AEROSPACE INDUSTRY SUPPORT INITIATIVE

IMPACT REPORT

2014/15

Aerospace Industry Support Initiative

an initiative of **the dti**

the dti
Department:
Trade and Industry
REPUBLIC OF SOUTH AFRICA

our future through science

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

Supporting the industrialisation of CFRTP clips for Airbus. Photo Credit: Airbus

AISI
VISION & MISSION

VISION

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

MISSION

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

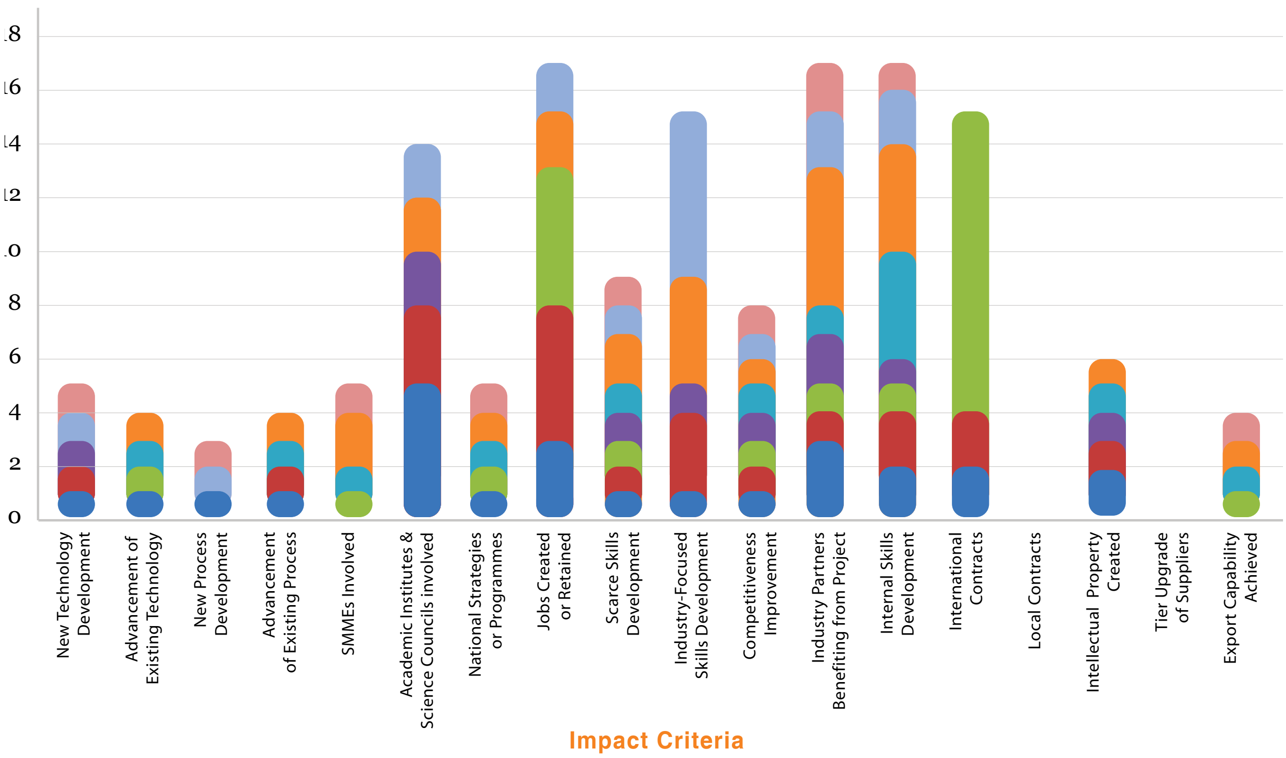
- Developing relevant industry-focused capabilities and facilitate associated transfer of technology to industry;
- Providing a platform for facilitating partnerships and collaboration amongst government, industry and academia, locally and internationally;
- Identifying, developing, supporting and promoting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

TABLE OF CONTENTS

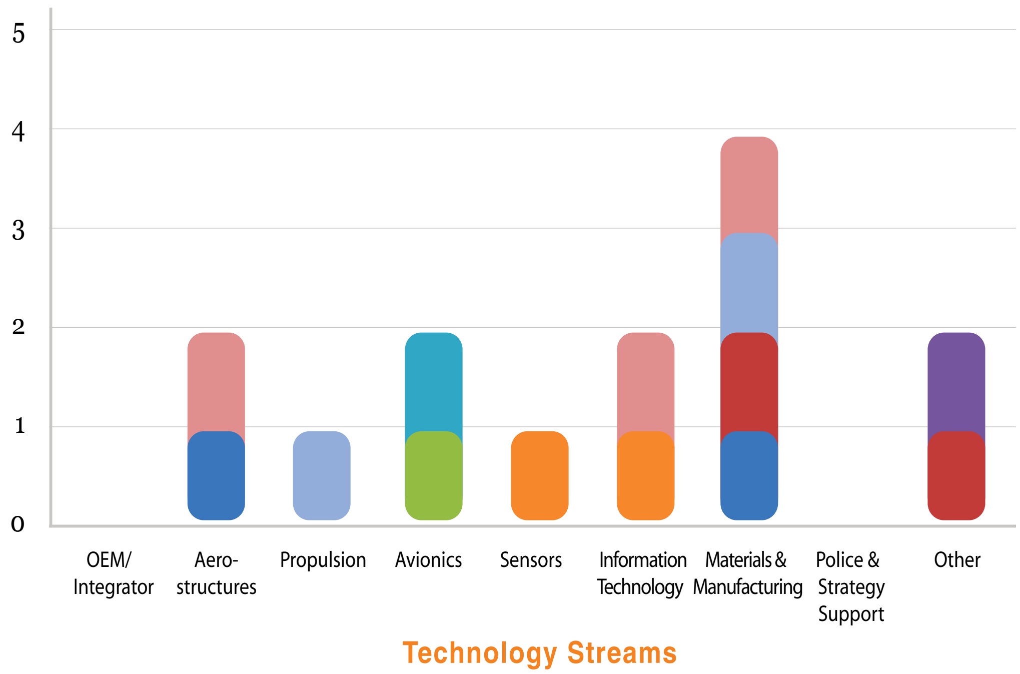
INDUSTRY IMPACT AT A GLANCE 2014/15

**Information and data have been taken from the reports submitted by the benefiting organisations for the eight projects completed in the 2014/15 financial year. The categories, technology streams and product markets are taken from the market segmentation framework as defined in the Aerospace Sector Development plan.*

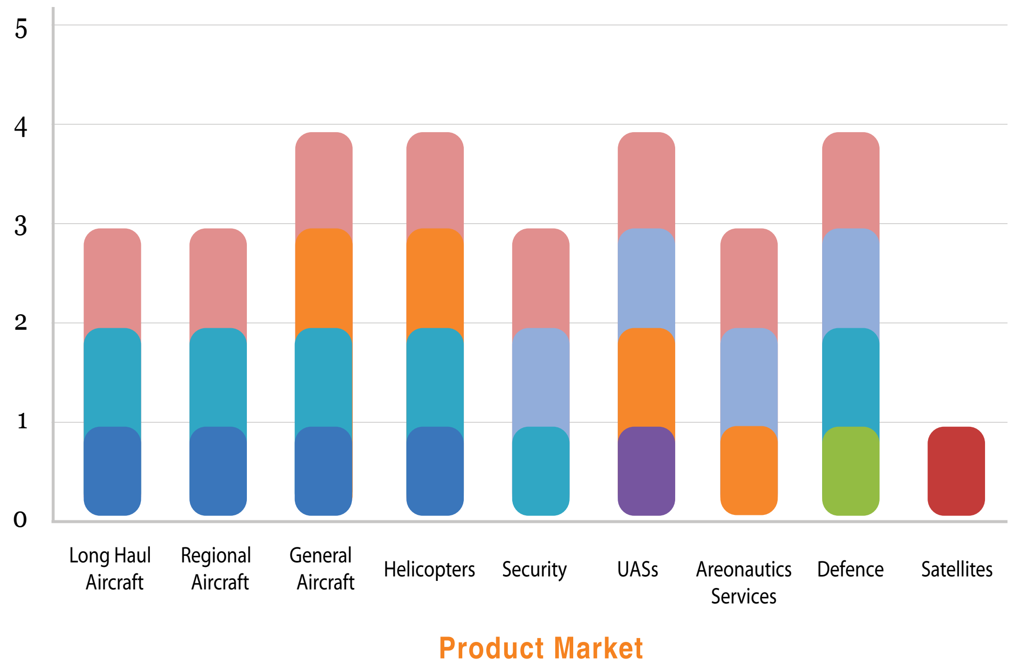
High level Industry Impact*



Project alignment to Technology streams*



Project alignment to Product markets*

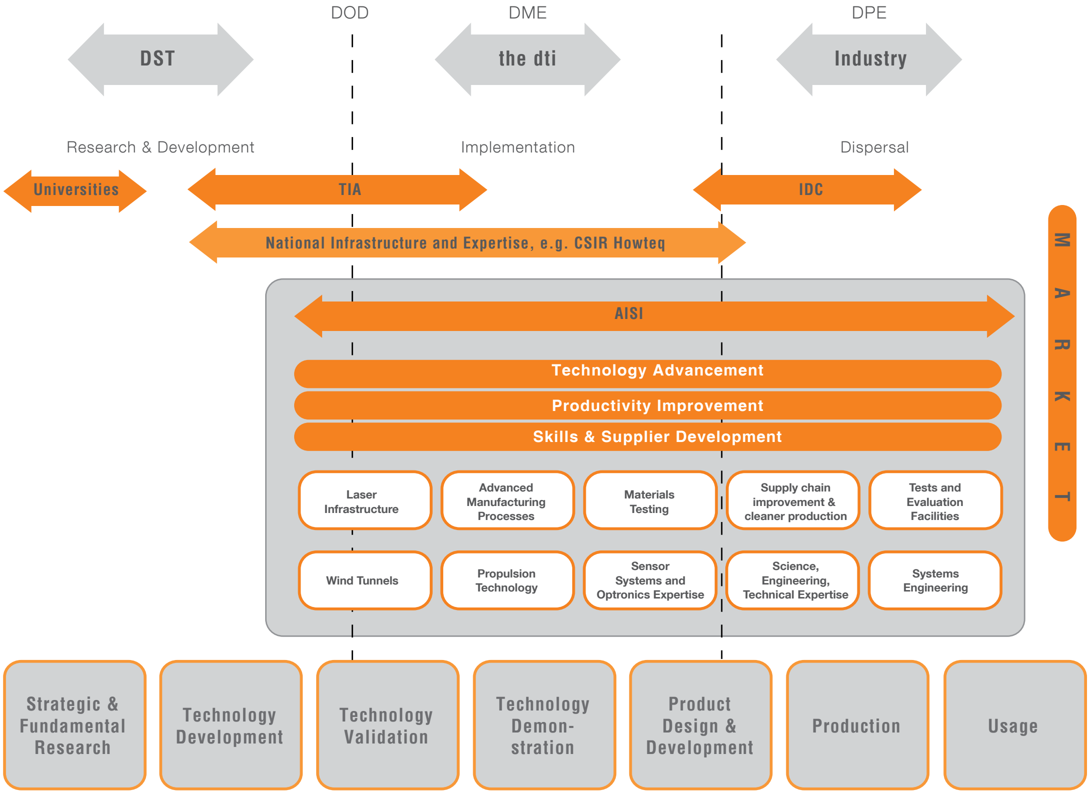


Projects completed 2014/15

- SatAuth Technology Demonstrator
- Small Gas Turbine Technology Developments
- Airborne Observatory Hyperspace Unit
- Avionic Component Design & Manufactute
- High Levels of Model S
- Radiation Screening for Satellites
- Laser Shock Peening III
- Aerodynamic Investigation of a Rhomboid Wing

EXECUTIVE IMPACT SUMMARY

The Department of Trade and Industry (**the dti**), through its Advanced Manufacturing Chief Directorate, established the Aerospace Industry Support Initiative (AISI) to support the South African industry to improve its competitiveness. The AISI plays a complementary role to the support offered by additional government departments and support initiatives in the National System of Innovation (NSI). This is illustrated in the diagram below, which showcases the AISI position in the national value chain.

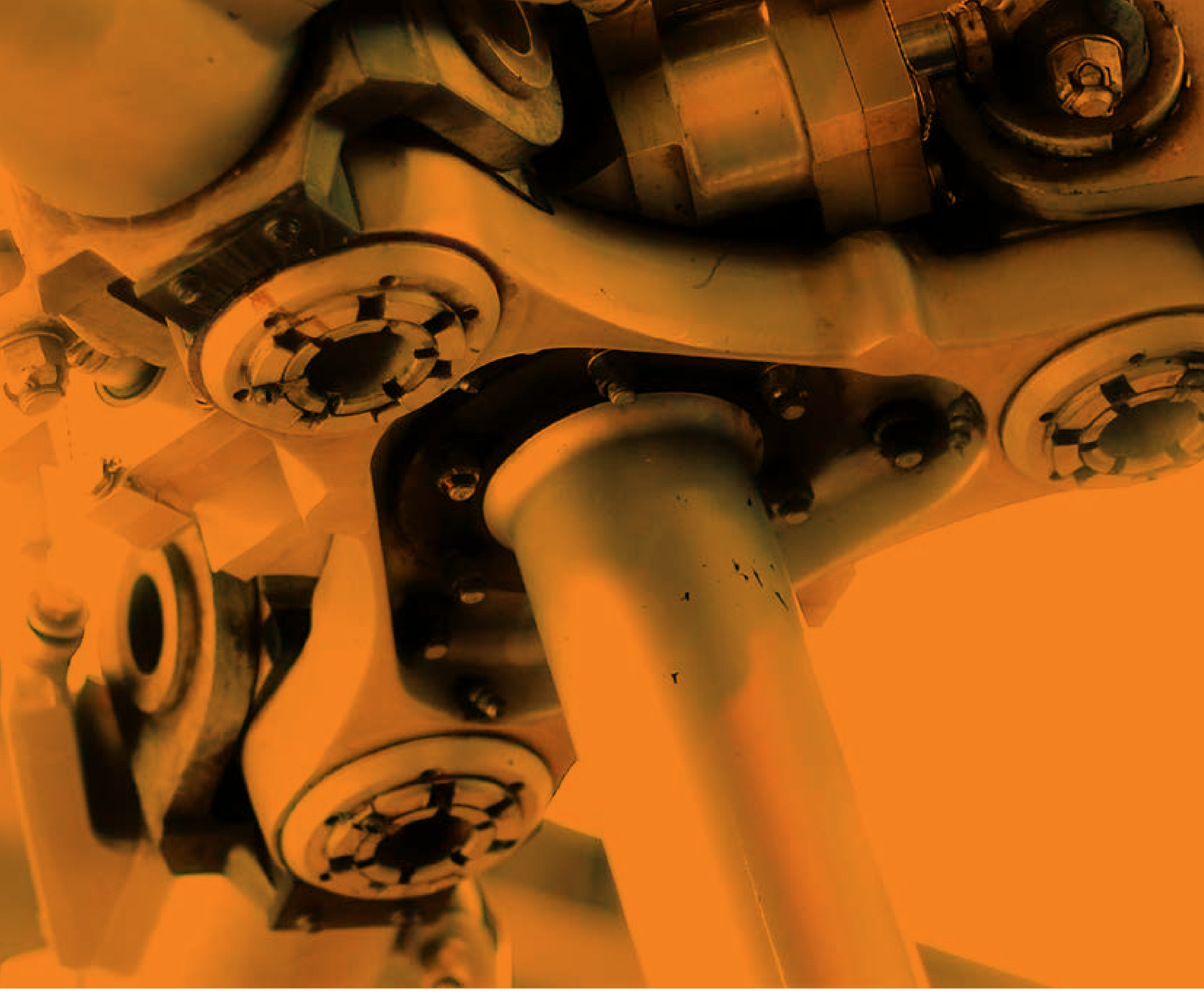


the dti utilises the Council for Scientific and Industrial Research's (CSIR) national expertise and infrastructure to improve the offerings of the local aerospace industry. The AISI's focused interventions for industry is done primarily through three areas, namely:

- Technology Advancement
- Productivity Improvement
- Supplier Development

During the 2014/15 financial year, the AISI undertook 31 projects with 64 industry partners benefiting directly or indirectly from the AISI investment.

Industry Support Investment:	R21 855 922.00
Number of Projects Undertaken:	31
Number of Organisations and SMMEs Involved:	64



The AISI implements its projects through four operating programmes, with an additional fifth programme dedicated to the coordination, promotion and awareness creation for industry by the AISI. These programmes are implemented to address the strategic objectives of **the dti**, and in doing so, address the requirements of the aerospace industry. During 2014/15, the operating programmes of the AISI were:

1. Industry Development and Technology Support
2. Sector Strategic Support Initiatives
3. Supplier Development
4. Sector Specific Skills Development
5. Coordination, Promotion and Awareness.

The following section will give a brief overview outlining the importance and the impact achieved through these programmes.

PROGRAMME 1

Industry Development and Technology Support

Industry Development and Technology Support focuses on advancing the involvement of industry in sectors reliant on advanced manufacturing for aerospace and defence.

South African industry is encouraged to advance niche capabilities and technologies with good value proposition through industrialisation.

- Partnerships are established between organisations to achieve this goal
- Access to national infrastructure and expertise is facilitated
- Specific emphasis is placed on drawing innovative processes, products and methods into industry. Industrialising technology from universities and institutions, and building on historical investments in Research and Development (R&D) from other sources such as the Department of Science and Technology (DST)

- Enhancing industry competitiveness by ensuring appropriate technology transfer interventions
- Utilisation of the AISI thematic networks to support this technology development and transfer
- Original Equipment Manufacturers (OEMs) are encouraged to include Small, Medium and Micro-sized Enterprises (SMME) as well as lower-tier suppliers, to ensure the continuous transfer of knowledge, expertise, capability and technology, and in doing so, broaden the industrialisation base.

Programme Focus	Technology Advancement
Predominant Technology Stream	Aeronautics, Defence, Space, Materials and Manufacturing
Industry Support Investment	R12 778 503.00
% AISI Investment of Programme Budget	59%
Number of Projects Undertaken	19*
Number of Organisations Involved	20**
SMMEs Involved	12
Resulting Impact on Industry	
New Technologies and Developments	14
Manufacturing Processes	2 processes supported to improve competitiveness within the aerospace manufacturing industry • Additive Manufacturing • Laser Shock Peening
Business Opportunity	1 SMME able to offer radiation screening services for satellite components.
Import Substitution	1 project promoted imported substitution.
Collaboration with Academia and Research Councils	2 universities, 2 research councils and 1 national laboratory collaborated with industry.
Projects Aligned to National Programmes	3 projects aligned with the requirements of the South African National Space Agency (SANSA) 1 project aligned with the development of the Square Kilometre Array (SKA) 2 aligned to national Unmanned Aerial Vehicle (UAV) activities.
Exposure to National Infrastructure	1 project exposed an SMME to national infrastructure.

**8 projects completed, 11 projects on-going*

***certain organisations are supported for more than one project*

PROGRAMME 2

Sector Strategic Support Initiatives

The Joint Aerospace Steering Committee (JASC) was established as a result of the findings of the Aerospace Sector Development Plan (SDP). The aim of JASC is to provide strategic positioning for the aerospace and defence industry in South Africa. Through **the dti's** involvement in the commissioning of the SDP, as well as its leading role in developing JASC, JASC and its activities have been positioned as a sector-wide strategic support initiative.

By integrating and utilising policies to strengthen aerospace and defence, JASC aims to facilitate competitiveness improvement programmes, government procurement, supplier development, international and multi-lateral agreements, export support mechanisms and funding for Intellectual Property (IP) exploitation, new product development and exports. It also aims to play a role in South African R&D coordination by influencing research agendas and financing mechanisms, and will also support various skills development initiatives while providing support and funding for technology industrialisation projects, R&D, and industrial infrastructure. JASC aims to achieve the above through the implementation of strategic national flagship projects, managed and implemented by the AISI.

The AISI hosts the JASC secretariat and is responsible for ensuring the JASC and its operations are in accordance with the applicable legislation, including without limitation, the Public Finance Management Act (PFMA) and Preferential Procurement Policy Framework Act (PPPFA), through the CSIR governance structures. Dedicated personnel are tasked to achieve these objectives, and report impact and progress to stakeholders, while ensuring that stakeholders remain informed and engaged. In addition to the secretariat, the AISI implements national flagship projects which are identified by JASC and approved by the AISI MANCO.

Programme Focus	UAVs
Predominant Technology Stream	Ground Control Stations
Industry Support Investment	R1 577 400.00
% AISI Investment of Programme Budget	7%
Number of Projects Undertaken	2
Number of Organisations Involved	12
Resulting Impact on Industry	
New Technologies and Developments	1
Skills Development	2 interns
Project Aligned to National Programmes	Alignment to national UAV activities.

PROGRAMME 3

Supplier Development

The AISI's supplier development interventions provide enabling mechanisms to assist industry to improve its competitiveness, productiveness and quality management systems and in doing so, optimise its operations and procedures to ensure the South African industry integration into global supply chains. The strategic focus remains on SMMEs with the objective of ensuring industry transformation, and the broadening of the economic base participating in the industry. 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.

It is the intention of the AISI to focus its future investment in its supplier development programme. The AISI wishes 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.

Programme Focus	Supplier Development
Predominant Services Stream	Standards, Accreditation and Quality Management Systems, Technology Transfer
Industry Support Investment	R5 276 749.00
% AISI Investment of Programme Budget	24%
Number of Projects Undertaken	9*
SMME Involved	24
Local OEMs Involved	2
Resulting Impact on Industry	
Efficiency and Profitable	Full supply chain visibility through web-based procurement portal utilised by 21 suppliers and one OEM.

**2 projects completed, 7 projects on-going*
***certain organisations are supported for more than one project*

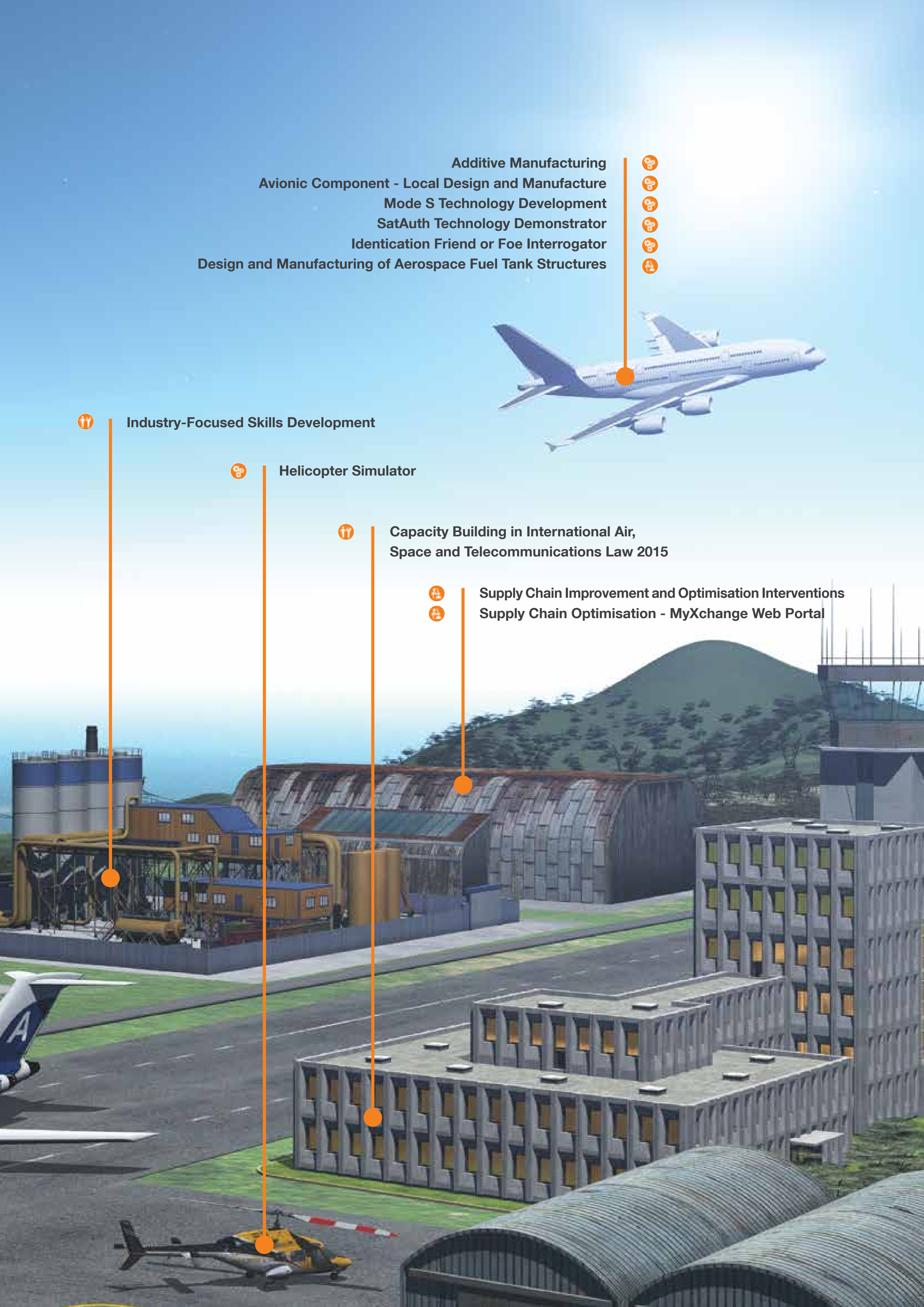
PROGRAMME 4

Industry-Focused Skills Development

While there are existing skills development and training structures in government, such as departments of Basic Education, and Higher Education and Training, there is a need for focused and targeted skills development initiatives that are designed for the South African aerospace sector. The AISI undertakes projects with the specific aim of utilising industry knowledge and technology to improve human capital, and developing skills which are appropriate to industry requirements.

Programme Focus	Skills Development
Predominant Skills Development Stream	Law, Policy & Strategy Engineering
Industry Support Investment	R1 221 537.00
% AISI Investment of Programme Budget	6 %
Number of Projects Undertaken	2
Number of Organisations Involved	13
Resulting Impact on Industry	
Capacity Development	7 Internship placements 22 Trainees in Air, Space and Telecommunications Law
Scarce Skills Development	Air, Space and Telecommunications Law Engineering
Transformation	45% of Trainees PDIs 85% of Interns PDIs
Exposure to National and International Experts	2
Alignment to National Councils and Programmes	South African Council for Space Affairs (SACSA) CSIR
Alignment to National Policies and Strategies	South African context for Space Law Alignment to national UAV activities

AISI-supported projects and its contribution to the aerospace and advanced manufacturing industries.


Additive Manufacturing
Avionic Component - Local Design and Manufacture
Mode S Technology Development
SatAuth Technology Demonstrator
Identication Friend or Foe Interrogator
Design and Manufacturing of Aerospace Fuel Tank Structures
Industry-Focused Skills Development
Helicopter Simulator
Capacity Building in International Air,
Space and Telecommunications Law 2015
Supply Chain Improvement and Optimisation Interventions
Supply Chain Optimisation - MyXchange Web Portal

PROGRAMMES

PROGRAMME 1

Industry Development & Technology Support

COMPLETED PROJECTS

- Aerodynamic Investigation of a Rhomboid Wing Unmanned Aerial System
- Avionic Component - Local Design and Manufacture
- Higher Levels of Mode S Technology Development
- Hyperspectral Sensor Upgrade
- Laser Shock Peening Phase III
- Radiation Screening Services for Satellites
- SatAuth Technology Demonstrator
- Small Gas Turbine Technology Improvements

PROJECTS IN PROGRESS

- Additive Manufacturing of Aerospace Components
- Identification Friend or Foe Interrogator Power Amplifier / Transmitter
- Nano-Satellite Imager Development and the Development of a New Hyperspectral Focal Plane and Mass Storage for a Space Imager
- Square Kilometre Array PC Board Localisation
- Stellar Gyro Development
- Unmanned Aerial Systems Datalinks and Antenna Solutions for Extended Communications Ranges

NEW PROJECTS

- Industrialisation of Joint CAD/CSIR Helicopter Simulator
- The Industrialisation of a Small, Low-Cost Transversely Excited Atmospheric (TEA) CO_2 Laser for the Aerospace Industry

PROJECT 1:

Aerodynamic Investigation of a Rhomboid Wing Unmanned Aerial System

Enhancing industry **design capabilities** by adding **value** in terms of **streamlined** UAS design and **control techniques** and **efficient** aerodynamic characterisation processes **UNMANNED AIRCRAFT SYSTEMS**

BENEFITING INDUSTRY

Paramount Advanced Technologies

The South African industry has been involved with Remotely Powered Vehicles (RPVs) and Unmanned Aircraft Systems (UASs) since the late 1970s. During the 1980s, South Africa was a leader in the operational application of Unmanned Aerial Vehicles (UAVs). Over the last two decades, the local industry has made strides in certain technologies associated with a UAS. Unfortunately, the actual platforms remained relatively conventional and there has been little work done to maximise aerodynamic efficiency. The approach towards airframes tended to be quite conservative, which paid off in solid, reliable airframes being offered to the market but with considerable scope for improvement. Paramount Advanced Technologies (PAT) explored the potential of a much more radical configuration, namely a rhomboid wing configuration. This configuration allows for high manoeuvrability, an important criterion in UAS design and development.

