

Introduction to SASA

The leading platform for industry, academia and civil society to engage in the South African space arena incorporating education, research, space awareness, policy, science and technology issues.

The South African Space Association was officially launched on the 6th October 2009. In that time memberships have grown and we hosted our first annual SASA Congress in Cape Town on the 7th October 2010, in addition to outreach and awareness activities for World Space Week 2010. This year holds new exciting developments, the first of which is the launch of our quarterly newsletter...e Space. We thank you for your support to date and hope that you find the congress to be a useful resource to you.

Overview

The South African Space Association provides a forum for space professionals to interact and exchange ideas. This is a membership-based professional association which will seek accreditation with the South African Council for Natural Scientific Professions (SACNASP). As with other professional associations, various grades of membership have been established, with the highest grades limited to those individuals who have made leading contributions to the development of the space arena in South Africa.

Objectives of the Space Association

- To act as a source of specialist information and advice to government and to the public on space-related issues.
- To serve as a forum for information exchange among space professionals in South Africa.
- To link with similar national and international associations.
- To build capacity in the scientific, technical, legal, policy and public education aspects of the South African space arena.
- To provide networking opportunities for students as well as young & established space professionals.
- To provide a forum where space professionals and companies can pursue employment and recruitment possibilities.
- To provide study and vocational training opportunities in a wide range of disciplines supporting the space arena in SA.
- Promote public awareness of the importance of space science & technology.



SASA Congress 2012

Abstract List:

Session1:

Development the space industry in South Africa

CHALLENGES AND OPPORTUNITIES FOR THE SPACE INDUSTRY IN DEVELOPING COUNTRIES

Sias Mostert

Space Commercial Services

Creating and sustaining a space industry turns out to be a significant challenge in a developing country. Achieving a successful space industry is important for local employment, international collaboration and competition and successful national programs. In South Africa there have been a number of attempts at establishing a space industry. The paper will investigate the efforts and suggest a future space industry organisation architecture that could implemented successfully in developing countries.

ECONOMIC RATIONALES FOR SPACE - CREATING A SUSTAINABLE SPACE MARKET IN SOUTH AFRICA

Khalid Manjoo

Sun Space and Information Systems

One of the biggest debates spanning decades in the global space arena is regarding the economic rationale for spaceflight. From small satellites in Low-Earth Orbit (LEO) to robotic and manned-missions, these efforts have been seen by opponents of spaceflight as extravagances that waste money that could be better spent "on Earth"; that is, in different areas like environment, transport, housing, education and social programs. Those in favour of spaceflight often respond with the real economic benefits that can be seen on Earth as a result of our space-based capabilities. This document is written in defense and in support of space programs, particularly in a South African context. It is intended to demonstrate the full-effect of space on the economy, describing how space directly and indirectly creates and provides value and benefit to all human beings, and how Government support is essential if we are to compete on the global level of skills and ideas.

FINANCIAL, ECONOMIC AND POLICY ISSUES AND SOLUTIONS TO BE ADDRESSED IN THE COMMERCIALISATION AND PRIVATISATION OF DIFFERENT AREAS OF THE SPACE INDUSTRY GLOBALLY

Carla Sharpe

Foundation for Space Development

In international markets across many industries one can see motivational changes in the markets towards collaboration and development of core competencies. This is not only due to increased globalisation, competition and technical advance. Complementary technology or research techniques allow for sharing of capital requirements, risk spread, economies of scale and overcoming barriers to entry. There has also been a change in organisational structure of cooperation to non-equity partnerships which is visible in the space programs and individual projects. These are of particular interest to developing nation participation and the development of their policies towards collaboration. This paper seeks to explore new economic approaches to valuing space projects and the subsequent benefit to the entities and economies involved as well as the associated policy implications. With new changes in partnership structures and the increased interest and participation of the private sector in space programs, how do private partners participate in a way so as to preserve commercial practises while preserving the space treaties? This paper seeks to explore commercialising and privatising various sectors within the space arena with a focus too on the issues being faced as space flight becomes increasingly commercialised, particularly as sub orbital flights become a reality for members of the public, and what challenges are faced from a policy perspective.

