory control and management. A further aim was to implement Juran's Trilogy – comprising three managerial processes: quality planning, control and improvement. Audit findings determined that the second aim – establishing a quality management system – had to take priority.

The quality management system was reviewed and the manual was revised for the first time since 2012. This meant a completely new write-up of the quality manual, including content such as the quality policy manual, business and work process flowcharts, document control, and implementation programme.

Specifically, during the course of the project, quality procedures were developed as well as procedural manuals for manufacturing, production planning, purchasing, sales order, and quality inspection. The quality management manual, policy statement, objectives and goals were designed in addition to documents relating to quality planning and control, non-conformance recording documents, data collection document, control charts, corrective/preventive action plan, scrap analysis sheet, quality control sheet and measurement tools.

In terms of production planning and to fully utilise resources and run the plant to full capacity, the company needs to record every activity that takes place in the production process. Planning and work study documents developed for this purpose include a production planning sheet, scheduling sheet, work-in-progress sheet, time study sheet, and work instruction sheets for all products manufactured by the company.

This project has increased Denel Dynamics' confidence in Sinjana Engineering because we now work according to the processes we have created ourselves. We are able to manufacture on critical components.

– Sinjana Engineering

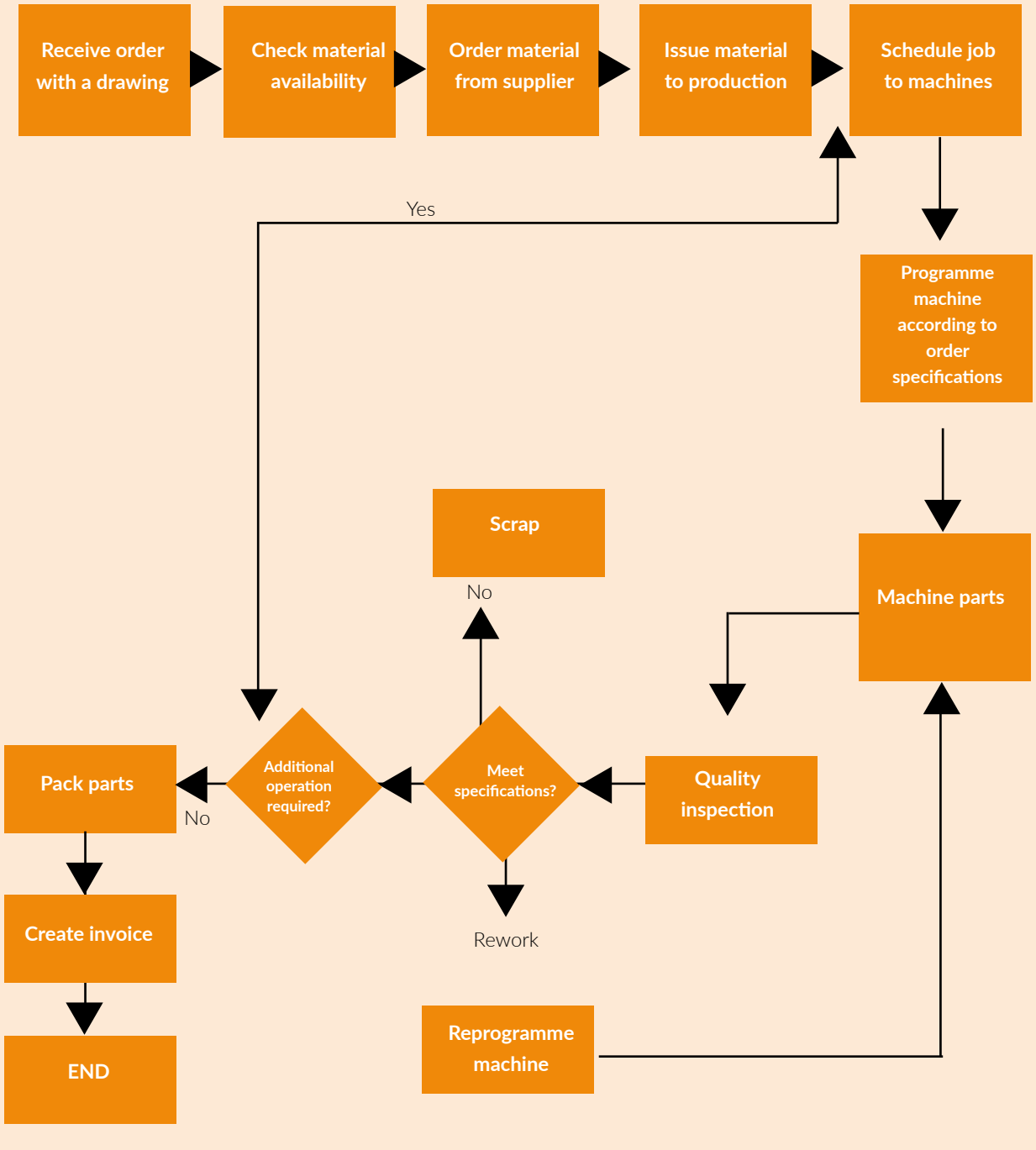
It is envisaged that the implemented interventions will assist Sinjana Engineering to run the production process smoothly. It will also improve quality and thereby secure more contracts.

In addition, this project created two job opportunities. The first job created was that of a Production Manager. The second job opportunity was for the Quality assurer. When the interventions commenced, it was clear that these two positions needed to be filled so that the people can be trained while the implementations take place.

SUCCESSFUL COLLABORATION

The University of Pretoria and University of Johannesburg assisted by providing additional guidance and supervision to students who were involved in the Sinjana Engineering project. A main customer of Sinjana, Denel Dynamics, approached the CSIR to – with help from the AISI – assist Sinjana with critical issues impacting its sustainability.

AN IMPROVED PRODUCTION PROCESS FLOW DIAGRAM



Design and manufacturing of aerospace fuel tank structures

The AISI facilitated collaboration between Denel Aerostructures, the CSIR and the University of Pretoria (UP), which will establish a specialised capability for the loads analysis of aerospace fuel tank structures. This is an excellent example of technology transfer to an original equipment manufacturer and validation through the use of national infrastructure. This project will, among other benefits, provide critical design information to the local industry. It will also provide the country with an international competitive advantage, attracting foreign investment and growing the industry's footprint in the global supply chain. High value-added manufacturing will enable sustained growth of human resources and skills development.

THE PROJECT IN MORE DETAIL

The movement of a liquid inside another moving object, known as sloshing, is an important aspect of aerospace fuel tank design. Sloshing in large fuel tanks causes impact loading on structures and can threaten the dynamic stability of the vehicle in which they are contained – typically airliners and space launch rockets.

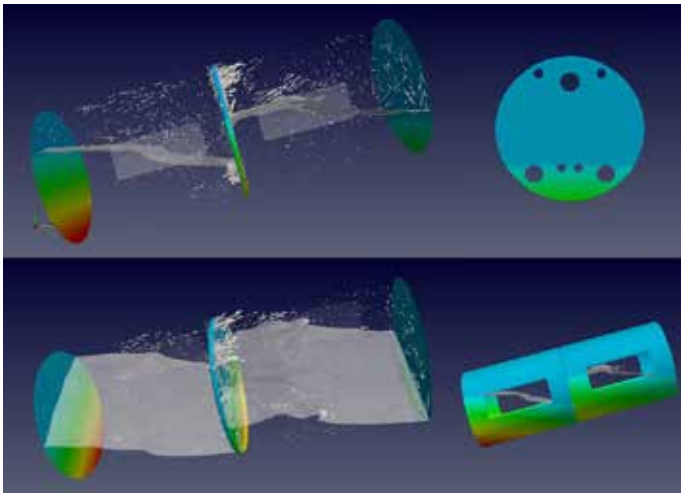
The AISI commissioned the validation and industrialisation of advanced analysis procedures during the design and manufacturing of fuel tank structures. The test tanks were manufactured by Denel Aerostructures and an experimental programme was run with the Centre for Asset Integrity Management at the University of Pretoria. The experimental data are used to validate the software developed at the CSIR to predict dynamic fuel loading on aircraft structures.

This work has not only demonstrated close correlation between the numerical and experimental data, but has also established confidence in the use of the software during the design of fuel tank structures. Following this, Denel Aerostructures could verify the design of the Rooivalk drop tank. The project demonstrated the integration of high-fidelity modelling in the product development cycle of fuel tank systems and extended the value offering of the South African aerospace industry.

A second part of the project aims to demonstrate the application of the technology to a tank based on an unmanned aerial vehicle (UAV) system being designed at Denel Aerostructures. It is not uncommon

Left: Fuel sloshing demonstration at the University of Pretoria.

Below: Fuel tank sloshing simulation done by the CSIR.



The main benefit of our work is to provide more accurate design loads due to fuel sloshing in the fuel tanks of aircraft. This could lead to more optimal designs and increase structural safety. In addition, expensive tests could be reduced if the load predictions of the software are correct.

- Denel Aerostructures

to find high fuel-airframe weight ratios; for example, in one such system it is estimated that the weight of airframe would only be 20% of the fuel weight; thus making the system highly sensitive to the dynamic behaviour of the fuel. This project addresses the design, analysis and testing of a generic fuel tank structure for UAVs.

SUCCESSFUL COLLABORATION

Denel Aerostructures has extensive background in the design and manufacturing of complex metallic and composite aero-structures for the military and commercial aerospace sectors. It has an established track record in the design and manufacturing of integral fuel tanks, notably for the Impala, Bosbok and Kudu aircraft, as well as external fuel tanks, for example ferry tanks for the Rooivalk combat helicopter.

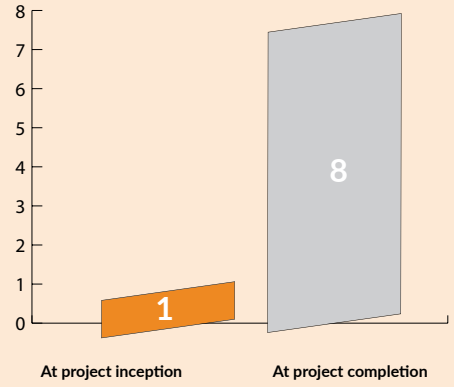
The CSIR has developed software to model dynamic fuel movement and subsequently predict loading on tank walls and baffles (used to restrain the flow of a fluid). This high-fidelity simulation approach provides design engineers with greater insight into the operating conditions of tanks during the design process and allows them to improve safety of the system and increase its efficiency.

Tests to validate the numerical algorithms used in the analysis of fuel sloshing in tanks are critical to establish confidence in the simulation software – and adoption by industry. Virtually no usable validation data are available in literature, and experimental analysis therefore represents significant value addition. Here the UP's Centre for Asset Integrity Management comes in. Its background in dynamic response reconstruction with a large range of servo-hydraulic actuators and the capacity to do accelerated multi-actuator tests on multi-ton structures, places it in the ideal position internationally to integrate research with industrial-scale experimental facilities.

Fuel tank assembly at Denel Aerostructures.

Benefits and impact

Technology readiness level



Predominant product market

- Aeronautics
  - Long haul aircraft
  - Regional aircraft
  - General aircraft
  - Helicopters
  - UAVs
- Defence
- Space
  - Satellites
  - Launch vehicles

Scares skills development

- Structural analysis to high-fidelity modelling of dynamic fuel loading to complement the existing empirical approach
- Improved knowledge of numerical modelling of fuel sloshing
- Experimental analysis of liquid sloshing in tank structures

Industry focused skills development

- Denel made use of vacation students to help with the CAD design
- During manufacturing young artisans were employed
- During the experimental phase a lab technician received training to operate the PID controller
- The University of Pretoria developed a training platform to to introduce students and technicians to experimental and numerical sloshing analysis

Intellectual property

- Experimental data generated for the validation process
- Simulation data generated as part of the numerical analysis
- The designs of the experimental tanks and test rig

Import substitution

- Denel Aerostructures is producing external fuel tanks for the Rooivalk helicopter
- Locally developed software to simulate fuel sloshing can be used, there is no need to buy commercial software from international venders

Feasibility of natural fibres in aerospace structures

Natural fibres offer a good strength-to-weight ratio. This, with the growing popularity of green technologies and the need to reduce manufacturing costs, contributes to natural fibres being seen as a substitute for synthetic glass fibres. South Africa needs to grow its local composite market and has yet to make an impact in the global market. Interiors are one area where natural fibres may be employed. The capability developed within this project is linked to the use of natural fibres in the development of the Small African Regional Aircraft (SARA), a national flagship programme by Denel Aerostructures. The aim of the project is to take natural fibres from a research into a production environment. The feasibility of using natural fibres in aerospace interiors is assessed and, where possible, the emphasis is on locally manufactured and researched natural fibres.

THE PROJECT IN MORE DETAIL

Natural fibres are already successfully used in the automotive and other commercial applications. The aerospace industry has started to take an interest in natural fibres, but to be accepted the fibres must meet stringent safety, quality and certification requirements. Flax is the most researched natural fibre, and shows the greatest promise to be accepted as a structural fibre for aerospace structures.

Part of the feasibility study aimed to identify its reliability and repeatability (i.e. as a natural fibre, are its strength properties, the same from harvest to harvest); how its strength properties behave under hot/wet environments; and what its flame, smoke, toxicity and heat release properties are.

Flax fibres are currently included in various aerospace research and development programmes worldwide and show superior specific substance and strength to the synthetic glass fibre. Also of special interest is its excellent dampening and acoustic properties. Passenger safety regulations are extremely strict. Flax fibres have inherent safety advantages that make them suitable for aircraft interiors, such as doors for baggage components, interior liners, and cabin floors. However, due to the stringent aircraft testing requirements, they will probably only find their way into aircraft structures by 2020.

To determine the feasibility of qualifying natural fibres for aircraft interior structures, Denel Aerostructures selected:

- An appropriate natural fibre available from the global market that shows promise for aerospace application;

SUCCESSFUL COLLABORATION

Denel Aerostructures, with the support of the AISI, is characterising the material properties of an epoxy resin/flax fibre composite laminate with the purpose of using this material in the interior liners of the new regional aircraft developed under the SARA programme.

Two SMMEs were used to develop the local woven flax fibre fabrics: Herdman's spins the long fibre flax yarn and supplies Svenmill, who weaves it and supplies the flax fabric to Denel Aerostructures. Academic institutions involved are the CSIR, the University of the Witwatersrand and Tshwane University of Technology.

Trimmed interior lining.

- An industry standard for benchmarking purposes;
- A fibre from the local market;
- An appropriate thermoset resin suitable for aerospace application; and
- An appropriate manufacturing process suitable for the aerospace industry as well as transferable to local SMMEs, ensuring supplier development.

It further defined the manufacturing process in a standard operating procedure, ensuring it is repeatable and transferable. The material properties of selected fibre were characterised to acceptable aerospace industry standards prior to manufacturing the test coupons.

Denel Aerostructures has been able to develop globally comparable natural flax fibre fabrics in about a third of the expected timeframe. A further spin-off has been indications from the local market to collaborate on developing carbon fibre fabrics, a synthetic fibre widely used on aerospace structures. From a local perspective, Denel Aerostructures can activate the natural fibres value chain, break into the lucrative global composites market and create much-needed jobs.

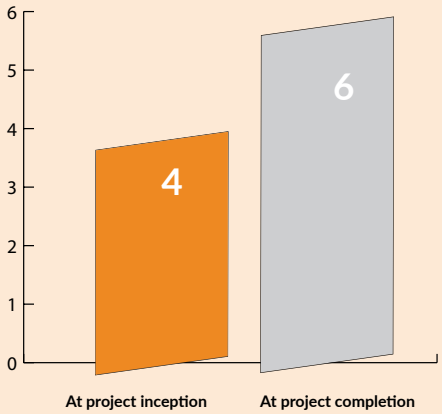
Manufacturing of interior lining.

The aerospace market is still one of the most promising markets when it comes to composites. Due to fluctuations in oil prices and the risk of future shortages, aerospace manufacturers are turning to alternative materials to build lighter aircraft that are reliable and environmentally friendly.

- Denel Aerostructures

Benefits and impact

Technology readiness level



Product markets:

Aeronautics
- Regional aircraft
- General aircraft
- Helicopters

Other
- Unmanned aerial vehicles
- Secondary and tertiary aerostructures

National strategies and programme alignment
- Industrial Policy Action Plan
- Small African Regional Aircraft

Jobs created or retained
- 8 at Denel Aerostructures
- 6-7 at local fibre and fabric SMMEs
- Potential for substantial jobs in value chain (local farmers to fibre material manufacturers)

Industry focused skills development
- 4 students
- Local value chain
- Local woven natural fibre
- Aerospace industry-aligned quality control

Intellectual property
- Test methods and results, manufacturing processes

Export capability
- Work in progress: Svenmill to export locally developed natural and synthetic fibres

Import substitution
- Local products benchmarked against international products

Localisation and industrialisation of insulation blankets

This project focused on Aerosud Aviation's supply of insulation blankets for the Airbus A400M programme, which are currently purchased from a company in Canada. In line with the Industrial Policy Action Plan of the dti and similar government initiatives, Aerosud Aviation seeks to increase the local content in the parts it manufactures. The barrier to entry in manufacturing insulation blankets locally was seen to be low and the savings that could be realised, significant. The largest barrier was finding and affording a machine that would be suitable to accurately cut the wide variety of materials that make up these insulations. However, with a suitable machine located and the support provided by the AISI, the project became a reality and is now entering the production phase.