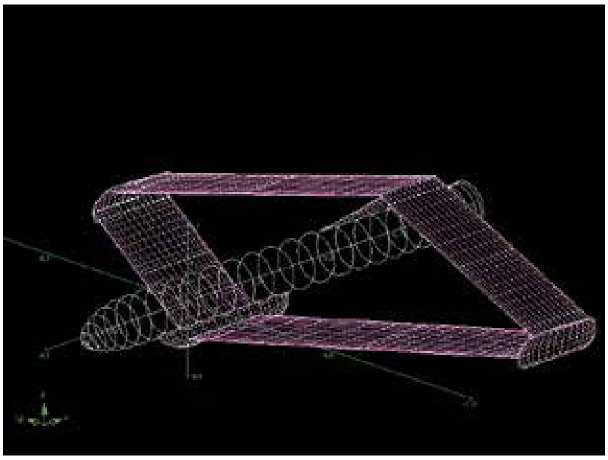


Figure 1: Athena Vortex Lattice (AVL) software model for aerodynamic and flight dynamic analysis

Due to the increased rate at which the global UAS market has been growing, it has become more and more difficult for the South African industry to compete globally. The progress in local avionics has allowed the industry to continue to remain somewhat competitive in certain areas, but it has become clear that more investment is required to remain a significant player in this competitive global industry. One area in which significant improvements can be made is airframe technology. These potential improvements can be achieved by the selection of more efficient configurations that are optimised to extract the maximum performance potential, without compromising reliability or any other aspect of the operational capability of the bigger system.

One Master of Science (MSc) **student** benefited from this project; **primary focus** on UAS control and **optimisation techniques**

The small UAS market is particularly saturated, making it even more difficult to compete in this segment of the UAS industry and requires even more research, development and industrialisation.

The project is aimed at improving the rhomboid airframe to the point where it will outperform other systems in this UAS class. There is potential in the rhomboid configuration, as already demonstrated with the prototype airframe, to offer a solution that covers a very wide speed band. The ability to move at high speed and then loiter at very low speed increases the potential application areas of the airframe tremendously, opening up the possibility to offer the system to a wide market sector, including law enforcement agencies, commercial operators and military users. The CSIR is developing a Multidisciplinary Optimisation (MDO) capability as well as a capability in UAS control. Both capabilities are directly applicable to PAT's requirements for optimising its UAS platforms.

GOALS AND OBJECTIVES

The goal of the Rhomboid Wing UAS (Roadrunner) project is to enhance industry design capabilities by adding value in terms of streamlined UAS design and control techniques, and efficient aerodynamic characterisation processes.

The two-year project had the following objectives for the 2014/15 year:

- Calibration of the aerodynamic model used within the optimisation process via the wind tunnel results
- Completion of the final conceptual optimisation of the rhomboid wing UAS
- Control surface scheduling and optimisation study.

Figure 2: Rhomboid wing UAS experimental setup (front view)

OUTCOMES

The work over the past year has resulted in a control surface scheduling and optimisation study for a unique configuration of UAS. The study describes and quantifies the advantages of the proposed control implementation.

IMPACT AND BENEFITS

Productivity Improvement

The optimisation of the control scheduling is required to fully exploit the unique characteristics of the rhomboid wing. The Roadrunner configuration lends itself to the ability to manoeuvre itself in ways that are not possible with conventional configurations. In particular, lateral motion without yawing and vertical motion without pitching is possible.

Figure 3: Rhomboid wing UAS experimental setup (rear view)

The AISI support has provided the opportunity to develop the techniques used to optimise the control scheduling scheme for the Roadrunner. Significant insight has been gained into the optimisation of flight controls during this work; this can be applied to other unmanned aircraft systems. The direct result of the current work is an improved capability for the Roadrunner system that will increase its marketability.

Market Access and Networking Opportunities

The insight gained into the application of optimisation routines and their application will certainly assist in the further development of an in-house multidisciplinary optimisation capability to possibly replace that of the original code utilised.

Industry Benefits

Currently the CSIR is developing a number of unmanned aircraft systems for both its own experimentation purposes and to support local industry. Two new unmanned aircraft were designed by the CSIR in the past year for the local industry. One of these airframes, Hungwe II, was developed for Denel Dynamics. The application of the Master's student's knowledge and capabilities to future airframes (unmanned and possibly manned) will enable the CSIR to produce not only more optimal airframes for industry but to also provide the optimum control system design in support of that airframe.

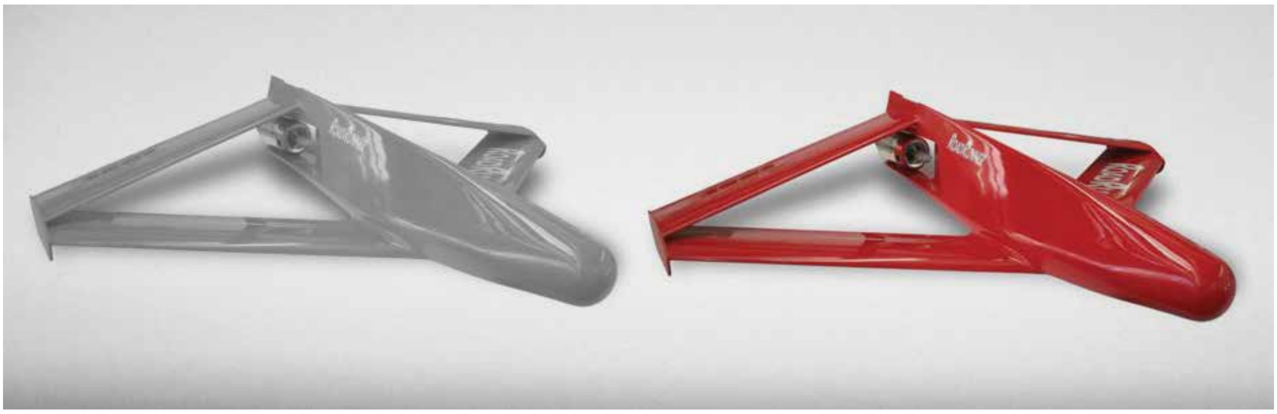


Figure 4: Roadrunner model

ADDITIONAL IMPACT AND BENEFITS

Predominant Technology Stream	Control Optimisation
Predominant Product Market	• Aeronautics - UAS
Technology Development Status	New Technology Development
SMMEs Involved	None
Academic Institutions and Science Councils Involved	CSIR University of Pretoria (UP): MSc student supervision
Scarce Skills Development	Both UAS control and optimisation are scarce skills.
Industry Partners benefiting from project	PAT: direct benefit Incomar Aeronautics: indirectly through the supervision of and insight into the MSc work.
Internal Skills Development	One employee on an MSc Studentship.
Intellectual Property Created	Optimisation of the control system for the rhomboid wing.

PROJECT 2:

Avionic Component - Local Design and Manufacture

BENEFITING INDUSTRY

Daliff Precision Engineering

Daliff Precision Engineering is a supplier to Tellumat of machined avionics components and was requested to develop a mounting tray for the transponders that Tellumat was manufacturing for the export market. The transponder mounting trays were being imported and previous attempts by Tellumat to develop a locally designed and manufactured tray had failed the stress tests. The primary objective was to design, manufacture and approve a mounting tray that would eliminate the need to import the product as well as open up potential export markets for the tray.

IMPORT SUBSTITUTION AND LOCALISATION

For the past eight years Daliff has been producing machined components for the airframes of the Airbus A400M military aircraft and mechanical avionic components for a number of local companies. In order to secure this type of business Daliff was required to obtain a number of international certifications and Original Equipment Manufacturer (OEM) approvals. In the process of obtaining these certifications and approvals Daliff benefited from significant technology transfer and process improvements from a number of sources, including Airbus, Aerosud and Denel Aerostructures. As a result of Daliff's enhanced technical and manufacturing capabilities, combined with Broad-Based Black Economic Empowerment (B-BBEE) Level 1 certification, Daliff is becoming an increasingly attractive supply partner to higher tier aerospace and avionic companies. It is these offerings that attracted Tellumat to approach Daliff to become its mechanical supply partner, the first opportunity was to design, qualify and manufacture the Transponder Mounting Tray (TMT).

Figure 1: Transponder mounting tray for avionic components (side folded)

> Import substitution of **transponder mounting trays** through the implementation of this project

As Daliff's core capability has been limited to machining and assembly and not design, Tellumat has introduced Daliff to its former mechanical design team to assist with this project. Some years ago, Tellumat retrenched its capability due to business circumstances and now wishes to re-establish an outsourced mechanical design capability in Daliff. The intent of both parties is that Daliff (as supply partner to Tellumat) will assume responsibility for both the design and manufacture of mechanical components.

The relationship with Tellumat sees a higher tier company providing the opportunity for an SMME (Daliff) to move beyond only machining and assembly into the design arena.

> The new **transponder mounting tray** can be produced at considerably **lower cost** than that of an **imported tray**

This is a very significant opportunity as it provides a relatively risk-free move into design and manufacture as the product is known to Tellumat and the market for the product via Tellumat is assured. Very importantly, the design capability is also ex-Tellumat. It provides for an almost seamless supply partner relationship between Daliff and Tellumat.

In summary and conclusion, Tellumat requires the product and is able to assist Daliff to make the step into design and qualification of the part. In the longer term, Daliff will be in a position to design and qualify other parts and build up a catalogue of avionic mechanical components which it can market worldwide.

GOALS AND OBJECTIVES

- To design, qualify and manufacture a transponder and avionic mounting tray for a Tellumat transponder at a globally competitive price
- To produce the required number for Tellumat and ultimately market to other local and global customers
- Obtain a detailed brief from the end customer (Tellumat) as to the functionality, physical dimensions and testing regime to which the product must be subjected in order to be qualified
- Detailed analysis of commercially available mounting trays
- Detailed analysis of previously failed Tellumat-designed trays
- Design of component
- Simulation of testing protocol
- Obtain customer buy in of design subject to actual testing on sample parts
- Production of batch of sample parts for testing
- Implement any changes necessary following testing of first sample batch
- Customer acceptance of component design, testing rest results and sample batch of components.

OUTCOMES

The Daliff-designed and manufactured tray has met all the product specification requirements as set out by Tellumat as well as the commercial requirement to be cheaper than the imported product.

The fact that the Daliff tray can be produced at a considerably lower cost than that of an imported tray, strongly suggests that there is a good business opportunity by developing a full range of trays across the full size range and marketing these locally and internationally.

Testimonial

"Without the AISI funding, this design and manufacturing project would not have been undertaken. A small SMME such as Daliff cannot afford to take on risky design projects for which the payback period is envisaged to take years until the product becomes established in the market place."

Rowland Chute, Chairman, Daliff Precision Engineering

IMPACT AND BENEFITS

Market Access and Networking Opportunities

The fact that Daliff has designed and produced a 3/8 mounting tray will now enable a full range (different sizes) of mounting trays to be developed and marketed.

Organisational Benefit

Daliff had not undertaken an avionics product design before. This was a very steep learning curve and introduced a number of new aspects of the aerospace industry, which bodes well for the future.

Figure 2: Transponder mounting tray for avionic components (side unfolded)

In the immediate future Daliff will supply its mounting trays to Tellumat and as this is a long-term product requirement from Tellumat, it will increase its turnover over years to come.

In the medium term, in addition to Tellumat, there are other local companies that currently import this product. They will now have the option to source locally from Daliff.

In the longer term, the global export market is where the real potential lies but this will take time as the product will have to be approved by the major OEMs and their tier 1 and 2 suppliers.

Industry Benefits

Another local product has been designed and can be locally manufactured, thus providing local avionics companies with the ability to source locally, with shorter lead times and at a lower cost.

Project Outcomes in Support of Achieving AISI Goals

Developing the local aerospace industry and make it globally competitive.

An initiative such as the development of the mounting tray, which will immediately create additional turnover for Daliff in supplying to Tellumat and later the global market, is a perfect opportunity for designing a technical product that has commercial value.

PARTNERS AND COLLABORATORS

- eeZeeCAD: Design assistance and drafting of reports and standards
- Tellumat: Review of previously failed locally designed trays.

ADDITIONAL IMPACT AND BENEFITS

Predominant Technology Stream	Avionics
Predominant Product Market	• Aeronautics - Long Haul Aircraft - Regional Aircraft - General Aircraft - Helicopters - Security • Defence
Technology Development Status	Advancement of Existing Technology
Manufacturing Process Development Status	Advancement of Existing Process
SMMEs Involved	• Daliff Precision Engineering (Pty) Ltd • eeZeeCAD
Alignment to National Strategies or Programmes	Development of the avionics sector.
Number of Jobs Created or Retained	Dependent on the volume of sales over the short to medium term. Estimates are one skilled job for every fifty trays produced per month.
Scarce Skills Development	Exposed Daliff senior staff to all the issues of designing and qualifying an avionics part. There are limited people in South Africa with this experience.
Competitiveness Improvement	The development of the tray is the first time Daliff has designed and produced a product for which the Intellectual Property (IP) is owned by Daliff. This will enable Daliff in time to develop a complete product range of trays as import substitution for the local market and hopefully to be exported as well.
Industry Partners Benefiting from Project	Tellumat now have the option of purchasing a local product instead of importing it.
Internal Skills Development	Four senior Daliff employees were intimately involved in developing the design and the preproduction engineering as well as the final production of the test tray.
International Contracts	The tray was designed to incorporate imported hardware fittings due to the time constraints. Significant research was done and contact made with potential suppliers of the hardware to establish as their product specification.
Local Contracts	Design company eeZeeCAD
Export Capability Achieved	Definitely export potential as Daliff's initial costing suggests the product is globally competitive.
Import Substitution Achieved	Yes, Tellumat can now source the tray locally as opposed to importing it. The local market still has to be investigated to see what the demand is.

PROJECT 3:

Higher Levels of Mode S Technology Development

BENEFITING INDUSTRY

Tellumat

Identification Friend or Foe (IFF) transponders are used by civil and military aircraft to identify themselves to radar systems. In particular, Mode S is a selective surveillance and data link system that is used in civil Air Traffic Control (ATC). Mode S is increasingly becoming mandatory in the international ATC environments, requiring that all aircraft be fitted with Mode S transponders. Current IFF systems in South Africa can operate in Mode S level 2 with basic surveillance data capability (minimum data link transponder). Internationally, there is a move for military and civil aircraft to be fitted with greater Mode S capability, which Tellumat has developed through this project.

AIRCRAFT-TO-AIRCRAFT COMMUNICATION

In an ATC environment, it is important to be able to detect and identify all aircraft, so that each aircraft can be safely guided and controlled during take-off and landing and along its flight path.

- Detection is primarily accomplished by a Primary Surveillance Radar (PSR), which is able to detect, but not identify, aircraft
- Identification is accomplished by a Secondary Surveillance Radar (SSR). SSR works on the following principle:
    - o A ground-based interrogator transmits a sequence of pulses to all aircraft, effectively asking "Who are you?"
    - o A transponder on each aircraft replies with another sequence of pulses, effectively saying "This is my identity".

The upskilling of **two software engineers** and in part, a **firmware engineer**, hardware engineer, test engineer and **quality assurance engineer**

Traditional SSR uses Air Traffic Control Radar Beacon System (ATCRBS) modes of interrogation, which is a very simple and basic form of aircraft identification.

However, as aircraft traffic has increased over the years, the traditional ATCRBS technique has placed an increasing burden on the ATC system. This has led to the development of Mode S, which allows for a much more efficient means of aircraft interrogation and reply. Instead of all aircraft being interrogated continuously and replying continuously, Mode S allows for selective identification of individual aircraft, and the aircraft replies only when it is specifically addressed. Mode S is increasingly becoming mandatory in the international ATC environment, requiring that all aircraft be fitted with Mode S transponders.

Tellumat's competitiveness has declined in recent years due to non-compliance to latest international IFF requirements. Current IFF systems in South Africa can operate in Mode S level 2 with basic surveillance data capability (minimum data link transponder). Internationally, there is a move for military and civil aircraft to be fitted with greater Mode S capability, such as:

- Elementary Surveillance (ELS)
- Enhanced Surveillance (EHS)
- Extended Squitter (random pulses) (ES) for Automatic Dependent Surveillance-Broadcast (ADS-B) operation
- Traffic Collision Avoidance System (TCAS) interfacing capability.

This is especially evident in enquiries emanating from other IBSA/BRICS countries (Brazil, Russia, India, China and South Africa), Austria, United Kingdom, Ukraine, Algeria, Korea and Indonesia. The existing Tellumat PT-2000 (minimum data link transponder) IFF transponder was upgraded for this purpose.

Figure 1: High level Mode S transponder

Mode S capability includes:

- Elementary Surveillance
- Enhanced Surveillance
- Extended Squitter for Automatic Dependent Surveillance-Broadcast operation
- Traffic Collision Avoidance System interfacing capability

TRANSPONDER DESIGN AND MANUFACTURE IN SOUTH AFRICA

Tellumat has been developing, manufacturing and supplying transponders in South Africa since the late 1980s, initially for the local military aircraft requirement, and subsequently also for export. Transponders have also been fitted to ships for identification purposes.

Since 2002 Tellumat has also been supplying locally developed and manufactured transponders with a subset of the Mode S capability. The transponder supports basic Mode S transponder function as well as the minimum Mode S ground-to-air, air-to-ground and air-to-air data-link requirements. The hardware was designed to support an Extended Length Message (ELM) capability and TCAS interface allowing for these options to be fully implemented at a later stage by a software upgrade. Up to now, this has been acceptable in South Africa and in traditional exports markets where Mode S is not in use for ATC.

In the past few years, enquiries have been coming in from overseas customers for transponders specifying:

- Full Mode S level 2
- Elementary Surveillance
- Enhanced Surveillance.

There have also been occasional requirements for integrating the transponder with a TCAS. These new requirements drove Tellumat towards the development of an upgrade for the existing PT-2000 transponder, which met the growing requirements from the international aviation market for higher levels of Mode S.

GOALS AND OBJECTIVES

The project goal was to develop, build, test and qualify a prototype transponder that met the aforementioned requirements for:

- Full Mode S level 2
- Elementary Surveillance
- Enhanced Surveillance
- Extended Squitter for Automatic Dependent Surveillance-Broadcast
- Traffic Collision Avoidance System
- Develop and test software modifications to the PT-2000 transponder to meet the specified requirements
- Develop and test firmware and hardware modifications to the PT-2000 transponder
- Update the PT-2000 test bench
- Qualify the upgraded PT-2000, so that it can be formally released as a product.

OUTCOMES

The current development capability within Tellumat was utilised for this development resulting in the following:

- Specification of full requirement with traceability to international standards
- Development and qualification with delivery to client
- Development of a test environment for test and qualification
- The creation and retention of jobs after a time of recent commercial stress in the IFF business.

IMPACT AND BENEFITS

Market Access and Networking Opportunities

This project takes the PT-2000 IFF / Mode S transponder to the latest Mode S standard, namely RTCA DO-181E, effectively placing it as a noteworthy competitor in the defence market place, where civil aerospace standards are increasingly being applied. The AISI support has already led to an early deliverable being contracted for ELS.

Organisational Benefit

The major benefit to Tellumat is obtaining new orders for transponders which would not be possible without the higher levels of Mode S. This funding carried part of the Tellumat engineering team through a period of low trading volume. The team was available to address new contracted opportunities when the business cycle picked up. After a layoff of production for more than two years, Tellumat received orders for PT-2000 transponders.

Industry Benefits

- Job retention in a stressed business climate
- Competitiveness improvement
- Capability retention
- Sub-contractors and suppliers continue to benefit from the downstream activities.

Skills and Human Capital Development

This project has allowed the upskilling of two software engineers and in part, a firmware engineer, hardware engineer, test engineer and quality assurance engineer, in the new standard developments found within RTCA DO-181E, using Tellumat's existing system engineering and software development and qualification processes.

The importance of skill retention in the current PT-2000 production environment cannot be underestimated. Without AISI support, this would have been lost in a time of business stress.

TESTIMONIAL

"This commercial success underscores the importance of this funding to Tellumat, and also to the greater South African aerospace industry. In particular, Tellumat can anticipate further orders for its transponders from customers requiring the higher levels of Mode S."

Brian Ferguson, Manager: Identification Systems, Tellumat

ADDITIONAL IMPACT AND BENEFITS

Predominant Technology Stream	Avionics
Predominant Product Market	Defence
Technology Development Status	Advancement of Existing Technology
Alignment to National Strategies or Programmes	The project is aligned to **the dti's** Industrial Policy Action Plan (IPAP) and Aerospace SDP.
Number of Jobs Created or Retained	**Retained:** • Two software engineers • In part: Project Manager, System Engineering, Configuration Manager **Created:** • One software engineer • Several jobs of undetermined number have been created on the production line post this development
Scarce Skills Development	Software and Test Equipment engineers specialising in IFF and Mode S applications.
Industry-Focused Skills Development	Downstream in manufacturing of the developed product
Competitiveness Improvement	Competitors with higher levels of Mode S capability, i.e. ELS, EHS, ES.
Industry Partners Benefiting from Project	Mark Gierie, a software engineer, has been contracted to provide SMME software design and qualification services for the PT-2000 IFF Transponder and test bench. Downstream, mechanical components for the new PT-2000 IFF Transponder are being manufactured by Daliff Precision Engineering and printed circuit boards are being manufactured by TraX Interconnect; other SMMEs benefiting are companies such as 5-star Painting.
Internal Skills Development	Apart from the engineers benefiting in skill retention and development during the development project, particularly in software, the IFF transponder production capability was re-established within Tellumat subsidiary, Grand Tellumat Manufacturing (GTM), where many new employment opportunities have been created. Several of the technicians working on the integration and testing of the transponders are trainees, gaining experience alongside more experienced employees. Graduate engineers from the South African Navy are also hosted on the production line from time to time to gain industrial experience.
Export Capability Achieved	A large part of Tellumat's IFF business has always been export. Through the AISI support, this position of an order book with 99% export and 1% local is being maintained.
Import Substitution Achieved	The project provided an indirect benefit in that engineering capability was retained within Tellumat on IFF transponder products. After receiving several production orders for PT-2000 IFF transponders, it was found that the RF soft board supply became problematic. Some of the problems encountered were: • Only two sources worldwide, one in the United Kingdom and one in Canada • Substantially escalating prices • A weak Rand pushing price up further • Poor quality deliverables • Supply restrictions to certain of Tellumat's customers It was therefore decided to redesign the soft boards using newer substrate technologies and a local manufacturer, TraX Interconnect, was selected to supply the new RF boards, thus substituting imported boards with local boards.

PROJECT 4:

Hyperspectral Sensor Upgrade

BENEFITING INDUSTRY

SIMERA Technology Group
Agricultural Research Council
Stellenbosch University

Hyperspectral sensors are a systems technology used in image capturing whereby images of a scene are collected in tens to hundreds of narrow spectral bands simultaneously. Hyperspectral imagery provides the potential for more accurate and detailed information extraction. These images are used in aerial vegetation and soil surveying research. Vegetation species, stress and disease can also be detected through hyperspectral imaging. By attaching the sensor to an Unmanned Aerial Vehicle (UAV), an "airborne observatory" can be used to capture imagery required by the user. By improving the baseline hyperspectral imager (MK1) unit at Simera Technology Group to deliver more accurate data from a spectral viewpoint and, at the same time cover a larger swath width, a more commercially competitive product will be available. The development of a low-cost unit will service a larger market sector, especially in a developing region such as the Southern African Development Community (SADC) and Africa.

The **development** of the **hyperspectral system** resulted in **scare skills development** (optical design) f**or four employees**

Figure 1: Computer Aided Drawing (CAD) model of hyperspectral sensor

UPGRADING HYPERSPECTRAL SENSORS AT SIMERA TECHNOLOGY GROUP

The goal of the original development (MK1) was to conceptualise, design and build an instrument that can capture useful hyperspectral data in the most cost-effective manner possible. For this reason certain performance parameters had been reduced to lower limit values, of which the most noteworthy was a fairly low field of view and high levels of spectral frown. These initial performance shortcomings could be overcome with longer duration data capturing and post processing respectively, both of which are not ideal from a system cost-effectiveness viewpoint.

Participating in this project gave **engineers** and **partner consortium members** further exposure to **practical** optical **systems design**, integration and **field testing**

GOALS AND OBJECTIVES

The principal goal of the current AISI-funded project was to improve the baseline hyperspectral imager MK1 unit, to deliver more accurate data from a spectral viewpoint and, at the same time, cover a larger swath width. Both of these improvements will directly lead to a more commercially competitive product. On equal footing, the goal was to

Figure 2: Hyperspectral imager prototype during testing

keep the cost of the final design as low as possible, since the development of a low-cost unit will service a larger market sector, especially in a developing region such as SADC and Africa.

All of these changes funded by the AISI programme will increase the commercial attractiveness of the hyperspectral MK2 imager and give local research and commercial entities access to more data.

Figure 3: Test image of vegetation (middle spectrum)

OUTCOMES

- An upgraded hyperspectral sensor for high resolution imagery and surveying.
- Participating in this AISI project gave the SIMERA engineers and partner consortium members invaluable further exposure to practical optical systems design, integration and field testing. This will further prepare all members of this consortium to better represent South Africa as part of the photonics industry. This was clearly indicated as a key high tech enabler for upcoming economies and employment opportunities by the Photonics Initiative South Africa (PISA).
- The development of advanced imaging systems up to hardware and extensive test level will have a marked impact on future developments and markets. Funds to develop new prototypes or demonstration units are typically limited and the absence of hardware to demonstrate, severely limits the market opportunities.

TESTIMONIAL

"It is clear that the AISI-funded upgrade project immediately improved SIMERA's position to market and grow its optics offering. The support gave SIMERA a sound platform from which to investigate and market similar technology offerings and it is certain that after completion of the Hyperspectral MK2 sensor, SIMERA can market and further commercially gain from this technology baseline."

Johann du Toit, Managing Director, Simera Technology Group

IMPACT AND BENEFITS

Market Access and Networking Opportunities

Hyperspectral units of the current MK2 design have not yet been made commercially available, although SIMERA already received four requests for such an instrument from various remote sensing and mapping companies. SIMERA is currently revising the cost baseline and preparing marketing material.

The execution of the project and the trust AISI placed in SIMERA, together with the associated internal capability and capacity expansion, led to SIMERA securing additional optical system development contracts for two more hyperspectral sensors of the MK1 type, both used as research test beds, as well as additional remote sensing payloads for light aircraft and UAV platforms. The total value of these projects already exceeded the value of the initial AISI support.

It is clear that the AISI support was a key enabler for SIMERA to grow rapidly in this field and it is certain that, after the successful completion of the Hyperspectral MK2 unit.

Organisational Benefit

SIMERA expanded its optical engineering development team for the current and other optical-based work with four permanent positions, one being a national diploma candidate and another two Master's degree candidates. Recently, SIMERA also appointed an additional industrial design engineer to assist with hardware design work for current optical and other development projects.

In total, seven engineers, draftsmen and industrial designers plus three interns have gained experience and participated in the execution of this project. Two external engineering development companies (Forest Sense cc and Garcer cc), an academic institution (Stellenbosch University [SU]) and a science council (Agricultural Research Council [ARC]) participated in the design and development of the hardware item.

Industry Benefits

Remote sensing and machine vision in general represent a rapidly growing industry sector with applications thoroughly entrenched in all aspects of modern living and production processes for first-world and developing countries alike. South Africa needs to grow its existing photonics industry to keep up, or as in most cases, catch up with international contenders in this arena, an aspect PISA clearly recognises. Developing photonics instruments locally instead of sourcing them internationally, will help to stimulate and grow our indigenous design and development capability, and will give support industries such as precision production, electronics development and computing technologies the opportunity to grow.

Socio-Economic Benefit

The developed hyperspectral sensor will be integrated into the SU and ARC airborne observatory, which is a research test bed. This will give the ARC and other academia access to direct and applicable research data, making their research more valuable and immediately applicable to South African conditions. Currently the sensor suite in this test bed is limited, and the hyperspectral sensor will further improve the overall capability. This funding will therefore allow the university and ARC to conduct applicable and world-class remote sensing research, preparing South Africa to collaborate with international partners and to be in a better position to give advice on future remote sensing mission planning and acquisition projects.

Technologies for this observatory can be sourced internationally; a significant part of this can be developed at a system and even component level in South Africa. By supporting this project, the AISI will give the participating members the opportunity to venture into new technology areas, to potentially unlock future markets. Downstream supply companies will also benefit from the local participation.