HOUWTEQ AND THE SOUTH AFRICAN NATIONAL SPACE PROGRAMME (NSP)

Danie Meiring

Denel Dynamics

Houwteq, a satellite assembly, integration and testing facility is located close to Grabouw in the Western Cape. It was built as part of the facilities for the previous Space program that was terminated in the 90's. Through the years, the facilities have been used for various purposes, from training to multi-media productions. The buildings have been maintained and secured by a small and dedicated team. Some of the original equipment was mothballed and not used during this time. Other equipment was used and upgraded as needed. The Houwteq buildings can house more than 400 people and the laboratory facilities are unique in South Africa. These facilities will play a vital role in the proposed National Space Program. This presentation is a short review of the status of Houwteq, the stakeholders, the requirements for capabilities and the proposed way forward in support of the National Space Program.

TOWARDS AN INTEGRATED LAUNCH SERVICES INDUSTRY IN SOUTH AFRICA

Mark Comminos

Marcom Aeronautics and Space

South Africa possesses strong technical and manufacturing capabilities in all major engineering fields however is yet to crack the ultimate business case, that of commercial satellite launch services from the Republic. Any such venture requires significant support in various forms from a variety of private, public and academic entities. This presentation provides an overview of the legal, political, logistical, commercial and technical hurdles to be addressed and overcome to ensure scheduled, cost-effective and sustainable commercial launch services from South Africa.

Session 2:

The roles of Government

AFRICA'S SPACE HERITAGE: INVENTORY, ANALYSIS, & FUTURE POSSIBILITIES

Keith Gottschalk

University of the Western Cape

South Africa's most spectacular space-related project before the SKA bid was the missile and space launcher project of the 1980s. The challenge for space historians is that this military project was throughout its life cycle under total censorship. Even today, with no possibility of prosecution, the space engineers do not publically talk about it. After South Africa became a democracy, various brief accounts have appeared in the public domain, but they are problematic in at least three ways. First, they focus on the atom bomb project, devoting only a few pages, or even only paragraphs, to the RSA-3, as merely a future delivery mode for the A-bomb. Second, the published accounts focus on what Israel did in South Africa, instead of what the South Africans did in South Africa. Third, rather than making the most probable deductions, many accounts compete to be more sensationalist than their commercial rivals. Space historians may take heart from the fact that this situation is no different to that which confronted authors at the start of research into Peenemunde, Tyutatum, and Jiuquan. This paper probes all literature and brochures in the public domain for contradictions, and for independent confirmations. This also requires analyzing if one publication is a derivative of another.

DEVELOPMENT OF A NATIONAL REGULATORY REGIME FOR OUTER SPACE ACTIVITIES

Peter Martinez

South African Council for Space Affairs

Space activities are by their very nature international in character. This paper describes the international legal framework for outer space activities and how this is domesticated in South African law through the Space Affairs Act and the SA Council for Space Affairs. The activities of the Council and the development of a national regulatory framework are discussed.

STANDARDS FOR SPACE SYSTEMS

Hennie Rheeder

South African Council for Space Affairs

The objective of this paper is to make the reader aware of the need for space system standards. The historical reasons for the establishment of the International Civil Aviation Organisation (ICAO) are discussed regarding the setting of minimum standards for initial and continued airworthiness, for crew training and medical qualification, and for operational practices. The fact that NASA and the US Federal Aviation Administration have worked out their division of roles for clearing a new generation of private-sector spaceships for liftoff is discussed and that anytime NASA is paying for the service from a provider, NASA standards will apply. ISO Space Systems and Operations Standards are discussed and local resources for Software Quality, Process Improvement and Standards are described.

SPECTRUM ASPECTS OF SATELLITE COMMUNICATIONS

Linden Petzer

South African Council for Space Affairs

The nature of satellite communication creates the risk of harmful interference occurring between different radio communication services in different countries or within the same country. International and national regulatory frameworks have been established to manage this risk. This paper looks at the International Telecommunication Union (ITU) procedures for the co-ordination of satellite networks.