THE PROJECT IN MORE DETAIL

To further reduce manufacturing costs and improve Aerosud's competitiveness, the manufacture of insulation assemblies should be industrialised at an Aerosud-certified location. This project not only advanced the capability to assemble and deliver assembled components, but also brought foreign spending back to South African companies through localisation of this technology.

This AISI-supported project delivered a fully certified and industrialised process for the manufacture of A400M insulation blankets as per the Airbus requirements. The industrialisation of the assembly created jobs to deliver approximately 550 insulation assemblies per month.

Aerosud pursued this project as an ideal localisation initiative. The insulations were traditionally purchased from Canada at high cost. The localised product will attract a small amount of labour, where the skill level is reasonably low. The labour requirement can also be filled by persons with disabilities.

The required capital equipment has been purchased and the design and industrialisation processes to support production are in full swing. The process mapping was initiated during January 2016 and the machine commissioned in April 2016, followed by the requisite training

Since this initiative is a technology transfer programme, there is no direct improvement in productivity related to insulation blankets; however, there is more throughput overall. The applicability of this technology to related processes will convert many manual labour hours to machine functions which will increase productivity in other areas substantially.

> *Interesting concepts on possible process and efficiency improvement in the manufacture of the insulations have been tabled as a result of this initiative.*
>
> **– Aerosud**

SUCCESSFUL COLLABORATION

Manufacture of insulation assemblies was industrialised at an Aerosud Aviation certified location, as mandated by aerospace manufacture certifications. The intention was to create a long-term sustainable platform in partnership with Dreamhouse to manufacture insulation assemblies for delivery to Airbus for the duration of the A400M project. Other supply opportunities will be investigated in parallel with the current supply chain. Aerosud Aviation has formed new relationships with its suppliers and customers around the topic of insulation blankets.

Due to the versatility of the cutting machine that was selected for this programme, several other areas of process improvement have been identified. The most significant opportunity is the automated cutting of prepreg material (a reinforcing fabric which has been pre-impregnated with a resin system).

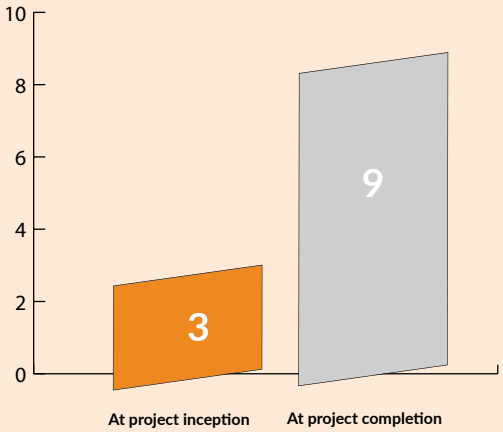
Stowage box insulation blanket.

Insulation blanket LSU (LH).

Insulation Blanket WF (HTZ).

Benefits and impact

Technology readiness level



Product markets

Aeronautics

- Long haul aircraft
- Regional aircraft
- General aircraft
- Helicopters

National strategies and programme alignment

Sector development plans and aerostructures roadmap

Aerosud Aviation-specific skills development

12

International contracts

1 contract for the supply of insulation assemblies

Intellectual property

Manufacturing processes for product class

Export capability

Export volumes increased

Import substitution

Yes

Process design of continuous fibre-reinforced thermoplastic joining methods

Process design of continuous fibre-reinforced thermoplastic (CFRTP) joining methods enabled Aerosud Aviation and other industry partners to start participating in the CFRTP assembly market. In this project CFRTP parts were analysed from the specific viewpoint of assembly. Joints between metal components and CFRTP structures were also investigated as an integral part of major assemblies. A complete assembly for installation on an aircraft was produced and tested to ensure that the full process design cycle is understood and tested.

THE PROJECT IN MORE DETAIL

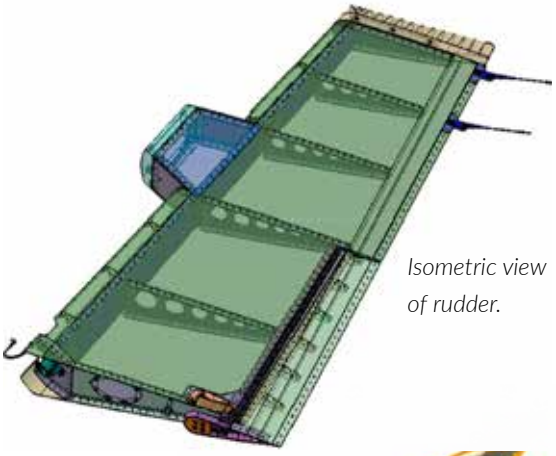
This project has developed and demonstrated the capability for robust process chain design and manufacture of CFRTP assemblies in the South African aerospace environment. It has positioned Aerosud Aviation to penetrate new markets and localise previously inaccessible work packages.

One capability required to make CFRTP assemblies concerns the making of small CFRTP parts. This is within Aerosud Aviation's current CFRTP capability, a typical example being the CFRTP frame clips for the A350. These clips are small, have a continuous thickness and no local variations in thickness.

Within the context of this research project, which started in 2007 and was co-funded by the Department of Science and Technology's Advanced Manufacturing Technology Strategy, a CFRTP stamp-forming process was developed. Subsequently, an industrial process was developed with AISI support. This led to the successful implementation of manufacturing processes for 1 800 frame clips per month for the Airbus A350 programme.

The frame clips were made for the centre fuselage of the aircraft. They are class 1 primary parts and secure the fuselage skin panels to the fuselage structural framework. For example, there are more than 470 types of frame clips produced by Aerosud Aviation for the A350, and more than a 1 000 Aerosud Aviation frame clips in each A350.

Another requirement to make CFRTP assemblies is the ability to make large parts. In 2013, Aerosud Aviation developed and commissioned the largest CFRTP press in the world to support the A400M programme. The CFRTP



Isometric view of rudder.

Final assembled demonstrator.

One of the most relevant achievements is the formation of a coherent multidisciplinary development group that can perform all the functions relevant in the lifecycle of the product – from design and analyses to tool design, manufacture, assembly and structural verification. Our next step is to package the rest of the questions that we discovered into logical work packages and start developing solutions that will fit our environment.

– Aerosud Aviation

SUCCESSFUL COLLABORATION

A number of organisations contributed to this project with AISI supplying the technology development funding. During the project, emphasis was placed on development of younger technicians and including more of the composite production team at both Aerosud Aviation and Denel Aerostructures. Denel Aerostructures will perform tests on CFRTP joints to understand the physio-chemical interactions at the heat affected zones. The African NDT Centre will develop non-destructive testing procedures to inspect the joints for porosity. Other partners include the KVE Composites Group, design, manufacture and welding of ring doubler; Altair received training in HyperMesh and OptiStruct to use in the design of the organic hinge fitting; Stellenbosch Uni-versity, additive layer manufacture of hinge fitting; Aniform, draping and analysis of skin and ribs; Delft University of Technology, ultrasonic spot welding of shear cleats to ribs; University of the Witwatersrand, simulations as part of an MSc student's studies; and Tencate, a material supplier.

interior panels currently produced on this press are not of a structural nature and are still relatively flexible, which means that the geometrical tolerances are not that tight. Moving towards CFRTP assemblies will require Aerosud Aviation to manufacture large structural parts on this press, for which the challenge related to residual stresses and shape deformations increases significantly.

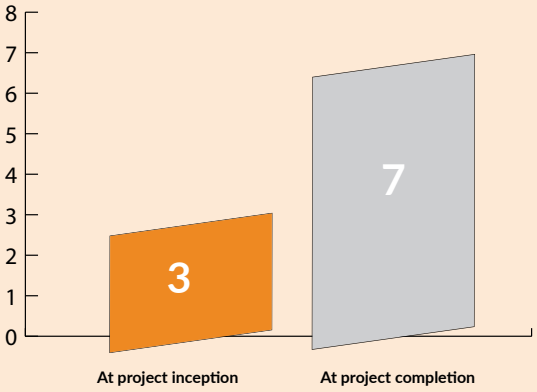
Hence, the next capability required is to model residual stresses in small and large CFRTP parts. Within the A350-clips programme it was found that inconsistent deviations in part geometry could be attributed to inconsistent residual stresses that could be influenced by a number of factors. The University of the Witwatersrand investigated the critical process parameters influencing the residual stresses.

A fourth capability is to assemble CFRTP parts and metallic-to-CFRTP parts. Although welding is the preferred method for joining CFRTP assemblies, the project had to include also adhesive bonding and mechanical fastening in those cases where different materials needed to be assembled (e.g. metal-to-CFRTP) or when space constraints caused insufficient access to welding equipment. Within the AMTS-funded research project it was attempted to use the capability of the local plastics industry to weld CFRTP. While these initial attempts were unsuccessful, it did demonstrate that welding of plastics differs significantly from welding of CFRTP.

Overall, the project was a success, with a total of four demonstrators manufactured. The use of the Aniform draping software allowed for innovative blank designs, resulting in well-formed parts; and the ultrasonic and induction welding techniques proved suitable for such aircraft structure applications. Further indications of success are that Tencate will use one of the demonstrator rudders at international exhibitions to promote the type of products that can be developed with its material; and the most prolific CFRTP material supplier in the aerospace community asked to exhibit the Aerosud Aviation development.

Benefits and impact

Technology readiness level



Product market

- Aeronautics
  - Long haul aircraft
  - Regional aircraft
  - General aircraft
  - Helicopters

National strategies and programme alignment

Sector development plans and aerostructures roadmap

Scarce skills development

Process design is a very difficult skill to master, senior engineers from Aerosud Aviation were intensively trained on new software and in some cases had to develop new methods for solving simulation challenges.

Industry focused skills development

1 MSc student

Internal skills development

6

Intellectual property

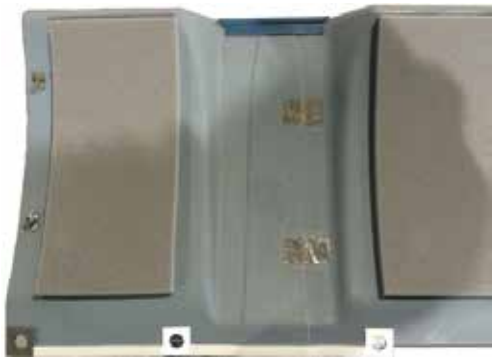
Yes, the methods for solving these engineering problems are complex and now reside with Aerosud Aviation

Process design and validation of continuous fibre-reinforced thermoplastic overlap joining methods

The design, industrialisation and validation of continuous fibre-reinforced thermoplastic (CFRTP) will enable Aerosud Aviation to develop as a primary supplier of CFRTP assemblies. In this project the process of joining multiple CFRTP blank parts to create a larger single piece complex geometry part was established. With this process now in place, qualified CFRTP assembly parts will be produced and delivered for installation on Airbus A400M aircraft.

THE PROJECT IN MORE DETAIL

Aerosud Aviation's current Airbus A400M cargo linings project requires the manufacture, qualification and delivery to the final assembly line of various CFRTP parts. One such CFRTP part, notably the lower connection units (LCUs), has large complex-geometry parts and has proved extremely difficult to manufacture from a single sheet of CFRTP material.

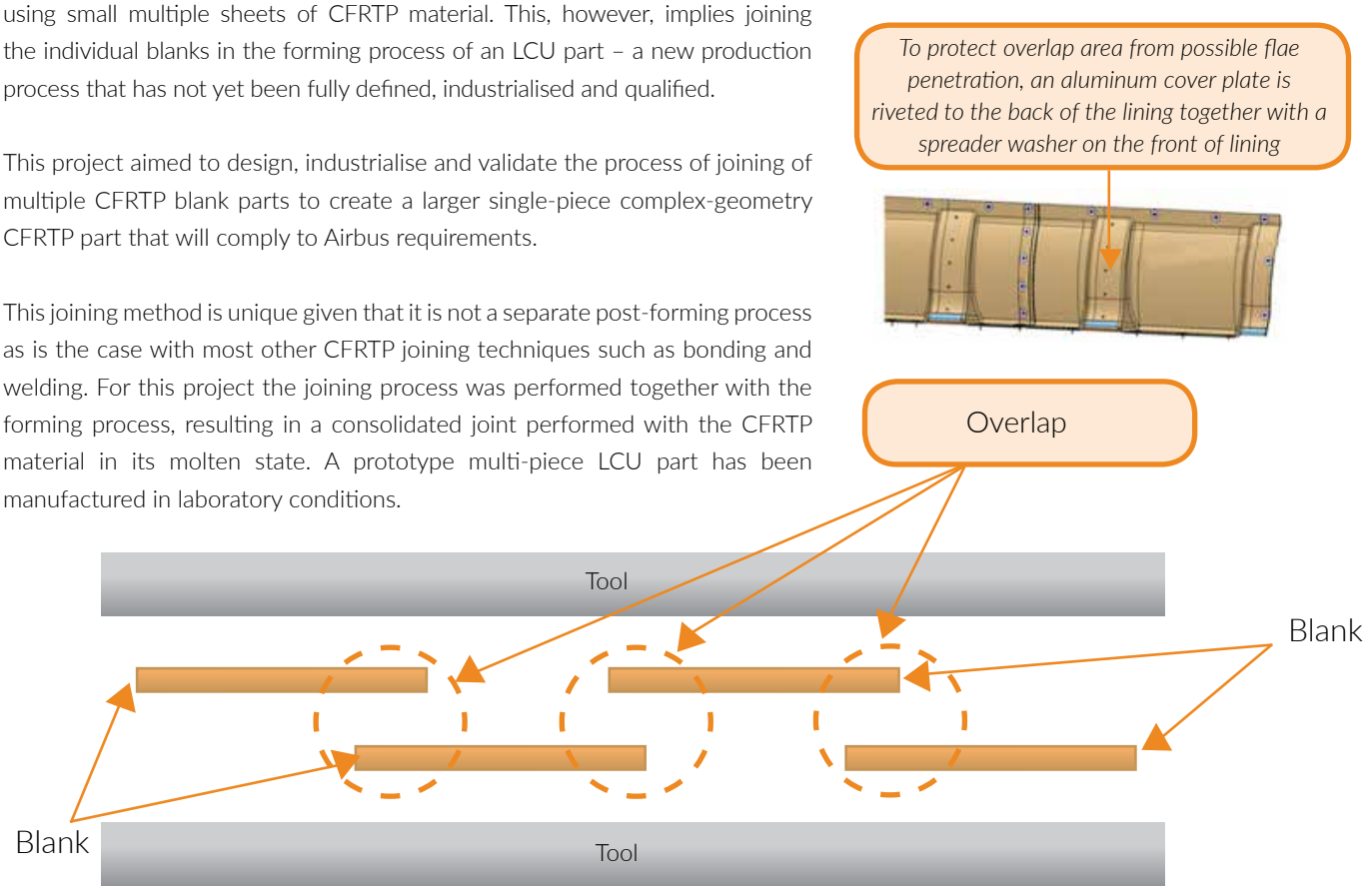


Finished multi-piece LCU panel.

Two problems had to be addressed: high manufacturing scrap rates, and difficulties in achieving the correct geometry of the parts. Further analysis of the geometry of the LCUs indicated that in the process of pressing the CFRTP sheet, the amount of material stretch required is beyond the capability of the material. It was proposed that the LCU parts be manufactured as per design definition, using small multiple sheets of CFRTP material. This, however, implies joining the individual blanks in the forming process of an LCU part – a new production process that has not yet been fully defined, industrialised and qualified.

This project aimed to design, industrialise and validate the process of joining of multiple CFRTP blank parts to create a larger single-piece complex-geometry CFRTP part that will comply to Airbus requirements.

This joining method is unique given that it is not a separate post-forming process as is the case with most other CFRTP joining techniques such as bonding and welding. For this project the joining process was performed together with the forming process, resulting in a consolidated joint performed with the CFRTP material in its molten state. A prototype multi-piece LCU part has been manufactured in laboratory conditions.



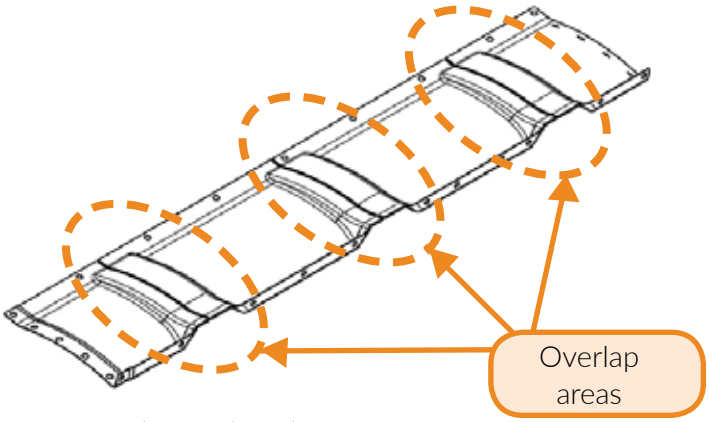
Proposed manufacturing concept – overlapping joints during forming process.