The development of lower cost speciality remote sensing equipment will reduce the cost of precision farming. This in turn will aid with food security and quality planning.

ADDITIONAL IMPACT AND BENEFITS

Predominant Technology Stream	• OEM/Integrator • Sensors • Information technology
Predominant Product Market	• Aeronautics - General Aircraft - Helicopters - UASs - Services • Agricultural Sensor Development
Technology Development Status	Advancement of Existing Technology
Manufacturing Process Development Status	Advancement of Existing Process
SMMEs Involved	• Forset Sense cc • Garcer cc
Academic Institutions and Science Councils Involved	• Stellenbosch University's Department of AgriSciences • Agricultural Research Council (ARC)
Alignment to National Strategies or Programmes	The project will fit into the PISA programme to grow the optical industry at all levels in South Africa.
Number of Jobs Created or Retained	• One industrial designer • One optical designer
Scarce Skills Development	• Optical designer • Precision optomechanical component production (general skill and capacity development at SIMERA's suppliers)
Industry-Focused Skills Development	• Three vacation intern • One year-long intern
Competitiveness Improvement	The capability to develop optical systems from specifications to instrument will give us a competitive edge.
Industry Partners Benefiting from Project	• Stellenbosch University's Department of AgriSciences commercial services (will make use of sensor during field surveys done for local farmers and research units) • ARC field work (will make use of sensor in their research observatory) • Forest Sense cc (execution and development partner; will make use of sensor and data for clients; also potential reseller of hardware systems) • Carger cc (developed specialised skills during participation) • Donnees Engineering (improved precision production skills)
Internal Skills Development	Four internal employees improved their skills during the development of this system.
International Contracts	• Basler Charge-Coupled Device (CCD) Sensors • Xsense IMU system suppliers • Tower Optical (optical element production)
Local Contracts	• RI Tech (for the supply of compact form high performance computing elements)
Intellectual Property Created	• Design and integration of hyperspectral sensor system

PROJECT 5:

Laser Shock Peening Phase III

BENEFITING INDUSTRY

Local Aerospace Manufacturing Industry
CSIR
University of the Witwatersrand

This CSIR-led initiative set out a three-year plan to establish a Laser Shock Peening (LSP) infrastructure to ensure uptake of this technology by the aerospace and other industries. The programme is a multi-institutional effort, which combines the unique laser expertise of the CSIR and LSP expertise at the School of Mechanical, Industrial and Aeronautical Engineering at the University of Witwatersrand, through the support of the National Aerospace Centre (NAC), the Laser Rental Pool Programme and the CSIR's Parliamentary Grant (PG) funding.

LASER SHOCK PEENING

Laser Shock Peening (LSP) is a surface engineering technique/process used to induce beneficial residual stresses in materials, through the high-magnitude shock waves generated by a high-energy laser pulse. The deep and high-magnitude compressive residual stresses impacted by the LSP process increase resistance of the material to surface-related failure such as fatigue, and stress corrosion cracking.

Peening is the process of working a metals surface to improve its material properties, by deliberately inducing compressive stresses or relieving tensile stresses already present. Application of peening technology can extend to any metal component requiring enhanced fatigue performance and currently includes aerospace, power generation and automotive industries.

Laser Shock Peening is a surface engineering technique/process used to **induce beneficial** residual stresses in materials, through the **high-magnitude** shock waves generated by a **high-energy** laser pulse

The most common peening method used is Shot Peening. This method involves firing of small solid metallic or ceramic spherical beads at a metallic surface to generate a plastic deformation of the impacted surface, which will result in a local state of compression. At first glance, it would seem that bombarding a metal part with an intense stream of tiny metal or ceramic balls under controlled conditions to induce the compressive stresses might not be the best approach to making that part more resistant to cracking and corrosion. However, shot peening is a tried-and-true technique for strengthening metals and is commonly used by the automobile industry for springs. Shot peening can also be used to control porosity and for surface texturing.

When commercialised, **Laser Shock Peening-treated components** will have an improvement in fatigue properties leading to **reductions** in airframe structures weight and **cost savings** with regards to production and maintenance costs

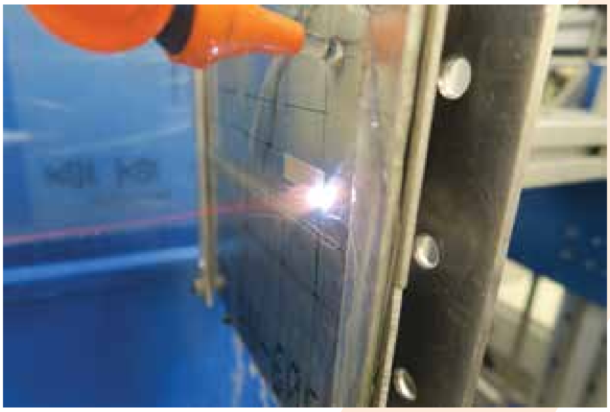


Figure 1: Working LSP cell (laser and optical system)

There are, however, a number of drawbacks:

- Kinetic energy limitations
- Surface roughness
- Shallow depth
- Durability of shot
- Process control and uniformity
- Complex surfaces.

In order to overcome these limitations and meeting the modern accepted industrial practices, such as automation and repeatability of the process, without too much human intervention, LSP was introduced at the beginning of the 1970s. LSP is currently successfully used at an industrial level for extending fatigue lives of aircraft engine components, e.g. titanium jet engine blades, and several investigations produced valuable knowledge to aid this section of aerospace technology. This is due to the fact that LSP provides deeper compressive stress as well as a significant increase in process flexibility with respect to the potential geometries of treated areas. The benefits of LSP can be summarised as follows:

- Excellent surface finish
- Compressive stresses that are 10 times deeper than those attainable from conventional treatments
- Wide range of geometries can be treated (complex shapes)
- Exceptional process control and uniformity through precise overlapping of laser beam profiles across the surface of the target
- No consumables other than electricity.

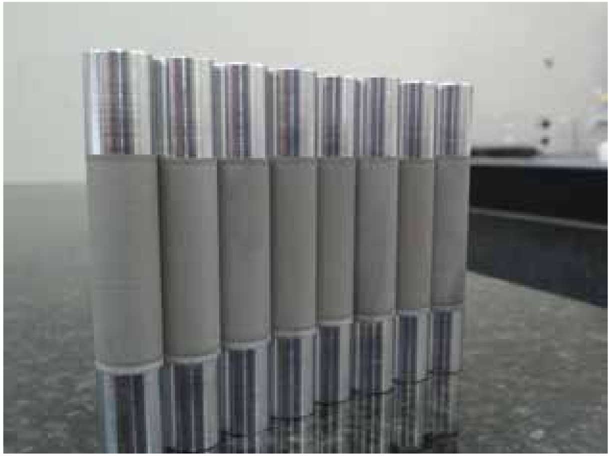


Figure 2: LSP processed round AA7075 aluminium alloys

The intense (high-energy) laser pulse is fired to the work-piece that is covered with a water layer or an absorbent coating (usually a black paint). An explosion is generated, which results in very intense plasma that is constrained by the adjacent coating and water layer. A pressure pulse reaching several gigapascals is generated. This pressure pulse propagates as a shock wave deep into the material and generates compressive residual stresses.

These stresses can be manipulated and controlled according to the desired application. A typical example of such a desired application is enhancement of fatigue life of a component. A clear increased of fatigue life was obtained in laser shock processed coupons.

Despite the abovementioned benefits presented by the LSP project and the available literature, it is apparent that most research studies focus on the basic understanding of LSP phenomena, but do not take into consideration the expectations of the various industries involved.

GOALS AND OBJECTIVES

An LSP infrastructure was established to ensure uptake of this technology by the aerospace and other industries. By combining the unique laser expertise of the CSIR with the expertise of a group of local and international LSP experts, a combination available nowhere else in the world, LSP technology can be demonstrated and validated for more general use by the aerospace industry. This would place South Africa at the forefront of this developing technology to give the local aerospace industry a significant competitive advantage in the field of stress fatigue susceptible aerospace components.

Sufficient scope exists for improvements in LSP technology and by utilising the laser and laser/material interaction expertise at the CSIR and establishing an LSP workstation in collaboration with Higher Education Institutions (HEIs) and industry, the collaborators can gather a significant benefit from LSP with regards to:

- Adding to the manufacturing capabilities of South Africa and its aerospace industry, which is being supported by **the dti** through initiatives such as AISI, by establishing an LSP facility for low-volume, high-value aerospace and tooling components
- Establish an LSP facility geared to support industry through execution of feasibility studies, and support in small specialised production
- Increased participation in, and contribution to local and international R&D programmes dealing with advanced manufacturing by creating research capacities and linking these with the needs of industry to promote technology transfer, thereby beneficiating the resources for the South African economy
- Significantly expand South Africa's capacity to undertake world-class cutting-edge research in stress fatigue susceptible aerospace components
- Promote human capital development in the fields of LSP systems, which involve laser processes, aerospace, metallurgy, mechanical engineering and materials science.

OUTCOMES

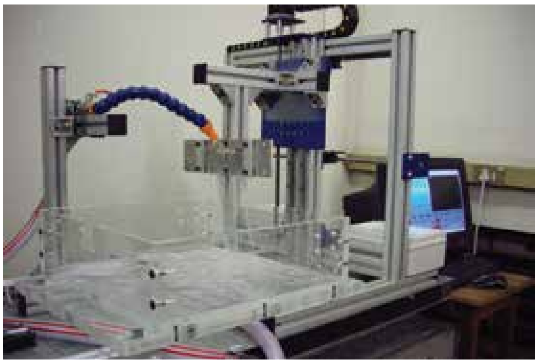


Figure 3: Basic LSP processing station

Significant and very important milestones were achieved, these include:

- An LSP process cell demonstrator was commissioned and tested
- Optimised the performance of the LSP system
- Demonstrated the improvement in fatigue performance of the aforesaid Laser Butt-Welded (LBW) components
- Optimised LSP parameters and established LSP procedure for aerospace components
- Applied the LSP procedure on aerospace components, primarily for Airbus
- Promoted human capital development in the fields of LSP systems, which involve laser processes, aerospace, metallurgy, mechanical engineering and materials sciences
- Established a consortium of interested parties that include industry and academia
- Published and presented the findings of experiments.

IMPACT AND BENEFITS

Productivity Improvement

LSP treated components will have an improvement in fatigue properties leading to reductions in airframe structures' weight and cost savings with regards to production and maintenance costs.

Market Access and Networking Opportunities

The AISI funding was used to secure additional funding from the National Research Foundation-supported Laser Rental Pool Programme as well as Parliamentary Grant funding from the CSIR.

The CSIR-WITS LSP group has been invited to participate in a European Consortium for a 2020 Horizon proposal by a prominent HiLASE Institute in Prague, Czech Republic.

Organisational Benefit

This support is assisting the CSIR to fulfil its mandate:

- Strengthen the science, engineering, and technology base of lasers in South Africa so as to ensure South Africa remains up to date with new technology and developments
- Establish research collaborations with local and international HEIs and industry in the laser field
- Develop and direct laser-based knowledge to industry so as to improve competitiveness and thereby create new job opportunities
- Partner with public and private sector in the field of lasers
- Reduce entry barriers into laser technology for local industry.

Industry Benefits

Increase local and international market access opportunities for the local aerospace industry by improving competitiveness of these industries through the development and introduction of unique locally developed LSP technology and process. The resultant expansion and improvement of the aerospace-related national research and manufacturing infrastructure will lead to increased revenues and job opportunities.

Skills and Human Capital Development

At present, this project focuses on the establishment of the LSP cell, and understanding of the physics and the materials science behind this process. Participation of students at postgraduate-level:

Four students from the University of the Witwatersrand are involved in this project. Of these, one student graduated with an Master of Engineering (M.Eng) in 2013; one student has had his thesis upgraded from an M.Eng to Doctor of Philosphy (PhD) due to the quality of the work produced. However, this will require an additional year of study to complete. Two students are currently completing MSc degrees, expected date of graduating is in December 2015.

Project Outcomes in Support of Achieving AISI Goals

This project is supporting the goals of AISI by:

- Developing a new technology to improve the competitiveness of the local aerospace industry, thereby promoting exports, creating new job opportunities and contributing to the knowledge economy
- Supporting the development of a new technology to improve the probability of future commercialisation opportunities
- Promoting the participation of local and international industry in industry-focused R&D
- Integrating the efforts of science councils, HEIs and industry to develop products and services for local aerospace industry and support human capital development.

PARTNERS AND COLLABORATORS

Principal collaborators & supporters

- School of Mechanical, Industrial and Aeronautical Engineering, University of the Witwatersrand
- CSIR
- Aerosud
- Eskom
- Stellenbosch University
- University of Cape Town
- National Aerospace Centre
- Nelson Mandela Metropolitan University

Local

- Denel Dynamics
- Nuclear Energy Corporation of South Africa
- University of Johannesburg

International

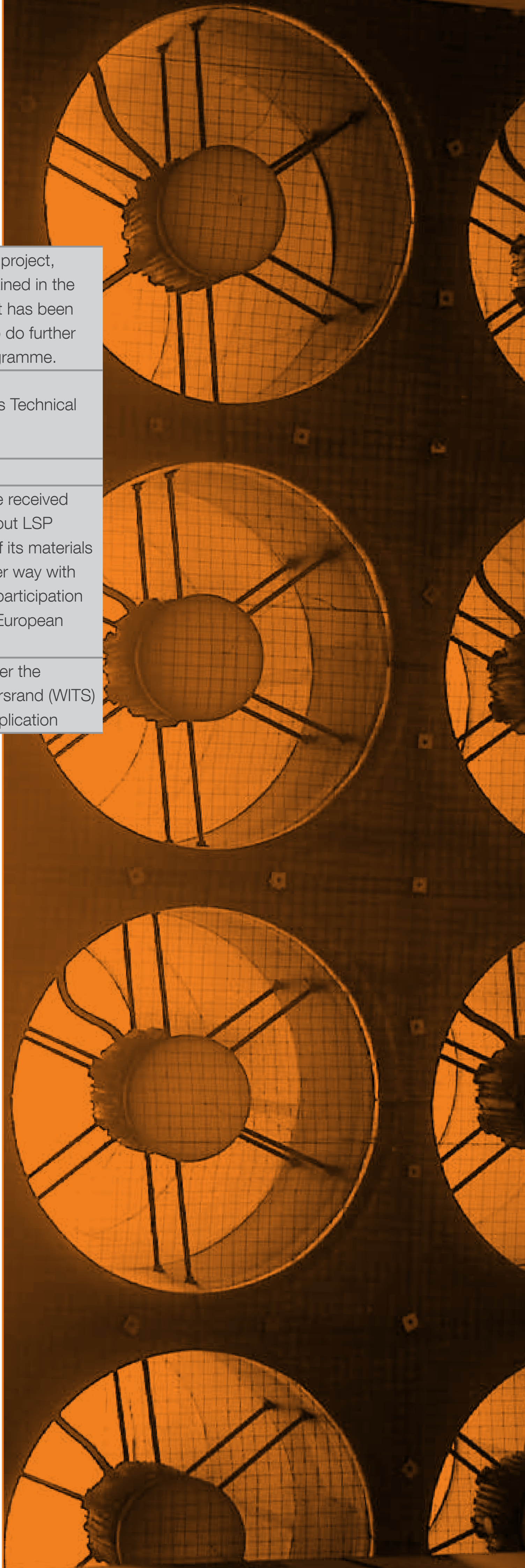
- AgustaWestland
- Airbus
- Airbus Space & Defence
- Boeing
- Piaggio Aero Industries
- University of Bologna
- University of Pisa
- University of Ljubljana

The partners were selected on the basis of their current and future needs, and in some cases, their knowledge in the field of LSP.

Figure 4: Laser peened tungsten carbide components

ADDITIONAL IMPACT AND BENEFITS

Industry-Focused Skills Development	During the course of this project, several students were trained in the LSP project. One student has been employed by the CSIR to do further development on the programme.
Industry Partners Benefiting from Project	• Aerosud • South African Airways Technical (SAAT) • Airbus
Internal Skills Development	2
International Contracts	• Formal requests were received from Airbus to carry out LSP treatment on some of its materials • Agreements are under way with HiLaser, Prague, for participation in the Horizon 2020 European Framework
Intellectual Property Created	Yes, these were filed under the University of the Witwatersrand (WITS) • Provisional patent application



PROJECT 6:

Radiation Screening Services for Satellites

BENEFITING INDUSTRY

Heliocentric Technologies ZA

Heliocentric Technologies ZA embarked on a radiation screening project in order to support South Africa's efforts in building a sustainable space industry. Avoiding the radiation effects in satellite electronic components requires the use of extremely expensive radiation-hardened components, which offer low performance and long delivery times. A solution to this is to screen the components for radiation effects and qualify them for use on satellites. Before the radiation screening service can be offered to the satellite community, all testing equipment must be designed and assembled, and each test must be verified as representative of the space environment. This project focuses on the initial testing and validation of all equipment before offering the radiation screening service to the SA space community.

RADIATION SCREENING

Radiation effects on satellite electronic components have proven to be a major impediment to the survivability of satellites in the space environment.

> **Heliocentric** is able to offer on demand single event effects **radiation screening** and mitigation services to **local and international** organisations to ensure the **survivability** of its electronic components

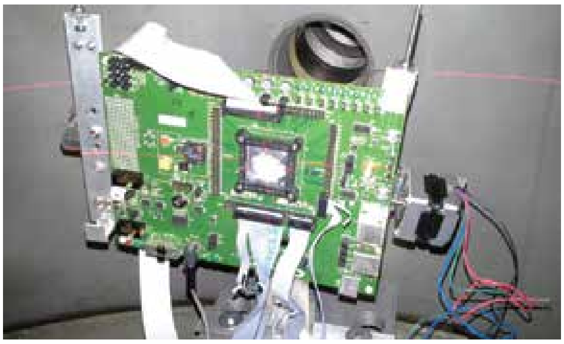


Figure 1: Experimental setup for radiation screening

Mitigating these effects has traditionally required the use of extremely expensive radiation-hardened components, which are only available with low performance and very long delivery times. Another solution is to screen the components for radiation effects, and qualify them for use on satellites. This is usually a quicker and easier fix for Total Ionising Dose (TID) effects, compared to Single Event Effects (SEE).

For satellite developers, SEE screening provides an assurance that selected parts will not fail in the space environment. SEE screening identifies failures due to high-energy cosmic radiation and trapped proton effects.

> Single Event Effects screening **identifies failures** due to high energy **cosmic radiation** and trapped proton effects.

SEE testing requires access to facilities that can deliver high energy protons, up to 100MeV. There are only a handful of these facilities in the world, and they are typically booked out and expensive. As there is currently no provider offering

Figure 2: Beam facilities at iThemba Labs

a radiation screening service in South Africa, every satellite development team that wishes to screen its components must dedicate personnel and funds to learning how to perform these tests and arrange once-off access to the facility. The skills required to perform tests of this nature, though highly specialised, can be harnessed using local talent from the space-related programmes hosted at some local universities and with the help of international expertise.

Heliocentric intends to close these gaps by forging the necessary relationships, developing capability in terms of local skills development, and devising a test methodology that can be applied at a local test facility.

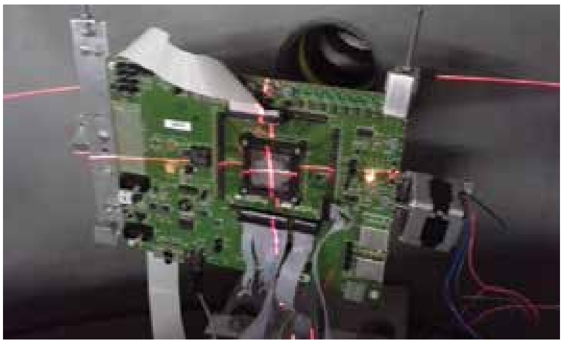


Figure 3: Experimental setup for radiation screening, beam alignment

GOALS AND OBJECTIVES

To carve a niche for South Africa in the global space arena as the sole provider of radiation testing services for satellites in Africa by developing this capability, and creating demand for relevant talent in South Africa. The objectives were to:

- Develop and validate a customised methodology for qualifying electronic components for SEE at iThemba LABS
- Support AISI goals of improving industry competitiveness and industrialisation from small enterprises
- Create demand for local talent in the area of radiation testing for satellites.

OUTCOMES

The project was successfully completed and Heliocentric Technologies ZA is able to offer on demand single event effects radiation screening and mitigation services to local and international organisations to ensure the survivability of their electronic components.

Heliocentric has been successful in adapting one of the beam lines at iThemba LABS for SEE testing and is in a position to offer this service to the local and international space industry depending on beam time availability. Other radiation testing services, e.g. TID and SEE mitigation offerings, are also available on demand.

In fulfilling this project, Heliocentric has amassed knowledge related to Field-Programmable Gate Arrays (FPGA) and related devices.

The local talent developed during this project will continue to explore techniques to mitigate the effects of SEE in electronic devices and develop solutions to reduce the harmful effects of the harsh space environment on satellite electronics.

TESTIMONIAL

"The AISI-supported project holds more potential than merely establishing Heliocentric as the sole provider of radiation testing services (for satellites) in South Africa. Heliocentric is fast creating a strong position in the global space industry evident through the interest shown by prospective international clients who are keen to employ our services."

CJ Nwosa, Project Lead, Heliocentric Technologies ZA

IMPACT AND BENEFITS

Productivity Improvement

Locally, the AISI-funded project is helping to cement Heliocentric's competitive position by establishing it as the first major provider of radiation testing services. Previous efforts, though not many, were on an ad hoc basis and failed to publish any successful results.

Generally, due to very tight schedules at test facilities, radiation services have very long lead times (up to two years) and some satellites are launched even before an opportunity for testing arises. Judging by the experience with beam time availability, Heliocentric anticipates an average lead time of three months to provide this service to both local and international clients after the 'go live' date at the end of the project.

Organisational Benefit

Heliocentric has seen a number of benefits from the AISI supported project, including:

- Moving Heliocentric's vision from conceptual to development phase
- Setting the tone for operationalising the SEE service for the benefit of the South African space industry
- Providing a platform for Heliocentric to compete in the global scene as a radiation screening service provider
- Ability to promote postgraduate projects and contribute to local talent development in space industry.

Skills and Human Capital Development

- Number of bursars supported: 1
- Number of students supported: 3
- Training intervention: Training on beam calibration and set-up at iThemba Labs.

Project Outcomes in Support of Achieving AISI Goals

- Significantly enhance Broad-Based Black Economic Empowerment (B-BBEE) and contribute towards skills development
- Improve local industry competitiveness, market access opportunities, and foreign investment
- Increase the contribution of small enterprises in the economy and ensure that new technologies are taken up by industry through an active process of innovation.

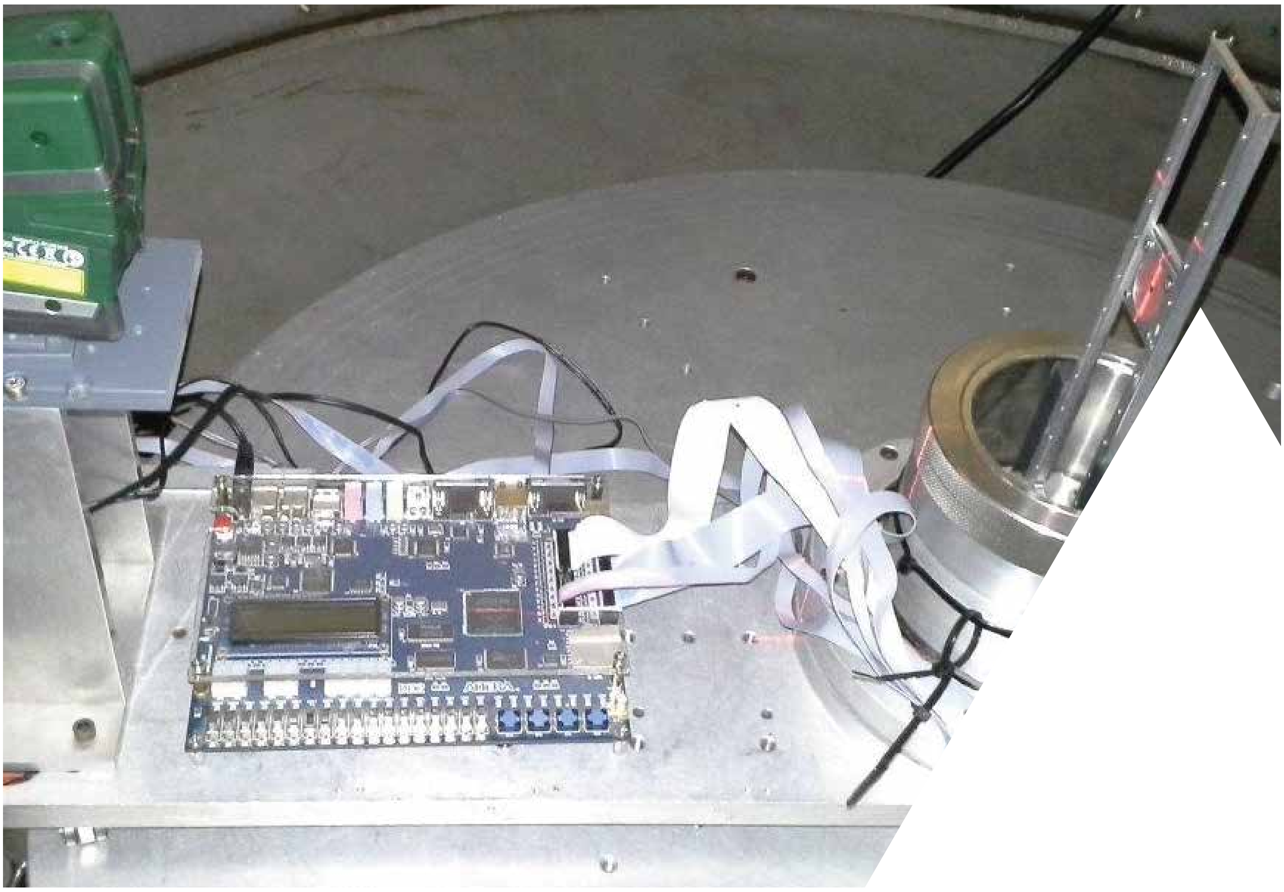


Figure 4: Component setup for SEE testing

ADDITIONAL IMPACT AND BENEFITS

Predominant Technology Stream	• Radiation testing of electronics • Materials and Manufacturing
Predominant Product Market	• Space • Satellites
Technology Development Status	• New Technology Development
Manufacturing Process Development Status	• Advancement of Existing Process
Academic Institutions and Science Councils Involved	• French South African Institute of Technology at the Cape Peninsula University of Technology • Nelson Mandela Metropolitan University • iThemba Laboratory for Accelerator-Based Sciences
Number of Jobs Created or Retained	• 5
Scarce Skills Development	• Yes. Radiation testing is not readily available in SA due to unavailability of test institutions and requisite skills. Heliocentric has developed complex radiation data set analysis and sensitive electronics fabrication skills.
Industry-Focused Skills Development	• 3
Competitiveness Improvement	• Yes
Industry Partners Benefiting from Project	• iThemba Labs
Internal Skills Development	• 2
International Contracts	• 2
Intellectual Property Created	• Single Event Effect mitigation techniques on satellite electronics

Figure 5: Heliocentric Technologies team

PROJECT 7:

SatAuth Technology Demonstrator

BENEFITING INDUSTRY

Satellite Authorisation Systems

The business model for the sale of duty free commodities on-board commercial airline flights has historically been constrained by the limitations of the on-board card payment facilities, which could not authenticate transactions whilst in flight. Card payments currently constitute up to 75% of all duty-free sales. The delayed authentication of the card transactions results in losses to merchants of between 3-4% of total sales turnover. SatAuth resolves the commercial risk by providing communications infrastructure that facilitates the authorisation of commercial financial transactions in real-time (on-board and in-flight). By making use of the Iridium Satellite infrastructure (Global Positioning System), SatAuth is able to ensure transactional communications around the globe.

SOUTH AFRICAN INDUSTRIALISATION

Satellite Authorisation Systems (SatAuth) was developed 15 years ago. The main objectives were to provide the most cost-effective solution to real-time acquisition of debit and credit card transactions primarily in the aviation industry as well as in areas that have unreliable or no telecommunications infrastructure.

SatAuth is a purely South African product, and has to date been funded independently by its creators. SatAuth required AISI funding for international certifications, a pre-requisite for the installation of the solution on a live aircraft.

This has enabled SatAuth to continue the proudly South African tradition with the national carrier, South African Airways (SAA), instead of sourcing funding internationally.

SatAuth's **built-in tracking** facility is a **world-first**; it can provide **secure** independent tracking facilities to the **entire aviation** industry

Figure 1: Antenna cabling by SAAT technicians

The SatAuth project was created in order to provide a communications solution in an environment that traditionally did not have a viable and/or cost-effective linkage to financial infrastructure. The SatAuth project team opted to develop a solution for the most stringent environments initially, in order to standardise the design as a solution across less stringent applications – reducing rework and design modifications specific to individual environments.