[Session 3:](#)

[Development of human capital and academic research](#)

THE F'SATI SPACE PROGRAMME

Nyameko Royi and Tony Lumbwe

Cape Peninsula University of Technology

The F'SATI programme at CPUT has been developed to promote growth among post-graduate students in the area of space science and technology. Students have the opportunity to work towards obtaining a dual-degree qualification at masters level. Upon completion of the F'SATI curriculum they receive an MTech from CPUT and an MSc from ESIEE in France. Their first year consists of course work aimed towards the fundamentals of space science and technology. The students' research project begins in their second year where they have the opportunity to explore cutting edge

research in the field of nano-satellites. The platform of study utilised by the programme is that of the CubeSat standard which allows universities a cost effective approach to space science. Upon completion of their course work and research projects, the students have the option to join the Professional Development and Skills Retention (PDSR) arm of F'SATI. This group actively develops CubeSat systems while allowing students to progress from an academic to a professional working environment in a guided and developmental setting. Within the PDSR group, students are able to take their research knowledge and actively design and build a CubeSat from conception to launch.

APPLYING THE CUBESAT CONCEPT AS A VEHICLE TO GROW GRADUATE ENGINEERS IN SA

Shahen Naidoo

Denel Dynamics

The shortage of skilled engineers in Science and Engineering in South Africa is well documented, and Denel Dynamics has experienced this first hand. The technical nature of the work conducted within the aerospace industry, combined with the high average age of engineers, further compounds this problem. The Engineering Academy of Learning (EAL) was established to develop and grow graduate engineers to enable them to be productive in as short a time as possible. The EAL uses a multifaceted approach to develop graduates by combining formal courses, on job training and a development project into a one year internship programme for graduate engineers. The current intern project is the design and construction of a 1U Cubesat. The project is broken into three parts: Ground station and communications; Structure and backbone (consisting of on-board computer, power and solar cells); and Payload and launch. The interns work on this project as three groups, each addressing a part of the design, with an integration effort that involves members of all the groups. The interns are exposed to the systems life cycle, from design through to development, construction, utilisation and ultimately disposal. This presentation is a summary of how the Cubesat project has been used to expose the graduate engineer to the aches and pains of high tech development work.

SGAC - THE ULTIMATE NETWORK OF NETWORKS FOR STUDENTS AND YOUNG PROFESSIONALS

Pierre van Heerden

SA Astronomical Observatory/ University of Johannesburg

Since its inception, the Space Generation Advisory Council has evolved into a vast network that spans the Globe with several thousand members in over 90 countries, making it the premier network of students and young professionals in the space arena. I will give a brief summary of the organisation, including its goals and ideals, our activities in South Africa, Africa and beyond and discuss potential future involvement of the SGAC in the growing South African space sector.

SPACE STUDIES PROGRAM 2012, INTERNATIONAL SPACE UNIVERSITY

George Calder-Potts

South Africa is an up and coming space nation, however, further progress is dependent on advancing the careers of our human resources. Without opportunities to grow in the field, few people would choose space. Although conferences are a great way to network and see new ideas and concepts, the downside is you don't get to know many attendees well, trying to meet a thousand people at large conferences in less than a week is impossible. However if you know 100 individuals well, in the space sector globally, you can probably reach those same thousand via your network of well known contacts. The author feels the greatest benefit of the Space Studies Program (SSP) is precisely that you have a group of 100+ highly motivated space enthusiasts from a broad spectrum of society and 9 weeks to get to know them. At the end of my program I could identify 95% of the participants by name and knew something about each. SSP12 was thoroughly enjoyed by the vast majority of the participants and some strong friendships grew out of the program. This presentation will take you through the general structure of an SSP, namely coursework, department activities and a team project. As well as my personal experiences in Florida which include the Kennedy Space Centre, rocket launches of both model and satellite rockets, Disney world, TEDxISU, various panels and various group activities. The SSP is well worth doing. If you want to intern in a space company the ISU masters program is well worth doing as the last three months is a compulsory internship. However the program is not cheap, but is good value for money and scholarships are available from various sources.