This project was a success. With the design of a process to manufacture a single LCU part from multiple blank sheets, Aerosud Aviation is now able to deliver components that comply with the designed geometry and meet all qualification requirements defined by Airbus. These components are installed and flying on the Airbus A400M aircraft.

– Aerosud Aviation

All design principles applicable to the LCUs and their installation on the Airbus A400M aircraft have been defined. Due to the change to the multi-piece LCU geometry with overlap joints, four specific issues were affected and new design principles or concepts had to be found to ensure compliance as per the Airbus A400M requirements. The four issues – all of which were successfully resolved – were electromagnetic interference performance, flame burn through performance, section thickness build-up in the overlap region, and avoiding clash with the aircraft structure.

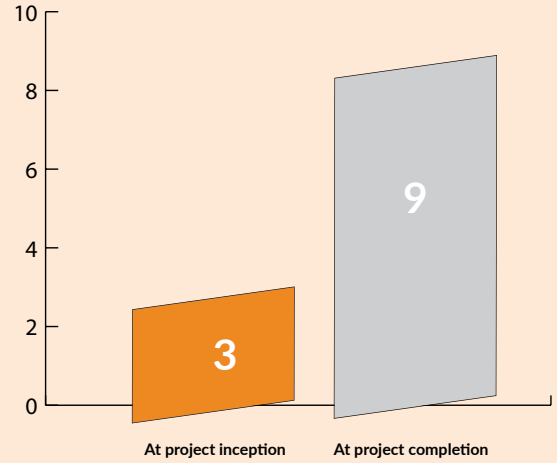
The project has resulted in further development of valuable know-how in the simulation studies of CFRTP material, improved tooling and material blank design knowledge. All these factors result in Aerosud Aviation being able to manufacture CFRTP components and assemblies cost effectively and consistently.



Proposed LCU with overlap joints.

Benefits and impact

Technology readiness level



Product market

- Aeronautics
  - Long haul aircraft
  - Regional aircraft
  - General aircraft
  - Helicopters

National strategies and programme alignment

- Sector development plans and aerostructures roadmap

Scarce skills development

- Process design is a very difficult skill to master, senior engineers from Aerosud Aviation were intensively trained on new software and in some cases had to develop new methods for solving simulation challenges.

Industry focused skills development

- 1 tool design technician
- 1 MSc engineering student

Skills development at Aerosud Aviation

- 9

International contracts

- Retaining contract to manufacture LCUs

Intellectual property

- Process design methods

SUCCESSFUL COLLABORATION

Aerosud Aviation was the lead partner in this project with a budgetary involvement of 88%. Structural testing expertise was offered by Denel Aerostructures; the University of the Witwatersrand provided forming simulation services; and Airbus assisted with flammability testing.

Process design of titanium fluid-cell forming

The aerospace industry is constantly looking for new and improved ways to design more fuel-efficient aircrafts, and the material characteristics of titanium provide the required level of strength and durability without adding excess weight. However, to maintain and grow the value proposition of the current supplier, Aerosud Aviation, to original equipment manufacturers (e.g. Airbus and Boeing), continuous cost reduction is the primary deciding element. Hence, Aerosud Aviation has successfully developed and demonstrated the capability to design a complete process chain for the manufacture of titanium sheet-based products.

THE PROJECT IN MORE DETAIL

Fluid cell forming is a technically elegant process. It is also a much more robust and practical process for complex shapes. Titanium and its alloys are attractive because of the galvanic compatibility with carbon-based composites and strength-to-weight ratio. This metal is also very expensive, emphasising the importance of demonstrating the capability to manufacture complex shapes from sheet as opposed to expensive machining.

While titanium sheet forming is a process that requires specialised tooling and equipment, industrialisation of components must be done in as short a cycle as possible so as to ensure financial viability. The only way to guarantee this short cycle of industrialisation is through understanding the fundamental design of the manufacturing process chain. This includes computer modelling and simulation of the forming process, tool design and analysis, tool manufacture, and part manufacture and analysis.

The project developed and demonstrated a capability to design a complete process chain for the manufacture of titanium sheet-based products using hydroforming for aerospace applications.

Hydroforming or fluid-cell forming utilises a process that uses high pressure fluid to form metal into the required shapes. The disciplines involved in this chain include forming simulation, tool surface correction for spring back, and tool manufacture. One of the key success factors of the process chain is the ability to correctly characterise the material properties.

The concept design phase of the project investigated the simulation of simple and complex shapes; exercised due diligence in understanding the parameters and boundaries of the software, material and forming process; and designed the first iteration tooling concepts using the simulation data.

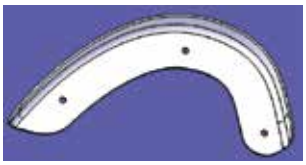
The detailed design phase comprised the programming of full simulation loops including corrections and all strain data to test formability, i.e. the ability of metal workpieces to undergo deformation without being damaged. Once the designs have been fully analysed, they are ready for prototype launch.

The demonstrator phase showed good correlation between the different parts and corresponding simulations and also confirmed the usability and strength of selected materials.

For Aerosud Aviation, the major organisational benefit from the project is the ability to accurately simulate the forming processes, thereby saving time and money on tooling and rework. The project also highlighted how little is understood about metal forming and the necessity for further research in this area to position companies to benefit from the resources available.

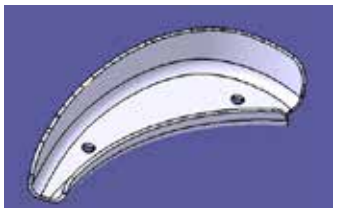
One of the most significant outcomes of this project, is that Aerosud Aviation Aviation is now a member of the joint lab for machining and forming – together with Stellenbosch University and Fraunhofer IWU, among others. These networks are invaluable when it comes to solving advanced simulation problems. It is also a testimony to the high level of the development being conducted.

– Aerosud Aviation



Large riblet.

Large riblet part.

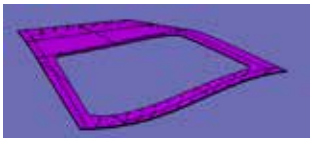


Small riblet.

Small riblet part.

Bracket.

Titanium component after forming.



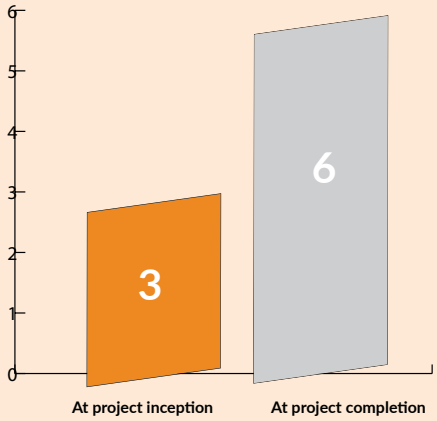
Skin.

Formed titanium blank on tool.

Benefits and impact

While no new long-term contracts resulted from this development, small-scale packages can now be accessed from Denel Aerostructures. This development also positions Aerosud Aviation for high complexity work packages.

Technology readiness level



Product market

Aeronautics

- Long haul aircraft
- Regional aircraft
- General aircraft
- Helicopters

National strategies and programme alignment

Sector development plans and aerostructures roadmap

Scarce skills development

Process design is a very difficult skill to master, senior engineers from Aerosud Aviation were intensively trained on new software and in some cases had to develop new methods for solving simulation challenges.

Industry focused skills development

1 MSc engineering student

Skills development at Denel

6

Intellectual property

Simulation and process design methods

SUCCESSFUL COLLABORATION

Fraunhofer undertook the biaxial testing to obtain the biaxial strain data – a complex process only done by two companies in the world. Aerosud Aviation's long-standing relationship with Fraunhofer assisted in this regard. Fraunhofer also supplied further training and guidance on the use of true material properties. ESI was the software supplier and training provider. Denel Aerostructures supplied the fluid cell press used for the development.

Ultra-high cycle fatigue design and testing of high strength aerospace materials

Many newly designed systems and high strength materials are required to last for longer operational life cycles at increased frequencies. This requirement will extend the amount of fatigue cycles experienced by the new designs into the high to ultra-high cycle range. Ultra-sonic fatigue research has been primarily undertaken in France, the United States of America, Slovakia, Austria and Japan. A lack of understanding exists of the effects of ultra-high cycle fatigue (UHCF) on high-strength materials that are subjected to UHCF loading. To this end, Denel Aerostructures is extending existing work to enhance the testing capability of the most widely used modern aerospace materials, and to create a complete and more comprehensive database of modern aerospace grade high-strength materials, which may be used in the future.

THE PROJECT IN MORE DETAIL

Denel Aerostructures aimed to develop a working fatigue and damage tolerance testing system that can be used to test a variety of high durability materials in the field of ultra-high cycles.

Once the system has been fully developed it is likely that it would be put to use in developing new materials that make use of new technologies such as grown/3D printed components. The system would be able to gather the data necessary for the improvement of existing materials as well. For example, one of the hurdles in adopting new materials and processes (such as grown/3D printing) in the aeronautical industry is the availability of reliable (third party) material data in different fields, such as fatigue specification data. This UHCF machine would be one of the means to be used to provide this data.

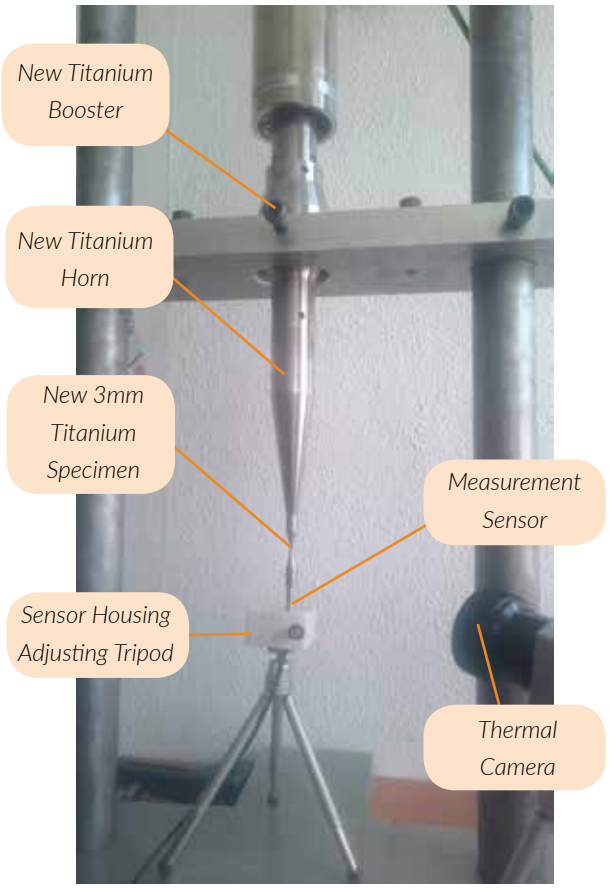
Progress includes the design and development of a testing system that is capable of testing both aluminium and titanium aerospace grade materials up to and above the giga-cycle region of testing – that is billions of loading cycles.

The work has also resulted in the incorporation of a sensor system capable of monitoring and recording data up to 50 kHz (50 000 cycles) during testing. Stress-life data curves have been developed for both the materials with additional upgrades and materials to be developed and tested in the future. With the aid of the AISI support initiative, core improvements have been made through insight and understanding gained by testing. This project has further enhanced the UHCF testing capabilities of Denel Aerostructures' test laboratory allowing for improvement in the design of specialised structures where fatigue may be a concern for components in the Gigacycle (109 cycles) or Haibach region.

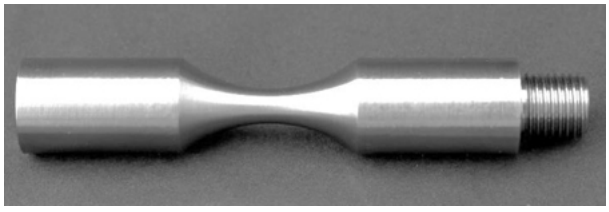
The successful completion of the system will result in the development of optimised high strength materials, which would ultimately lead to cost saving as well as increased safety since much of the data for these new materials do not exist. Completion of the current phase of the project is expected in 2016 with a next phase that will include temperature effects and the introduction of varying loading ratios being completed in 2017.

The primary benefit of this project for the industry is to develop the capability to optimise components for modern high strength materials for use in industry. There is no testing facility currently dedicated to UHCF testing in South Africa with this capability. Fatigue data, which were previously unavailable within the Gigacycle region, can contribute to the development of new structures and components that require high strength and longer operational lives.

- Denel Aerostructures



The test rig setup with newly designed components is shown in the UHCF test system setup.



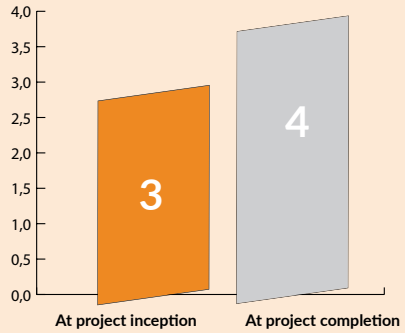
The cast titanium UHCF specimen was used as a baseline (after calibration and verification) for all further testing.

SUCCESSFUL COLLABORATION

The chief partner in the UHCF testing system development was the CSIR in procuring and manufacturing of the wrought titanium booster, horn and specimens for S-N (stress vs. number of cycles) data construction. The CSIR also assisted with the development of the capacitive sensor measurement system verification. The master's thesis through phase 1 of the project has also been completed (with the University of the Witwatersrand) and is currently awaiting final appraisal. The second master's project (through phase 2) will commence during the 2016 period of development.

Benefits and impact

Technology readiness level



Product market

- Aeronautics
  - Long haul aircraft
  - Regional aircraft
  - General aircraft
  - Helicopters
  - Security
  - Unmanned aerial systems
  - Services
- Defence
- Space
  - Satellites
  - Launch vehicles
  - Services

Scarce skills development

- High strength material property database expansion
- Studies on the effects and nature of ultra-high cycle fatigue on new material manufacturing technologies
- UHCF testing procedures and process
- Signal and data processing

Industry focused skills development

- 1 Master's student

Skills development at Denel

- 2

Intellectual property

- Testing machine
- Testing procedure, methodologies
- In-house algorithms

Local contracts

- Denel Dynamics (Umbani Project)

Import substitution

- UHCF testing is achievable locally with on-going enhancements

Technology Transfer for SMME Development

> The Wright Brothers created the single greatest cultural force since the invention of writing. The airplane became the first World Wide Web, bringing people, languages, ideas, and values together.
>
> — Bill Gates, CEO, Microsoft Corporation

The AISI seeks to increase impact by supporting and implementing supplier development enablers, transferring technologies to improve SMME capabilities, and ensuring the appropriate skills and knowledge have been transferred to sustain SMME economic participation.

Projects to reach these objectives include:

- Industrialisation of a joint CAD/CSIR helicopter simulator
- The industrialisation of a small, low-cost TEA CO_2 laser
- SKA PC board localisation
- Small gas turbine technology improvements

Industrialisation of a joint CAD/CSIR helicopter simulator

Cybicom Atlas Defence (CAD) and the CSIR have developed a prototype helicopter simulator aimed at the South African Navy's requirement for a helicopter flight deck trainer (HFDT). The HFDT was demonstrated at the African Aerospace and Defence expo in 2014 and elicited strong interest in the commercial and defence markets for a cost-effective, locally developed simulator. Assistance from the AISI provided the impetus to complete a major upgrade to the original prototype in a very short time.

THE PROJECT IN MORE DETAIL

The goal of the project was to commercialise the CAD helicopter image generator system and the CSIR simulator to advanced demonstration model/pre-production model status. This has been achieved and the resultant Helicopter Flight Trainer is already installed at the South African Navy's Simulation Facility in Simonstown.

At a high level, the scope of work comprised a design phase where market research into existing helicopter image generator system designs was conducted; best-of-breed design elements incorporated into the final design; final seats and control were selected; and the facility elements (mountings, cabling, etc.) were designed.

The manufacturing phase followed, with the image generator mounting supports and structure as well as the seat and equipment housing manufactured and the new seat/controls purchased. Software updates concerned an

Original monitor mounting.

update to HELISIM models for various helicopter types and the development of a stand-alone scenario and training management tool for commercial markets.

The South African aerospace industry benefits from the introduction of a new manufacturer (CAD/CSIR) of locally developed simulator products. In addition, the industrialisation of the simulator has resulted in an increase in the technology readiness level from 4 to 5.

SUCCESSFUL COLLABORATION

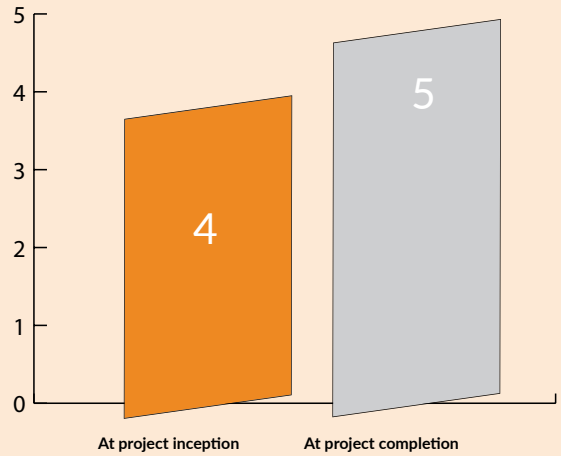
CAD was responsible for the visuals (image generator and displays), integration with scenario management (STAGE) and other South African Navy simulators. The CSIR was responsible for the helicopter simulation – in particular modelling effects for deck landing, as well as the controls, seat and instrumentation. Melex Industrial was responsible for the local design and manufacture of the monitor mounting system, while Rugged Interconnect was the local supplier of industrial computers.