By combining **established skills** in **information technology**), **communications** and **finance**, SatAuth was able to create a **payment infrastructure solution.** This opens the doors for **risk-free** commercial **transactions** to be completed **globally.**

GOALS AND OBJECTIVES

For certification purposes, the European Aviation Safety Agency (EASA) and Federal Aviation Administration (FAA) certifications are reciprocal and are acknowledged by the South African Civil Aviation Authority (SACAA), thus ensuring that the requirements of both international aviation local certification bodies have been met.

Figure 2: SAA aircraft during installation of SatAuth system

The goal was to complete the installations on the ZS-SLA (South African Airways Cabin Trainer), and ZS-SLF (Live Aircraft) airframes with the South African Airways Technical (SAAT) teams, within the SAAT process and procedural requirements.

Sufficient avionic and product testing on these aircraft was required in order to prove that the SatAuth solution works as designed, and will be able to deliver a commercially viable product.

OUTCOMES

- The installations on the SAA live aircraft were highly successful and well executed
- The SAAT installation processes and procedures have been documented in line with international operators and Aircraft Maintenance Officers (AMO)
- The Supplemental Type Certificate (STC) inclusive of the Service Bulletin (SB) and the commercial in confidence agreement documents can now be updated with the component changes and concession changes identified and specified during the installation process. This forms part of common practice in the aviation industry, where a first-of-the-kind STCs are installed.

TESTIMONIAL

"The AISI support made it possible for the final confirmation testing and certification processes to be completed within shorter timeframes, which allowed for the installation and testing of the solution on the SAA-identified test aircrafts ZS-SLA and ZS-SLF before it was decommissioned."

Janine Roux, Programme Manager, SatAuth

Figure 3: Installation of SatAuth system by SAAT technicians

IMPACT AND BENEFITS

Organisational Benefit

The certification and the testing of the SatAuth infrastructure was not possible without the financial support of the AISI. Were it not for the AISI support, the testing project would have had to be delayed until sufficient independent funding could be sourced. Alternatively, SatAuth may have been forced to engage with other Global Duty Free agents (other than those owning the SAA concession), who may then have claimed the rights to the launch of the SatAuth Product – thus denying this truly South African product a local launch.

Industry Benefits

Commercial Benefits

Risk-free commerce on-board including the promotion of high-value typically South African goods and services, and the opening of the offering to Value Added Resellers, to offer additional high-end value services and products without risk.

Figure 4: SatAuth server installed in overhead compartment

Figure 5: Location of SatAuth antenna on ZS-SLF aircraft

Aerospace Industry Benefits

SatAuth's built-in tracking facility is a world-first, which can provide secure independent tracking facilities to the entire aviation industry. This has been highlighted as a priority need following the unfortunate disappearance of the Air Malaysia flight MH-370.

ADDITIONAL IMPACT AND BENEFITS

Technology Development	New Technology Development
Manufacturing Process	New Process Development
No. SMMEs Involved	19
Scarce Skills Development	The manufacture, assembly, quality assurance of the SatAuth Server.
Competitiveness Improvement	Currently, little or no competition for the SatAuth Technology exists, making the product unique as a financial transaction channel and independent tracking product.
Industry Partners Benefiting from Project	• South African Airways Technical (SAAT) for the installation of the SatAuth system • South African Civil Aviation Authority (SACAA) for the development of new harmonics testing standards
Internal Skills Development	The manufacture and construction, quality assurance and testing of the SatAuth Server.
Export Capability Achieved	Yes, since the server has been designed according to international standards in the aviation industry.
Import Substitution Achieved	Components were to have been supplied by a United Kingdom supplier; now been sourced locally and undergoing Gerotek certification.

PROJECT 8:

Small Gas Turbine Technology Improvements

BENEFITING INDUSTRY

Cape Aerospace Technologies

The lack of a propulsion systems capability in South Africa has been identified as a deficiency in the aerospace industry in the Sector Development Plan. Propulsion systems are controlled by two different means in the aerospace industry internationally. The first is through piston engine companies being bought out and owned by a few international players in the Unmanned Aerial Vehicle (UAV) sector. Secondly, gas turbines are strictly controlled strategic technology requiring enduser certificates that effectively limit the sale of weapons systems (but which also apply to civilian systems) to third parties. Given that there is a clear market and strategic need for the South African industry to develop a propulsion sector, and the past investment (of the 1980s) in gas turbine technology, the opportunity exists to develop a niche sector through support for a single product with potential to expand into a multitude of markets. This has led to the development of the CAT 200 KS engine, the first new gas turbine prototype in South Africa since the late 1980s.

GAS TURBINE DEVELOPMENT IN SOUTH AFRICA

Given that there is a clear market and strategic need for the South African industry to develop a propulsion sector, and the past investment (of the 1980s) in gas turbine technology, the opportunity exists to develop a niche sector through support for a single product with potential to expand into a multitude of markets.

A new SMME, **Cape Aerospace Technologies**, has been created and a **consortium formed** to **support the development** of a gas turbine engine

Figure 1: Prototype CAT micro gas turbine engine

Since 2009, a number of students have started doing research on micro gas turbines at the Stellenbosch University (SU), gaining knowledge and insight into turbomachinery. The micro gas turbines and turbine-related equipment used by the students are supplied by Cape Aerospace Technologies (CAT). CAT was established through the support of the AISI. The interest in micro gas turbines has grown considerably at the SU due to the exposure given to the students through collaboration with CAT. The first engine is intended to be a small, conservative starting point: A 200 N gas turbine for dual use in small UAVs and drones but with potential applications in the Radio Control (RC) Hobby market.

A remarkable **technical achievement** by getting the first new **gas turbine prototype** running in **South Africa** since the late 1980s

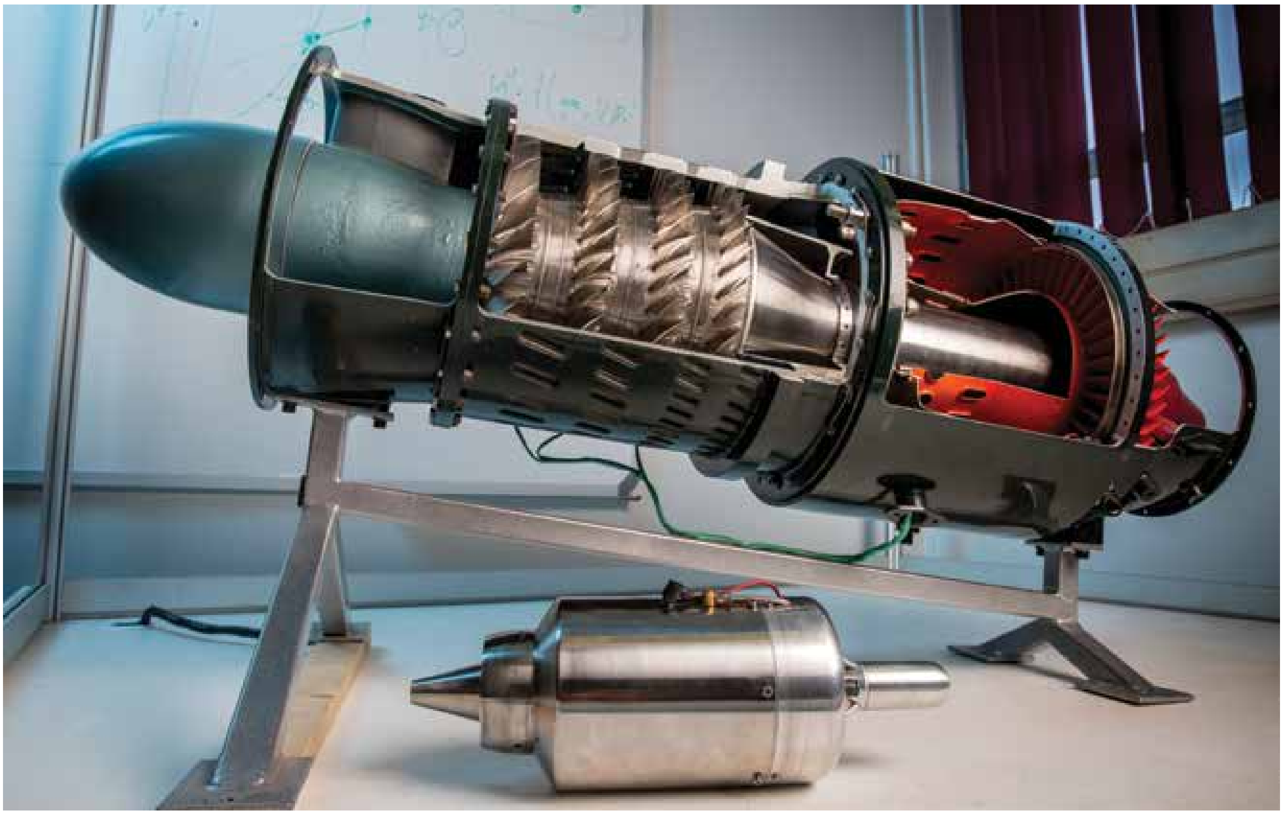


Figure 2: Comparison between APA 350 turbojet (developed in the 1980s) and the CAT engine

Research and investigations on micro gas turbine components such as the compressor and diffuser have started in 2009 at the SU and have included the combustion chamber, nozzle guide vanes and turbine wheel in recent years as the research and studies have grown. These activities are growing in scope and knowledge utilising student grant funding from the Defence Research and Development Board. The micro gas turbine used as baseline for these tests is the Baird Micro Turbine 120 Kero Start (BMT 120 KS).

CAT, together with the CSIR and the SU, has made remarkable technical achievements by developing the first new gas turbine prototype running in South Africa since the late 1980s.

Figure 3: Software model of turbine blades

PHASE II

GOALS AND OBJECTIVES

Following the successful integration of the SU compressor design capability into the CAT200 engine, the intention of this project is to foster the on-going development of micro gas turbine engines and in particular the combustion system of the CAT 200 KS, as part of the formal collaboration between CAT, the SU and the CSIR. In particular this project is aimed at:

- Granting CAT access to relevant facilities at the SU
  - The thrust test bench
  - The combustor test rig
  - Transferring technical knowledge to students
- Funding the development work on the engine with regard to the compressor and turbine matching and combustor development
- Continuing the transfer of established Intellectual Property (IP) and skills to the next generation of aerospace engineers.

This project had two main objectives:

- Successful matching of the compressor and turbine
- The experimental redesign of the CAT 200 KS combustor using the facilities at the SU.

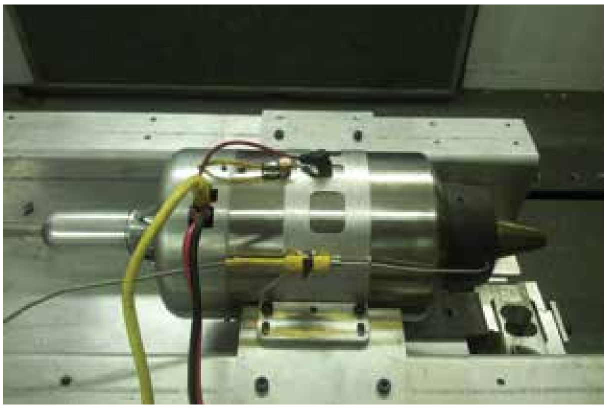


Figure 4: CAT engine during testing

A great challenge in the pursuit of an efficient and effective small gas turbine engine is the complete combustion of fuel in the restricted volume available. This task is aimed at pooling the existing knowledge base in South Africa in order to attempt a solution to this problem.

OUTCOMES

- This project has made remarkable technical achievements by developing the first new gas turbine prototype running in South Africa since the late 1980s
- A new SMME has been created and a consortium formed to support the development of a gas turbine engine
- It is comforting to see that the CAT 200 KS performs slightly better than a commercially produced German-engineered micro gas turbine, namely the JB 220. The engineers at CAT are, however, not satisfied with the engine exhaust gas temperatures at its top end and will therefore not consider placing it on the market yet
- CAT is also the first company to investigate atomisers and swirlers to use for combustion in micro gas turbines, with promising spinoffs.

IMPACT AND BENEFITS

Productivity Improvement

The design process from initial turbine cycle design to manufacture and testing have been streamlined through a number of verification methods, namely 1-D design and Computational Fluid Dynamics (CFD) analysis, thanks to funding received from the AISI.

During the course of this project a number of high precision manufacturing processes were perfected, e.g. 5-axis Computer Numerical Control (CNC) milling.

Market Access and Networking Opportunities

Based on results obtained from tests done on the JB 220, the CAT 200 KS could be placed on the market, since it operates in a similar fashion. The engineers at CAT will, however, not consider placing a product on the market, which is not absolutely sound according to their experience and knowledge. For this reason, the product is not yet mature enough to enter the market. Nonetheless the results produced by the CAT 200 KS are very promising.

Organisational Benefit

Apart from the fact that a company was started in 2013, namely CAT, through funding by AISI, the funds enabled CAT to streamline its design process to deliver a world-class micro gas turbine. The company focuses mainly on the manufacturing and development of micro gas turbines to aerospace specifications. The first potential product for this company has been developed to a high degree through the application of these funds.

The funds enabled CAT to support the SU undergraduate and postgraduate students specialising in turbomachinery and help build interest in the aerospace field.

Industry Benefits

Figure 5: Students working on the CAT engine

Propulsion has long been identified as an undeveloped sector of the national aerospace and defence industrial portfolio. This project aims to address this shortfall starting with a small gas turbine development that is easily affordable and the establishment of an SMME with the potential to grow into the sector. The project has helped immensely with:

- Establishing the knowledge surrounding the manufacture of high-precision, rotating machinery
- Deepening the knowledge base and access to facilities for the SMME in question
- Transfering knowledge from the historical programmes to future generations
- Sectors in the military and defence have shown interest in the CAT 200 KS.

Skills and Human Capital Development

- Labaratory technician to operate gas turbines.

Project Outcomes in Support of Achieving AISI Goals

The AISI has assisted immensely in the establishment of an SMME, and the subsequent employment of the founding member of this SMME. The AISI has further funded the development of its first prototype and given access to science councils and Higher Education Institutions' (HEIs) knowledge and facilities as per the AISI mandate.

Propulsion is a key component of any aerospace industry and is identified as a missing element in the overall South African system. This project aims to address this by developing a small but sustainable industry capable of enabling much larger product offerings such as glider aircraft and Denel Dynamics weapons systems and target drone developments.

PARTNERS AND COLLABORATORS

- CAT (SMME): Design, manufacture and testing
- CSIR: Oversight, design, analysis and marketing
- Stellenbosch University (HEI): Student projects and facilities.

PHASE III

The AISI contributed towards the successful integration of the SU compressor design capability and combustion system into the CAT 200 KS gas turbine. This project led to the re-engineering of the entire engine, with a number of successful spin-offs and invaluable information gained.

The proposed project aims to advance the state-of-the-art within this market segment so as to place the South African industry in a leading position by commercialising the CAT 200 KS for the local and the lucrative export market. After careful consideration of data and insights gained during previous work, it became clear that to be the leader in the micro gas turbine field, mixed flow compressors need to be incorporated into the new 200 N engine design. This project will therefore focus on the design and manufacture of a high-pressure mixed flow compressor. The current international market does not have any comparable product offering. The same methodology will later be used to design a high-pressure mixed flow compressor for a high-value added 600 N gas turbine engine. We believe it will lay the basis for a future independent aeromotive capability for South Africa. The fastest growing developing economies place a premium on aerospace skill sets, and South Africa should be leading in this regard.

The current phase is intended to continue to give CAT access to facilities at Stellenbosch University and to fund its activities. In addition CAT will continue to assist undergraduate and postgraduate students at Stellenbosch University doing work on gas turbines, as it has done for the past two years since inception.

GOALS AND OBJECTIVES

This project is intended to enable the development of a prototype/demonstrator engine by integrating a diagonal/mixed flow compressor into the 200N engine. Funding will be utilised to manufacture components for the prototype engine and test articles, induce the interaction between the CSIR, SU and CAT.

This project has three objectives:

- Design a mixed flow compressor for the CAT 200 KS
- Finetune all components and procedures to commercialise the CAT 200 KS engine as a product
- Train, educate and give exposure to young engineers working on turbomachinery.

EXPECTED OUTCOMES

A prototype gas turbine engine that utilises a mixed flow compressor.

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PROJECTS IN PROGRESS

PROJECT 1:
Additive Manufacturing of Aerospace Components

BENEFITING INDUSTRY

Denel Dynamics
Aerosud Aviation
Titanium Manufacturing and Aerospace Industry

Additive Manufacturing (AM) is generally considered as a new and emerging manufacturing technology and has not been fully adopted by industry due to limitations in commercially available technology. Traditional manufacturing technologies are often subtractive (materials are removed via a cutting or milling process); AM relies on various energy depositing technologies to fuse materials into 3D functional near-net-shape parts. The benefits are accelerated manufacturing cycles, reduced waste, minimised cost, reduced energy use and reshaped supply chains. The objective of this project is to develop suitable AM build and qualification strategies for aerodynamic and structural aerospace components.

Two aerospace components were selected to be manufactured using **additive manufacturing** techniques

ADDITIVE MANUFACTURING

The majority of components in the aerospace industry require complex profiles and relatively small lot sizes. In such circumstances the cost benefit associated with mass production does not exist. A process such as investment casting needs considerable upfront investment in dies and is not as flexible as AM. Conventional machining costs are well known. Especially in the case of machining titanium alloys which are classed as “difficult to machine”, process costs can be expensive. There is a continuous search for more cost-effective alternatives. AM is a good candidate technology to complement the status quo. Technology transfers from this project will stimulate possible local manufacture of selected parts for this industry with the associated socio-economic benefits.

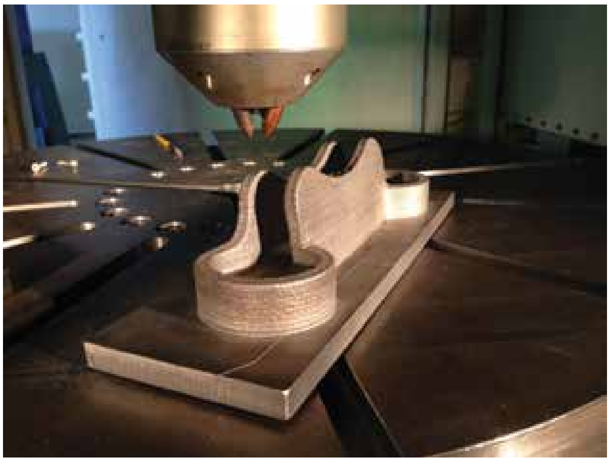


Figure 1: Engine bracket being manufactured using AM techniques

Training opportunity for one **mechanical technician**, one new **metallurgical technician** and one **new researcher** (Master’s level)

GOALS AND OBJECTIVES

The goal of this project is to develop suitable AM build and qualification strategies for two generic aerodynamic and structural aerospace components and then build prototypes of them.

The objectives of the project are to:

- Revisit existing designs for parts and make the necessary adjustments to optimise the benefits available from AM technology, and then quantify the build strategy and process parameters
- Build the actual parts on an AM system
- Quantify the Non-Destructive Testing (NDT) inspections of the manufactured components
- Quantify the material integrity and strength of the manufactured components.

Figure 2: Engine brackets comparison: AM built from 304 Stainless steel (left) and machined from 17-4PH Stainless steel (right)

The work package for the last year was primarily focused on the first objective. Three milestones were identified to accomplish this objective:

- Optimise process parameters and scanning strategies
- Perform tensile tests for strength determination and preliminary NDT inspection to identify internal defects
- Build sub components for detail analyses, which resemble realistic heat inputs and cooling rates similar to the final building operation of the complete part.

The main reason for undertaking the project is to develop suitable AM build and qualification strategies for two generic aerodynamic and structural aerospace components. Both components are in-flight components that demand a favourable strength-to-weight ratio and are also exposed to elevated temperatures or load forces in operation.

The work package set out for the past year mainly concentrated on identifying the driving parameters that will affect the final performance when compared to the user requirement specifications. This included AM building strategies, microstructures, identified risks through first inspections and the building of sub components so realistically that they would experience similar heat input exposures compared to the final built component.

For both industrial aerospace manufacturers this project is a quick step forward. Both had AM in mind for future development, but neither of them has the capacity in-house at the moment to build AM parts and audit the shortcomings in the process. By participating in this project they manage to create a better understanding with especially their mechanical design teams for the AM process that will serve them well in the future. In addition, it facilitates a less cumbersome technology development and technology transfer process for them.

OUTCOMES

A few areas with a relative high risk for defect formation were identified, which will require more investigation before the final building specifications can be formalised. It is also evident that AM manufactured parts will need post heat treatment in order to obtain optimum mechanical properties. Although the Computerised Tomography (CT) scan process proved to be excellent for pore detection and quantification, it failed to supply relevant data about cracks.

IMPACT AND BENEFITS

Productivity Improvement

In the South African manufacturing environment the flexibility offered by AM technology will improve the competitiveness of local manufacturers for low-volume parts of higher complexity.

Organisational Benefit

This project expanded the scope of application of equipment and human resources. It built additional capability in the AM domain.

Industry Benefits

This kind of project lowers the entry barriers for industrial manufacturers towards research, development and implementation of AM technology.

Skills and Human Capital Development

This project provided training opportunity for one mechanical technician, one new metallurgical technician and one new researcher (Master’s level).

Project Outcomes in Support of Achieving AISI Goals

This project serves to assist existing aerospace manufacturing companies towards implementation of new technology into their existing markets.

PROJECT 2:

Identification Friend or Foe Interrogator Power Amplifier / Transmitter

BENEFITING ORGANISATION

Identification Friend of Foe (IFF) forms an integral part of aircraft to aircraft communications as seen in the Higher Levels of Mode S Technology development project. In an Air Traffic Control (ATC) and air defence environment, it is important to be able to detect and identify all aircraft, so that each aircraft can be safely guided and controlled or monitored during take-off and landing and along its flight path. Detection is primarily accomplished by a Primary Surveillance Radar (PSR), which is able to detect, but not identify, aircraft. Identification is accomplished by a Secondary Surveillance Radar (SSR). SSR works on the following principle:

- A ground-based interrogator transmits a sequence of pulses to all aircraft, effectively asking "Who are you?"
- A transponder on each aircraft replies with another sequence of pulses, effectively saying "This is my identity".

The amplifier forms an integral part of the interrogator. This project focuses on localising the design and development of the amplifier, thereby decreasing the need for imported components. Its development is in line with that of the Higher Levels of Mode S project.

This project would initially **overcome power** amplifier/ transmitter **shortcomings** currently experienced, effectively placing it as a **noteworthy competitor** in the defence market place

Figure 1: IFF Interrogator

Tellumat

INTERROGATOR DESIGN AND MANUFACTURE IN SOUTH AFRICA

Tellumat has been developing, manufacturing and supplying Identification Friend or Foe (IFF) equipment in South Africa since the late 1980s, initially for the local military aircraft requirement, and subsequently also for export. Interrogators have been fitted to ships and radars for identification purposes in the SA Navy Frigates and South African Army Ground Based Air Defence System (GBADS) programmes.

Identification **Friend or Foe transponders** aid in the detection of aircraft to ensure **safe guidance and control** during take-off and landing

INTERROGATOR APPLICATIONS

When Tellumat commenced the PR-4000 IFF / Mode S interrogator design, the decision was made to purchase an Off-The-Shelf (OTS) transmitter (source and power amplifier) from a company in the United States of America (US). This transmitter has problems in meeting the international Standardisation Agreement (STANAG) and International Civil Aviation Organisation (ICAO) specifications for IFF. There have also been several reliability problems and failures. There also appears to be a lack of willingness from the Original Equipment Manufacturer (OEM) to fix the design to meet the specification. Another potential problem is the fact the the OEM is a US manufacturer and the item is subject to International Traffic in Arms Regulations (ITAR) control and future end-users may be restricted.

Subsequently, new amplifier techniques and devices are now becoming available to allow for technology development resulting in an easily manufactured, cheaper, lighter amplifier that draws less current and dissipates less heat.

This project would initially overcome power amplifier/transmitter shortcomings currently experienced with the PR-4000, effectively placing it as a noteworthy competitor in the defence market place.

The PR-4000 is a contender for the SA Navy's Project Biro replacement programme, the SA Air Force's Project Chutney ATC, long-range and tactical mobile radar; and the SA Army's ongoing GBADS programme. The power amplifier/transmitter could also be offered as a product in its own right to other IFF interrogator manufacturers.

GOALS AND OBJECTIVES

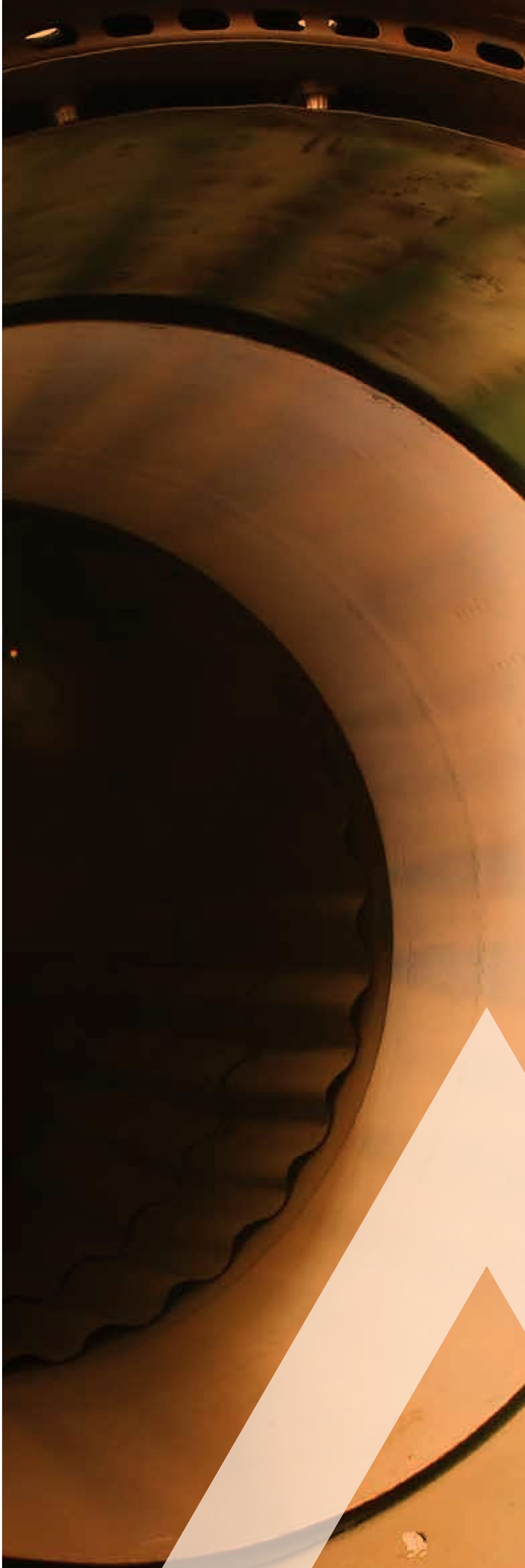
The project goal is to develop, build, test and qualify a prototype power amplifier/transmitter

The project objectives are to:

- Define and specify the requirements for the power amplifier/transmitter
- Develop and test the power amplifier/transmitter in order to meet these requirements
- Qualify the power amplifier/transmitter, so that it can be formally released as a product
- Integrate the power amplifier/transmitter into the PR-4000 and qualify it in the interrogator environment.

EXPECTED OUTCOMES

A qualified power amplifier/transmitter that would replace the current imported amplifier.



PROJECT 3:

Nano-Satellite Imager Development and the Development of a New Hyperspectral Focal Plane and Mass Storage for a Space Imager

BENEFITING ORGANISATION

Space Advisory Company

Nanosatellites, also called nanosats, are used to describe artificial satellites with a mass between 1 and 10 kg. Nanosatellites are attractive because their small size makes them affordable and opens up the possibility for a constellation of satellites. They can piggyback on larger launches, which avoid the need for a dedicated launch. With the development of nanosats, the need for miniaturising electronics components such as cameras (space imagers) becomes essential. Developing space nations are recognising the potential of nanosats for education, skills development and training resulting in an increased demand for nanosats and space imagers. The overall goal of this project is to demonstrate South Africa's capability to appropriately specify, design, procure and adapt Commercial-Off-The-Shelf (COTS) components and then to assemble and test a low-cost space imager customised for nano-satellite missions.

SPACE INDUSTRY TECHNOLOGY DEVELOPMENT

This is an industry-focused technology support project with the aim of enabling the development of a new technology product for which an identified market exists. This in turn should enable market entry and global competitiveness for the South African space industry. The proposed project will derive specific benefits.

These projects will demonstrate **South Africa's capability** to appropriately **specify, design, procure and adapt** COTS and then to **assemble and test** a low-cost space imager customised for **Nanosat missions**

It will set an architectural and component-based baseline that can serve as a defined and documented basis for the further development of the Nanosat imager as per the overall goal, and realise a COTS-based product (validated through system assembly, integration and testing). During this process, it will also lead to the establishment of the competencies and capabilities needed in developing such a product.