SPACE OUTREACH AND EDUCATION PROPOSALS

Khalid Manjoo

Sun Space and Information Systems

Raised awareness of the benefits of science and technology is essential to support a South African society that can compete with the rest of the world as we head forward into the 21st century. This document deals with proposals aimed at outreach and education in South Africa specifically in the sector of Space Science and Technology. The projects discussed in this document span the entire knowledge-based spectrum. They are aimed at young learners between grades 1 to 12; students at tertiary institutions, young professionals in the space industry, policy and decisions makers in Government as well as the rest of the South African community at large, towards not only educating them more about space, but more importantly, developing a knowledge-based economy and a labour force with adaptive skills to deal with the ongoing rapid changes in technology.

THE SPACE SCIENCE OUTREACH AND AWARENESS PROGRAMME

Anacletta Koloko

SAASTA

The Space Science Outreach and Awareness Programme was developed by the Department of Science and Technology (DST) with the aim to develop and implement public engagement activities that effectively contribute to a stimulated and engaged South African society around space science and related applications, while supporting the development of a critical mass of globally competitive

human resources in prioritised areas. This programme is situated in the Science Communication unit at SAASTA and one of the activities is aimed at stimulating meaningful public debate around space science and getting industry involved.

Session 4:

Space Science

SPACE SCIENCE IN THE NEW SPACE AGENCY

Pierre Cilliers

SANSA Space Science Directorate

SANSA Space Science Directorate is responsible for one of the four Strategic Programmes Directorates of the South African National Space Agency (SANSA). The presentation will focus on the mandates of SANSA, SANSA Space Science Directorate, and the Regional Space Weather Warning Centre for Africa, hosted by SANSA Space Science in Hermanus. The presentation will include some of the instruments and models used for Space Weather prediction, and include an overview of significant Space Weather events and their impacts on technologies in South Africa since the start of solar cycle 24.

THE SQUARE KILOMETRE ARRAY - AN ASTRONOMICAL ADVENTURE

Nadeem Oozeer

SKA South Africa

The Square Kilometre Array (SKA) Project is mankind's quest to build the largest, and most sensitive, radio telescope in history. This next-generation scientific facility will probe the very beginnings of the universe to answer the most fundamental questions facing science today: What is Dark Matter? What is Dark Energy? What are the laws of nature, and how did they guide the evolution of the first stars and galaxies? Are we alone? South Africa, along with eight other African countries, has been selected to host a bulk of the SKA. This talk will look at a variety of aspects of the South African journey to host the SKA - from leading the scientific and technological developments through its KAT-7, MeerKAT and other projects, to what we will look forward to once the SKA is built. once constructed.

SALT: FROM INNOVATIVE TECHNOLOGIES TO CUTTING-EDGE SCIENCE

David Buckley

South African Large Telescope

SALT (the Southern African Large Telescope) is the largest optical telescope in the southern hemisphere. It was built in ~6 years by a South African led project team and began full science operations in 2011.

In this talk I will discuss the construction of SALT and its suite of first generation science instruments, highlighting some of the innovative technologies involved. SALT's initial teething troubles will be reviewed and some of the lessons learned from this. Finally, a brief summary will be given of some of the science programs that are now being carried out by the SALT partners.

KELT-SOUTH AND THE QUEST FOR EXOPLANETS

Rudi Kuhn

SA Astronomical Observatory

The search for planets outside of our solar system is one of the most exciting fields in astronomy at present. Although searching for extrasolar planets (exoplanets) dates back many years, the techniques needed to detect them have only recently been developed with the first being discovered in 1992. At present 834 exoplanets are known, with many hundreds still in the pipeline to be confirmed. In my talk I will be discussing the different methods astronomers use to find exoplanets and focus on one particular telescope dedicated to the discovery of these interesting objects; KELT-South.