Based on feedback, it is clear that the market for cost-effective but highly functional helicopter simulators is totally under-developed... We have identified a requirement to train fire-fighting pilots for both fixed wing and helicopters. To achieve suitable realism (e.g. wind and smoke), a high-end simulation tool like HELISIM is required as well as a strong research capability (as provided by the CSIR). This is an opportunity for CAD and the CSIR to create a new market niche for a locally developed product.

– Cybicom Atlas Defence

Benefits and impact

Technology readiness level



Product market

- Aeronautics
  - Helicopters
- Simulation and training

Scarce skills development

- Integration of STAGE and HELISIM product functionality

Number of jobs created or retained

- 2 retained

Skills development

- 2

Intellectual property

- Pre-production advanced demonstration model helicopter simulator

Import substitution

- Local manufacture of display cladding and mounting

The industrialisation of a small, low-cost TEA CO_2 laser

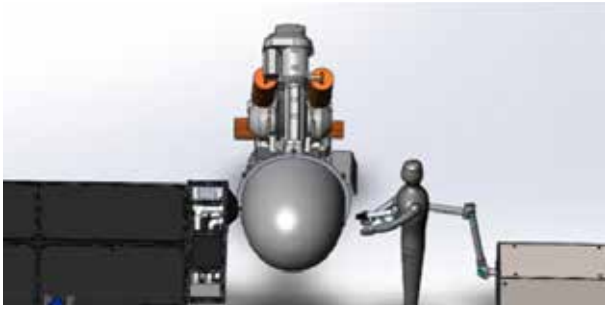
PaR Systems developed a laser that has a characteristic wavelength ideally suitable for use in the aerospace industry to easily prepare surfaces for recoating. However, market research showed that cost and size of the laser were barriers to market entry. With the help of the AISI and a number of other collaborators, PaR Systems set out to industrialise a small, cost-effective transversely excited atmospheric (TEA) CO_2 laser. The company achieved its goals and successfully developed, tested, industrialised, manufactured and marketed its new compact TEA CO_2 Laser.

THE PROJECT IN MORE DETAIL

Light detection and ranging (lidar), laser-based non-destructive testing and surface treatment are all technically advanced systems used in the aerospace and military industries. These systems have all demonstrated the need for smaller, lightweight and lower priced CO_2 lasers. The goal of this project was to industrialise an already proven CO_2 laser technology that will fulfil the requirements for a smaller and cost-effective CO_2 laser in advanced technologies.

Commercial aircraft have to undergo a cycle of scheduled inspections. During major maintenance, an aircraft is rigorously inspected and the paint of numerous surfaces must be removed to expose the underlying structures. The cleaned aircraft structure allows the inspection team to locate metal corrosion, micro-cracks, and material fatigue that may be detrimental to aircraft safety. Due to the increased susceptibility to minor defects, the painted surfaces of the nosecone, landing gear, engine covers and helicopter blades are more frequently stripped for inspection and servicing. Current paint removal procedures use an environmentally unfriendly, hazardous chemical to remove the paint. However, this only works well on metal structures, as the chemicals are detrimental to the integrity of composite structures.

Apart from designing a smaller, cost-effective TEA CO_2 laser that meets industry specifications and that favourably responds to market information gathered over more than two years, the objectives of the project also included procurement of all parts and components, manufacturing and assembly of the laser, factory testing and accreditation, and marketing of the finished product.



A size comparison of the large paint removal system (left) versus the smaller system (right).

The redesign and improvement of the laser considered issues such as maintaining the high quality of the laser, reducing the size of the laser, reducing the time needed to assemble the laser – a key contributor to the high price of the laser, and replacing several components to further save costs. The design requirement and preliminary design ideas were drawn up by Stellenbosch University. Making use of easy-to-assemble sub-assemblies, PaR was able to reduce the time taken to build a laser by more than 50%.

This laser has been geared for applications relevant to the aerospace industry. It has demonstrated surface cleaning capabilities that will enable aerospace companies to remove paint and debris from aircraft panels. As a result of the reduction in cost and size, this laser is a compact, cost-effective solution that can be provided to the aerospace, advanced manufacturing and research industries.

– PaR Systems

The pulse duration needed for applications such as surface treatment, paint removal, laser non-destructive testing and ablation is ideally a short pulse with a high energy content. With this laser PaR has been able to reduce the duration of the optical pulse to below 70ns compared to the 120ns of current paint removal lasers. The laser has also demonstrated successful paint removal as well as insulation stripping capabilities.

Since the start of the marketing campaign of the laser, PaR has received more than 10 enquiries for the laser. Potential uses include paint removal from aircraft structures; surface treatment of aircraft turbine blades; lidar; ablation of composite materials for wind turbine blades; nuclear decontamination; 3D imaging of Perspex; wire stripping; ultra-sonic testing; plasma generation; and laser-induced breakdown spectroscopy.

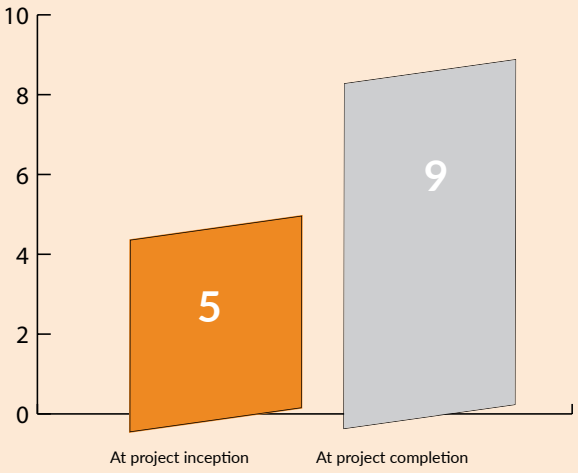
SUCCESSFUL COLLABORATION

CAD was responsible for the visuals (image generator and displays), integration with scenario management (STAGE) and other South African Navy simulators. The CSIR was responsible for the helicopter simulation – in particular modelling effects for deck landing, as well as the controls, seat and instrumentation. Melex Industrial was responsible for the local design and manufacture of the monitor mounting system, while Rugged Interconnect was the local supplier of industrial computers.

Laser prior to shipping.

Benefits and impact

Technology readiness level



Product market

- Aeronautics
  - Long haul aircraft
  - Regional aircraft
  - General aircraft
  - Helicopters
  - Unmanned aerial systems
  - Services
- Defence

Number of jobs created or retained

- 10

Scarce skills development

- Laser design
- Laser manufacturing and assembly

Competitiveness improvement

- The price of the laser has reduced by 50%, the product is designed for manufacturability and mass production of the laser is now possible.

Export capability achieved

- The laser is an exportable product and has achieved CE and FDA certification

Square Kilometre Array PC board localisation

A localisation strategy initiated by the Square Kilometre Array (SKA) South Africa for high-end electronics and mechanical systems aims to prepare local industry to offer more significant contributions to the international SKA project once it starts construction in 2018. Support received from the AISI will add further impetus to prepare companies for SKA participation. This project focuses on upgrading and enhancing TraX's capabilities in support of the SKA's localisation strategy and to position TraX as a supplier of Class 3 printed circuit boards (PCBs) to the aerospace and defence industries in South Africa.

THE PROJECT IN MORE DETAIL

TraX Interconnect specialises in fast turnaround manufacture of PCBs, ranging from simple single-sided and plated through-hole to complex multilayer. It is a strategic partner to several aerospace/military and learning institutions, all of which stand to benefit from an increased capability. This investment will also position TraX to tender for other PCBs making up the sub-systems of the MeerKat telescope.

A market and needs analysis showed that increasing TraX's manufacturing capability will result in the company being able to manufacture many of the PCBs currently made offshore for the aerospace and military industry. However, to be able to tender for this work, the manufactured boards would need to meet Class 3/A performance requirements.

TraX followed a phased approach to implement the Class 3 acceptance requirements. Firstly, TraX identified those acceptance requirements of the IPC-6012 standard that were not being met. The second phase involved refurbishing the laboratory as the new equipment required double the size of the original workspace. Ordering and installing new equipment followed in the third phase, as well as substantial training given to laboratory staff. The work instructions of the new equipment were drawn up and incorporated into the existing ISO quality management system. During phase four, TraX's first article inspection report was compiled and a comprehensive study made of a number of similar reports from offshore manufacturers. The best practices identified from these reports will be incorporated into TraX's planning.

Manufacturing to Class 3 required the development of TraX's in-house software, TraXbase, to implement production controls, traceability and acceptance requirements. This task is a deliverable throughout the two-year project, and will continue long after the project has been completed. Part of the development included the implementation of Insight software. Subsequent to successful implementation, TraX processed more than 600 PCB designs and improved its quotation turnaround time as well as quotation accuracy. A number of other software upgrades were also completed.

Meeting Class 3 standards will also require development of new ISO documentation, quality assurance reports and traceability reports. This expertise will be subcontracted initially and once developed and implemented, transferred.

Apart from training of laboratory personnel, specialised training of computer-aided manufacturing engineers is necessary. Training will be provided by two engineers from NCS in India as this expertise is not available in South Africa.

Special attention was also given to continuous improvement of processes to ensure that any future requirements of the SKA can be catered for. Component manufacturers are a big driving force in this technological evolution as they create smaller and more complex components, requiring more intricate interconnects and complicated stack ups within the PCB design. In particular, TraX required key process improvements in resin-, copper-, and thermally conductive paste-filled vias (vertical interconnect access), in pad via, and mechanically drilled micro vias.

> *The benefit to the aerospace industry is strategic: having increased capability locally, will speed up product development and time to market. At the same time, it will protect South African intellectual property.*
>
> **– TraX Interconnect**

SUCCESSFUL COLLABORATION

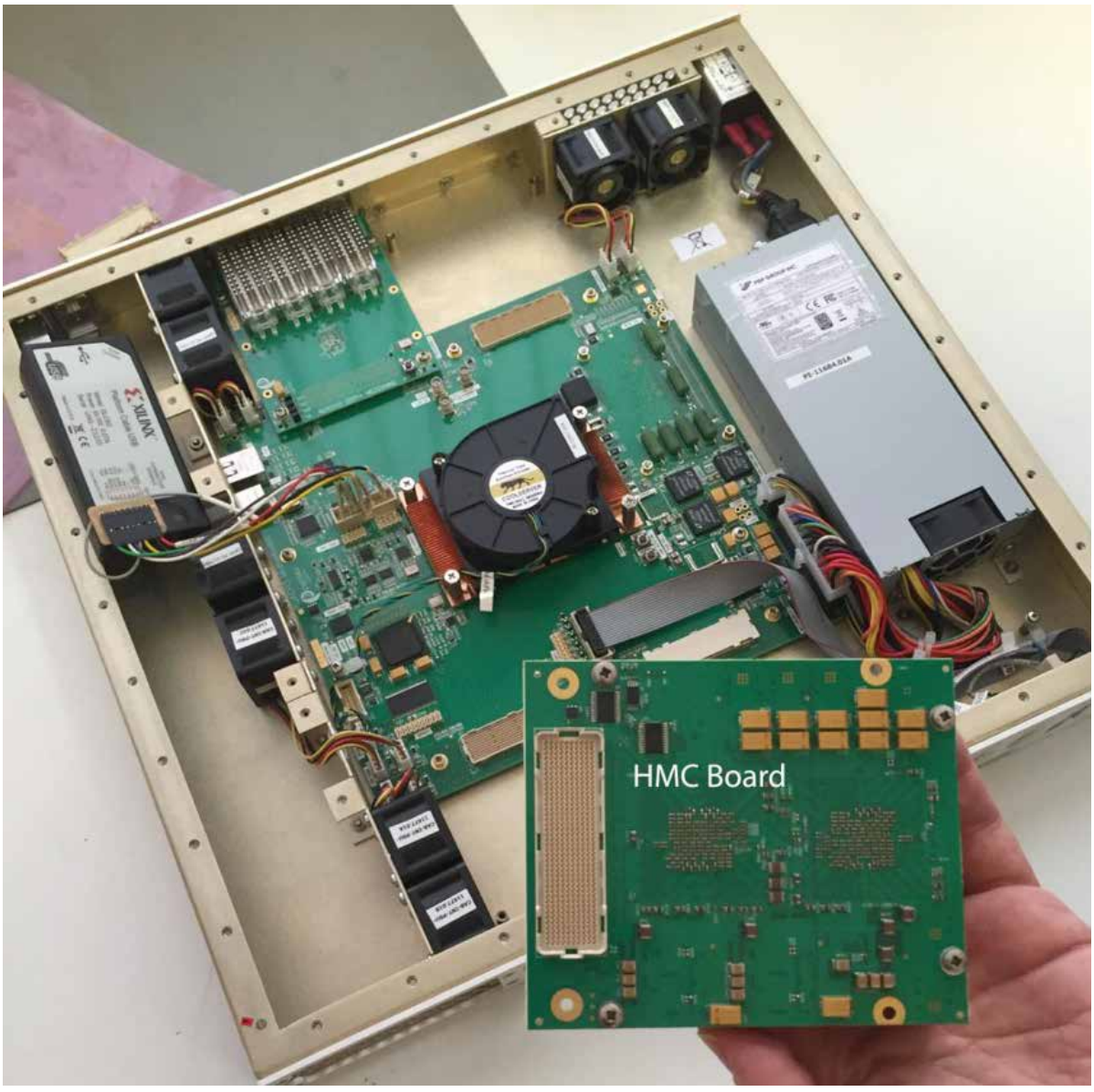
This is a joint project undertaken by the AISI in collaboration with the DST's Technology Localisation Implementation Unit (TLIU).

While not directly involved in this technology localisation project, the following institutions will also benefit from the training, process and software improvements. TraX works closely with higher education institutions such as the universities of Stellenbosch, Cape Town, Pretoria and CPUT by hosting open days for students, assisting with project boards and providing technical advice. The localisation project will see NCS in India partnering with TraX to offer training at the NCS' own expense.

Benefits and impact

While the project is not yet completed, TraX has already started to reap the benefits. Apart from work requests from the SKA, it has also received work from the European organisation for nuclear research, CERN, and locally from the Gauteng Department of Education.

Once the project is completed, TraX will not only meet Class 3 acceptance requirements and provide the necessary first article inspection reports, but it will also be able to deliver a number of services to the SKA and the broader aerospace and defence sectors, including manufacturing all of the SKA's PCBs seen to date as well as multilayer PCBs with varying, complex specifications.



The hybrid memory cube board, which plugs into the SCARAB board for the SKA. The photo shows the board unplugged from the SCARAB board previously known as Roach 2.

Small gas turbine technology improvements

The successful integration of a compressor design capability – specifically diagonal/mixed flow – and combustion system into the Cape Aerospace Technologies (CAT) 200 Kero Start (KS) gas turbine, made possible with the AISI's support, also led to the re-engineering of the engine with a number of spin-offs and knowledge gained.

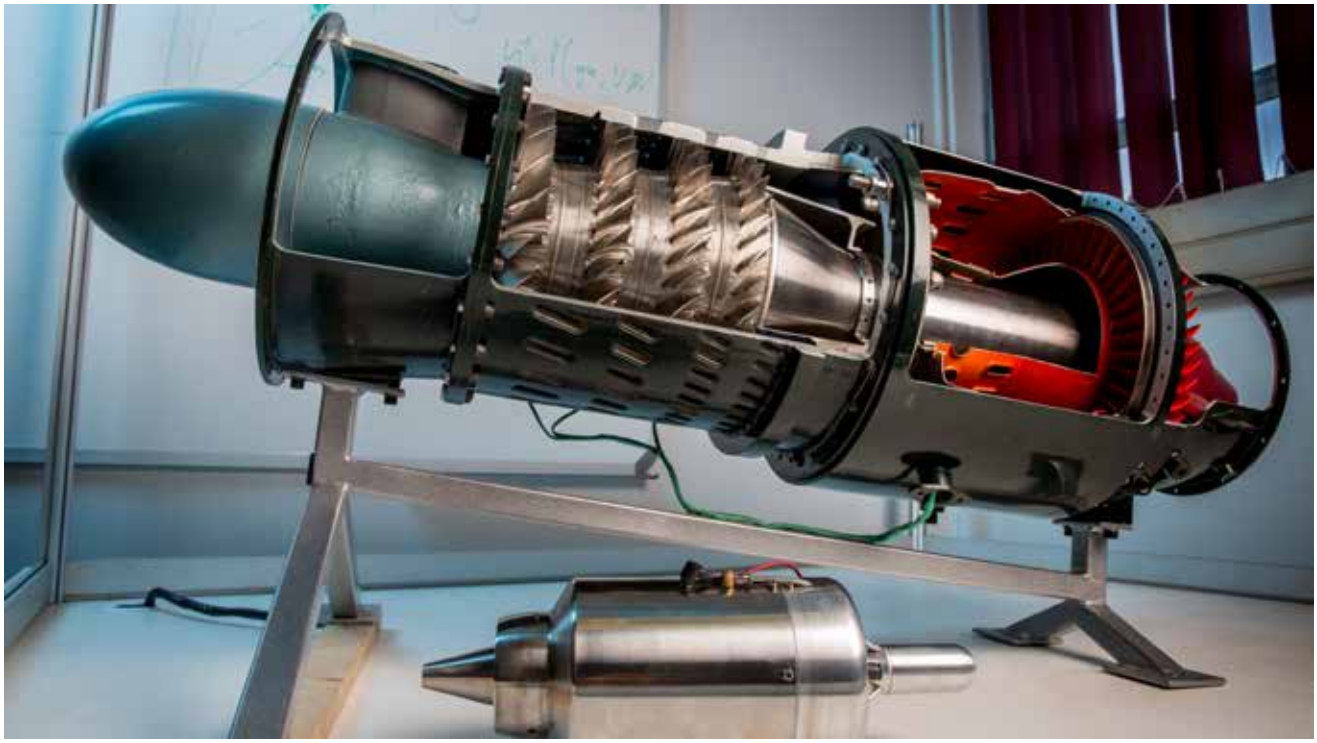
THE PROJECT IN MORE DETAIL

Cape Aerospace Technologies (CAT) was established in 2013 to fill the void in terms of aerospace companies in South Africa manufacturing high precision micro gas turbines. The lack of a propulsion systems capability in South Africa is a deficiency in the aeronautical industry and hampers South Africa's global participation.