The term **nanosatellite** refers to a satellite with a **mass** of between **1 and 10 kgs**

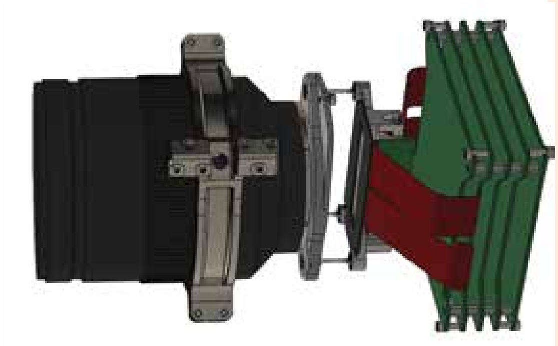


Figure 1: CAD model of nanosat camera

NANO-SATELLITE IMAGER DEVELOPMENT

GOALS AND OBJECTIVES

The overall goal is to demonstrate South Africa's capability to appropriately specify, design, procure and adapt COTS components and then to assemble and test a low-cost space imager customised for nano-satellite missions with the following salient specifications:

- 20-25 m Ground Sample Distance (GSD)
- >= 160 km swath
- Panchromatic or Red, Green Blue, possibly multi-spectral .

EXPECTED OUTCOMES

- An engineering model of the nanosat imager
- Communicating South African capability to international clients, but also giving current practising engineers and interns practical hardware development exposure
- Establishment of the competencies and capabilities needed to develop such a product in the future.

DEVELOPMENT OF A NEW HYPERSPECTRAL FOCAL PLANE AND MASS STORAGE FOR A SPACE IMAGER

GOALS AND OBJECTIVES

The overall goal is to demonstrate South Africa's capability to support NanoSat missions by appropriately specifying, designing, procuring and adapting COTS components for a new technology hyperspectral focal plane and mass storage for a space imager.

EXPECTED OUTCOMES

The final deliverable will be an engineering model of the new technology hyperspectral focal plane and mass storage, as well as the establishment of the competencies and capabilities needed to develop such a product in the future.

PROJECT 4:

Square Kilometre Array PC Board Localisation

This project is a **collaborative effort** between the **AISI** and the **Technology Localisation Implementation Unit** of the DST, hosted by the **CSIR**

BENEFITING ORGANISATION

TraX Interconnect

Square Kilometer Array (SKA) South Africa has embarked on a localisation strategy for the high-end electronics and mechanical systems that are in development for the MeerKAT telescope. It is envisaged that this will assist in preparing local industry for deeper participation in the international SKA project once it starts the construction phase in 2018. Part of the localisation strategy is incorporated in the supply chain management processes. In this regard the SKA often specifies local content, for instance, on the antenna contract, where 75% local content was required. SKA South Africa will assist local industry to become approved suppliers. This project will position TraX Interconnect as a strategic supplier of Class 3 Printed Circuit Boards (PCBs) to the aerospace and military industries in South Africa.

Figure 1: TraX staff working on the Camtek AOI machine used for SKA PC board development

PC BOARD MANUFACTURING

TraX Interconnect is currently positioned as the leading manufacturer of PCBs circuit boards in South Africa, and sees itself playing a very strategic role in the supply of PCBs to the electronics industry but in particular to the aerospace industry. TraX currently supplies many aerospace customers in South Africa with both technical support and printed circuit boards; however, it has been limited in its potential to supply the volume of PCBs required due to the following factors.

- The technology required by the aerospace industry advances annually and will continue to do so. TraX has over the last 20 years largely been able to improve its capability by constantly re-investing in plant and processes. For the past few years TraX has not been able to invest in equipment at the rate required due to difficult trading conditions. This has resulted in TraX's capabilities lagging behind the curve of offshore competitors.

This project will focus on **upgrading and enhancing** TraX Interconnect **capabilities** in **support** of the Square Kilometre Array Localisation Strategy

Figure 2: Direct Imaging equipment used for SKA PC Board Development

- The aerospace industry typically requires a high reliability product that is manufactured in accordance with Interconnecting and Packaging Electronic Circuits (IPC) Class 3 specifications. Whilst TraX has managed to implement a customer-agreed standard with its largest aerospace customer, it has been unable to implement full Class 3 due to the costs involved. TraX is aware of a significant amount of work that is currently done offshore and would very much like to repatriate this work to South Africa by achieving this standard.

Figure 3: Cyclic Voltammetric Stripping (CVS) analysis equipment to analyse the reverse pulse plating chemistry

The viable market in South Africa has moved from lower-end, higher-volume electronics to high-end, low-volume electronics. In this market TraX remains price competitive with regards to the high-technology, more complex PCBs. This trend is not unique to South Africa and with the majority of the world's printed circuit boards being made in the Far East, the reality is that TraX will never be able to compete on price. Instead it will follow the European trend of differentiating itself through its technology offerings and, most importantly, the support it provides to the local electronics industry for design, application engineering and design for manufacture.

GOALS AND OBJECTIVES

- To support the upgrade and improvement of TraX's capabilities allowing it to position itself as a strategic supplier of Class 3 boards to the aerospace/military and electronics industry in South Africa
- To build on the capabilities in-house, through a process of continuous improvement in processes, software, quality and training.

EXPECTED OUTCOMES

Enhancement of TraX as a strategic supplier of Class 3 PCBs to the aerospace and military industries in South Africa.

Figure 4: TraX laboratory setup

PROJECT 5:

Stellar Gyro Development

This project will utilise a **small multidisciplinary team**, including engineers with skills in electronics, **Field-Programmable Gate Arrays** design, embedded processing, **optics**, software development and **mechanical design**

BENEFITING ORGANISATION

NewSpace Systems

Satellites use different systems for orbit and attitude control. These control systems ensure that the intended orbit of the satellite is followed, and calculate the necessary adjustments, should they drift out of orbit. Some of these control systems make use of the Sun or other light sources to measure the position of the Sun or light sources relative to the satellite's position. Depending on this position, the satellite makes the necessary adjustments to retain its original orbit. A stellar gyro is an advanced solution to solve the problem of drift in traditional gyroscope solutions.

ATTITUDE CONTROL SYSTEMS FOR SATELLITES

The design goal of the stellar gyro is to address the problem of maintaining a high-quality attitude estimate throughout the orbit, notably during eclipse. The sun and magnetic field vectors can be used to find attitude estimates, along with rate gyroscopes to filter and improve the attitude estimate. However, maintaining attitude knowledge in eclipse, in the absence of the Sun vector measurement, is challenging and is often addressed by propagating rate information from the rate gyroscopes at the cost of drift. In order to maintain a high-quality attitude estimate in eclipse, two current alternatives are employed.

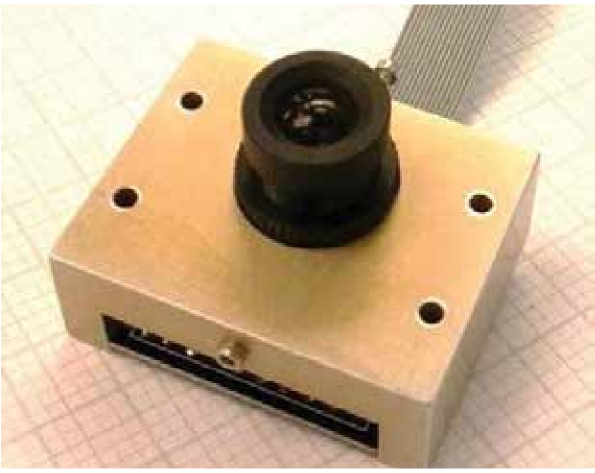


Figure 1: Stellar gyro camera

A star tracker/mapper can be used to identify star constellations and retrieve absolute attitude. However, star trackers add cost and complexity as they require a star database, high update rates, and consequently high-quality optics, sensors and a Sun-baffle. The second method is to use an Earth horizon sensor. For the sensor to work in eclipse, the infra-red spectrum corresponding to the H_2O absorption bands is used. This typically requires a specialised Infrared (IR) sensor, a detector cooling system, or a chopping or rotation mechanism to generate differential readings of the Earth and space temperatures.

A stellar gyro is an advanced solution to **solve** the problem of **drift** in **traditional gyroscope** solutions. This is **essential** for attitude control of **nanosatellites.**

Such a system requires significant power and the mechanical systems have reliability concerns. The units tend to be physically large and need to be mounted on the nadir face which is already a scarce resource due to communications antennae and Earth observation payloads.

A stellar gyro is a key technology for achieving higher performance smaller spacecraft. It achieves fine pointing accuracy at lower cost, uses less spacecraft resources (mass, power, volume) and demonstrates high reliability through robustness 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.

GOALS AND OBJECTIVES

This project will develop an operational stellar gyroscope up to qualification model stage. A prototype camera system will be used to collect real star field images of the night sky to validate the algorithms. Matrix Laboratory (MATLAB) simulations will be written to show the expected attitude determination accuracy achievable with this technology during the eclipse phase.

The objective will be to develop a commercial product 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.

EXPECTED OUTCOMES

A stellar gyroscope for low-cost small and nanosatellites, which is market-ready as an attitude control sensor.

PROJECT 6:

Unmanned Aerial Systems Datalinks and Antenna Solutions for Extended Communications Ranges

BENEFITING ORGANISATION

Tellumat

Datalink solutions to date have targeted the medium-to-large Unmanned Aerial Vehicle (UAV) market with line-of-sight communications ranges up to 250 km, provided the appropriate antenna systems are implemented. These antenna systems would typically be engineered or selected and integrated by the system integrators (i.e. individual components being utilised as a complete system). Several of the local or imported system integrators acquiring or investigating datalinks have identified the need for full end-to-end link solutions whereby the appropriate airborne and ground antenna solution is available as a complete antenna solution or product. For smaller UAVs, datalinks significantly impact the total weight of the UAV. These datalinks weigh in excess of 3 kg, making them suitable for UAV platforms with a total weight in excess of 80 kg. Tellumat has identified a market requirement for a light-weight, short-range datalink for platforms weighing less than 40 kg. These projects address the need for a lightweight datalink for smaller UAV platforms and an end-to-end antenna solution for larger platforms.

DL-5200 SHORT RANGE UAV DATALINK

GOALS AND OBJECTIVES

The project goal is to address the short range (>30 km) UAV video datalink market with a locally designed and manufactured Tellumat product, the DL-5200. This product will allow Tellumat to effectively address local and international small UAV operator requirements.

These projects will **build local competencies** in **Unmanned Aerial Vehicle** datalink developments and **promote export capability**

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

The **primary function** of a datalink system for a UAV is to **transfer real-time data** and video from the **UAV platform** to a **Ground Control Station**

Figure 1: Example of a ground based steerable antenna

Figure 2: Short Range Datalink

EXPECTED OUTCOMES

A qualified DL-5200 datalink product that is ready for the UAV market.

UNMANNED AERIAL SYSTEMS ANTENNA SOLUTIONS FOR EXTENDED COMMUNICATIONS RANGES

GOALS AND OBJECTIVES

The project goal is to offer the market, specifically Unmanned Aerial System (UAS) integrators locally and abroad, a Tellumat datalink solution that is capable of ranges up to 250 km.

The scope of the project is to develop, test and industrialise an airborne steerable antenna solution together with a ground-based high-gain tracking antenna. An additional objective is to integrate the airborne steerable antenna onto a suitable test platform for testing and demonstration.

EXPECTED OUTCOME

A complete antenna solution for increasing communication ranges up to 250 km.

PROJECT 1:

Industrialisation of Joint CAD/CSIR Helicopter Simulator

BENEFITING ORGANISATION

Cybicom Atlas Defence

Flight simulators have become a part of most pilot training and development. They offer safety, educational, financial and environmental benefits. Flight simulation has changed the typical flight training environment and is fast becoming an established tool in training programmes. The recent unveiling of the Simulation Centre at the SAS Simonsberg (Maritime Warfare Training Centre) signifies the importance of flight simulators and their growth in South Africa. This was a joint venture between the South African Navy and industry. Cybicom Atlas Defence (CAD) and the CSIR provided the technology infrastructure and simulation software for the training centre. Moving forward, CAD and the CSIR are focusing on industrialising these technologies and generating a product that is suitable for small-scale production for the simulator market.

TECHNOLOGY TRANSFER AND INDUSTRIALISATION

CAD has invested in simulator Research and Development (R&D) over the last three years in order to achieve a local solution for cost-effective products for the South African Navy (SAN) and other South African markets. The challenge faced is to meet the demands of local budgets while providing simulators that are competitive with overseas products in terms of functionality and build quality.

A **collaborative effort** that focuses on **technology transfer** and **industrialisation**

Figure 1: Original monitor mounting for simulator

The experience with the local design and development of the SAN's Engineering Test Bed and Periscope Simulator indicated quite clearly that local industry is able to provide world-class solutions at substantially reduced prices. However, although the current prototypes have a high degree of functionality, they do not have the finish and build quality of overseas commercial and defence simulators.

Simulators are critical to the operation of the civilian and military **flight training environments** and are a **major contributor** to improving **aviation safety**

CAD and the CSIR have jointly developed a prototype Helicopter Simulator (HELISIM) primarily aimed at integration with the CAD Helicopter Flight Deck Lander (HFDL). CAD is responsible for the visuals (Image Generator [IG] and displays), integration with scenario management and other

Figure 2: Testing of the original simulator

SAN simulators. The CSIR is responsible for the helicopter simulation (in particular, modelling effects for deck landing as well as the controls, seat and instrumentation).

Figure 3: CAD Bridge simulator

This project is intended to convert the current prototype to a product suitable for small-scale production. The main elements of the project are design and construction of a custom stand for the five screen IG display; selection, purchase and integration of the final seat and controls; design and construction of support structures for seat and instrumentation; update of HELISIM models to specific helicopters; and design of stand-alone operation for commercial markets.

GOALS AND OBJECTIVES

The project goal is to commercialise the CAD helicopter IG system and the CSIR helicopter simulator to pre-production model status.

This project is intended to convert the current prototype to a product suitable for small-scale production. The main elements of the project are:

- Design and construction of a custom stand for the five screen IG display
- Selection, purchase and integration of the final seat and consoles
- Design and construction of support structures for seat and instrumentation
- Update of HELISIM models to specific helicopters
- Design of stand-alone operation for commercial markets.

EXPECTED OUTCOMES

A helicopter simulator suitable for small-scale production to cater for the civil and defence markets.

Figure 4: CAD Periscope simulator

PROJECT 2:

The Industrialisation of a Small, Low-Cost Transversely Excited Atmospheric (TEA) CO_2 Laser for the Aerospace Industry

BENEFITING ORGANISATION

PaR Systems

There has been a dramatic increase in the use of composite material in the aerospace industry due to the strength-to-weight ratio. The use of composites brought new challenges to tasks that were already well established, e.g. aircraft non-destructive inspection and paint removal. Due to the nature of composite material it is susceptible to delamination and damage during manufacturing and operation. For this reason the aerospace industry required a tool to conduct non-destructive testing to ensure the integrity of the material. Current Non-Destructive Testing (NDT) and paint removal mechanism of these composite structures require a costly and time consuming task which can be simplified by making use of CO_2 laser advanced technological systems similar to that developed by PaR Systems.

PaR Systems has developed a laser that has a **characteristic wavelength** that is ideally suitable for the **aviation industry**; applications include **non-invasive testing** and paint removal

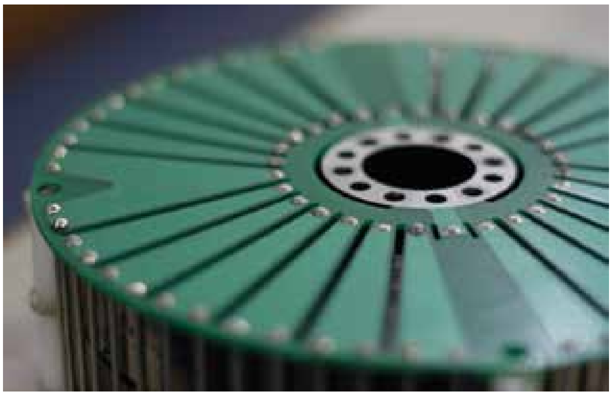


Figure 1: Pulse electronic compressor used in the laser

LASERS FOR THE AEROSPACE INDUSTRY

PaR Systems has developed a large-scale laboratory surface treatment system and a large-scale industrial laser ultrasonic testing system that demonstrates considerable benefits in both NDT, and paint removal of aircraft structures. PaR's large industrial aircraft NDT system uses a CO_2 laser to detect material defects. The system is presently being used at the Lockheed Martin Factory in Fort Worth, Texas, where jet fighters are produced for the US Air Force.

A laser is a device that **emits light** through a process known as **optical amplification**. This optical amplification system produces a **beam of light** which remains fairly coherent over **long distances**

Market research has made it clear that the aerospace industry has an increasing need for the development of smaller and more mobile NDT and surface treatment systems. During the past year PaR Systems received several enquiries for a small CO_2 laser system that can be used in the aerospace industry for NDT, coating removal and Light Detection and Ranging (LIDAR) systems. There is clearly a positive inclination from the aviation market leaders regarding these technologies, which PaR is able to demonstrate; however, initial cost to design and manufacture a smaller CO_2 laser that can be incorporated into these technologically advanced systems is excessively high.

Several other spinoff markets that can also benefit from the development of this smaller pulsed CO_2 laser are systems used for medical skin debridement (removal of dead or damaged skin), laser ranging, cosmetic treatment, Infrared (IR) counter measures, target marking, remote sensing and LIDAR, to mention a few. The latter three will be beneficial to the aeronautical industry.

Figure 2: Laser vessel circulating fan

The designs will ensure that all manufactured parts can be supplied by local South African companies. The assembly and testing of the new small TEA CO_2 laser will be conducted at PaR System's South African offices. The proposed project will be performed by qualified, experienced South African PaR Systems staff with the aid of the Stellenbosch University (SU) and local industry.

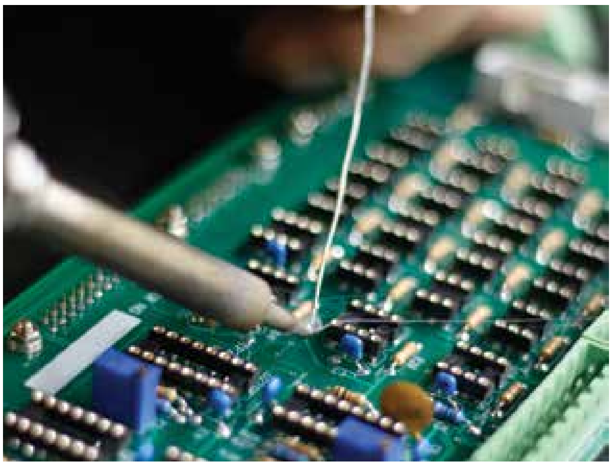


Figure 3: Soldering of arc detector boards

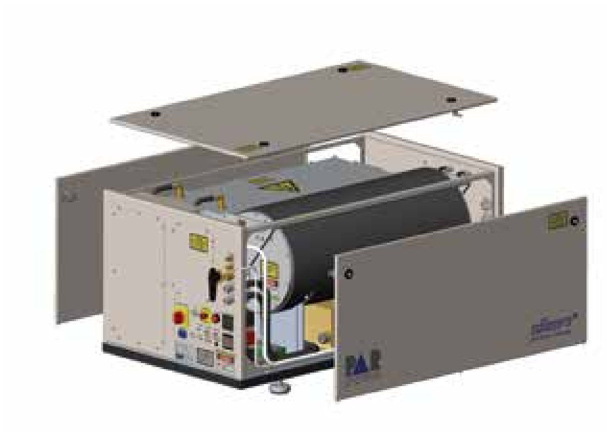


Figure 4: Laser assembly

GOALS AND OBJECTIVES

LIDAR, laser NDT and surface treatment are all technically advanced systems that are used in the aerospace and military industries. These systems have all demonstrated the need for a smaller, lightweight, lower-priced CO_2 lasers. The goal of this project is to industrialise an already proven CO_2 laser technology that will fulfil the requirements for a smaller and cost-effective CO_2 laser in all of advanced technologies mentioned above.

The design of a smaller, cost-effective TEA CO_2 laser meeting industry specifications.

EXPECTED OUTCOMES

A low-cost laser that can be utilised in the aerospace industry for NDT and paint removal.

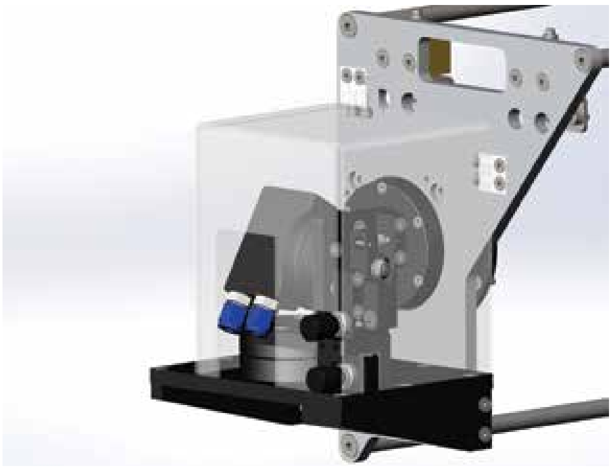
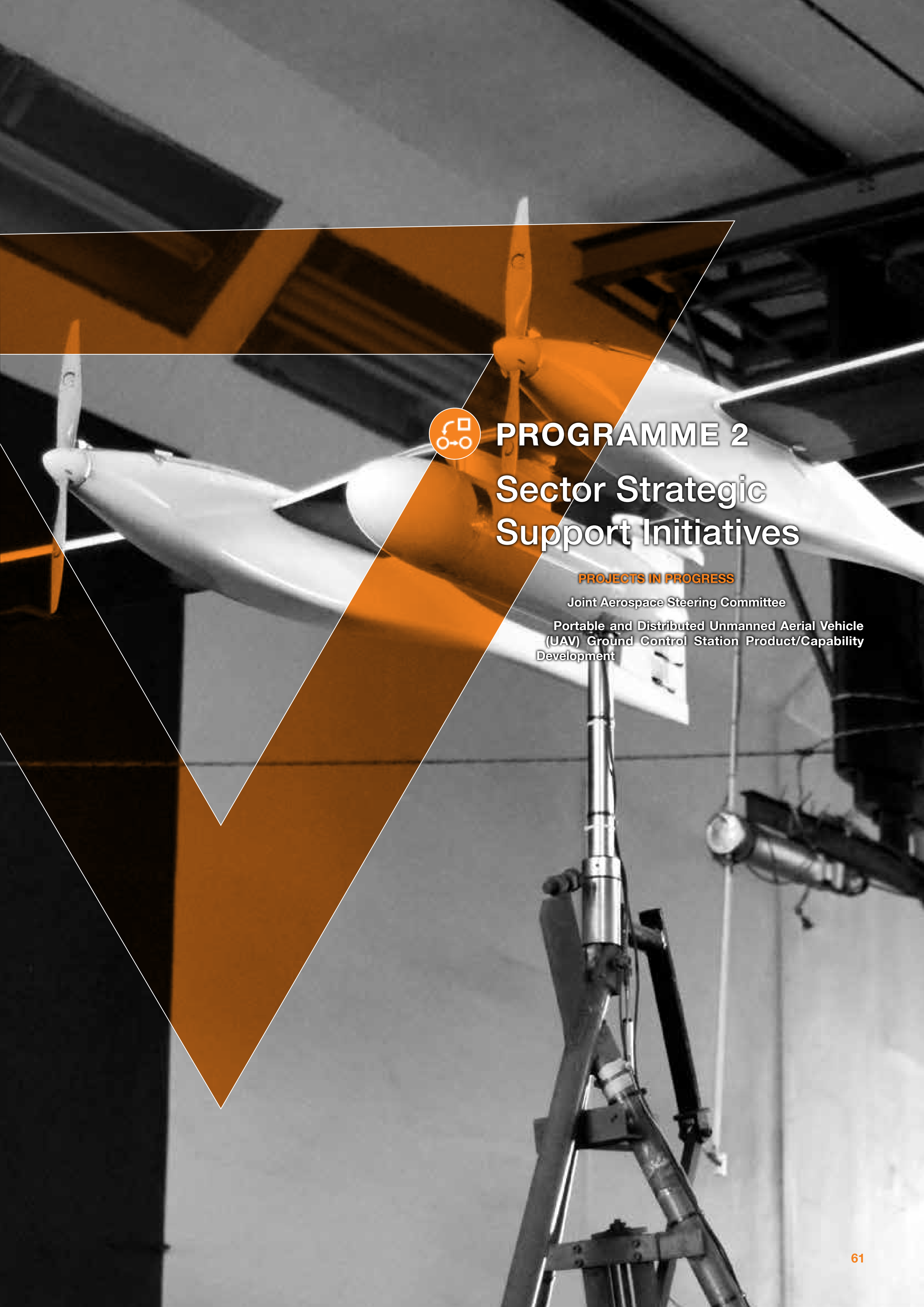


Figure 5: Resonator rear view



PROGRAMME 2

Sector Strategic Support Initiatives

PROJECTS IN PROGRESS

Joint Aerospace Steering Committee

Portable and Distributed Unmanned Aerial Vehicle (UAV) Ground Control Station Product/Capability Development

PROJECT 1:
Joint Aerospace Steering Committee

BENEFITING INDUSTRY

South African Aeronautics and Defence Industries, Government and Academia

The Joint Aerospace Steering Committee (JASC) was established as a result of the findings of the Aerospace SDP. The aim of JASC is to provide strategic positioning for the aerospace and defence industry in South Africa. Through the **the dti's** involvement in the commissioning of the SDP, as well as its leading role in developing JASC, JASC and its activities have been positioned as a sector-wide strategic support initiative.

JOINT AEROSPACE STEERING COMMITTEE

By integrating and utilising policies to strengthen aerospace and defence, JASC aims to facilitate competitiveness improvement programmes, government procurement, supplier development, international and multi-lateral agreements, export support mechanisms and funding for Intellectual Property (IP) exploitation, new product development and exports. It also aims to play a role in South African R&D coordination by influencing research agendas and financing mechanisms, and will also support various skills development initiatives while providing support and funding for technology industrialisation projects, R&D, and industrial infrastructure. JASC aims to achieve the above through the implementation of strategic national flagship projects, managed and implemented by the AISI.

JASC has **three** sub-forums that include:
Industry
Government
Research and Development

JASC VISION

To create a focused, globally competitive South African aerospace and defence industry that also serve as a local source of high technologies, skills, and foreign revenue.

JASC MISSION

To develop, coordinate and manage the aerospace and defence industry capabilities, skills, entities and infrastructure and knowledge to ensure that the industry has sustainable growth, international partnerships in development and production programmes and that the aerospace and defence activities are beach heads for increased national HCD and skills development programmes.

JASC STRATEGIC OBJECTIVES

The key objectives of the JASC are as follows:

I. Establish and maintain a national aerospace and defence forum where government, industry, academia and research organisations meet to ensure that aerospace and defence is coordinated and represented at a national level, especially on:

- Industry positioning on the national policy and industrial domain
- Industry support mechanisms
- Export assistance programmes
- Identification, definition and management of flagship projects (large projects that involve industry, R&D organisations and government)
- Human capital development
- Establishment and support of local aerospace and defence clusters.

II. Facilitate strategic decision making and review of projects

III. Develop and maintain econometric data on the aerospace and defence industries

IV. Develop position papers and provide advice at national level

JASC meets on a monthly basis and comprises members of the following institutions:

- Department of Trade and Industry
- Department of Science and Technology
- Department of Defence
- Department of Public Enterprises
- Department of Transport
- National Treasury
- Aerospace Maritime and Defence Association (Two seats representing industry)
- Commercial Aviation Association of South Africa
- CSIR
- Industrial Development Corporation
- Technology Innovation Agency.

The AISI hosts the JASC secretariat and is responsible for ensuring the JASC and its operations are in accordance with the applicable legislation, including without limitation, the Public Finance Management Act (PFMA) and Preferential Procurement Policy Framework Act (PPPFA), through the CSIR governance structures. Dedicated personnel are tasked to achieve these objectives, and report impact and progress to stakeholders, while ensuring that stakeholders remain informed and engaged. In addition to the secretariat, the AISI implements national flagship projects which are identified by JASC and approved by the AISI MANCO.

PROJECT 2:

Portable and Distributed Unmanned Aerial Vehicle (UAV) Ground Control Station Product/ Capability Development

The **funding** has **supported** the retention of **four skilled employees**

Figure 1: Portable Ground Control Station for UAVs

BENEFITING INDUSTRY

Tellumat

The Portable UAV GCS consists of a combination of hardware and software components, which enable the ground staff to execute the command-and-control functions in an UAS. The development of a networkable and portable GCS will enable the extension of the UAV command and control to Beyond-Line-Of-Sight (BLOS), through a distributed network of multiple control stations. The development of the portable GCS will be executed in two phases. The first phase entails 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, will be enhanced with added features to make the GCS ready-for-flight. Phase 2 entails the redesign and architecture of the GCS software to incorporate the networked and distributed functionality in the portable and distributed GCS.