PARTICLE-IN-CELL SIMULATIONS OF BEAM-DRIVEN ELECTROSTATIC WAVES IN A PLASMA

Etienne Koen

SANSA Space Operations

Using a particle-in-cell simulation, the characteristics of electrostatic waves are investigated in a three-electron component plasma including an electron beam. A Maxwellian distribution is used to describe the electron velocities. Three electrostatic modes are excited, namely electron plasma, electron acoustic, and beam-driven waves. These modes have a broad frequency spectrum and have been associated with intense broadband electrostatic noise observed in the Earth's auroral zone. The simulation results compare well with analytical dispersion and growth rate relations. This agreement serves to validate the simulation technique.

[Session 5:](#)

[Space Technology](#)

SUMMARY OF TECHNOLOGIES REQUIRED FOR SPACE-BASED OPTICAL INTERFEROMETRY AND THEIR APPLICATIONS

Pierre van Heerden

SA Astronomical Observatory/University of Johannesburg

There are many interesting applications of space-based optical interferometers, particularly in astronomical disciplines. These include the direct imaging of extra-solar planets and the study of extra-solar planetary atmospheres, high-precision astrometry, the refinement of astronomical distance scales and the

structure of our galaxy, which is why the development of a space-based optical interferometry telescope and the technology required to realise it is likely to become a key goal of major astronomical and space research and development organisations in the near future. During the presentation I will discuss what technologies would need to be developed for such a mission, potential spin-offs of these technologies and how South African institutions can become involved.

INTRODUCTION OF SEE TESTING IN SOUTH AFRICA USING PROTONS AND NEUTRONS.

David Wright

Heliocentric Technologies

Heliocentric Technologies have identified a need in the microsatellite, nanosatellite and cubesat industry for increased reliability via testing. To meet that need we are introducing radiation testing services to South Africa. These radiation services include both SEE testing and TID testing. In order to meet that need we have assembled a team with the necessary skills and experience to conduct radiation tests, and we have identified the necessary infrastructure here in South Africa to carry out those tests. We have also validated our test procedures in a radiation test campaign in partnership with Ithemba Labs. Having validated our radiation procedures with local infrastructure, we are ready to offer radiation testing to the satellite industry. Our aim is to be able to provide the full range of radiation testing for satellite components, including full SEE certification, to the microsatellite, nanosatellite and cubesat industry worldwide by providing a competitive price for our service.

DYNACUBE: VAN ALLEN BELT RADIATION AND TEMPERATURE MEASUREMENTS

Yolindi de Jongh

Denel Dynamics

A group of recently graduated engineers at Denel Dynamics is solving the problem of designing and implementing a 1U Cube Satellite (Cubesat) system as a training initiative. The science mission that the Cubesat aims to embark on revolves around the solar maximum that occurs in 2012-2013. The mission is to measure radiation and temperature variations as close as possible to the Earth's Van Allen radiation belts. Images of the earth will also be taken. The project is broken into three sub-projects: Ground station and Communications; Structure and backbone (consisting of on-board computer, power and solar cells); and Sensory payload and launch. The structure has been designed from scratch according to the Cubesat specifications and incorporates radiation shielding. The radiation is measured inside the Cubesat and also outside, unprotected by the shielding. The ground station receives data from the temperature and radiation sensors, as well as image data from the camera. The ground station also sends commands to the Cubesat. The design, development and manufacturing phase of the project will come to a close in December 2012. It is planned that the Cubesat will be launched during 2013.

SATELLITE-TO-SATELLITE COMMUNICATIONS RELAY CONSTELLATION

Andrew Nicol

University of Cape Town

Communications between a satellite and its Earth-based ground station are an intrinsic aspect of a satel-

lite's operational function. Satellite communications typically require each satellite to have their own link to a ground station. With available radio spectrum being a limited resource, regulation has resulted in satellites needing to make use of frequency sharing techniques for their transmissions. Satellites without a geostationary orbit have only a small window, often just a couple of minutes, in which they can communicate with their ground station. In addition, a satellite's communications subsystem commonly consumes the majority of its power budget, sometimes as much as three quarters, even at low earth orbits. Satellites without coverage of their ground station or those requiring uninterrupted communications have been limited to relay implementations using ground based infrastructure to perform the interconnect between the satellite and its final destination, in some cases making use of additional satellites to achieve the relayed transmission. With satellites often streaming raw, unprocessed data; the requirements and overheads can be quite costly and adds to the congestion of the ground based networks. This paper addresses the option of establishing a satellite constellation for the provision of communications relay facilities to academic, scientific and amateur satellites by means of a satellite to-satellite mesh network topology. The establishment of the satellite constellation may be achieved using a new dedicated network of satellites with their express purpose to provide these communications facilities, and/or alternatively by defining protocols and methodologies that may be incorporated into new satellite projects to extend the network. An offering of this nature would provide networked satellites with uninterrupted global communications coverage irrespective of their orbit.