In addition, Denel Dynamics requires a small gas turbine (600 N SLS thrust) to power the Umbani/Al-Tariq glide bomb, with a further requirement of generating 600 W of electrical power while fitting within the tail pipe of the weapon and being able to relight at 30 000 ft. This specification will fill a market gap identified in 2008 already. The same engine could be used to power future unmanned aerial vehicles, target drones and glider sustainers (self-launchers), as well as offering the possibility of decentralised local power generation using biomass fuels for remote areas.

This project thus aimed to place South Africa in the lead globally in terms of state-of-the-art micro gas turbines by developing a prototype/demonstrator engine, and designing and integrating a diagonal/mixed flow compressor into the 200N engine. Further objectives included commercialising the CAT 200 KS locally and internationally and giving young engineers working on turbomachinery exposure and training.

Highlights thus far include the successful design of an optimised mixed flow compressor delivering a pressure ratio of 5:2 at 120 krpm – none of the turbine manufactures in this market segment achieves anything close to a pressure ratio of 5:1; 0.45kgs and 75% isentropic efficiency (a parameter to measure the degree of degradation of energy in steady-flow devices). The turbine stage was optimised to match the new mixed flow compressor requirements. CAT manufactured



CAT 200 KS Gas Turbine (front) with the APEX Gas Turbine (back) developed in the 1980s.

This project has made remarkable technical achievements by getting the first new gas turbine prototype running in South Africa since the late 1980s. We believe it will lay the basis for a future independent aeromotive capability for South Africa as a result of the work done by CAT thus far. The fastest growing developing economies place a premium on aerospace skill sets, and South Africa should be leading in this regard.

– Cape Aerospace Technologies

the turbine rotor and stator in-house, opening a number of possibilities as this capability is a significant asset to CAT.

The final experimental tests on the CAT 200 KS is still on-going; however, the results produced by the original CAT 200 KS look very promising. The project has also greatly assisted with generating knowledge about the manufacture of high precision, rotating machinery; enabling access to Stellenbosch University's facilities; transferring knowledge to future generations; eliciting interest in the CAT 200 KS from defence-related companies; and, because of the experience gained from the project, potentially growing the 200 N gas turbine to an 800 N candidate.

SUCCESSFUL COLLABORATION

Following the successful integration of the Stellenbosch University compressor design capability into the CAT 200 engine, the project will foster the on-going development of micro gas turbine engines as part of the formal collaboration between Cape Aerospace Technologies (original equipment, IP, design and manufacture), Stellenbosch University (student projects for and use of advanced design facilities) and the CSIR (design and analysis, consortium oversight). Industry partners benefiting from the project include the Institute for Advanced Tooling, X-Sight X-ray Services, Escape Guages, Executive Engineering, Donnees Engineering, Micton Hobbies, SBB Machine Tools, Leadwell, Haas CNC, and GRW Germany.

Benefits and impact

Predominant product market

- Aeronautics
  - Security
  - Unmanned aerial systems
  - Services
- Defence
- Space
  - Services

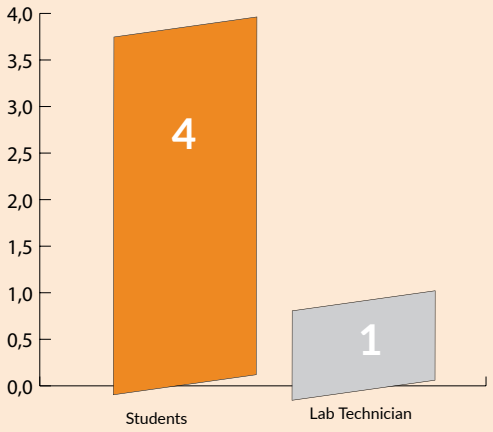
Number of jobs created or retained

2

Scarce skills development

Turbomachinery design and precision engineering

Industry focused skills development



Internal skills development

3

Export capability achieved

Possibly upon final engine testing. If the engine performs as predicted, it should dominate this market segment internationally.

Aerospace Safety

> All the calculations show it can't work. There's only one thing to do: make it work.
>
> — Pierre Georges Latécoère, early French aviation entrepreneur

One aspect of the AISI's mission – enhancing the global competitiveness of the South African aerospace and defence industry – concerns identifying, developing, supporting and promoting the interests and capabilities of the South African aerospace and defence industry. In this regard, the importance of aerospace safety cannot be over-emphasised.

One project in this field is:

- Identification Friend or Foe interrogator power amplifier/transmitter

Identification Friend or Foe interrogator power amplifier/transmitter

In aid of air traffic control and air defence, Tellumat has co-funded the development of an Identification Friend or Foe (IFF) / Mode S interrogator (the PR-4000). Subsequent to performance challenges demonstrated by an internationally sourced power amplifier/transmitter that also resulted in non-conformances of the PR-4000, it was decided that such a critical component of the interrogator architecture should be kept local and in-house. The challenge to develop a power amplifier/transmitter to address the PR-4000's shortcomings while also being scalable and flexible to address future product requirements was met by March 2016.

THE PROJECT IN MORE DETAIL

It is vital to be able to detect and identify all aircraft in an air traffic control and air defence environment. This ensures that aircraft can be safely guided and controlled or monitored during take-off and landing and along its flight path. Detection and identification are accomplished by a primary surveillance radar and a secondary surveillance radar, respectively.

Tellumat has developed, manufactured and supplied IFF equipment in South Africa since the late 1980s, initially for local military aircraft and later also for export. Interrogators have been fitted to ships and radars for identification purposes in the South African Navy Frigates and the South African Army Ground Based Air Defence System programmes.

In 2008, the company initiated an IFF/Mode S interrogator development. The interrogator was the only element missing from its entire offering in this area, with local and international demand growing for interrogators in the sheltered, ground mobile and naval sheltered environments.

When starting on the design, it was decided to buy an off-the-shelf transmitter – a crucial part of the interrogator – from an international original equipment manufacturer (OEM). However, not only did the product not meet international quality and safety standards, the OEM seemed unwilling to correct the design to meet specifications.

The design and development of a suitable power amplifier/transmitter was put forward to the AISI as an ideal project to meet the AISI goals of improving competitiveness, capability, localisation, and SMME development. Tellumat has committed nearly R 32 million to the project, representing a co-investment of 68%. Projections are that this investment would unlock a competitive product with a conservative estimate of R54 million in sales in the next five to eight years.

The project aimed to define and specify the requirements for the power amplifier/transmitter; develop and test it to ensure it meets the set requirements; qualify it to formally release the power amplifier/transmitter as a product; and integrate it into the PR-4000 and qualify it in the interrogator environment.

Radio frequency (RF) interference was one of the main problems of the original OEM amplifier. Among the many interventions implemented and challenges faced, the Tellumat team, including RF experts, could address this. The selection of the source signal and how it is generated has been proven to remain stable under the strong RF interference experienced inside the module. The Critical Item Development Specification was completed and was used during the development of the sub-modules and test jigs.

One of the key project benefits to Tellumat is that it has already obtained new orders for interrogators, which would not be possible without a suitable transmitter. The project also gave rise to the localisation and modernisation of the positive intrinsic negative (PIN) switch – a requirement not part of the original scope. AISI support played an important part in ensuring the utilisation of a team of RF engineers to undertake the design work required.

SUCCESSFUL COLLABORATION

Internal resources were utilised for the various phases. Additional engineering manpower was contracted to independent/SMME contractors: GMOS Interconnect for specialist RF design and layout; PDP Projects for specialist power supply design; DSCOMS for simulation software; RFDesign and Conical Technologies, specialist RF components suppliers; TRX Electronics, a component supplier; and TraX Interconnect for printed circuit board manufacturing.

This project takes the PT-4000 IFF / Mode S interrogator to the market by replacing a problematic foreign-sourced OEM transmitter with a Tellumat design. One of the prime project benefits was that of job retention. Another was, and still is, being competitive. South African industry benefits from the availability of RF engineers whose grounding was honed at Tellumat. Sub-contractors and suppliers continue to benefit from the downstream activities, for example, the PIN switch will be manufactured in South Africa by TraX Interconnect.

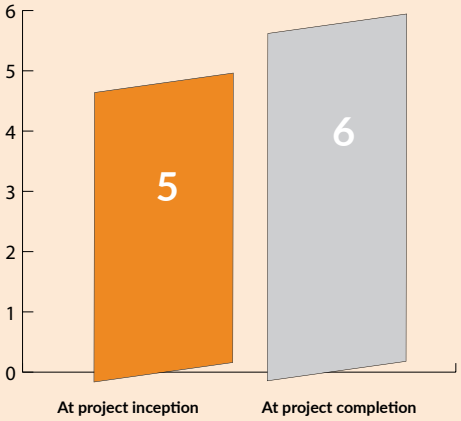
– Tellumat

PR-4000 IFF / Mode S Interrogator.

Intermediate and final stage module assemblies (integrated).

Benefits and impact

Technology readiness level



Predominant product market

- Defence

Alignment with national strategies or programmes

- Industrial Policy Action Plan
- Aerospace Sector Development Plan
- SANDF acquisition programmes

Number of jobs retained full time

- 3 technical

Number of jobs retained part time

- 8

Number of contract positions created

- 2

Scarce skills development

- High power, high altitude RF modules
- Advanced RF signal control
- Miniaturisation of RF modules

Internal skills development

- Engineers benefitted in skill retention and development during the development project, particularly in RF hardware, firmware and software.

International contracts

- During the early development phase, Tellumat obtained an order for a transmitter and PIN switch for an IFF interrogator development project in India. As part of a wider Indian IFF strategy, Tellumat has partnered with a local company. In the partnership, Tellumat will provide the RF part and the Indian company will provide the signal processing and mechanical part.

Space

I have the normal desire, experienced by everybody who's ever flown an airplane with a certain amount of zoom capability, to go a little bit higher and a little bit faster.

– Gordon Cooper, Mercury 9 astronaut, in Life magazine, 1959

In supporting South African space initiatives and human capital development and in line with national space policies, legislation and action plans, the AISI takes its lead from the South African National Space Agency and collaborates with key stakeholders in the space sector in South Africa. These include the South African Council for Space Affairs, and the Department of Science and Technology.

Projects in this area include:

- Nanosat imager development
- Hyperspectral focal plane and mass storage for a space imager
- Stellar gyro development

Nanosat imager development

The AISI has set its sights on technological advancement and improved competitiveness beyond Earth's atmosphere through a partnership with a local SMME, the Space Advisory Company (SAC), to develop a nanosatellite imager. The successful completion of this project will demonstrate South Africa's capability to appropriately specify, design, procure and adapt commercial off-the-shelf (COTS) components and to assemble and test a low cost space imager customised for nanosat missions.

THE PROJECT IN MORE DETAIL

Nanosatellites are artificial satellites with a mass between 1 and 10 kg. Their small size makes them affordable and opens up the possibility for a constellation of satellites. They can piggyback on larger launches, which avoids the need for a dedicated launch. With the development of nanosats, the need for miniaturising electronics components such as cameras (space imagers) becomes essential.

SAC and its partners have a rich history in designing and realising space related products. A market analysis identified a gap for high performance nanosat imagers. The proposed imager will set a new performance/mass/cost point within the market. In addition, it is a direct investment in a defined priority sector and will increase market access opportunities for and export of South African goods and services.

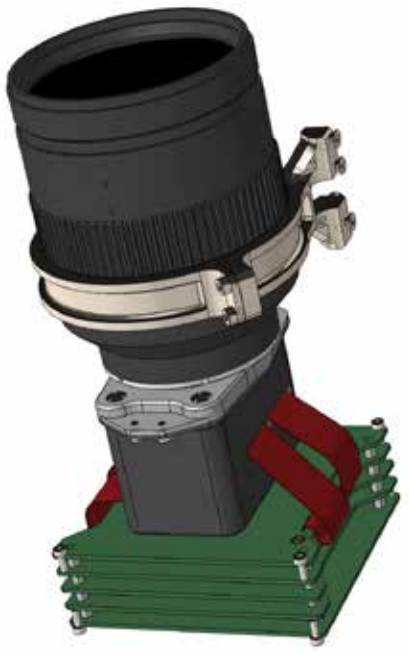
The AISI programme has assisted greatly in terms of ensuring that we are on par with our competitors globally. We realised that there is a gap in the nanosatellites market and needed to improve on existing technology. A big demand for nanosats exists as they are cheaper to launch. Also, because of the lower orbit, you get frequent passes from the satellite which could provide you with two to three passes in a day.

– Space Advisory Company

The project will add to the development of local content and the capability of South African entities in the field of unmanned aerial systems and space missions. The designed imager will be used for remote sensing with vast applications, for example vegetation monitoring. As the result of this project, SAC has been talking to potential international and local clients who are interested in buying sensors, and a complete imager.

In addition, several unintended benefits were realised, such as improvements made to the electronic ground support equipment to ensure that it can run the necessary tests before integration with the satellite.

While the practical results of the project are valuable, the skills development resulting from this project is far more valuable. It exposed a number of engineers and managers



CAD drawing of the nanosat imager.

SUCCESSFUL COLLABORATION

SAC was responsible for systems architecting, integration, interface development and testing; sensor identification, sourcing and adaptation; and programme management. Simera undertook the objective sourcing, focal plane design, opto-mechanical adaptation and sourcing, integration and testing. Stellenbosch University was responsible for the environmental and radiation testing.

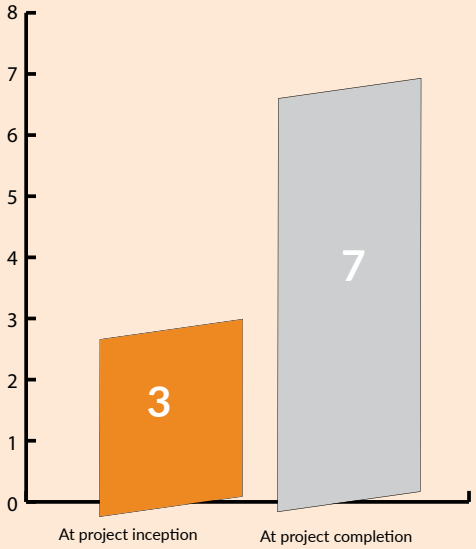
to previously unknown challenges. The skills learned will not only assist in the future stages of this project but also in other projects.

Overall, the project is a success, the sensor with its supporting electronics is operational. It is recommended that the electronics are taken through environmental and radiation testing. The optical assembly should also be tested further. To fully qualify for use in space, the lens should be tested at temperatures below 15°C. A modulation transfer function (MTF – a widely used method to describe lens performance) test should also be conducted in more locations along the proposed location of the sensor, to fully plot the MTF vs. distance from the centre of the image plane. Alternatively, a full field sensor arrangement can be mounted on the image plane and overall performance can be evaluated. This will provide an accurate indication of whether the lens should still be used in the telescope design, or if a new optical design should be investigated.

Engineering model of the nanosat Imager.

Benefits and impact

Technology readiness level



Predominant product market

- Space
  - Satellites
  - Services

Alignment with national strategies or programmes

- Industrial Policy Action Plan
- National Development Plan
- National Industrial Participation Programme
- National Exporter Development Programme
- National Industry Policy Framework

Number of jobs created or retained

- 8

Scarce skills development

- Systems engineering
- Digital engineering
- Signal process engineering
- Optics designing
- Opto-mechanical engineering
- CAD designing

Internal skills development at Simera

- 4

Intellectual property

- Integration and re-engineering of COTS components to realise a nanosat imager capable of a wide swath imagery

Import substitution

- Valid alternative to international nanosat imagers

Hyperspectral focal plane and mass storage for a space imager

Research showed that a hyperspectral imager would be a valuable asset for the nanosat market due to the value of the data obtained from the imager verses the cost of a nanosat, putting a new performance benchmark in place for such satellites. This project focused on the design, implementation and verification of a hyperspectral camera for a nanosat and a supporting mass memory system. This work follows on the development of the nanosat imager (see previous article).