GROUND CONTROL STATIONS

A UAV GCS consists of a combination of hardware and software components which enables the ground staff to execute the following functions in an UAS:

- Monitor and control the take-off and landing of a UAV
- Control the Mission and Navigational status
- Monitor and control the Payload
- View Payload video
- View target and point-of-interest information
- Monitor UAS operational status and health
- Administer the data communication link
- Control and monitor the antenna positioner
- Alert the operators to failure/alarm conditions in the UAS
- Facilitate secure networking with external systems
- Facilitate the enforcement of operational and flight safety processes and procedures.

Selected as the **Joint Aerospace Steering Committee** flagship project

The main components of the GCS are:

- Mission Control Station (MCS) – this component is usually manned by two operators: one to perform the functions of a pilot to monitor and control the UAV; the other operator performs the functions to monitor and control the payload and its video output. The operators require Operator Control

Units (OCU) to interface to the system. The two units are identical in hardware, but are differentiated in the software applications for the two operator types. The OCU typically has a computer and two monitor screens for each operator
- Ground Data Terminal (GDT) – this component consists of an Automatic Antenna Positioning Unit and its associated datalink and antenna
- Support equipment – including Uninterrupted Power Supply (UPS) unit, Meteorological Station, External Communication Unit, Radio Frequency (RF) Beacon, and spares.

A portable GCS would provide the following benefits in both the military and commercial environments:
- Mobility
- Lower cost
- Ease of distribution
- Quick setup.

Tellumat has made a strategic decision to produce a portable GCS for both the commercial and military environments. This portable GCS will be used to service short-to-medium range UAVs.

GOALS AND OBJECTIVES

Tellumat has various elements of a UAS ground station and associated avionics as a result of a product development roadmap that was started in 2007. The project goal is to develop a portable GCS to complement the existing Tellumat suite of UAS sub-systems.

The project will focus on the design, development and testing of a man-portable OCU hardware and software. More importantly, it will develop local capability in the design and development of UAS subsystems.

The project will be executed in two phases.

Phase I (2014/15)
- Design, develop and test the hardware for the portable OCU
- Enhance the existing software baseline to flight-ready status.

Phase II (2015/16)
Develop and architect the OCU software with the following feature enhancements:

- Network capability
- Encryption
- Video and data storage improvements
- Split payload and operator control
- Multi-pass control between various system users (segregated ground station elements)
- An objective for Tellumat is to have this design capability in South Africa to ensure a level of autonomy and obviate the need for importing costly solutions from international suppliers.

PARTNERS AND COLLABORATORS

This project was completed in partnership with the CSIR, more specifically the CSIR's Modular UAS – Long Endurance (MUAS-LE) program. The goal is to demonstrate the collective ability of the CSIR and Tellumat to the South African (or international) end-users. These technologies may then be adapted with minimal effort and cost, to satisfy various end-user requirements without major timescale or technical risk.

OUTCOMES PHASE I

Portable Ground Control Station (PGCS) has been manufactured and all hardware tested.

TESTIMONIAL

"The funding received from AISI for this project has been welcome support in a time of commercial stress in the UAS business. The funding has supported the retention of four skilled employees in the business. The funding has also indirectly supported local SMMEs, which have been contracted to supply product and services to the project."

Graham April, Project Manager, Tellumat

PROGRAMME 3

Supplier Development

COMPLETED PROJECTS

Supply Chain Improvement and Optimisation Interventions

Supply Chain Optimisation - MyXchange Web Portal

PROJECTS IN PROGRESS

Design and Manufacturing of Aerospace Fuel Tank Structures

Natural Fibres in Aerospace Structures

Process Design of Continuous Fibre Reinforced Thermo-Plastic Joining Methods

Process Design of Titanium Fluid-Cell Forming

Ultra High Cycle Fatigue Design and Testing of High Strength Aerospace Materials

NEW PROJECTS

Localisation and Industrialisation of Insulation Blankets

Process Design and Validation of CFRTP Overlap Joining Method

COMPLETED PROJECTS

PROJECT 1:

Supply Chain Improvement and Optimisation Interventions

BENEFITING ORGANISATION

Vestcast

Supply chain improvements and optimisation interventions represent an important element when considering operational efficiency. For smaller manufacturing SMMEs, these interventions become vital as they result in decreased scrap metal rates and increased productivity, all leading towards an improved cost saving in operations. A supply chain needs analysis identified Vestcast, a manufacturing SMME that focuses on investment castings, as an organisation that could benefit from improvement and optimisation interventions. The CSIR is currently supporting the AISI with the 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.

IMPROVEMENTS AND INTERVENTIONS

Vestcast is a job shop production plant, meaning that it only Makes To Order (MTO). The challenge the company faces is a high level of scrap despite having a quality management system in place. In 2012 and 2013, about R400 000 worth of products were scrapped annually due to quality defects. At times the production line is able to keep the scrap quantities at a minimum, resulting in overproduction. According to lean manufacturing principles, overproduction is one of the seven wastes. Therefore, the root causes for defects need to be eliminated to reduce overproduction and thereby reduce waste.

Pareto analysis, Fishbone Diagram and **5 Why's** were some of the tools **used to uncover** the **root causes** of defects leading to **high scrap rates**

The defects affect the quality of castings, which sometimes leads to customer dissatisfaction. The defects also affect the lead time because of re-work that has to be done, thereby causing delays. The company sends out customer satisfaction surveys to all its customers. The customer surveys are analysed and the quality of products and lead time are identified as leading complaints from customers.

The company was recently audited on its quality management system and there was a finding of high rate of defects. This finding might prevent the company from being quality certified in future as this indicates a lack of proper utilisation of the quality management system. For the company to attract more business and stay competitive, the defects must be eliminated.

Manufacturing companies can utilise the **tools and methodology** used in this **project** to reduce scrap levels and thereby **maximise their profits**

An investigation into the root causes was conducted using a root cause analysis technique. Pareto analysis, Fishbone diagram and 5 Why's were some of the tools used to uncover the root causes of defects leading to scrap. The identified recurring defects were analysed to eliminate their root causes.

GOALS AND OBJECTIVES

The goal of this project was to improve quality at Vestcast by properly utilising its quality management system. The quality management system is currently in place but the company still faces high levels of scrap. The utilisation of all the tools that the quality management system provides should lead to the reduction of scrap levels. When the quality management system is implemented, improvement tools and monitoring tools are provided to ensure that the quality is maintained at acceptable levels.

Quality improvement is an ongoing process that requires continuous improvement techniques. This project aims to use these tools to identify and eliminate the root causes of defects.

The main aim of this project is to improve quality at Vestcast. The objectives were:

- To identify factors affecting quality at Vestcast (including utilisation of the quality management system that is currently in place)
- To identify defects contributing to a high monetary loss
- To utilise the continuous improvement tools and techniques, which are provided in the quality management system to identify defects that lead to a high scrap rate thereby addressing the root causes
- To minimise the scrap rate by eliminating root causes contributing to defects.

Figure 1: Vestcast inventory management

OUTCOMES

At the conclusion of the project the findings and recommendations were presented to Vestcast management. A corrective action plan, responsible person and timeframes were proposed and discussed during the presentation. Quality Circles, which were formed by a group of workers, were successfully implemented.

IMPACT AND BENEFITS

Industry Benefits

It is common for manufacturing companies to experience defects. Implementing the quality management system assists companies to have tools and techniques for reducing defects. Poor utilisation of the quality system can lead to a high scrap rate.

Figure 2: Manufacturing done at Vestcast

The project for improving quality at Vestcast employed different engineering problem-solving tools. The manufacturing companies can utilise the tools and methodology used in this project to reduce scrap levels and thereby maximise their profits.

Skills and Human Capital Development

A number of third-year industrial engineering students from the University of Johannesburg assisted in collecting data for root cause analysis for defects. One of the implemented interventions at Vestcast was Quality Circles. Quality Circles empowered the personnel at Vestcast because they were trained on problem-solving techniques and on how to use quality tools.

PROJECT 2:

Supply Chain Optimisation - MyXchange Web Portal

BENEFITING ORGANISATION

Aerosud Aviation and Supplier Base

The AISI appointed Collaborative Xchange to develop the capabilities of the South African SMME base. The project was initiated by **the dti** and has been successful in mobilising the local aerospace industry to bring together the disparate systems of the various supply chain role players. The solution provides complete supply chain visibility for the South African aerospace industry. The benefits of a solution of this nature are immediately visible by comparing the current processes, efficiencies and operational excellence to those of manual processes used prior to the implementation of the MyXchange Solution. The adoption of the MyXchange solution within industry also allows for continual research and improvements related to today's best practice, and always drives efficiencies.

IMPACT AND BENEFITS

Productivity Improvement

- The MyXchange Solution assists with lean manufacturing by providing detailed order data in real time, which inform both SMMEs as well as OEMs of exact delivery/shipment dates
- Time efficient, as re-capturing of requirements are not required by SMMEs and OEMs
- All orders and invoicing processes available in a centralised environment
- Reduction in payment disputes as complete electronic audit trail of all ordering transactions are available to SMMEs and OEMs
- Reduction in paper usage due to electronic ordering
- Cost saving to SMMEs as minimal warehouse space is utilised.

Twenty-one SMMEs are currently active on the **MyXchange Portal**

There are currently twenty-one SMMEs active on the solution. The SMMEs see the following benefits from the solution:

- Suppliers are able to activate entire second tier supplier bases
- Forecasts of orders are available for the SMMEs, which provides them with sufficient time for the production of goods in line with the OEM's requirement. This also assists the SMMEs to identify any production shortages based on demand and in doing so, allow them to ensure optimal productivity
- Efficiency is achieved in terms of saving time, due to the elimination of re-capturing of orders. As a result, SMMEs are able to focus on additional production requirements
- Reduction in costs, by not requiring expensive Enterprise Resource Planning (ERP)/Materials Requirements Planning (MRP) systems
- Productivity is increased whilst reducing risk, as a result of accurate data as well as immediate data availability and automating forecasting
- Improved lead times as a result of automated solutions, shipment processes and production forecasting.

The portal also provides the **Original Equipment Manufacturer** with visible information on what its **supplier base** can and cannot deliver, as well as **tracking all purchase orders**

PROJECTS IN PROGRESS

PROJECT 1:

Design and Manufacturing of Aerospace Fuel Tank Structures

BENEFITING ORGANISATION

Denel Aerostructures
CSIR
University of Pretoria

Sloshing (the movement of a liquid inside another object also undergoing motion) is an important aspect of aerospace fuel tank design. This project proposes the establishment of a specialised capability for the loads analysis of aerospace fuel tank structures, thereby providing critical design information to the local industry. It aims to obtain a competitive advantage in the international market by leveraging locally developed technology and in so doing, attract foreign investment and grow its footprint in the global supply chain. The project will be undertaken by Denel Aerostructures (manufacturing), the University of Pretoria (UP) (experimentation) and the CSIR (computational modelling).

This project proposes the **establishment** of a specialised capability for the **design and manufacturing** of fuel tank structures in the **aerospace industry**

Figure 1: Fuel tank assembly at Denel Aerostructures

COLLABORATIVE EFFORT TO ENHANCE SKILLS, KNOWLEDGE AND TECHNOLOGY TRANSFER

With the aim of reducing cost, the international aerospace industry is increasingly outsourcing manufacturing and R&D as part of offset agreements. Given the urgent need to grow the South African economy and establish sustained job creation, the aerospace industry with its high value-added manufacturing provides a very attractive opportunity. South Africa with its extensive background in the aerospace industry along with its flexible and innovative engineering expertise is ideally suited to realise such opportunities and establish itself as a reliable, cost-effective manufacturing partner.

A collaborative effort between industry, academia and a science council to **advance aerospace knowledge** and capability

There are currently a number of internationally-recognised capabilities residing in South Africa, which are related to the design and manufacturing of aircraft fuel tank structures. Although these are currently being marketed and sold in both the local and international market, it is suggested that by combining these, a specialised capability may be established from which the economy may derive greater returns.

Denel Aerostructures (DAe) has extensive background in the design and manufacturing of complex metallic and composite aero-structures for the military and commercial aviation sectors. Evidence of this is DAe's involvement in a number of international programmes, including the A400M programme, in which it is a risk-sharing partner. Denel Aerostructures has an established track record in the design and manufacturing of integral fuel tanks (e.g. for the Impala, Bosbok and Kudu) as well as external fuel tanks (ferry tanks for the Rooivalk combat helicopter).

In recent years, 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.

Figure 2: Fuel tank assembly at Denel Aerostructures

To establish confidence in the simulation software, it is important to conduct tests to validate the numerical algorithms used in the analysis of fuel sloshing in the tanks. The Centre for Asset Integrity Management at the UP has a strong 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. This positions UP uniquely in the international market since it is able to perform integration of research with industrial-scale experimental facilities.

By leveraging these technologies and ensuring their integration it would be possible to establish locally a specialised capability for the design and manufacturing of fuel tanks. This will mainly be due to the capability of calculating fuel loads on the tanks provided by the CSIR's software. This would provide the South African aerospace industry with a very unique business opportunity to provide an all-inclusive and very competitive solution for the design and manufacturing of fuel tank structures.

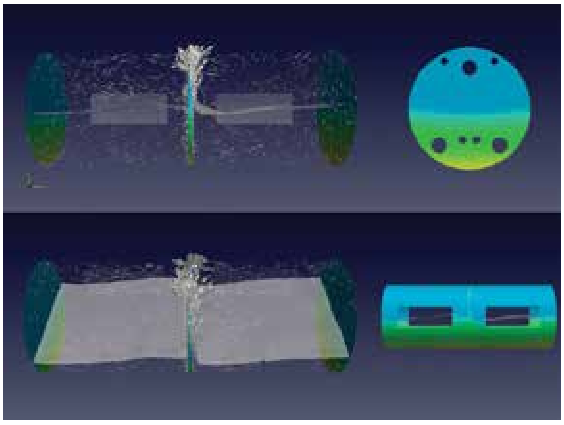


Figure 3: Fuel tank sloshing simulation done by the CSIR

GOALS AND OBJECTIVES

This project proposes the establishment of a specialised capability for the design and manufacturing of fuel tank structures in the aerospace industry. It aims to obtain a competitive advantage in the international market by leveraging locally developed technology and in so doing, attract foreign investment. Then, by building on high value-added manufacturing, it would be possible to ensure sustained growth of human resources and skills development. Furthermore, due to the nature of the work, it is likely to drive innovation and industrialisation. It is hoped that the establishment of this capability would act as a technology incubator.

Figure 4: CAD model of sloshing apparatus at the UP

Validation work package

The first step to allow for the adoption of the simulation technology and supporting industry is its validation. This step forms an integral part of the certification process. As part of the validation, it is proposed that a ferry/drop tank designed and manufactured by DAe be evaluated.

The tank under consideration is subject to severe dynamic fuel loading. By means of simulation, the design engineers can derive great insight of the resultant loading on the tank structure as well as its influence on the aircraft stability.

To establish confidence in the technology, it is, however, necessary to conduct experimental analyses to validate the accuracy of the numerical model and establish the accuracy of the predicted loads. Virtually no usable validation data are available in literature, and experimental analysis therefore represents significant value addition.

To validate the technology and allow for its application by industry, a dedicated test tank would be designed and manufactured to conduct experimental analyses. Thereafter, the tests would be numerically simulated and the results compared.

Application work package

The second part of the project will consider the application of the technology to a system under design. Denel is developing a rotatory wing UAV that would carry approximately 180 litres of fuel. It is estimated that the weight of the airframe would be only 20% of the fuel weight and for this reason, the structure would be highly sensitive to the dynamic behaviour of the fuel. This part of the project would concern the design, analysis and testing of the fuel tank structure of a rotary wing UAV.

This would allow for the integration of numerical simulation and experimental evaluation of the tank to support the design and manufacturing process. It is believed that by providing design engineers with better insight into system dynamics, this technology would reduce risk during the development stage and improve the efficiency of the system.

EXPECTED OUTCOMES

Advanced capability and know-how for the design and manufacturing of aerospace fuel tank structures.

PROJECT 2:

Natural Fibres in Aerospace Structures

BENEFITING ORGANISATION

Denel Aerostructures

Composites are the fastest growing materials market in the world. There is a continuous drive to use green technologies and reduce material and manufacturing costs. Natural fibres, owing to their good strength-to-weight ratio, are gaining in popularity and are 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. One area in which natural fibres may be employed is in aerospace class three-type structures, i.e. interiors. The capability developed within this project is linked to the use of natural fibres in the development of the South African Regional Aircraft (SARA) by Denel Aerostructures.

INDUSTRIALISING NATURAL FIBRES FOR THE AEROSPACE INDUSTRY

Composites are the fastest growing material market in the world. There is a need to reduce material costs and optimise process and production costs. There is also a continuous drive to use green technologies. The automotive industry, because of the hefty CO_2 emissions tax penalties, has started looking to composites for weight savings, in particular to the technologies employed by the aerospace industry. At the same time aerospace is copying the motor vehicle mass production techniques. We are heading for an interesting scenario where the low volume/high strength aerospace market will meet the high volume/traditionally low strength market.

Taking natural fibres from a **research environment** to the **next level** by **industrialising** it in an **aerospace manufacturing environment**

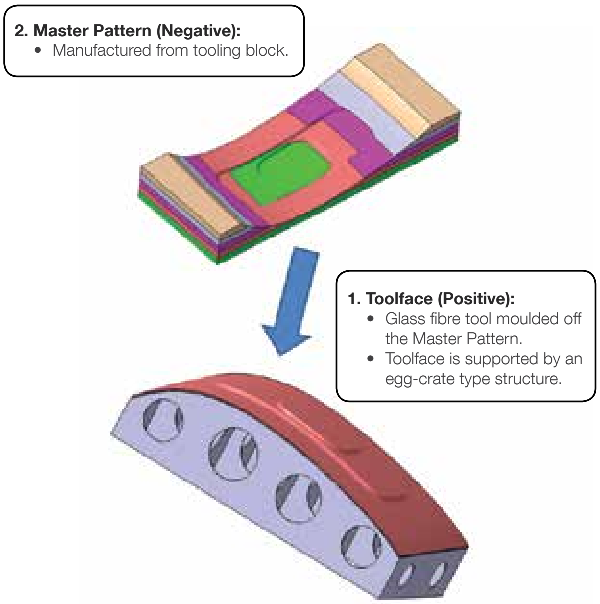


Figure 1: Master pattern and tool design for the SARA interior lining

The automotive industry has for some time been using out of autoclave manufacturing methods with great success and aerospace has followed suit. In addition automotive industry has been looking at natural fibres for motor vehicle interiors, with the aerospace industry also showing interest, especially for class three-type structures, i.e. interiors.

The intent is to **grow the local composite market** by utilising **natural fibres** developed by the local **South African market**

With the abundance of natural fibres in South Africa, extensive research resides locally, for example at the University of the Witwatersrand, Durban University of Technology and the CSIR. This research should now be taken to a higher

Technology Readiness Level (TRL) and the local aerospace industry can make a contribution by determining the feasibility of using some of these natural fibres in conjunction with a thermoset or thermoplastic matrix in aerospace structures, which will naturally also have spinoffs for the local industry at large.

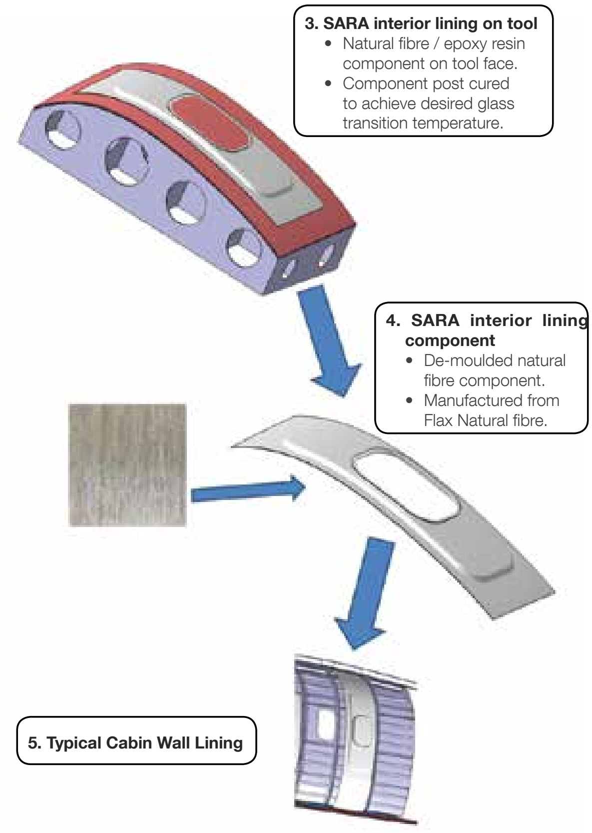


Figure 2: Typical SARA interior lining manufactured from Natural Fibres

GOALS AND OBJECTIVES

The aim will be to take natural fibres from a research into a production environment. The feasibility of using natural fibres in aerospace class three-type structures will be assessed (i.e. where loss of structure will not be catastrophic to aircraft). The emphasis will be on locally manufactured and researched natural fibres, where possible. The fibres will be processed in conjunction with a polymer matrix (thermoplastic or thermoset resin). A set of material tests allowable through coupon testing accounting for environmental conditions will be determined to a feasible manufacturing process. The feasibility loop will be closed by manufacturing and assessing an aerospace component to a frozen manufactured process. The outcome will be a ready-to-use design and a manufacturing process for the selected fibres in an aerospace structural environment. The local aerospace industry will be provided with a cheaper alternative to synthetic fibres, with the design and manufacturing data for aerospace-type composite structures. Further objectives are to:

- Take natural fibres from a research environment to the next level by industrialising the material in an aerospace manufacturing environment
- Determine the feasibility of using natural fibres in conjunction with polymer-based matrixes in aerospace structures; a pyramid approach will be followed
- The material allowable of the selected natural fibre/ polymer resin (thermoplastic or thermoset) will be characterised through coupon testing
- Account for environmental effects (i.e. temperature and moisture); the specimens will required to be aged
- Test specimens will be manufactured to a frozen repeatable process
- For damage tolerance requirements some coupons will be impacted
- Test a typical sub-component designed with coupon material allowable as inputs and manufactured to the selected frozen process in a manufacturing environment
- Typical sub-component that will be addressed will be either an aircraft interior component (monolithic or honeycomb reinforced, Boeing/Cayley project interior lining) or a monolithic-type structural beam.

EXPECTED OUTCOMES

Effectively utilising natural fibres in an aerospace manufacturing environment.

PROJECT 3:

Process Design of Continuous Fibre Reinforced Thermo-Plastic Joining Methods

BENEFITING ORGANISATION

Aerosud Aviation

Process design of Continuous Fibre Reinforced Thermo-Plastic (CFRTP) joining methods constitutes the next important layer of technology that will enable Aerosud and other industry partners to start participating in the CFRTP assembly market internationally. In this project CFRTP parts will be analysed from the specific viewpoint of assembly. Joints between metal components and CFRTP structures will also be investigated as an integral part of major assemblies. A complete assembly for installation on aircraft will be produced and tested to ensure that the full process design cycle is understood and tested.

The international aircraft industry produces a steadily increasing number of aircraft per month. The subsequent requirement for more light-weight components and faster manufacturing processes led Aerosud to initiate the project.

CONTINUOUS FIBRE REINFORCED THERMOPLASTICS PROCESSING DEVELOPMENT

This research project was co-funded through the DST's Advanced Manufacturing Technology Strategy (AMTS) and commenced in 2007. Within the context of this research project, a CFRTP stamp-forming process was developed. Subsequent industrial process development was conducted with AISI co-funding. This led to the successful implementation of manufacturing processes for 1 800 frame clips per month for the Airbus A350 programme.

The **Continuous Fibre Reinforced Thermo-Plastic** process will be demonstrated using the **rudder assembly** from the experimental Advanced High Performance Reconnaissance Light Aircraft **(AHRLAC) aircraft**

INCENTIVE FOR DEVELOPMENT OF CFRTP ASSEMBLY TECHNOLOGY

After forming the clips at Aerosud (Tier2 supplier), they are shipped to Spirit Aerostructures (Tier1 supplier) in the US where the clips are assembled to the aircraft frames and skins using rivets and bolts. The assembled panels are fed into the Airbus (OEM) assembly lines in France where they are mounted onto the aircraft.

This project will develop **younger technicians** and include more of the **composite production** team **at Aerosud**

The abovementioned flow of parts from Tier2 to Tier1 and finally to the OEM is currently the most commonly used route for a CFRTP part to be integrated in the final aircraft. This flow is, however, not ideal and the internationally recognised technical and logistical challenges can be summarised as follows:

- By fastening CFRTP parts with rivets and bolts, as most assemblies are done today, the fibre path is broken and point loads are introduced
- Using CFRTP welding technology, which is a faster process, one can yield a much lighter joint (more gradual load path; no need for metal fasteners)

- Because Tier1 suppliers have made the deliberate decision to outsource the development and manufacture of CFRTP parts to their Tier2 suppliers, their in-house knowledge base for CFRTP technology is insufficient to start the internal development of CFRTP welding technology.

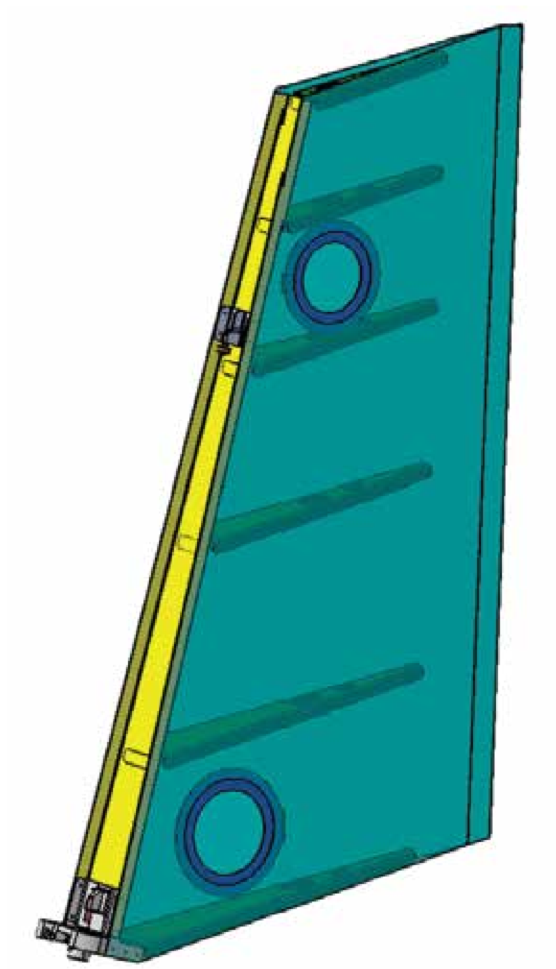


Figure 1: CAD model of rudder to be manufactured using CFRTP methods

The solution is obvious: Tier2's need to expand their capability from simply producing CFRTP parts to being able to supply complete CFRTP welded assemblies to existing Tier1 suppliers or directly to the OEMs, hence moving up in the aeronautical value chain.

The market for this capability expansion is evident from the increasing number of requests for complete CFRTP assemblies. Aerosud has a sound CFRTP knowledge base, which should allow it to tap into the ever-growing market of CFRTP assemblies in the near future, provided that a locally developing CFRTP assembly technology is started.

Further to basic CFRTP manufacturing knowledge, it has become evident that there is a great need to design full process chains for this technology. One of the intrinsic challenges of moulding CFRTP components is that the forming takes place using heated moulds (200-240°C). During the subsequent cooling down to room temperature, uneven thermal shrinkage introduces residual stresses, which cause the parts to deform. This residual stress pattern is complicated by the fact that a composite material is not homogeneous. Reliable modelling of residual stresses in this material will allow processes and tooling to be designed much faster with minimal iterations and, most importantly, the production of parts with tight geometrical tolerances, which is vital for producing assemblies. The ability to shorten the development time will also allow Aerosud sub-tier suppliers to participate in the supply of these components.

GOALS AND OBJECTIVES

This project will develop and demonstrate the capability of a robust process chain for the design and manufacture of CFRTP assemblies in the South African aerospace environment.

For the purposes of this project, an all-metallic rudder assembly from the experimental aircraft AHRLAC will be re-designed to be manufactured in CFRTP.

The objectives are the following:

- Design and analyse CFRTP components
- Design and analyse CFRTP common and metal joints
- Manufacture and inspect parts
- Assemble and test full assembly
- Technology transfer.

EXPECTED OUTCOMES

A new process for the joining of CFRTP structures.