To optimize the constellation's capabilities and keep congestion and latency to a minimum, the network would enact load balancing, prioritization, weighted shortest paths, as well as store and forward techniques taking into account the moving orbital positions relative to the destination ground station. The uninterrupted access to networked satellites provides operators with the ability to perform immediate actions such as attitude corrections should the satellite need to be repositioned to point at a celestial event or Earth-based disaster; alternatively more critically evasive manoeuvres may be performed such as collision avoidance or mothballing to ride out a solar storm. With the constellation providing shorter range communications facilities, satellites making use of the system would require less power allowing for focus on streamlined functionality.

Session 6:

Space Applications

SHOULD SOUTH AFRICA DEVELOP A SAR CAPABILITY AS PART OF ITS NATIONAL SPACE PROGRAMME?

M. Inggs, W. Nel and D. Meiring

University of Cape Town, CSIR DPSS, Denel

Applications of Synthetic Aperture Radar (SAR) typically represent more than 60% of the research papers presented at current Earth Observation (EO) conferences. In addition, it is a critical part of many a country's surveillance capability, fitted to satellite, aircraft or Unmanned Airborne Vehicles (UAVs). Thus, a national capability in the interpretation of SAR data is clear. However, the argument as to whether there should be a capability all the way to the sensor design and operation is an open question. There has been a proliferation of SAR sensors in the Developed World, with a great deal of catch-up in the Devel-

oping nations. We thus argue that the RSA must have a powerful capability in the use of SAR, especially in the area of EO. Monitoring of our environment, and our impact on it is crucial for planning for Global Warming. To build up this capability, we need a large injection into Human Capital Development (HCD), and must leverage on the expertise of the First World nations, who are keen to assist. This training, and the future operational systems relying on SAR will need timely and appropriate data. There are quite a few operational SAR systems, and some data is available either as a favour, or, at commercial, expensive rate. However, the biggest issue with all of these data sources is that almost inevitably, the right data is not available at the right time, as the guest user sits far down the chain of priorities. We believe that the RSA must, as part of developing its SAR applications expertise, also set up locally operated sensors (aircraft and UAV), as well as operate spaceborne sensors, completely under the control of South African or African Consortium control. Only then will be able to respond fully to our development and security needs.

SYNTHETIC APERTURE RADAR DATA EMPLOYED FOR THE MEASUREMENT OF DEFORMATION DUE TO MINING

Jeanine Engelbrecht, Michael Inggs

University of Cape Town

Synthetic aperture radar (SAR) images are formed by recording the phase (time delay) and amplitude (energy intensity) of microwave echoes returned from the earth surface. The phase measured by the SAR antenna is related to the number of wavelengths required to traverse the round-trip distance between the antenna and the earth's surface. Any ground motions that transpire in the radar line-of-sight direction would result in a slight increase or decrease in round-trip distance, causing an offset in phase. The interference pattern caused by the phase differences between two images captured at different times or different locations can be calculated, resulting in an interferogram. The phase difference information in an interferogram can be adjusted to compensate for phase contributions due to topography and orbital positioning, resulting in information that can be related to very small relative movements of the ground surface (centimetre or millimetre scale). This process is known as differential interferometry (dInSAR). dInSAR techniques are known for its ability to measure surface deformation and is frequently employed for disciplines such as volcanology, structural geology, geotechnics and work related to geohazard assessment such as the mapping of deformation after earthquakes and monitoring the stability of large engineering works. In South Africa, dInSAR techniques are being used to detect, measure and monitor surface deformation due to subsurface mining activities. Although traditional field-based deformation monitoring programmes is the norm (spirit levelling and GPS surveys), its limitations are recognised and includes the inability to get a synoptic view of potentially deforming areas since measurements are point-based. dInSAR techniques compliments the traditional measuring approaches by providing a synoptic view of deformation basins and the repeat image acquisition strategies provide the ability to monitor the evolution of deformation basins over time. Both C-band and L-band SAR sensors are being exploited for surface deformation monitoring, each providing different sensitivities to both small scale (sub centimetre) and large scale (tens of centimetres) surface deformation measurements. The objective of this paper is to show the results of the dInSAR measurements of surface deformation due to mining proving that the systematic acquisition of SAR scenes over time will enable the long-term operational monitoring of surface deformation due to mining activities.