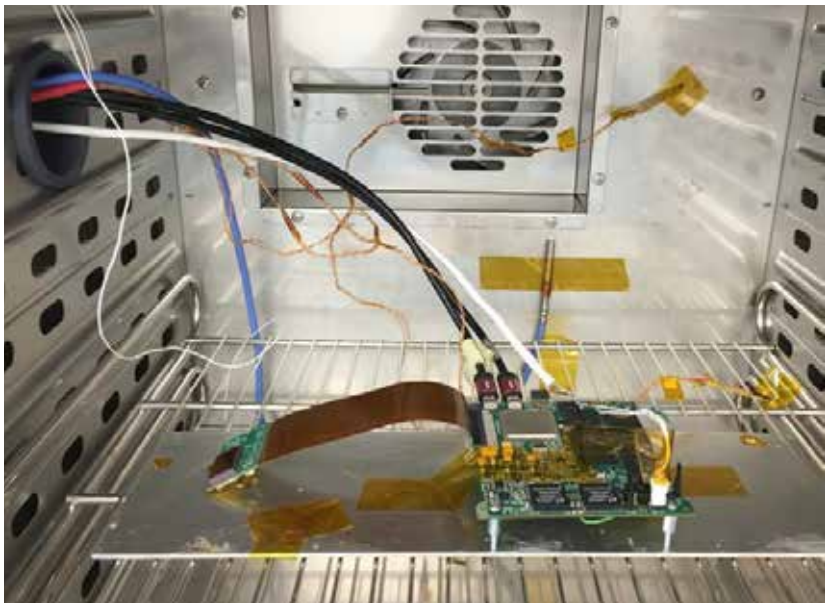
THE PROJECT IN MORE DETAIL

Stage 1 of this project demonstrated South Africa's capability to appropriately specify, design, procure and adapt COTS components and then to proceed to assemble and test a low cost space imager customised for nanosat missions.

In stage 2, a hyperspectral imager and a compatible mass memory unit was designed to be added to the nanasat. Due to the concurrent design of the previous stage of the project, much of the hardware could be reused for this stage of the project. The second round of hardware included a significant upgrade to the number of flashes used, flash configuration, power supplies, power supply configuration and more resource abundant field programmable gate array controller.

The data intensive nature of hyperspectral sensors meant that the project team had its work cut out to push the absolute limits in getting the maximum amount of speed and data capacity onto a standard form factor nanosatellite board.

Hyperspectral imagers record hundreds of spectral bands of relatively narrow bandwidths (5-10 nm). Such data allow for detailed identification of imaged materials (for example the composition of the land or the atmosphere), valuable for fields such as mineralogy, agricultural forecasting and environmental monitoring.



Control unit and sensor unit inside test chamber with power line, data lines and temperature sensors connected.

The company has developed the skill and gained confidence in designing payloads that will be globally competitive, hopefully assisting in securing contracts that will, in turn, increase job creation. The skills developed will also enhance the image of the South African industry and boost the export and manufacturing sector, as well as be used to secure more projects that will directly impact on job creation and training.

– Space Advisory Company

Through the use of a tailored European Cooperation for Space Standardization (ECSS) systems engineering process, a system was designed to meet the user requirements. A thorough engineering analysis of the electronic design has been done, and verification through performance testing has shown that the engineering model hardware operates according to its designed-for specification, which also includes testing of the flash controller.

The environmental and radiation tests have been successfully passed, completing the design effort.

The next step for the Space Advisory Company is the development of a flight model. This would entail addressing all of the issues identified during qualification testing of both the current and the previous stages of the project.

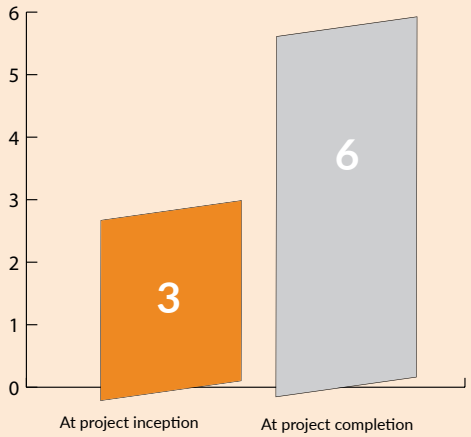
SUCCESSFUL COLLABORATION

Partners included TraX Interconnect, Baracuda, the Nelson Mandela Metropolitan University, SUN, the CSIR, NewSpace Systems, and Infruitec Radiation Facility.

Electrical ground support equipment (EGSE) next to the thermal test chamber.

Benefits and impact

Technology readiness level



Predominant product market

- Space
  - Satellites
  - Services

Alignment with national strategies or programmes

- Industrial Policy Action Plan
- National Development Plan
- National Industrial Participation Programme
- National Exporter Development Programme
- National Industry Policy Framework

Number of jobs created or retained

- 8

Scarce skills development

- Systems engineering
- Digital engineering
- Optics designing
- Opto-mechanical engineering
- CAD designing

Industry focused skills development

- 1

Internal skills development

- 5

International contracts

- Negotiations with potential international client are underway

Stellar gyro development

The goal of the stellar gyro project was to produce a new type of attitude sensing system suitable for small spacecraft. With AISI assistance, the work was taken through the design realisation to preproduction prototype and qualification stages, so that it is ready for marketing to international satellite customers. The NewSpace Systems stellar gyro is expected to pass through qualification testing and is due for first launch by the end of 2016.

THE PROJECT IN MORE DETAIL

A stellar gyroscope is an innovative solution to solve the problem of drift in traditional gyro solutions. This solution will solve the problem of accurate attitude knowledge during the period the spacecraft is in eclipse and can no longer orientate itself relative to the Sun.

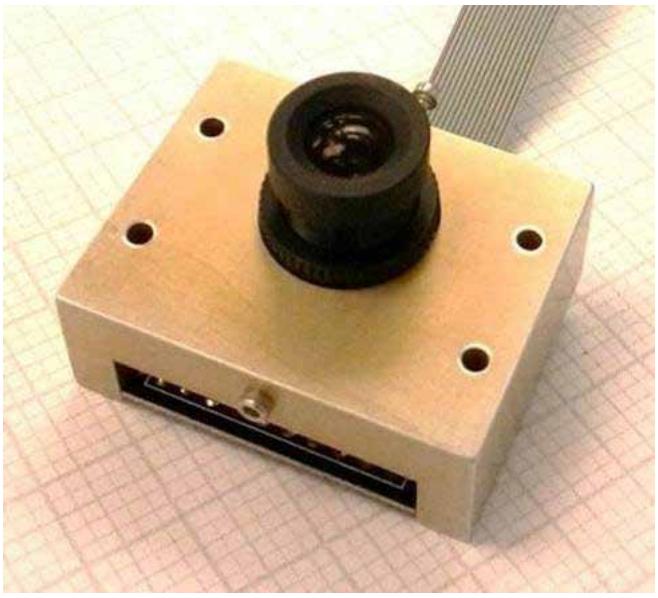
A key technology for achieving higher performance smaller spacecraft, it achieves fine pointing accuracy at lower cost, using less spacecraft resources (mass, power, volume) and with high reliability by being robust to aging effects such as radiation damage.

The concept works by calculating the rotation rates of a spacecraft by comparing the translation of stars in successive images taken with a small, low-cost camera. The comparison algorithm is very robust to errors in the image, and degrades gradually as damage to the detector increases with radiation exposure. As the stars in the field of view are the same in the two images, no drift is built up between successive calculations of rate. NewSpace Systems will design, develop, manufacture, test and qualify a stellar gyro such that it is ready to be offered to the market as an attitude control sensor.

Building on the foundation of work done by the University of Kentucky and SSBV UK, the project will proceed through the traditional stages of a development project; that is design, manufacture and testing. A small multidisciplinary team including engineers with skills in electronics, FPGA (field-programmable gate array) design, embedded processing, optics, software development and mechanical design, will be involved in the project.

SUCCESSFUL COLLABORATION

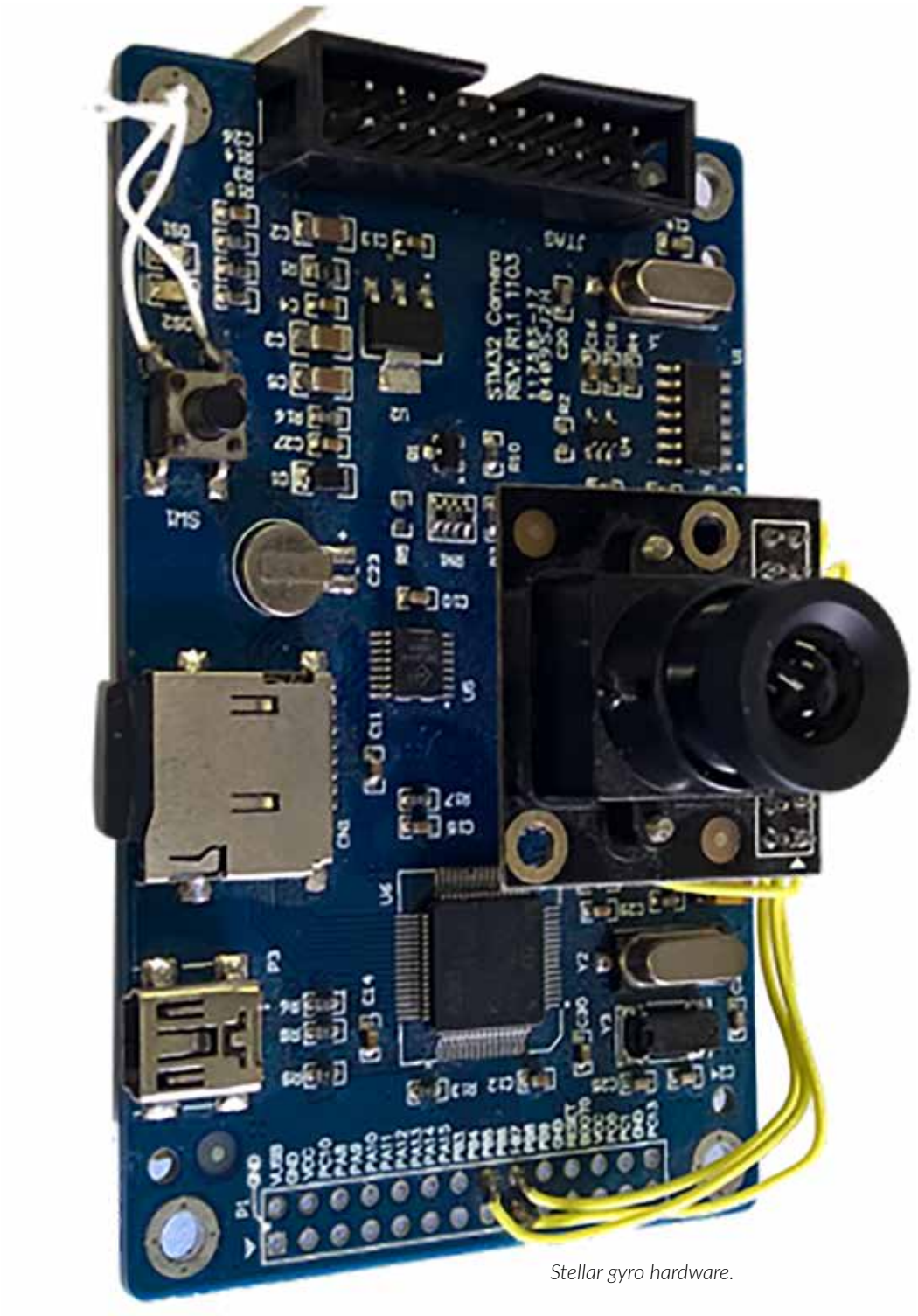
The project is led by NewSpace Systems. The Space Advisory Company have expertise in attitude control system design, and this team will be used to develop the simulations of the stellar gyro performance when combined with other sensors and actuators in a simulated orbit environment.



Stellar gyro camera.

This project will develop an operational stellar gyroscope up to qualification model stage. A commercial product will be developed that has clear economic and reliability advantages over a full star mapper solution, while showing technical and cost superiority over an Earth sensor or alternative gyro-based solutions.

– NewSpace Systems



Stellar gyro hardware.

Unmanned Aerial Vehicle Avionics

> Nothing ever built arose to touch the skies unless some man dreamed that it should, some man believed that it could, and some man willed that it must.
>
> – Charles Kettering, Inventor

A key cog in the AISI's strategy for a competitive and productive aerospace and defence industry relates to developing relevant industry focused capabilities and facilitating associated transfer of technology to industry. To single out only one sector, the unmanned aerial vehicle and system market has tremendous potential for growth and technology leadership.

Projects in this area include:

- Portable UAV ground station
- Unmanned aerial systems antenna solutions for extended communications ranges
- UAV short range datalink

Portable UAV ground station

The support received from the AISI has enabled Tellumat to develop a portable and distributed unmanned aerial vehicle (UAV) ground control station (GCS). This development extends the UAV command and control to beyond-line-of-sight, through a distributed network of multiple control stations. In addition, all data can be distributed in real time inside the footprint of a defined distribution network. It also makes the co-location of various operators in vast geographical locations a reality.

THE PROJECT IN MORE DETAIL

Tellumat has various elements of an unmanned aerial system (UAS) ground control station and associated avionics as a result of a product development roadmap that was started in 2007. The AISI project aimed to develop a portable GCS to complement the existing Tellumat suite of UAS sub-systems.

Further objectives included the development of local capability in the design and development of UAS subsystems and achieving a complete product portfolio, including the distributed functionality of the GCS, of locally produced UAS subsystems.

Prior to development of the GCS, viable alternative UAS subsystems were only available from foreign sources, and often subject to international regulations or import restrictions. Commercialising this capability in South Africa ensures a level of autonomy and avoid importing costly solutions from international suppliers.

The development of the portable GCS was executed in two phases. The first entailed the high level system design; and the design, procurement and build of the hardware for a portable and distributed GCS. An existing GCS software baseline, which was developed for non-flight demonstration purposes, was enhanced with added features to make the GCS ready-for-flight.

In the second phase, with the use of commercial off-the-shelf (COTS) networkable hardware, network architecting and the redesign of the GCS software enabled Tellumat to meet the required objectives, which concerned the network and distribution capability of the GCS. The operator control unit software was enhanced with network capability and security, video and data storage, payload and pilot operator control, multi-pass control between various system users; and a digital intercom system.

The UAV GCS enables ground staff to execute a number of functions in a UAS, including monitoring and controlling the take-off and landing of a UAV; controlling the mission and navigational status; monitoring and controlling the payload; viewing the payload; viewing the target and point-of-interest information; monitoring the UAS' operational status and health; administering the data communications link; controlling and monitoring the antenna positioner; alerting the operators to failure or alarm conditions in the UAS; facilitating secure networking with external systems;

This project has created a niche for Tellumat in the UAV systems and GCS space. Very few, if any, other organisations have the networkability of a GCS which was produced in this project. The resulting capability will benefit the aerospace industry in that video can be made available in real time, enabling quicker decision-making. A good scenario would be the deployment of such a system in the Kruger National Park to combat rhino poaching. This could be conducted with manned or unmanned aerial platforms.

– Tellumat

and facilitating the enforcement of operational and flight safety processes and procedures.

An additional goal of the project was to provide training and mentorship to interns at both Technician and Master's Degree level. Tellumat has employed two Trainee Technicians and two Master's level engineering interns. They received significant project experience in the area of product development applicable in the area of UAS development. Three of the four interns have subsequently been appointed permanently with Tellumat.

This project has allowed for the creation of a new technology product and contributed to the upskilling of staff. It has allowed job creation beyond the project and created the platform for expansion in the field, thereby creating further growth.

SUCCESSFUL COLLABORATION

Most of the implementation was done with a networking consultant from Visio Technologies, and with the in-house Tellumat team, as the work was mostly software related. Other collaborations included RS Components, component supplier; Kline Engineering, mechanical assemblies manufacture of the operator control unit (OCU); Shrike Marine, cable manufacturers for the OCU; Model Shop, mechanical assemblies for the OCU; and TraX, printed circuit board manufacture.

Benefits and impact

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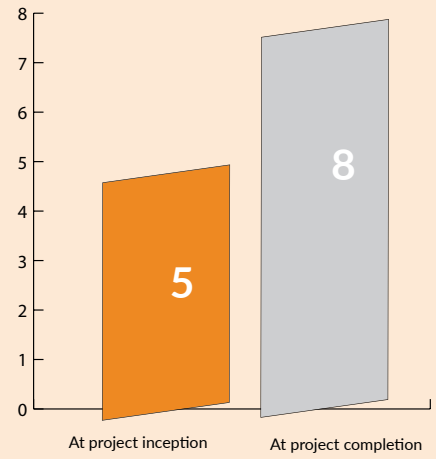
Technology readiness level



Predominant product market

- Aeronautics
- Unmanned aerial systems

Alignment with national strategies or programmes

- CSIR Modular Unmanned Aircraft System programme

Number of jobs created or retained

- 3

Scarce skills development

- Network Architecting
- Network Application Development
- System Engineering

Industry focused skills development

- 4

Internal skills development

- 8

International contracts

- Interest from KACST in Saudi Arabia

Operator Control Unit completed in Phase 1 of the project.