PROJECT 4:

Process Design of Titanium Fluid-Cell Forming

BENEFITING ORGANISATION

Aerosud Aviation

Titanium sheet forming is a process that requires specialised tooling and equipment. Industrialisation of components must be done with absolute minimal iteration to ensure the financial viability of the programmes. 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. This project will investigate through local and international collaboration the state-of-the-art methodologies for titanium sheet forming.

TITANIUM IN THE AEROSPACE INDUSTRY

The aerospace industry has been taking advantage of the benefits of titanium for decades. With extraction and processing costs continuing to decline, more aircraft are expected to use titanium in their structures. The industry is constantly looking for new and improved ways to design more fuel-efficient aircrafts, and the characteristics of titanium provide the level of strength and durability they need without adding excess weight.

However, to maintain and grow the current supplier position to the OEMs, continuous cost reduction is the primary deciding element. Competitiveness with a very strong emphasis on cost and weight reduction to promote efficiency and ultimately achieve reduced cost, can only be achieved by exploring manufacturing technologies that will allow Aerosud to reduce manufacturing costs on existing and future materials and processes.

Titanium and its alloys are extremely attractive because of two major attributes:

- Galvanic compatibility with carbon-based composites
- Strength-to-weight ratio.

Hydroforming or Fluid-Cell forming **utilises a process** that uses high pressure fluid **to form metal** into the **required shapes**

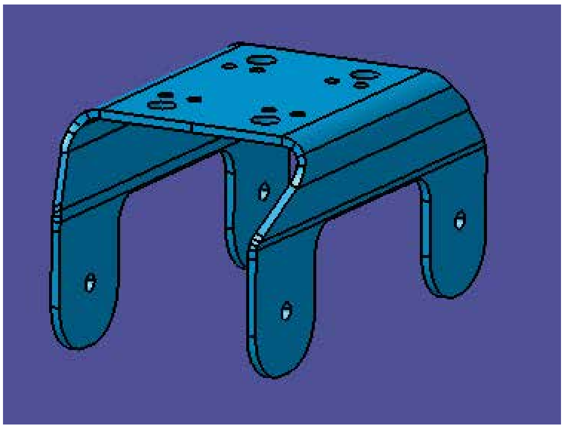


Figure 1: Demonstrator part bracket

Titanium is extremely expensive; it is therefore important to demonstrate the capability to manufacture complex shapes from sheet as opposed to expensive machining. Simulation modules aid the user to quickly build a parametric tool geometry using the component as a reference. Blank holder and die addendum surfaces are intuitively generated, affording the user an interactive process between die design and simulation.

Develop and demonstrate a capability to **design a complete process chain** for the manufacture of **titanium sheet-based** products using **hydro forming** for aviation applications

'Right first time' tooling can only be achieved by replacing physical try-out with virtual try-out, and by replacing it with the most accurate virtual try-out possible. This means being able to spot all the usual formability issues such as splits, wrinkles and slip-lines. Simulation must take into account all of the usual techniques: draw beads, spacers, lubrication, gas-springs, and variable cushion forces. These can all be easily included in the virtual simulation, just as the engineer would tune and optimise the process.

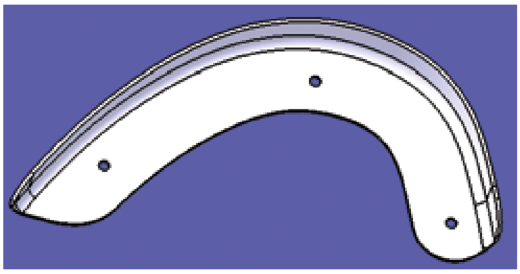


Figure 2: Demonstrator part large riblet

Titanium sheet metal forming promotes and strategically supports continuous development of current beneficiation programmes:

- Pre-forms for Additive Manufacturing (AM)
- Promotes development of joining technologies such as laser and friction stir welding
- Requires know-how and cooperation learnt from high performance machining
- Will exploit the natural symbiosis with composite materials
- Drives higher technology development programmes such as super plastic forming
- Drives simulation and material testing capabilities and assists in accreditation programmes
- Stimulates, creates and promotes synergy between industry, research councils and tertiary academic institutions.

All of the above will promote the total beneficiation of natural resources and increase the drive towards development and delivery of metallic titanium and titanium components from SA resources.

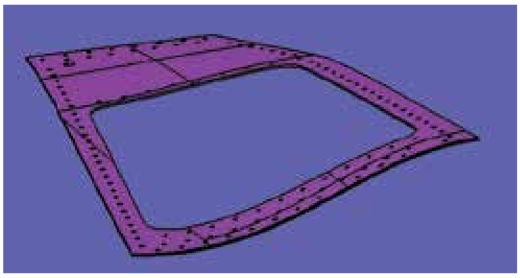


Figure 3: Demonstrator part skin

GOALS AND OBJECTIVES

This project will develop and demonstrate a capability to design a complete process chain for the manufacture of titanium sheet-based products, using hydro forming for aviation applications.

Current and future aerospace products (Boeing 787 and Airbus A350) require more efficient materials and processes with a strong emphasis on aluminium, titanium and carbon composite materials. Participation in manufacturing programmes of these products is governed by manufacturing efficiencies and unit cost.

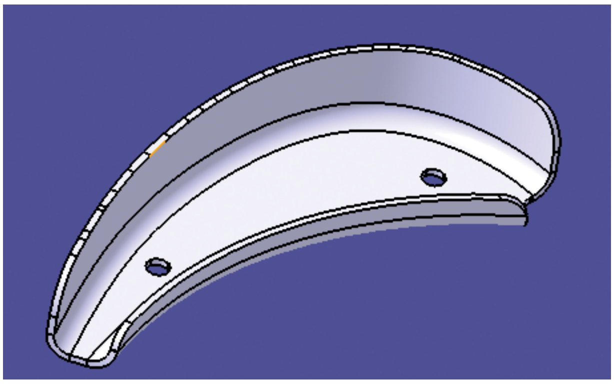


Figure 4: Demonstrator part small riblet

This project will focus on positioning the South African aerospace industry to participate in current and future supply chains with global aerospace OEMs on a sustainable basis. The overall aim is to overcome key capability barriers in relation to the manufacture of advanced sheet-based aerospace products. The key objectives can be listed as follows:

- Create a baseline simulation competency
- Create a simulation guided tool design capability
- Demonstrate simulation and design methods
- Validation of results.

EXPECTED OUTCOME

A new process for forming titanium for use in the aerospace manufacturing industry.

PROJECT 5:

Ultra High Cycle Fatigue Design and Testing of High Strength Aerospace Materials

BENEFITING ORGANISATION

Denel Aerostructures

Ultra-sonic fatigue research has been primarily undertaken in France, the United States of America, Slovakia, Austria and Japan. The research being undertaken is due to the fact that many newly designed systems and high-strength materials are required to last for increased 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. There is currently a shortfall in the understanding of the effects of Ultra High Cycle Fatigue (UHCF) (High Cycle Fatigue [HCF] will represent a sub-set of UHCF) on high strength materials which are subjected to UHCF loading. To this end, Denel Aerostructures (DAe) has endeavoured to extend the work already undertaken in order 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 implemented into future practical applications.

EFFECTS OF ULTRA HIGH CYCLE FATIGUE ON AEROSPACE MATERIALS

The understanding of fatigue behaviour (for a vast range of tested materials) of components that undergo loading within the low and high cycle regions is not very comprehensive. However, behaviour of ultra-high fatigue on high-strength materials (in particular) have only recently shown varying behaviour to those which have undergone low-cycle testing, due to material inhomogeneity, temperature change and defect location. There is thus a need to examine the effect of crack initiation of these materials under ultra-high cycle loading.

It is believed that this project will fill the need for a better understanding of high to ultra-high cycle fatigue effects on high-strength materials which exhibit the differing behaviour to that found in the low-cycle regime. Titanium (alloys) represents one of the most common material types currently exposed to UHCF-type loading due to its high load and temperature-bearing capability (used in high-temperature turbine blades, for example). The understanding of UHCF on titanium will not only help build a database for practical application but also prevent component failures, which have previously not been considered in the design phase.

Fatigue is a progressive and localised **structural damage** that occurs when a **material is subjected** to **cyclic loading**

The main reason for the current project is to undergo UHCF (larger than 107 cycle range) testing using aircraft-grade titanium. This forms a basis for an entirely new and previously untested (under UHCF) group of materials in addition to the previous work using aluminium. It is indeed noted that UHCF testing on titanium requires the design and analysis of a completely new specimen (‘horn’) for the UHCF testing machine in addition to the execution of more tests. It is also proposed that the original testing rig be modified in order to superimpose and study the effects of HCF against UHCF loads. The superposition of the two regions (fields) requires a complex analysis and re-design of the current testing machinery.

UHCF will include **testing on aircraft grade titanium** resulting in a more **comprehensive** database for **high-strength** aircraft grade materials

Figure 1: UHCF experimental setup

GOALS AND OBJECTIVES

The project goal is to develop capabilities on a variety of high-strength aircraft-grade materials (chiefly examining inclusion location and size of defect), which forms part of the study supplementing the previous work carried out on aluminium. An investigation into the variances between these materials due to HCF and UHCF loading will also be made. In addition to the testing of titanium using the developed testing rig, it is proposed that the testing rig also be modified in order to superimpose and study the effects of HCF and UHCF threshold limits. Further objectives include:

- The effect of UHC fatigue levels on high-strength materials (primarily used within the aerospace sector) will be investigated
- An adaptation for testing of UHCF on titanium as an extended capability.

EXPECTED OUTCOME

A mechanical testing machine capable of testing high strength aerospace materials and the effects of HCF and UHCF

Figure 2: UHCF testing equipment

NEW PROJECTS

PROJECT 1:

Localisation and Industrialisation of Insulation Blankets

BENEFITING ORGANISATION

Aerosud Aviation

Aerosud Aviation is currently a contributor to the Airbus A400M programme. Distribution of specific components to the programme has been delayed as there have been supply blockages in the delivery of insulation blankets from a foreign subcontractor. This situation has opened an opportunity to localise and industrialise the manufacture and assembly of these components. Manufacture of insulation assemblies will be industrialised at an Aerosud-certified location as this is mandated by aviation manufacture certifications. The intention is to create a long-term sustainable platform in partnership with local organisations to manufacture insulation assemblies for delivery to Airbus for the duration of the A400 project.

REDUCING MANUFACTURING COSTS THROUGH IMPORT SUBSTITUTION

The South African aerospace industry is stable, and even in the difficult recent economic climate, the South African aerospace industry reported growth. This is done through continuously exploring newer technologies, exploiting them to maintain a competitive edge and growing them to an advantage when considering other third-world and emerging countries.

Insulation or thermal blankets **protects components** from the harsh **environment** experienced **during flight**

However, to maintain and grow the current supplier position, continuous cost reduction is the primary deciding element. Competitiveness with a very strong emphasis on cost and weight reduction to promote efficiency and ultimately achieving reduced cost can only be achieved by exploring manufacturing technologies which will allow Aerosud to reduce manufacturing costs.

The manufacture of insulation assemblies will be industrialised at an Aerosud-certified location. This project will not only advance the capability to assemble and deliver assembled components, but will also bring foreign spending back to South African companies through localisation of this technology.

The **industrialisation** of the assembly will create an additional **5 permanent jobs** to deliver approximately **550 insulation assemblies** per month

GOALS AND OBJECTIVES

This project will deliver a fully certified and industrialised process for the manufacture of A400M insulation blankets as per the Airbus requirements.

To achieve the goal of this project, the following objectives will be reached:

- Acquiring of equipment
- Process design
- Industrialisation of process
- Manufacture of assemblies
- Certification of process
- Technology transfer.

EXPECTED OUTCOMES

A fully certified and industrialised process for the manufacture of insulation blankets as per Airbus requirements.

PROJECT 2:

Process Design and Validation of CFRTP Overlap Joining Method

BENEFITING ORGANISATION

Aerosud Aviation

Aerosud's current AIRBUS A400M cargo linings project requires the manufacture, qualification and delivery to aircraft final assembly line of various Continuous Fibre Reinforced Thermo-Plastic (CFRTP) parts. One CFRTP part referred to as the Lower Connection Units (LCUs) are large complex-geometry parts. The LCU parts have proved extremely difficult to manufacture from a single sheet of CFRTP material. In addition to the high manufacturing scrap rates, the correct geometry of the parts cannot be achieved resulting in Airbus not accepting the parts for installation on the aircraft. It was proposed that the LCU parts be manufactured as per design definition, using small multiple sheets (blanks) 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.

UNMANNED AIRCRAFT SYSTEMS

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 is performed together with the forming process, resulting in a consolidated joint performed with the CFRTP material in its molten state.

The process of **joining** of multiple **Continuous Fibre Reinforced Thermo-Plastic** blank parts in order to create **a larger single-piece complex-geometry** CFRTP part will be designed, industrialised and **validated** through testing to confirm compliance to **qualification** and OEM requirements

In addition to the development and industrialisation of this joining method, the detailed design and qualification of these overlap joints need to be performed in order to ensure compliance and qualification for acceptance of the LCU parts by Airbus for installation on the A400M aircraft. The qualification will require the manufacture and testing of full-scale as well as representative test samples.

GOALS AND OBJECTIVES

This project will provide the detailed design, industrialisation and qualification of overlap joints for the CFRTP LCUs parts to be installed on the AIRBUS A400M aircraft.

All qualified CFRTP assembly parts will be **produced and delivered** for installation on **AIRBUS A400M aircraft**

This project will require the following tasks to be performed:

- Develop the detailed design of LCU joints as per AIRBUS A400M requirements
- Perform simulation studies of the multiblank LCU parts
- Manufacture and testing of samples as required for the validation and qualification of the design and manufacturing processes required for the CFRTP overlap joints
- Industrialise the manufacturing process required for the CFRTP overlap joints in order to achieve required A400M production rates.

EXPECTED OUTCOMES

An industrialised manufacturing process for the overlap joints on CFRTP LCU parts.


ELTRA
Oxygen Nitrogen Hydrogen
Determinator

PROGRAMME 4

Industry-Focused Skills Development

COMPLETED PROJECTS

Capacity Building in International Air, Space and Telecommunications Law 2015

Industry-Focused Skills Development

COMPLETED PROJECTS

PROJECT 1:

Capacity Building in International Air, Space and Telecommunications Law 2015

BENEFITING ORGANISATION

University of Pretoria

The Institute for International and Comparative Law in Africa in the Faculty of Law of the UP, with the support of the AISI, facilitated capacity building in international air, space and telecommunications law. The capacity building was directed by a leading international expert in the field, Prof. Stephan Hobe, Director of the Institute of Air and Space Law at the University of Cologne, Germany, and Extraordinary Professor in the UP Faculty of Law. The capacity building focused on the legal framework pertaining to international air, space and telecommunications, including the relevant international treaties and their application within the South African context.

CAPACITY BUILDING

In 2009 the UP Faculty of Law was approached by **the dti** to assist with capacity building in the area of international air space and telecommunications law. At that point in time there

Thirty-nine people benefited from the course over **two years**

was no law faculty that offered any course pertaining to the international and national regulatory framework applicable in these fields in the country. During several meetings in the course of the year it became clear that the UP would have to involve international expertise for this purpose, as there was no local expertise available. Since the UP had strong ties with the Institute of Air and Space Law at the University of Cologne, it was decided to involve the Director, Prof. Stephan Hobe, who is an internationally recognised expert in the fields of air and space law.

It was agreed with **the dti** that the capacity building had to take place for members of industry and government dealing with matters of air, space and telecommunications law, as well as for lawyers who are involved in designing and applying the legal framework.

The capacity building provides a **unique opportunity** for members of the **civil service** and industry to **develop specialised skills** in air space and **telecommunications law**

GOALS AND OBJECTIVES

Transfer of knowledge of the regulatory framework pertaining to international air, space and telecommunications law to members of the civil service, industry, civil society and academia.

Course participants were required to understand and apply key aspects of:

- 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
- The role of international air law in combating terrorism.

OUTCOMES

In essence, the capacity building course has proven to be a success in its current form and should be sustained. Similarly, the Master of Law (LLM) programme has started off in a promising way. To ensure the sustainability of capacity in international air, space and telecommunications law in

Figure 1: Air Space and Telecommunications Law Class of 2015

South Africa in the long term, it is important to intensify the development of local capacity on both the Master's and doctoral level, as well as within industry and government. Currently, we are still reliant on foreign experts (such as Prof. Hobe) to teach international air and space law on a level that is internationally competitive.

The sustained support of AISI until the end of 2016 will help ensure the stabilisation of knowledge transfer in the country. By that time a critical mass of individuals in South Africa will have completed Master's and doctoral degrees (and more would be in the process of doing so). It is forecast that, at the end of 2016, an estimated 15 individuals will have obtained an LLM in international law with a specialisation in international air and space law. It is likely that one local doctoral candidate will have completed a degree with more doctoral candidates enrolled and progressing by that time.

Some of these graduates will remain in academia, either at UP or at sister faculties. They will teach and supervise theses on international air and space law. The remaining graduates will work in government departments or in industry, where they will design and/ or apply the regulatory framework in this area. In sum, sustained support will assist in intensifying capacity building in a manner that will ensure sustainable local expertise

Project Outcomes in Support of Achieving AISI Goals

By developing a better understanding of the international obligations binding South Africa, the South African legislature and civil service are in a better position to design and enforce a legal framework that balances legal responsibility with productivity. Without this balance, there is an enhanced risk of high liability claims for damages, which would undermine competiveness.

The capacity building course also constitutes an important institutional platform where members of academia and industry can exchange views, knowledge and experience regarding the type of regulatory framework that South Africa needs to maximise the capabilities of the aerospace industry.

IMPACT AND BENEFITS

Organisational Benefit

The project is assisting the UP in becoming the leading institution on the African continent in terms of transfer of knowledge in the area of air, space and telecommunications law.

Industry and Socio-Economic Benefits

Different branches of industry are able 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.

Given the very technical nature of international air, space and telecommunications law, it is not always easy to understand what the law allows and what it does not allow. The capacity building course provides an important foundation for understanding the law and how to operate within its framework. This inter alia includes knowledge of how to remain competitive without causing damage to others that will lead to liability.

The testimonials reflect that the course assisted participants from industry in gaining a better understanding of:

- The regulatory framework of civil aviation and requirements of specific clauses that are typical to bilateral agreements
- Legal issues pertaining to competition between airlines and the air service market
- Legal challenges pertaining to the risks and liability assumed by airlines
- Commercial opportunities in the space and telecommunications industry
- Topics which can benefit from more emphasis during the course include:
    - o Product liability law with the emphasis on aviation
    - o Legal transactions (e.g. contracts) pertaining to aviation law
    - o Legal aspects pertaining to acquisition, financing and leasing in relation to aviation
    - o Legal aspects pertaining to compliance in the areas of aviation ad telecommunications law
    - o Legal challenges pertaining to competition and telecommunications law in South Africa

PARTNERS AND COLLABORATORS

Institute of Air and Space Law, University of Cologne, Germany, (through Prof. Stephan Hobe).

PROJECT 2:

Industry-Focused Skills Development

BENEFITING ORGANISATION

Tellumat
CSIR

Utilising industry knowledge and technology is an important instrument in improving human capital development in the aerospace industry. Five interns were supported at the CSIR. Two interns are applying their trade in the Unmanned Aerial Vehicles (UAVs) laboratory with a primary focus on building composite materials moulds for UAV structures. Three interns are based in the experimental aerodynamics group focusing on multiple design and development tasks to improve the aerodynamics group's overall capabilities. Two postgraduate interns are currently placed at Tellumat. These interns are linked to the Portable Ground Station project at Tellumat (a Sector Strategic Programme). All seven interns improved their skills on aerospace projects.

Seven interns (six of whom are Previously Disadvantaged Individuals [PDIs]) supported over a **one-year period** at two prestigious **aerospace and defence** organisations

SKILLS DEVELOPMENT AT TELLUMAT

Intern Name	Roberto Gomes
Academic Background: (Highest qualification)	Master of Science (MSc) in Mechanical Engineering University of Cape Town (UCT), South Africa
Experience as an Intern	My experience as an intern has been thoroughly enjoyable thus far, and has provided me with the opportunity to learn a lot in the field of UAVs. I have been involved with the modelling of a UAV system in MATLAB/Simulink and running Hardware-In-the-Loop (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 (accelerometers, gyroscopes, magnetometers, pressure sensors, etc.) and actuators (control surfaces) that interface with the aircraft. In addition, the environment in which the aircraft flies is also simulated (this includes an atmosphere model and wind models, to name a few). More recently, I have been involved with the development of the sensor pack to be fitted onboard the UAV. Thus far, activities have included updating sensor pack software and uploading firmware, determining methods to calibrate the sensor pack to within acceptable accuracy, and data processing and analysis.
Plans and Aspirations	Since completing my engineering degrees, my plan is to successfully complete my internship at Tellumat and then seek a permanent position that allows me to apply my education, experience and skills in an environment that rewards creativity, innovation and problem-solving abilities. Working at Tellumat has allowed me to be exposed to some aspects in the aviation and aeronautics industry that interest me so much, and I am really grateful for the opportunity and hope to stay in the respective field in the future.

Intern Name	Mohamed SIddeeq Mansura
Academic Background: (Highest qualification)	Mechatronics Engineering Graduate (Currently completing Master's in Control Engineering at the University of Cape Town [UCT])
Experience as an Intern	I am part of the team that designs the Flight Mission Computer (FMC). My role initially was to modify existing control loops within the system and also redesign some of these loops. Thereafter I tweaked and designed different modes in which the aircraft would function; these include but are not limited to, glide mode, set point mode, manual mode and engineering mode. Currently I am busy with the safety standards with regard to the software within in the FMC.
Plans and Aspirations	I am hoping to complete my Master's and also be part of the successful implementation and testing of the UASES project. I would also like to gain more experience in the programming environment as well as design and implementation of hardware components that make up such systems.

SKILLS DEVELOPMENT AT AERONAUTICS SYSTEMS COMPETENCY WITHIN THE CSIR

Intern Name	Yetunde Dada
Academic Background: (Highest qualification)	BEng Mechanical Engineering, University of Pretoria (UP)
Experience as an Intern	I worked in the design projects in the thermal analysis field at the Medium Speed Wind Tunnel in the Aeronautics Centre at the CSIR. This internship has allowed me to grow my thermal analysis skills. I've improved on critical thinking and learnt how to structure projects around balance conditioning and electronics cooling. I've also been able to engage in the complete prototype creation process – design, analysis, build and testing. I have really enjoyed working at the CSIR. I felt like I was making an important contribution to aerospace projects. I was allowed to experiment through trial and error, and everyone facilitated my growth.
Plans and Aspirations	I'm going to complete my Master's of Design/Master of Business Administration (MBA) at the Illinois Institute of Technology. Being at the CSIR has fuelled my love for design, and one day I hope to return.

Intern Name	Sambharthan Cooppan
Academic Background: (Highest qualification)	Masters of Science in Engineering (Gas Dynamics) - 2014
Experience as an Intern	My work was Medium Speed Wind Tunnel-related (either directly or indirectly). I worked in a number of different areas, including software, design, wind tunnel set-up, installation and testing, and circuit design. An appreciation of the challenges faced when testing, constantly working with the workshop to make sure all parts are in order and connect properly, liaising with different staff members to produce a solution that is technically correct and is adaptable (can be used for more than one purpose), working with new ideas and technologies, and the importance of documentation. The most I got out of it was being surrounded by people who have confidence and authority in the decisions they make.
Plans and Aspirations	To become established in the aeronautical field by initially having a strong technical focus and progressing to be involved on the business side, project management and taking up a position in leadership.

Intern Name	David Nakampe Malematsa
Academic Background: (Highest qualification)	National Certificate (vocational) Mechanical Engineering Practical Skills Development Engineering Studies N4-N6
Experience as an Intern	Manufacturing of UAVs Preparing, painting and laying up composite parts Cutting 2D and 3D patterns on the Computer Numerical Control (CNC) Laser cutting complex servo mounts Wing calibration and testing
Plans and Aspirations	To apply my skills and knowledge to enhance my engineering capabilities and technical mind-set in order to innovate and be able to learn how to design and manufacture complex projects such as a light weight long endurance UAV or target drone.

Intern Name	Ragimana Phumudzo
Academic Background: (Highest qualification)	National Diploma: Mechatronics Engineering at Tshwane University of Technology (TUT) In Progress: BTech Mechatronics Engineering at the TUT with one subject left In Progress: BTech Industrial Engineering Part time Evening classes at the TUT
Experience as an Intern	Medium Speed Wind Tunnel and High Speed Wind Tunnel Calibration of pressure instruments Wind tunnels setups Analysing and presenting data to wind tunnel experts Installation, configurations changes and removal of model in the test sections Maintain good house keeping Reports writing and compilation of certificates
Plans and Aspirations	I have been employed as a wind tunnel technician/ technologist at the CSIR. My aspiration is to always have a better understanding in the technical field. I am inspired by the tunnel experts who find problems interesting and I would like to gain such experience and be like them.

Intern Name	Kgaugelo Mabeko
Academic Background: (Highest qualification)	National Diploma Mechanical Engineering
Experience as an Intern	Manufacturing of Unmanned Aircraft Vehicles Performing complex mechanical jobs, hand and eye coordination, manufacturing of moulds using composites materials, manufacturing of parts of the Unmanned Aircraft Vehicle, spray painting with spray gun, to create 2D and 3D CNC programmes using CamBam software and gaining the skills of a technician.
Plans and Aspirations	Use the knowledge I have learnt and the skills I have gained and apply them to improve other components or products in industry. I would also like to manufacture my own Unmanned Aircraft Vehicle.

AISI MANAGEMENT FRAMEWORK AND STRATEGIC INTENT

The South African government has taken a decisive position: to address the barriers to industrialisation; and upscale and sustain the aerospace and defence industry by using different instruments which include policies and regulation; and implementation of strategic programmes.

The National Industrial Policy Framework (NIPF) supports and promotes diversification of the economy away from its traditional reliance on increased value-add per capita, characterised by: increased downstream participation in higher value activities and value chain segments and technological leadership in specific technologies.

The NIPF serves as the foundation of the Industrial Policy Action Plan (IPAP), in a sense it frames the key performance indicators of IPAP that seek to prevent industrial decline and also support growth and diversification of South Africa`s defence industry. IPAP places emphasis on critical human capital development and technology platforms that are sector based in order to unlock manufacturing growth and employment in different sectors of the economy. It puts particular importance, amongst others, on the establishment of sectorial support programmes such as the AISI.

The AISI has a vision of **"positioning the South African aerospace and defence-related industry as a global leader, in niche areas, whilst ensuring effective interdepartmental participation and collaboration".** It aims to enhance the global competitiveness of the South African aerospace and defence industry by coordinating the implementation of an aerospace strategy as well as through either offering strategic interventions, or to fund such interventions within industry itself.

AISI STRATEGIC STRUCTURE

The AISI strategic guidance is provided by government key objectives, with input from JASC, industry, academia, and science councils.

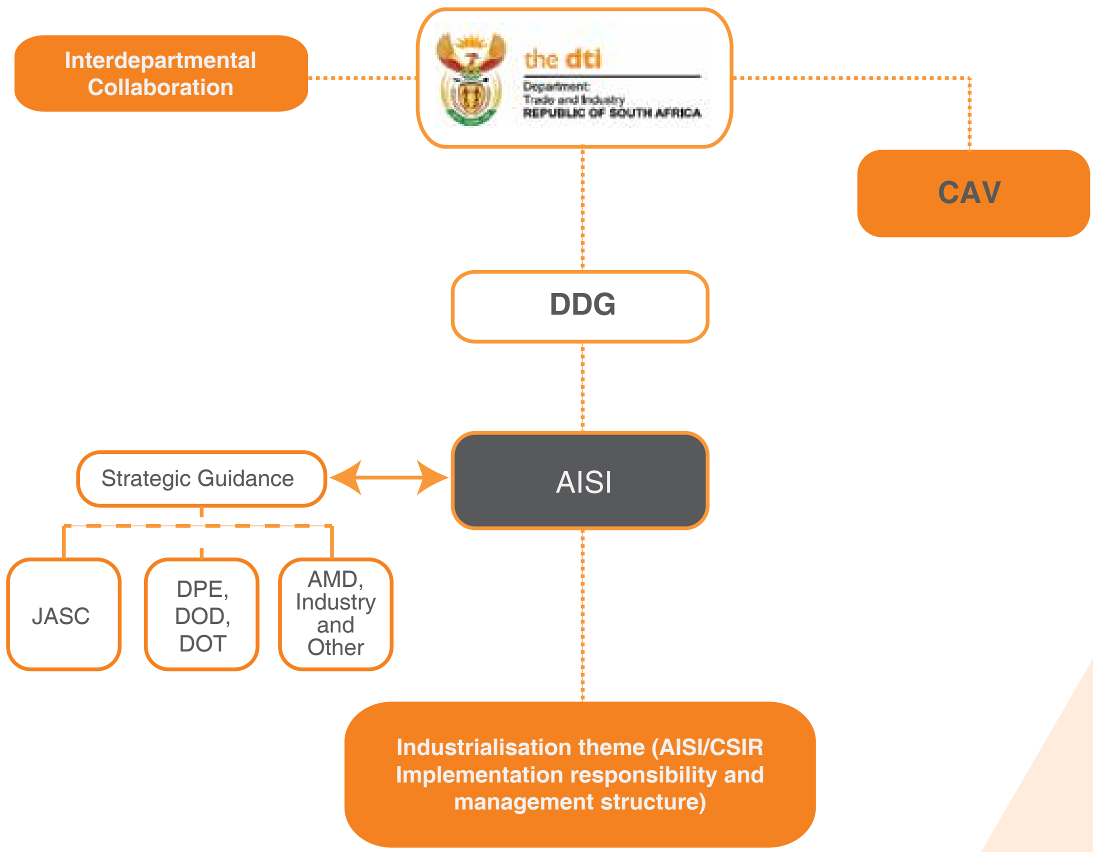


Figure 1: AISI Strategic Structure

AISI OPERATIONAL STRUCTURE

The AISI is an initiative of **the dti**, which is hosted and managed by the CSIR. The AISI is managed to comply with the applicable legislation, including without limitation, the Public Finance Management Act (PFMA) and Preferential Procurement Policy Framework Act (PPPFA), as well as to the CSIR's procedural and policy framework.