EXPERIMENTAL LUNAR MINING INITIATIVE (ELMI)

Ron Olivier

Shamayan Innovation Partnerships

ELMI, as its name suggests, sets out perform an experimental lunar drilling mission using local and available international technology expertise. South Africa has designed, built and operated satellites in-orbit. These satellites were purposed for earth observation, space science and communication experiments and paid for largely by governments and their agencies. The time has come for South Africa to move onto the next level of experimental space mission – a commercial focus! This mission proposal focuses on combining South Africa's outstanding mining industry with its successful spacecraft engineering expertise to investigate the prospects for a moon mining mission. The venture should investigate the major elements of lunar mining as a basis to evaluate full scale future distance space mining operations. In this respect, success would collaborate with BRICS and other space agencies that have expertise in developing lunar missions where they are willing to share. There are other innovative aspects to ELMI, which will be addressed in the presentation.

SPACE SITUATION AWARENESS AND THE AMATEUR SATELLITE TRACKER'S ROLE

Greg Roberts

After 55 years of satellite launches space has become dangerously congested, so much so that Space Situation Awareness has become extremely important to avoid space collisions and other serious problems. The amateur satellite observing community represents a non-trivial SSA capability as they provide the only source of orbital data freely available to anyone on the internet, on nearly four hundred classified satellites based on optical and radio observations made by skilled amateur observers of these objects.

INVOLVEMENT OF SA AMSAT IN THE DEVELOPMENT OF A NANO SATELLITE

Deon Coetzee

SA AMSAT

Amateur radio payloads on satellites are a common phenomenon. However with the development of nano satellites (also known as CubeSats) it is felt that it is time for Radio Amateurs in South Africa to have easy access to a Low Earth Orbit satellite on as many passes as possible.

Session 7:

Space Transportation and Rocketry

PROGRESS UPDATE ON THE DEVELOPMENT OF THE MAS10K LIQUID ROCKET ENGINE

Mark Comninos

Marcom Aeronautics and Space

The MAS10K LRE is a pressure fed regeneratively cooled liquid rocket engine technology demonstrator which could be developed further into an upper stage orbital transfer engine. Designed to operate at 20 Bar chamber pressure and produce 10kN of thrust at an expansion ratio of 5:1 this presentation covers the technical and manufacturing challenges encountered during the course of the program with the aim of highlighting the complexities of liquid rocket component manufacturing, integration and testing. Included in the presentation will be test footage of the successes and also some of the failures.

CONSIDERATIONS TOWARDS PROVIDING A SUSTAINABLE CUBESAT LAUNCH SERVICE FROM SOUTH AFRICA

Jacob Venter

Overberg Test Range

This presentation will explore technical, economical, and other considerations towards developing a dedicated cubesat launch vehicle that could be used to provide economically sustainable launch services from South Africa. The conceptual launch vehicle will be able to insert up to three 5U cubesats into a 600km sun-synchronous polar orbit.