Unmanned aerial systems antenna solutions for extended communications ranges

Tellumat has supplied datalinks for unmanned aerial vehicles (UAVs) since the early 1990s with radio products being deployed on platforms such as the Denel Seeker and Paramount Advanced Technologies Vulture UAVs. Datalinks are then typically integrated with ground and airborne antennas, along with suitable turning gears to maintain line of sight communications and desired ranges. This AISI-supported project has allowed Tellumat to develop its own ground dish antenna (GDA) and airborne directional antenna (ADA) to complement the existing UAV datalink products, widening Tellumat's footprint and increasing the prospects for new business.

THE PROJECT IN MORE DETAIL

A market need existed to extend the range capability of UAV data link systems. In response, Tellumat sought to develop a high gain GDA and an ADA. The intended target range was 250 km line of sight, while maintaining a fade margin of 10dB. The fade margin of 10dB means that a link availability of 95.8% can be maintained in a moderate multipath environment. To achieve a theoretical line of sight range of 250 km, and considering the curvature of the earth, a minimum height above ground of 10 000 ft is required.

Therefore, the project goal was to add two products to an existing UAV datalink portfolio that will offer the market long-range solutions for UAV systems. The first product, the ADA, offers high gain, is physically small and light weight to easily integrate onto a UAV. The second product, the GDA, has a high gain of 33dBi, is easy to manufacture and designed to interface with Tellumat's existing ground antenna turning gear.

Both these products have been successfully completed.

The design methodology used for the ADA followed that of a typical product development approach. The system engineering was done using a

CAD image of the GDA integrated with the Tellumat antenna positioner and DL-5000 radio datalink. This configuration is intended for delivery to a customer by mid-2016.

The AISI assistance has been of significant benefit to Tellumat, allowing it to expand its product portfolio and address new market opportunities while also improving the skills of those involved in the project. The realisation of the antenna products has assisted in securing two strategic customers. The estimated revenue resulting from this project is in the magnitude of R1 000 000 for the next 12 months, of which 50% is expected to flow to subcontractors and suppliers. Growth beyond the next 12 months is also expected.

– Tellumat

SUCCESSFUL COLLABORATION

The following partners were all instrumental in the development and success of the antenna project: Stellenbosch University, radio frequency antenna specialist and consultant; Antenna Magus, dish design software and consulting; MMS Technologies, dish manufacture; Rapid 3D, radome manufacture; RS Components, supplier of majority of components; Kline Engineering, mechanical assemblies manufacture; Shrike Marine, cable manufacturers; Model Shop, mechanical assemblies manufacture; TraX, printed circuit board manufacture; Five Star, spray painting.

model-based design tool called SysML, with a tailored list of military standard specification output documents. The design aspects of the project used DO-178 level D (software) and DO-254 (hardware) avionics certification guidelines for the software and hardware developments, respectively. The mechanical design was done using a 3D computer-aided design package called Solid Edge.

The GDA design was driven by a user requirement specification and based on this specialised field, detailed expert consultation was incorporated. Tellumat engaged the radio frequency experts at Stellenbosch University, an antenna design company called Antenna Magus and a composite/materials company called MMS Technologies.

The project has also created in-house knowledge of antenna development processes and understanding. In terms of new business, Tellumat has received a purchase order for eight GDAs with a further 10 imminent from three different customers. The company has also submitted tenders for the supply of ADAs to India, Saudi Arabia and Pakistan. Tellumat will integrate and supply the GDA and ADA onto its UAV system, ASTUS.

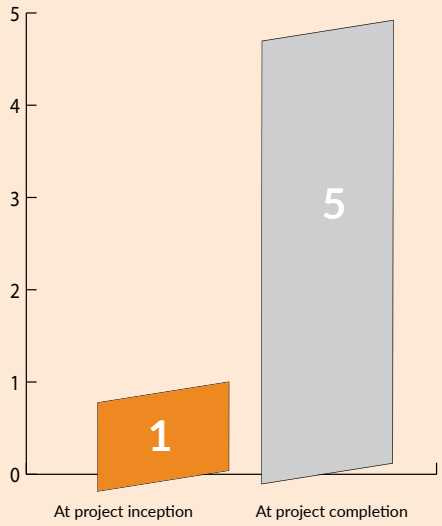
Tellumat no longer has to purchase an off-the-shelf GDA but can produce locally. Should manufacture adaptations be required in the future, Tellumat could easily do this since it owns the data pack and intellectual property for these designs.

Airborne directional antenna radome.

The airborne directional antenna with the lid removed. The horn antenna, printed circuit board with motor drive and GPS antenna can be seen.

Benefits and impact

Technology readiness level



Predominant product market

- Unmanned aerial systems
- Point-to-point datalinks

Number of jobs created or retained

- 2

Scarce skills development

- Systems engineering
- Antenna development

Industry focused skills development

- 4

Competitiveness improvement

- Extended UAV ranges

Internal skills development

- 4

International contracts

- Pakistan, India, United Arab Emirates, Kingdom of Saudi Arabia

Local contracts

- Paramount Advanced Technologies and Engineering

Intellectual property created

- Ground dish antenna
- Airborne directional antenna

UAV short range datalink

While datalink solutions to date have targeted the medium to large UAV market with line of sight communication ranges of up to 250 km, the commercial video links that exist are aimed at the radio controlled aircraft market. These products typically transmit a single video channel from a forward looking camera mounted on the aircraft and has a maximum range of less than 5 km. The primary objective of the project was to fill a niche between these two markets – the commercial radio control equipment and high-end UAV datalink radios – by developing and qualifying a small, lightweight (weighing less than 40 kg) video data transceiver link, capable of operation to a range of 40 km.

THE PROJECT IN MORE DETAIL

A number of queries directed to Tellumat and additional market research have highlighted a gap between current product offerings and the commercially available first person view (FPV) datalinks. FPV refers to a method where a radio-controlled vehicle is operated from the viewpoint of the remotely based 'pilot'.

Companies doing aerial reconnaissance or research and development testing and demonstrations are typically interested in ranges not exceeding 30 km and comprising a single video interface with a serial control interface. On the UAV, they would typically supply power to the radio from a small battery or alternator fitted to the engine.

Thus, the product required was a datalink system including a UAV radio, ground radio and small antenna tracking system. This product will be integrated into a ground control station (also read the article on page 56), also supported by the AISI.

The subsequent development of the DL-5200 video datalink created an opportunity for Tellumat to build on its local capability, enhance its product portfolio, and enable training of technicians and trainee technicians to gain valuable design and product test work experience.

The scope of work included acquiring a commercial off-the-shelf concept demonstrator, developing the DL-5000 base board and the DL-5200 integrated radio software; building local capability, leading to less dependence on international import restrictions; promoting export; delivery to the CSIR's modular unmanned aerial systems (long endurance) programme; and training and skills development.

The DL-5200 video data link development required research into the suitability and selection of orthogonal frequency division multiplexing radio modulation for UAV applications (i.e. where data are carried on many parallel data streams), the development of a custom switch and interface board, interface software and a bespoke lightweight mechanical housing.

This product effectively addresses local and international small UAV operator requirements. It has completed functional temperature, vibration and electromagnetic compatibility testing, with the product data pack in the process of release to configuration.

The DL-5200 datalink is capable of delivering real-time data and video to the ground. The video is a HD PAL interface, which is regarded as the most commonly used interfaces in the commercial UAV market.

DI-5200 Internal mechanics.

The DL-5200 project has enabled our customers to add this product to their solutions and then market to a larger international market segment. It has generated significant interest and an order has already been realised by one of our local customers, providing a much-needed boost to the local avionics industry. Training and upskilling was a key focus in this project and has resulted in trainee technicians, technicians and engineers with an improved and focused skill set able to serve the local UAV aerospace industry.

– Tellumat

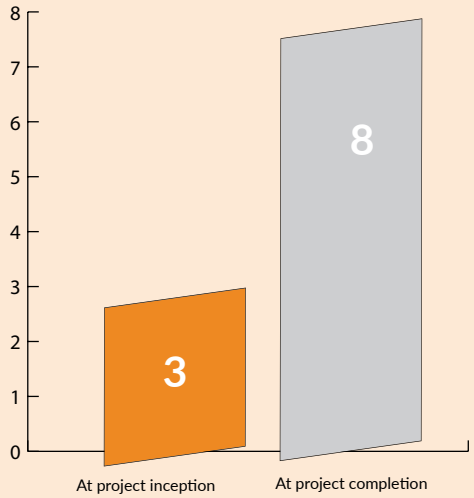
SUCCESSFUL COLLABORATION

A number of partners contributed to the success of the DL-5200 project: EzeeCad, principle mechanical design; TraX, printed circuit board manufacture; Rotoway SA's Richard Chase, the flight testing pilot; RS Components, supplier of majority of components; Rheomac, assembling of mechanical assemblies; Shrike Marine, cable manufacturers; Houwteq, electromagnetic compatibility test facility; GTM, printed circuit board assembly; and Tellumat's Quality Assurance and Defence departments for, respectively, environmental testing and product quality assurance; and product development, final assembly, test and purchasing.

DL-5200 datalink.

Benefits and impact

Technology readiness level



Predominant product market

- Aeronautics
  - Unmanned aerial systems

Number of jobs created or retained

- 4

Scarce skills development

- Radio frequency
- Embedded Linux
- Embedded networking

Industry focused skills development

- 2

Competitiveness improvement

- Enhanced datalink product portfolio
- Filling a niche between commercial radio control equipment and high-end UAV datalink radios

Internal skills development

- 4

Local contracts

- 2

Intellectual property created

- DL-5200 transceiver product

Import substitution

- Replaced a product from an American company in Tellumat's offering

Targeted skills development

Man's mind and spirit grow with the space in which they are allowed to operate.

– Krafft A. Ehricke, rocket pioneer

A need exists for focused and targeted skills development initiatives that are designed for the South African aerospace sector and that complement existing skills development and training structures of government. The AISI undertakes projects with the specific aim of using industry knowledge and technology to improve human capital, and developing skills which are appropriate to industry requirements.

Projects in this area include:

- Capacity building in international air, space and telecommunications law
- Capacity building in space law – Moot Court
- Project internships

Capacity building in international air, space and telecommunications law

The Institute for International and Comparative Law in Africa, situated in the Faculty of Law of the University of Pretoria (UP), with AISI support, facilitated much-needed capacity building in the regulatory framework of international air, space and telecommunications law over a six-year period. Courses and materials developed offered a unique opportunity for members of the civil service, industry and law students to gain specialised skills in these areas of law, and gave the UP a valuable competitive edge while also growing its knowledge base.

THE PROJECT IN MORE DETAIL

The capacity building programme focuses on the legal framework pertaining to international air, space and telecommunications, including the relevant international treaties and their application within the South African context.

The programme enables different branches of industry to optimise the regulatory framework for their productivity, due to better understanding of how the rules work. It is in particular very important for members of the civil service and industry to understand under which conditions the state or private operations can incur financial liability.

Representatives from the civil service and industry who deal with these legal aspects benefited from topics such as the public and private dimensions of air law; the regulatory system of the International Telecommunications Union; the combating of outer space pollution caused by space debris; the history and major principles of space law; the use of space for military purposes; liability for the wrongful use of space; and the role of international air law in combating terrorism.

The project has two components. The first concerns the capacity building for a broader audience (i.e. members of industry and the civil service). The second relates to the development of lawyers specialising in the regulatory framework concerning international air, space and telecommunications law; and involved the development of Master and Doctoral programmes in this field.

The future of the LL.M programme has been secured through a SARChI Professorship awarded to Prof. Erika de Wet of the UP Faculty of Law by the National Research Foundation for an initial period of five years (2016-2021). This support will assist in securing the expertise of Prof. Hobe for the LL.M programme and doctoral supervision in the immediate future.

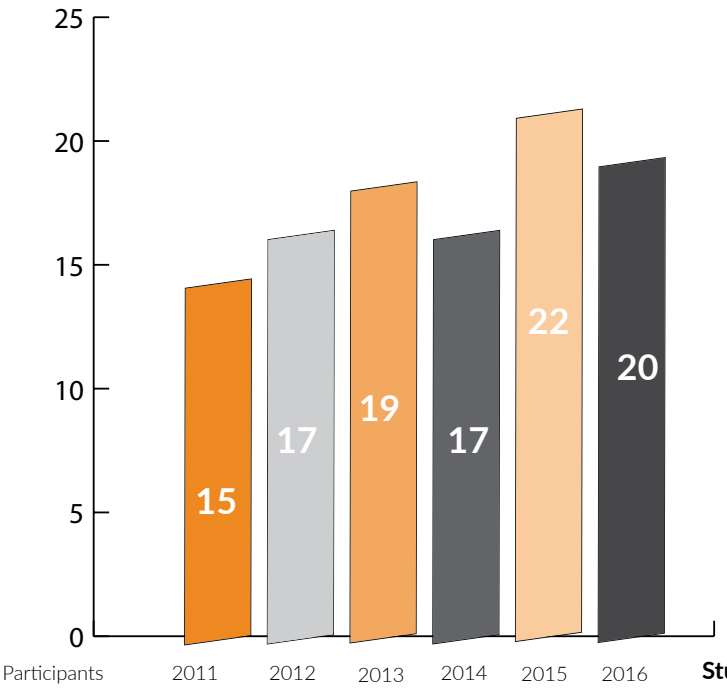
First row: L Peter, A Smit, E Lebeko, J van Staden, Prof. S Hobe, Prof. H Wildenboer, TM Mahlangu, I Nedzamba, H Wessels, M Adams. Second row: S Mhlongo, C Ramcharan, L Groome, J Vogel, D Thomas, A Dey-van Heerden, W Erlank, G Wolmarans, GO Muller.

While the numbers might be modest, it is worthwhile noting that no other (higher education) faculty on the continent is building capacity in the area of international air, space and telecommunications law. By the end of 2016 there will most likely be 15 LL.M graduates. This sector is extremely technical. The capacity building course provides an important foundation for understanding the law and how to operate within its framework. Among others, this includes knowledge of how to remain competitive without causing damage leading to liability.

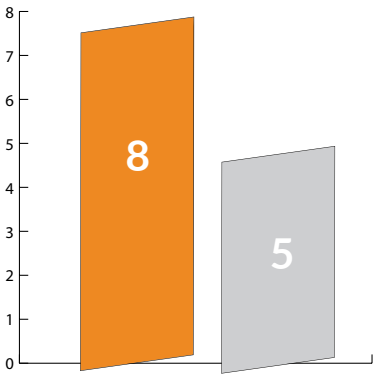
- University of Pretoria

In numbers

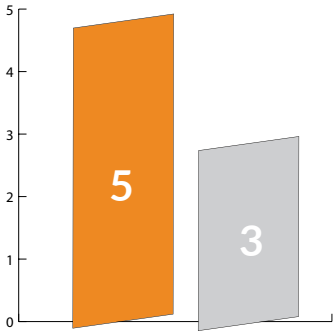
Participants in the certificate course aimed at industry and the civil service:



2015



2014



Students enrolled in the elective course:

2013

6 students enrolled for the elective and passed
4 finalised LL.M dissertation and graduated in April 2014

2014

5 students enrolled and passed
3 finalised LL.M dissertation and graduated in April 2015

2015

8 students enrolled and passed
5 finalised LL.M dissertation and graduated in April 2016

SUCCESSFUL COLLABORATION

The capacity building was directed by a leading international expert in the field, Professor Stephan Hobe, LL.M. (McGill), Director of the Institute of Air and Space Law at the University of Cologne, Germany, and Extraordinary Professor in the UP Faculty of Law.

Capacity building in space law – Moot Court

A competition to build capacity and raise awareness about space law was co-hosted by the dti, the AISI and the South African National Space Agency in May 2015. Sponsorships were received from Denel Dynamics, the CSIR, the Space Advisory Company as well as an anonymous donor.

The Manfred Lachs Space Law Moot Court Competition is an international competition for law students. The completion is organised by the International Institute of Space Law (IISL). More than 60 teams compete worldwide in different regional rounds for admission to the final round in October each year, which is held at the annual International Astronautical Congress.

The main objective of the competition is to build capacity in space law by creating a platform for debate, exchange and cooperation between students, academics and space law professionals on contentious broader matters of space, air, telecommunications and environmental laws.

The competition presented a unique opportunity for university law students to engage in matters of public international law of contemporary relevance to outer space and to develop their legal advocacy skills with other top universities in Africa.

A moot court competition simulates a court hearing (usually an appeal against a final decision), in which participants analyse a problem, research the relevant law, prepare written submissions, and present oral arguments.

– University of Oxford

2015 Space Law - Moot Court winners from Obafemi Awolowo University of Nigeria.

ABOUT THE COMPETITION

The first Manfred Lachs Moot Court Competition was held in 1992, when the Association of US Members of the IISL invited Georgetown University, George Washington University and the American University to each send two teams to participate in a moot court competition during the first World Space Congress held in Washington, D.C., USA.

Now the competition covers four world regions: North America, Europe, Asia Pacific and Africa.

The capacity building benefits to South Africa count as one of the main advantages of participating in the competition.

Space activities are ubiquitous and essential to modern life. At the same time, the sustainability of outer space is crowded, contested and complex. This needs to be regulated through international legislation.