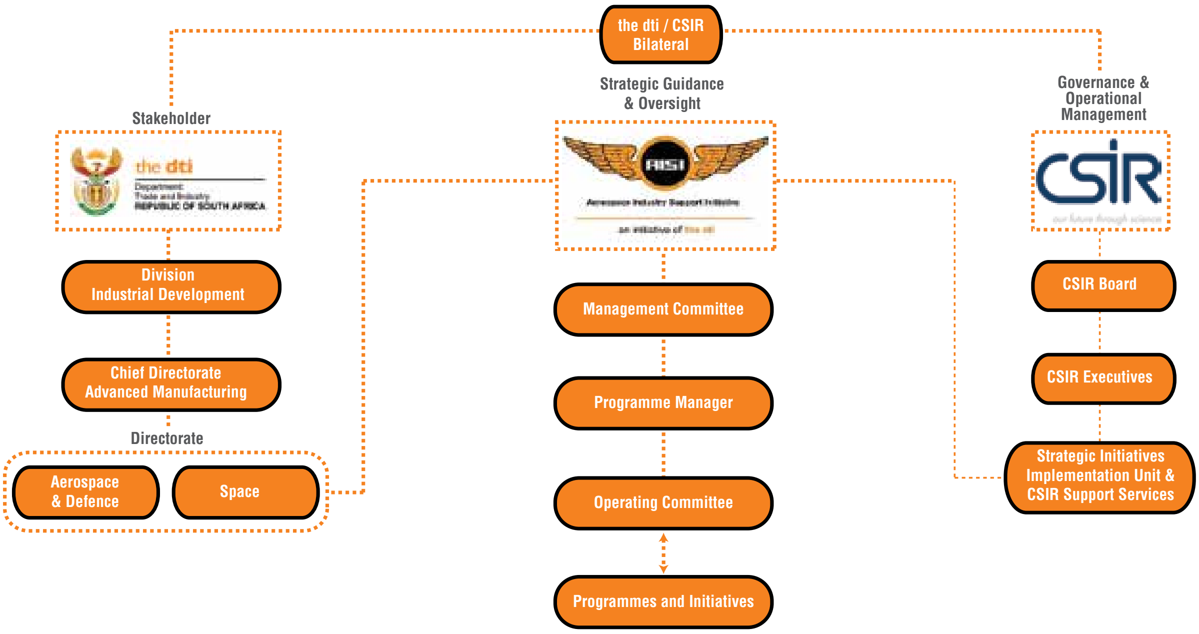


Figure 2: AISI Operating Structure

AISI FINANCIAL RESULTS

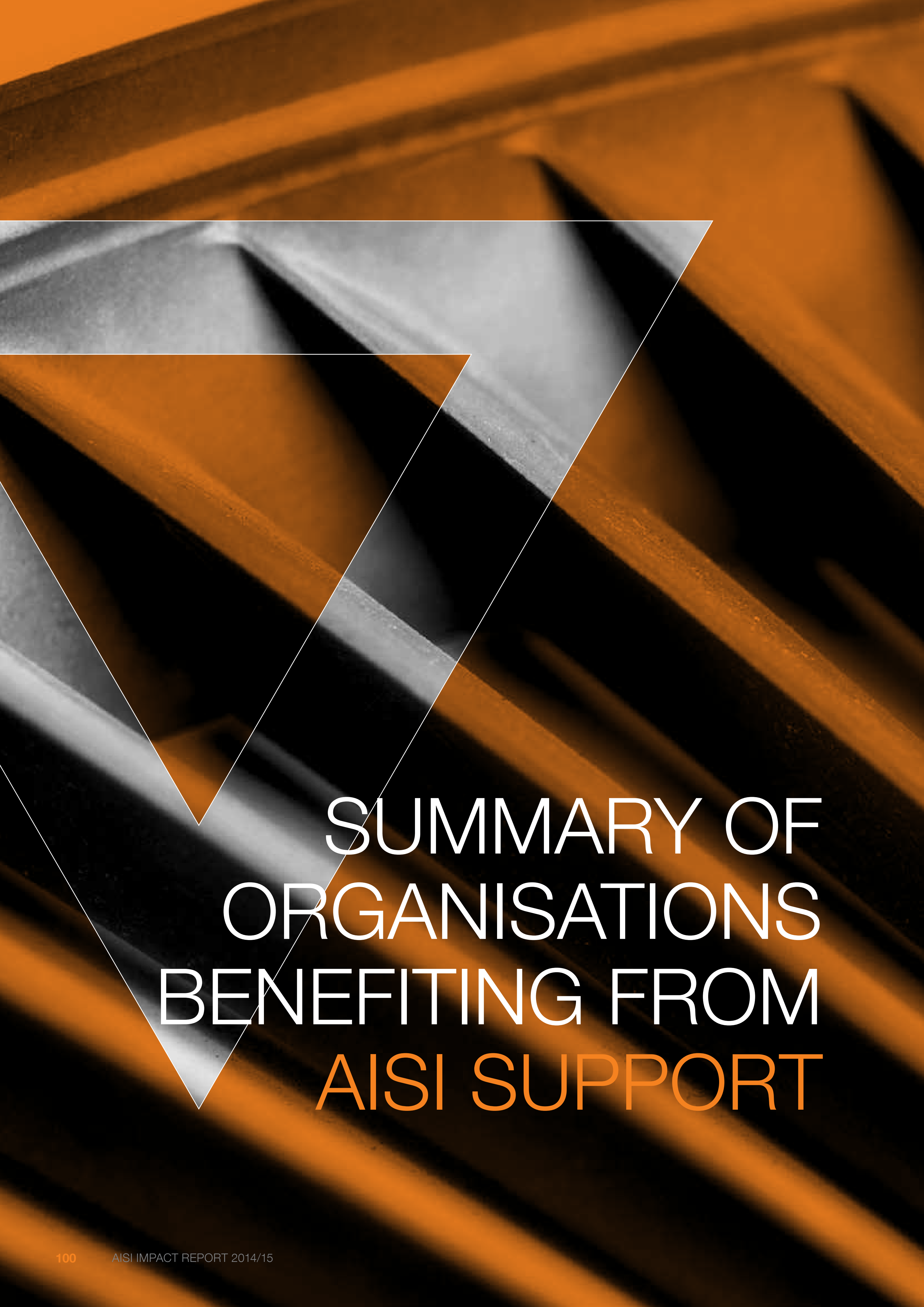
AISI FINANCIAL RESULTS FOR THE PERIOD 2014/15

	Period ending 31 March 2015 R
FUNDS INCLUDING INTEREST AVAILABLE AT BEGINNING OF PERIOD 01 APRIL 2014	**18,151,033**
FUNDS RECEIVED	**19,736,842**
Funds received	19,736,842
- funds transferred	22,500,000
- less: VAT payable to SARS	2,763,158
INTEREST RECEIVED 31 MARCH 2015	**657,817**
TOTAL FUNDING BEFORE EXPENSES	**38,545,692**
TOTAL ALL EXPENSES	**25,605,922**
OVERHEAD COSTS	**3,750,000**
AISI Management Cost	3,750,000
PROGRAMME COSTS	**21,855,922**
INDUSTRY DEVELOPMENT & TECHNOLOGY SUPPORT	12,778,503
SECTOR STRATEGIC SUPPORT INITIATIVES	1,577,400
SUPPLIER DEVELOPMENT	5,276,749
INDUSTRY-FOCUSED SKILLS DEVELOPMENT	1,221,537
CO-ORDINATION, PROMOTION & AWARENESS	1,001,733
Funds available but contracted at the end of the period, including interest received	**12,939,770**

Funding totalling R 19,736,842.00 was received from the **the dti** for the AISI operations in the 2014/15 financial year. This funding was utilised to fulfil the strategic objectives of the AISI and provide the South African aerospace industry with support for technology development, supplier development and industry-focused skills development.

This funding together with funding received from the previous year (R 18,151,033.00) totalled R 38,545,692.00. This was allocated and committed to programmes and projects as defined in the AISI Business Plan.

At the end of the 2014/15 financial period, R 12,939,770.00 was contracted to specific projects to be invested in the 2015/16 financial year.

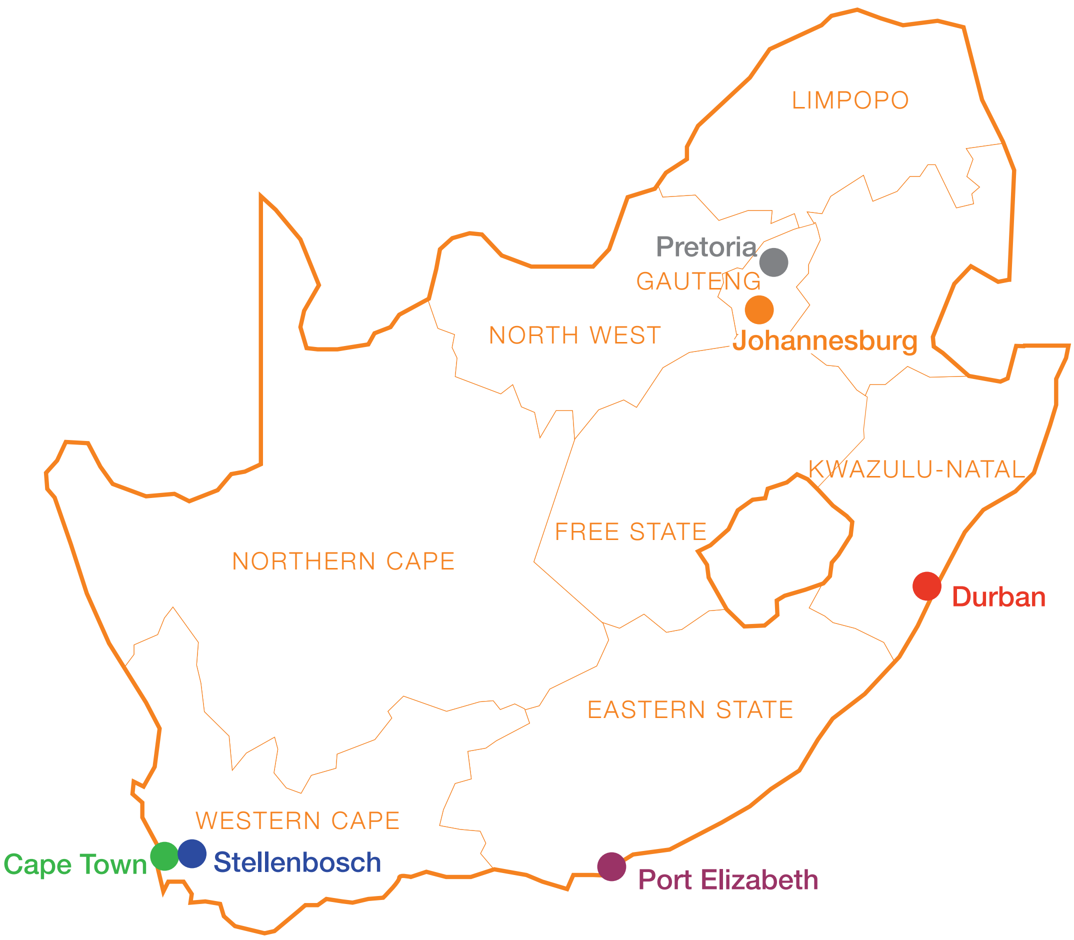


SUMMARY OF ORGANISATIONS BENEFITING FROM AISI SUPPORT

ORGANISATION NAME	PROJECT NAME	SMME	LOCATION
Advanced Material Technology	• Supply Chain Optimisation - MyXchange Web Portal	Yes	🟠
Aerosud Aviation	• Additive Manufacturing of Aerospace Components • Process Design of Continuous Fibre Reinforced Thermo-Plastic (CFRTP) Joining Methods • Process Design of Titanium Fluid-Cell Forming • Localisation and Industrialisation of Insulation Blankets • Process Design and Validation of CFRTP Overlap Joining Method • Supply Chain Optimisation - MyXchange Web Portal	No	⚫
Aerospace Maritime and Defence Association	• Joint Aerospace Steering Committee	N/A	⚫
Aerotechnic	• Supply Chain Optimisation - MyXchange Web Portal	Yes	🟠🟢
Agricultural Research Council	• Hyperspectral Sensor Upgrade	N/A	⚫
ANDT Centre	• Supply Chain Optimisation - MyXchange Web Portal	Yes	⚫
Applied Services	• Supply Chain Optimisation - MyXchange Web Portal	Yes	🟠
Aquajet Profiles	• Supply Chain Optimisation - MyXchange Web Portal	Yes	🟠
Arthur Channon Incorporated Attorneys	• Capacity Building in International Air, Space and Telecommunications Law 2015	Yes	⚫
AUVERGNE AERONAUTIQUE SLICOM	• Supply Chain Optimisation - MyXchange Web Portal	Yes	N/A (France)
Blackstar Communications	• Capacity Building in International Air, Space and Telecommunications Law 2015	Yes	🟠
Cape Aerospace Technologies	• Small Gas Turbine Technology Improvements	Yes	🟢
Cliff'sway Engineering	• Supply Chain Optimisation - MyXchange Web Portal	Yes	🟠
CMI	• Supply Chain Optimisation - MyXchange Web Portal	Yes	🟢
Collaborative Xchange	• Supply Chain Optimisation - MyXchange Web Portal	Yes	🟣
Compumach Engineering	• Supply Chain Optimisation - MyXchange Web Portal	Yes	🟠
Commercial Aviation Association of Southern Africa	• Joint Aerospace Steering Committee	N/A	🟠
Council for Scientific and Industrial Research	• Laser Shock Peening Phase III • Industry-Focused Skills Development • Design and Manufacturing of Aerospace Fuel Tank Structures • Capacity Building in International Air, Space and Telecommunications Law 2015 • Joint Aerospace Steering Committee	N/A	⚫
Cybicom Atlas Defence	• Industrialisation of Joint CAD/CSIR Helicopter Simulator	Yes	🟢
Daliff Precision Engineering	• Avionic Component - Local Design and Manufacture • Supply Chain Optimisation - MyXchange Web Portal	Yes	🟢
Denel Aerostructures	• Design and Manufacturing of Aerospace Fuel Tank Structures • Natural Fibres in Aerospace Structures • Ultra High Cycle Fatigue (UHCF) Design and Testing of High Strength Aerospace Materials	No	🟠
Denel Dynamics	• Additive Manufacturing of Aerospace Components	No	⚫
Department of Defence	• Capacity Building in International Air, Space and Telecommunications Law 2015 • Joint Aerospace Steering Committee	N/A	⚫
Department of Justice and Constitutional Development	• Capacity Building in International Air, Space and Telecommunications Law 2015	N/A	⚫
Department of Public Enterprises	• Joint Aerospace Steering Committee	N/A	⚫
Department of Science and Technology	• Joint Aerospace Steering Committee	N/A	⚫
Department of Transport	• Joint Aerospace Steering Committee	N/A	⚫

ORGANISATION NAME	PROJECT NAME	SMME	LOCATION
Department of Trade and Industry	• Capacity Building in International Air, Space and Telecommunications Law 2015 • Joint Aerospace Steering Committee	N/A	● (grey)
D&W Industrial	• Supply Chain Optimisation - MyXchange Web Portal	Yes	● (grey)
eeZeeCAD	• Avionic Component - Local Design and Manufacture		● (green)
French South African Institute of Technology (F'SATI) at Cape Peninsula University of Technology	• Radiation Screening Services for Satellites	No	● (green)
Glyn Marais	• Capacity Building in International Air, Space and Telecommunications Law 2015	Yes	● (orange)
Heliocentric Technologies ZA	• Radiation Screening Services for Satellites	Yes	● (orange)
Hulley & Associates	• Capacity Building in International Air, Space and Telecommunications Law 2015	Yes	● (red)
Industrial Development Corporation	• Joint Aerospace Steering Committee	N/A	● (orange)
ISCAR South Africa	• Supply Chain Optimisation - MyXchange Web Portal	Yes	● (orange)
iThemba Labs	• Radiation Screening Services for Satellites	No	● (green)
J Khumalo Attorneys	• Capacity Building in International Air, Space and Telecommunications Law 2015	Yes	● (grey)
Jack Pack Trading	• Supply Chain Optimisation - MyXchange Web Portal	Yes	● (orange)
John Fogwell and Associates	• Capacity Building in International Air, Space and Telecommunications Law 2015	Yes	● (grey)
National Treasury	• Joint Aerospace Steering Committee	N/A	● (grey)
Nelson Mandela Metropolitan University	• Radiation Screening Services for Satellites	N/A	● (purple)
NewSpace Systems	• Stellar Gyro Development	Yes	● (green)
Northern Bolt & Tool	• Supply Chain Optimisation - MyXchange Web Portal	Yes	● (orange)
PaR Systems	• The Industrialisation of a Small, Low-Cost Transversely Excited Atmospheric (TEA) CO_2 Laser for the Aerospace Industry	Yes	● (grey)
Paramount Advanced Technologies	• Aerodynamic Investigation of a Rhomboid Wing Unmanned Aerial System	Yes	● (orange)
Safety First	• Supply Chain Optimisation - MyXchange Web Portal	Yes	● (orange)
Safomar Industrial Brands	• Supply Chain Optimisation - MyXchange Web Portal	Yes	● (orange)
Satellite Authorisation Systems	• SatAuth Technology Demonstrator	Yes	● (orange)
Simera Technology Group	• Hyperspectral Sensor Upgrade	Yes	● (green)
South African National Space Agency	• Capacity Building in International Air, Space and Telecommunications Law 2015	N/A	● (grey)
Space Advisory Company	• Nano-Satellite Imager Development and the Development of a New Hyperspectral Focal Plane and Mass Storage for a Space Imager	Yes	● (green)
Stellenbosch University	• Hyperspectral Sensor Upgrade	N/A	● (blue)
Technology Innovation Agency	• Joint Aerospace Steering Committee	N/A	● (grey)
Tellumat	• Higher Levels of Mode S Technology Development • Identification Friend or Foe Interrogator Power Amplifier / Transmitter • Unmanned Aerial Systems Datalinks and Antenna Solutions for Extended Communications Ranges • Portable and Distributed Unmanned Aerial Vehicle (UAV) Ground Control Station Product/Capability Development • Industry-Focused Skills Development	No	● (green)
Tiffy Safety	• Supply Chain Optimisation - MyXchange Web Portal	Yes	● (orange)
Ti-TaMED	• Supply Chain Optimisation - MyXchange Web Portal	Yes	● (green)
Tony Beverley Agencies	• Supply Chain Optimisation - MyXchange Web Portal	Yes	● (grey)

ORGANISATION NAME	PROJECT NAME	SMME	LOCATION
TP Agencies	• Supply Chain Optimisation - MyXchange Web Portal	Yes	● (orange)
TraX Interconnect	• Square Kilometre Array PC Board Localisation	Yes	● (green)
University of Pretoria	• Design and Manufacturing of Aerospace Fuel Tank Structures • Capacity Building in International Air, Space and Telecommunications Law 2015	N/A	● (grey)
University of the Witwatersrand	• Laser Shock Peening Phase III	N/A	● (orange)
Vestcast	• Supply Chain Improvement and Optimisation Interventions	Yes	● (orange)
West Engineering	• Supply Chain Optimisation - MyXchange Web Portal	Yes	● (orange)



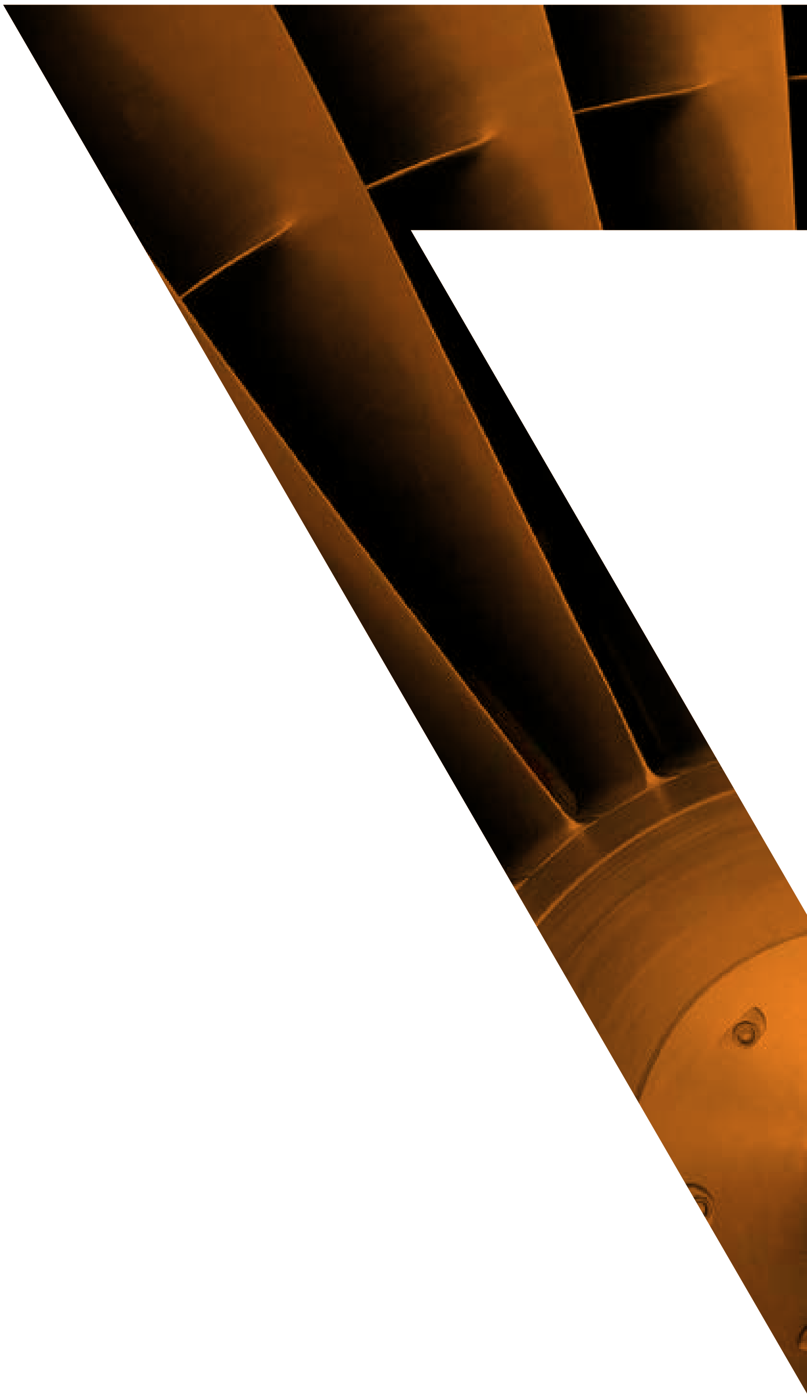
ABBREVIATIONS

ADS-B	Automatic Dependent Surveillance-Broadcast
AHRLAC	Advanced High Performance Reconnaissance Light Aircraft
AISI	Aerospace Industry Support Initiative
AM	Additive Manufacturing
AMO	Aircraft Maintenance Officers
AMTS	Advanced Manufacturing Technology Strategy
ARC	Agricultural Research Council
ATC	Air Traffic Control
ATCRBS	Air Traffic Control Radar Beacon System
AVL	Athena Vortex Lattice
B-BBEE	Broad-Based Black Economic Empowerment
BLOS	Beyond-Line-Of-Sight
BRICS	Brazil, Russia, India, China and South Africa
CAD	Computer Aided Drawing
CAD	Cybicom Atlas Defence
CAT	Cape Aerospace Technologies
CCD	Charge-coupled device
CFD	Computational Fluid Dynamics
CFRTP	Continuous Fibre Reinforced Thermo-Formed Plastic
CNC	Computer Numerical Control
COTS	Commercial-Off-The-Shelf
CSIR	Council for Scientific and Industrial Research
CT	Computerised Tomography
CVS	Cyclic Voltammetric Stripping
DAe	Denel Aerostructures
DME	Department of Minerals and Energy
DPE	Department of Public Enterprises
DST	Department of Science and Technology
EASA	European Aviation Safety Agency
EHS	Enhanced Surveillance
ELM	Extended Length Message
ELS	Elementary Surveillance
ERP	Enterprise Resource Planning
ES	Extended Squitter
FAA	Federal Aviation Administration
FMC	Flight Mission Computer
FPGA	Field-Programmable Gate Array
GBADS	Ground Based Air Defence System
GCS	Ground Control Stations
GDT	Ground Data Terminal
GSD	Ground Sample Distance
GTM	Grand Tellumat Manufacturing
HCF	High Cycle Fatigue
HEI	Higher Education Institution
HELISIM	Helicopter Simulator
HFDL	Helicopter Flight Deck Lander
HIL	Hardware-In-the-Loop
IBSA	India, Brazil, South Africa
ICAO	International Civil Aviation Organisation
IDC	Industrial Development Corporation
IFF	Identification Friend or Foe
IG	Image Generator
IP	Intellectual Property
IPAP	Industrial Policy Action Plan
IPC	Interconnecting and Packaging Electronic Circuits
IR	Infrared
ITAR	International Traffic in Arms Regulations
JASC	Joint Aerospace Steering Committee
LBW	Laser Butt-Welded
LCUs	Lower Connection Units
LIDAR	Light Detection and Ranging
LLM	Master of Law
LSP	Laser Shock Peening
M.Eng	Master of Engineering
MATLAB	Matrix Laboratory
MBA	Master of Business Administration
MCS	Mission Control Station
MDO	Multidisciplinary Optimisation
MRP	Materials Requirements Planning
MSc	Master of Science
MUAS–LE	Modular UAS – Long Endurance
NAC	National Aerospace Centre
NDT	Non-Destructive Testing

NIPF	National Industrial Policy Framework
NSI	National System of Innovation
OCU	Operator Control Units
OEM	Original Equipment Manufacturers
OTS	Off-The-Shelf
PAT	Paramount Advanced Technologies
PCB	Printed Circuit Boards
PFMA	Public Finance Management Act
PG	Parliamentary Grant
PGCS	Portable Ground Control Station
PhD	Doctor of Philosophy
PISA	Photonics Initiative South Africa
PPPFA	Preferential Procurement Policy Framework Act
PSR	Primary Surveillance Radar
R&D	Research & Development
RC	Radio Control
RF	Radio Frequency
RPV	Remotely Powered Vehicles
SAA	South African Airways
SAAT	South African Airways Technical
SACAA	South African Civil Aviation Authority
SADC	Southern African Development Community
SAN	South African Navy
SANSA	South African National Space Agency
SARA	South African Regional Aircraft
SatAuth	Satellite Authorisation Systems
SB	Service Bulletin
SDP	Sector Development Plan
SEE	Single Event Effects
SKA	Square Kilometre Array
SMME	Small, Medium and Micro-Sized Enterprises
SSR	Secondary Surveillance Radar
STANAG	Standardisation Agreement
STC	Supplemental Type Certificate
SU	Stellenbosch University
TCAS	Traffic Collision Avoidance System
TEA	Transversely Excited Atmospheric
the dti	The Department of Trade and Industry
TIA	Technology Innovation Agency
TID	Total Ionising Dose
TMT	Transponder Mounting Tray
TRL	Technology Readiness Level
TUT	Tshwane University of Technology
UAS	Unmanned Aircraft Systems
UAV	Unmanned Aerial Vehicle
UCT	University of Cape Town
UHCF	Ultra High Cycle Fatigue
UP	University of Pretoria
UPS	Uninterrupted Power Supply
US	United States of America
WITS	University of the Witwatersrand

Notes

Notes



AISI

Aerospace Industry Support Initiative

an initiative of **the dti**

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

the dti
Department:
Trade and Industry
REPUBLIC OF SOUTH AFRICA

CSIR
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info@aisi.co.za • www.aisi.co.za