– South African Council for Space Affairs

Held on 14 and 15 May 2015, six teams from Nigeria, South Africa, South Sudan, Uganda and Kenya participated in the Moot Court competition. The teams were required to debate a problem based on a hypothetical case that addressed questions related to on-orbit satellite collision, non-cooperative satellite removal and damages.

The Obafemi Awolowo University team from Nigeria won the competition and also won the prize for Best Memorial. The University of Pretoria was the runner up and also won the prize for Best Oralist. The Makerere University of Uganda team was the Second Runner Up.

Speaking at a dinner held on 17 May 2011 at UP, Nomfuneko Majaja, Chief Director: Advanced Manufacturing at **the dti**, highlighted the historic nature of the Africa Round. Dr Tare Brisibe, Chair of the Legal Sub-committee of the United Nations Committee on the Peaceful Uses of Outer Space, emphasised the need for international cooperation in the light of new technologies, and said that capacity building and training in space law are imperative for African countries to take their rightful place in the arena of current international space activities.

2015 Space Law - Moot Court participants.

AISI-supported internships in the Unmanned Airborne System Electronic Subsystems project at Tellumat

ROBERTO GOMES

Roberto Gomes.

Roberto Gomes says the internship at Tellumat has had a major impact on his career. He has always wanted to fly, but circumstances did not allow that. Instead, he did an engineering degree with the hope of getting into the aerospace or aeronautics industry. The AISI assistance and Tellumat made his hope a reality by enabling him to work on the unmanned airborne system electronic subsystems (UASES) project.

The UASES project includes aspects such as unmanned aerial vehicle (UAV), the flight mission computer, the sensor pack unit, the health and control unit, the ground control station, and the hardware-in-the-loop (HIL) simulator. The objective of the project is to develop a fully integrated UAV demonstrator and avionics system for aerial surveillance.

Gomes has learnt much, including implementing best engineering practices, processes and methods to meet a project's objectives; refining his leadership, teamwork and communication skills; and mechanical, electronic and software design.

His internship came replete with academic learning opportunities such as completing his MSc in Mechanical Engineering at the University of Cape Town; and attending a course in C programming which helped him hone his software development and programming skills.

Working on the UASES project has also given him exposure to work ethic and standards that taught him the value of professionalism.

In one of his projects, Gomes focused on modelling a UAV system in MATLAB/Simulink and running HIL simulations to test the flight computer and other hardware in real time. The HIL simulations include a mathematical representation of the aircraft aerodynamics as well as sensors and actuators that interface with the aircraft. The environment in which the aircraft flies must also be simulated through, for example, atmospheric and wind models.

Configuring the HIL simulations to accurately represent the UAV was one of the first objectives of this project. It has already undergone a qualification test procedure and received interest from potential clients.

Tellumat offered Gomes a permanent position subsequent to the completion of his internship, giving him the opportunity to grow further in the industry that he is passionate about.

My experience as an intern was thoroughly enjoyable and provided me with the opportunity to learn a lot in the field of unmanned aerial systems. The exciting UASES project, albeit challenging at times, has provided a great environment to apply myself as a young engineer. I would highly recommend further internship programmes like this one for others who are interested in pursuing a career in aerospace.

– Roberto Gomes, Tellumat

MOHAMED SIDDEEQ MANSURA

Mohamed Mansura's main objective since arriving at Tellumat as an intern has been the preparation of the flight mission computer (FMC) for integration with the other components on the UAV. The FMC is essentially the brain of the aircraft. It contains the control loops, the mission computer, the inertial navigation system and the communications routing. It interfaces with the sensor packs, the health and control unit, the ground control system, the servos, the air traffic control radio, the HIL simulation and the DL-5000 radio.

His first task was to design and implement some of the control loops and systems for the FMC. This was done using the aerodynamic model of the aircraft and modelled in MATLAB before being implemented using C programming on the FMC. These loops were tested using the aerodynamic model in the HIL simulation.

Mansura also implemented new features into the FMC. These features vary from logging extra telemetry packets to things such as sending and receiving tele-commands, implementing new safety alarms, setting up configuration files and implementing certain logical algorithms.

Learning opportunities included programming such as C, C# and MATLAB; implementing and adhering to engineering practices and processes; and exposure to electrical hardware and software components. Mansura has been offered a permanent position at Tellumat.

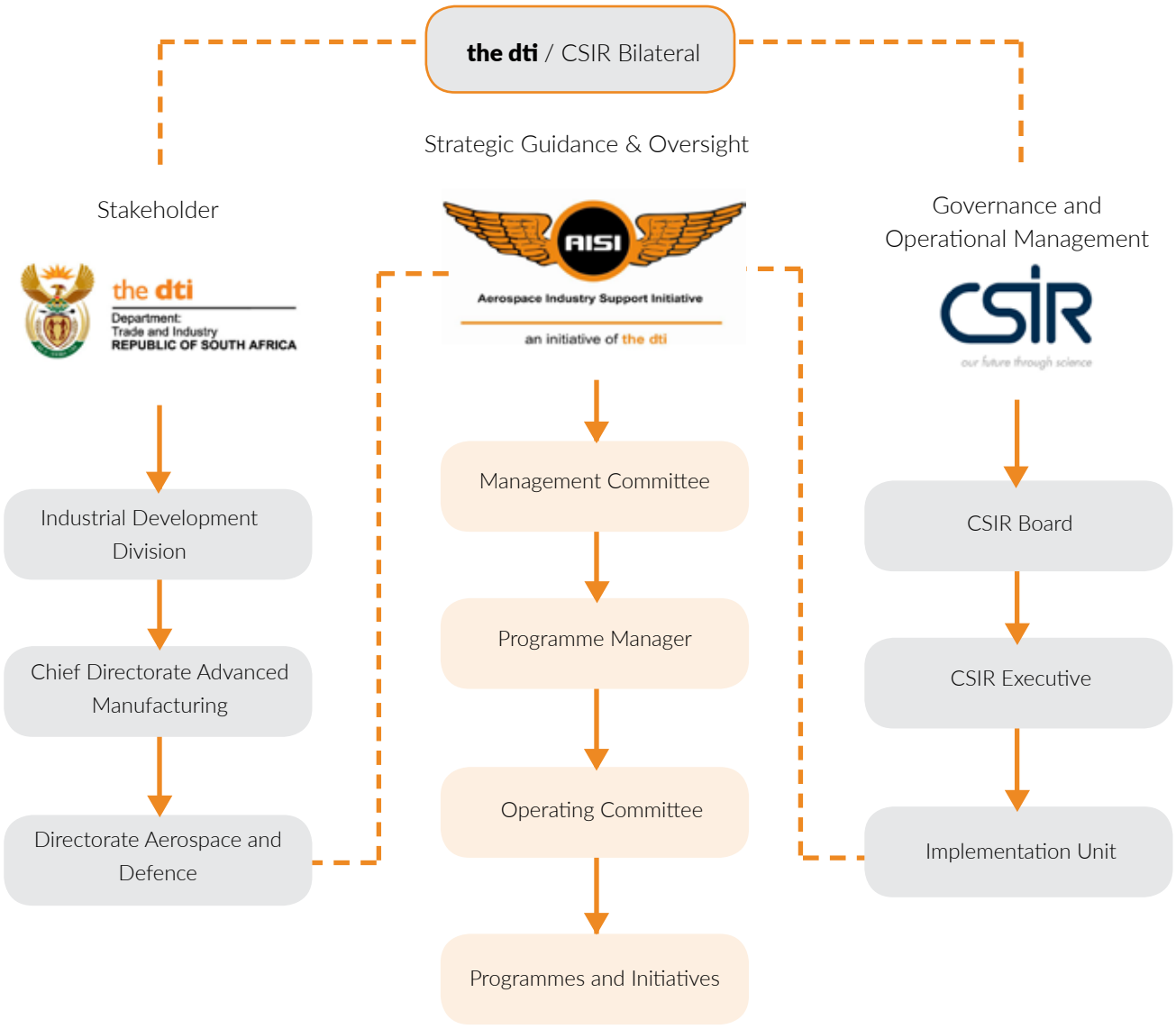
Mohamed Mansura.

The UASES project has taught me a lot and the project as well as the environment has given me the opportunity to expand and build on the knowledge I have gained at university. I would recommend more internship programmes to help budding engineers begin their careers.

- Mohamed Mansura, Tellumat

AISI Governance and

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 (PFMA) and the Preferential Procurement Policy Framework Act (PPPFA). The AISI operates within the procedural framework of the CSIR, and reports to the AISI management committee on a quarterly basis, as well as provide reporting input to the dti.



Financial results

Aerospace Industry Support Initiative

an initiative of the dti

FORECAST FINANCIAL REPORT FOR THE PERIOD ENDED MARCH 2016

	Actual Year to date March 2016 R
FUNDS INCLUDING INTEREST AVAILABLE AT BEGINNING OF PERIOD 01 APRIL 2015	**12 471 332**
FUNDS RECEIVED	**18 889 474**
Funds received	**18 889 474**
– funds transferred	21 534 000
– less: VAT payable to SARS	2 644 526
INTEREST RECEIVED 01 APRIL 2015 TO 31 MARCH 2016	**476 322**
TOTAL FUNDING BEFORE EXPENSES	**31 837 128**
TOTAL ALL EXPENSES	**25 446 935**
OVERHEAD COSTS	**4 125 000**
PROGRAMME COSTS	**21 321 935**
INDUSTRY DEVELOPMENT & TECHNOLOGY	7 452 652
SECTOR STRATEGIC SUPPORT INITIATIVES	2 648 560
SUPPLIER DEVELOPMENT	9 954 856
INDUSTRY FOCUSED SKILLS DEVELOPMENT	561 439
CO-ORDINATION, PROMOTION & AWARENESS	704 428
TOTAL FUNDING AVAILABLE AFTER EXPENSES	**6 390 193**

The AISI received a total funding allocation from **the dti** of R18 889 474 (excl. VAT). This funding was utilised towards fulfilling the strategic objectives of the AISI as set out in the approved business plan. The AISI facilitated industry support totalling R25 446 935 (excl. VAT) in the South African industry, investing funding from previous financial periods, which has already been contracted for industry support. The largest area of investment for the AISI was supplier development, with a secondary area of investment in industry development and technology support.

At the end of the 2015/2016 financial period, R6 390 193 was contracted for projects with deliverables in the next period.

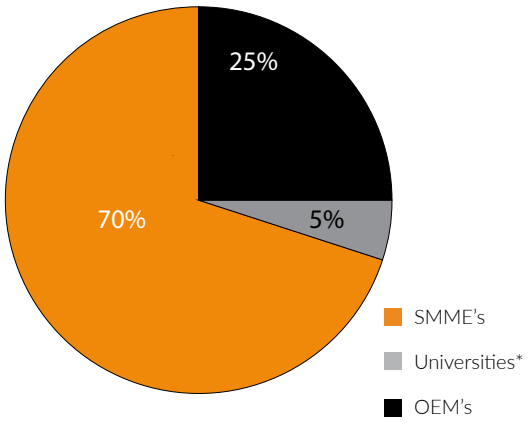
Summary of Organisations Benefiting from AISI Support

Organisation Name	Organisation Type	B-BBEE Level	Project Name
Daliff Precision Engineering	SMME	1	• Supplier Development Incentive Scheme
Sinjana Engineering	SMME	1	• Supply Chain Improvements and Optimisation Interventions
Cliff'sway Aerospace	SMME	2	• Supplier Development Incentive Scheme
Cybicom Atlas Defence	SMME	2	• Industrialisation of Joint CAD/CSIR Helicopter Simulator
Micromax	SMME	2	• Supplier Development Incentive Scheme
Ti-TaMED	SMME	2	• Supplier Development Incentive Scheme
PaR Systems	SMME	3	• Industrialisation of a Small, Low-Cost Transversely Excited Atmospheric (TEA) CO_2 Laser
T&T Engineering	SMME	3	• Supplier Development Incentive Scheme
Cape Aerospace Technologies	SMME	4	• Small Gas Turbine Technology Improvements
Compumach Engineering	SMME	4	• Supplier Development Incentive Scheme
NewSpace Systems	SMME	4	• Stellar Gyro Development
West Engineering	SMME	4	• Supplier Development Incentive Scheme
TraX Interconnect	SMME	6	• Square Kilometre Array PC Board Localisation
Space Advisory Company	SMME	8	• Nano-Satellite Imager Development • Development of a New Hyperspectral Focal Plane and Mass Storage for a Space Imager
Enterprises at University of Pretoria	University	2	• Design and Manufacturing of Aerospace Fuel Tank Structures
University of Pretoria	University	3	• Capacity Building in International Air, Space and Telecommunications Law 2016
Tellumat	OEM	2	• Unmanned Aerial Vehicle (UAV) Short Range Datalink • Identification Friend or Foe Interrogator Power Amplifier/ Transmitter • Unmanned Aerial Systems Antenna Solutions for Extended Communications Ranges • Portable Unmanned Aerial Vehicle (UAV) Ground Station • Industry Focussed Skills Development
Denel Aerostructures	OEM	3	• Design and Manufacturing of Aerospace Fuel Tank Structures • Feasibility of Natural Fibres in Aerospace Structures • Supplier Development Incentive Scheme • Ultra-High Cycle Fatigue (UHCF) Design and Testing of High Strength Aerospace Materials

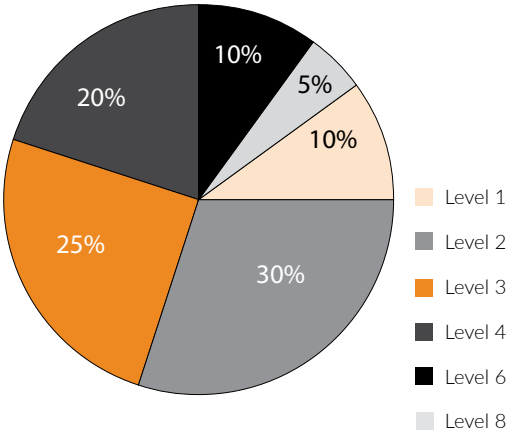
Organisation Name	Organisation Type	B-BBEE Level	Project Name
Denel Dynamics	OEM	3	• Additive Manufacturing of Aerospace Components
Aerosud Aviation	OEM	6	• Additive Manufacturing of Aerospace Components • Localisation and Industrialisation of Insulation Blankets • Process Design and Validation of Carbon Fibre Reinforced Thermoplastics (CFRTP) Joining Methods • Process Design and Validation of Carbon Fibre Reinforced Thermoplastics (CFRTP) Overlap Joining Methods • Supplier Development Incentive Scheme

Sector Wide Beneficiaries	
Project Name:	**Beneficiary:**
Space Law Moot Court	African Space Law Institutions and Students
Project Name:	**Beneficiary:**
Capacity Building in International Air, Space and Telecommunications Law 2016	• City of Tshwane • City of Tshwane Metropolitan Municipality • City Property • Department of Defence • Department of Environmental Affairs • Department of International Relations • North West University • Rooth and Wessels Attorneys • Savage Jooste and Adams Inc • South African Airways • South African National Defence Force • Tlisang Private Capital • VDT Inc • Vogel Inc • Vorpakt
Project Name:	**Beneficiary:**
The Department of Trade and Industry **(the dti)** Radar Localisation	South African Radar Industry
Project Name:	**Beneficiary:**
Additive Manufacturing of Aerospace Components	Titanium Machining Industry

Type of benefiting organisations



B-BBEE levels of benefiting organisations



*Training provided through the University of Pretoria for the Capacity Building in Air, Space and Telecommunication Law course.

Abbreviations

AISI	Aerospace Industry Support Initiative
the dti	Department of Trade and Industry
SMME	Small, medium and micro-sized enterprises
TEA	Transversely excited atmospheric
CO_2	Carbon dioxide
UHCF	Ultra-high cycle fatigue
CNC	Computer numeric control
CMM	Coordinate measuring machine
GD&T	Geometric dimensioning and tolerancing
UP	University of Pretoria
SARA	Small African Regional Aircraft
CFRTP	Continuous fibre-reinforced thermoplastic
LCU	Lower connection unit
S-N	Stress vs. number of cycles
CAD	Cybicom Atlas Defence
CAD	Computer aided design
CSIR	Council for Scientific and Industrial Research
HFDT	Helicopter flight deck trainer
Lidar	Light detection and ranging
SKA	Square Kilometre Array
PCB	Printed circuit board
CAT	Cape Aerospace Technologies
KS	Kero Start
IFF	Identification Friend or Foe
OEM	Original equipment manufacturer
RF	Radio frequency
PIN	Positive intrinsic negative
SAC	Space Advisory Company
COTS	Commercial off-the-shelf
MTF	Modulation transfer function
ECSS	European Cooperation for Space Standardization
EGSE	Electrical ground support equipment
FPGA	Field-programmable gate array
UAV	Unmanned aerial vehicle
UAS	Unmanned aerial system
GCS	Ground control station
OCU	Operator control unit
GDA	Ground dish antenna
ADA	Airborne directional antenna
FPV	First person view
LL.M	Master of Laws
IISL	International Institute of Space Law
UASES	Unmanned airborne system electronic subsystems
HIL	Hardware-in-the-loop
FMC	Flight mission computer
PFMA	Public Finance Management Act
PPPFA	Preferential Procurement Policy Framework Act

the dti
Department:
Trade and Industry
REPUBLIC OF SOUTH AFRICA

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