PROGRESS IN THE UNIVERSITY OF KWAZULU-NATAL'S PHOENIX HYBRID SOUNDING ROCKET PROGRAMME

Bernard Genevieve, Seffat M. Chowdhury, Michael J. Brooks, Jean-Francois P. Pitot de la Beaujardiere, Kirsty Veale, Lance W. Roberts

University of Kwazulu-Natal

In 2010 the Aerospace Systems Research Group in the University of KwaZulu-Natal's School of Engineering initiated the Phoenix Hybrid Sounding Rocket Programme. This aims to create human capital for South Africa's aerospace industry through the development of a family of hybrid rockets as technology demonstrators. The primary aim of HCD is achieved through postgraduate student involvement, while the main technical aim is to develop a hybrid sounding rocket capable of reaching 100 km apogee. As an intermediate step, the programme aims to develop the Phoenix-1A low altitude vehicle with a payload capacity of 1 kg and target altitude of 10 km. This presentation describes progress in the construction and testing of Phoenix-1A. In this regard, a rigorous process of structural design and computational analysis work is complete and the manufacture of the vehicle is presently being finalised. To date, the flight oxidizer tank and motor have been developed, pressure tested, and integrated together by means of four high strength stainless steel struts. The aluminium

stabilizing fins have been fabricated and the manufacture of composite airframe components is ongoing. A cold flow test of Phoenix-1A flight motor has been performed and two hot-fire ignition failures are described, along with their possible causes. The development of UKZN's in-house hybrid rocket flight simulation software tool, HYROPS, is discussed. Present objectives of the program are to successfully hot-fire the flight motor by the end of 2012, and to fly the vehicle once the motor-performance has been characterised.

CAPE ROCKET SOCIETY: FROM "FIRE IN THE ORCHARD!" TO OTB

Ockert Strydom

Cape Rocket Society

Cape Rocket Society (CRS) was formed by a bunch of engineering student enthusiasts to impress girls. Since those early days we have grown up a bit and now regularly launch high power experimental rockets from the Overberg Test Range. The presentation give an overview of the achievements of CRS, the lessons learned along the way and the latest methods we use to develop safe motors and fuels. Range safety tips will be given. Finally a CANSAT competition is proposed as a launch vehicle for human capital development.

AN OVERVIEW OF THE TURBOPUMP DEVELOPMENT PROGRAMME IN THE UNIVERSITY OF KWAZULU-NATAL'S AEROSPACE SYSTEMS RESEARCH GROUP

Jonathan Smyth, Luke Philogene, Jeffery Bindon, Michael Brooks, Graham Smith and Glen Snedden

University of Kwazulu-Natal

Space technologies are becoming increasingly important to economic development in Africa. Despite this, the continent lacks a satellite launch capability and its reliance on foreign launch service providers may be seen as both limiting development and compromising economic independence. South Africa, with its well developed space infrastructure, is in a uniquely favourable position to lead the way to an African launch capacity. Although South Africa previously acquired launch experience through solid-propellant technology, the commercial booster market is dominated by liquid-propellant engine technology. For this reason a turbopump design capability would be vital to any future South African commercial launch initiative. In this context, the University of KwaZulu-Natal's Aerospace Systems Research Group, located in the School of Engineering, has initiated a turbopump development programme to identify the key challenges in high-performance turbopump design. This programme currently consists of two projects; the preliminary design of a kerosene turbopump and the development of a pump test facility. The kerosene turbopump is designed for use in a commercial booster engine of a vehicle capable of lifting 50-500 kg payloads into a 500 km circular, sun synchronous orbit from a South African launch site. This application necessitates a small, light weight pump capable of reliably meeting the engine's flow requirements while utilising a relatively simple and low cost design. The impeller is designed to operate at 14500 rpm while providing a flow rate of 103 kg/s and a head-rise of 890 m of kerosene. This presentation will de-

scribe the design methodology being used, focusing on the impeller geometry and its predicted performance. The presentation will also address the development of a pump test facility for use in improving the design process and validating impeller performance. The closed loop test rig will run scaled down impellers derived according to the pump affinity laws. The facility will enable an experimental investigation of the impeller's head-rise, capacity, power consumption, efficiency and net positive suction head requirements. Pressure distributions in the impeller will be investigated to improve understanding of the through-blade flow characteristics and assist in design optimisation. Data will provide a reference for future CFD work. The test rig will use a 65 kW hydraulic motor coupled to a 6:1 gearbox to drive the impeller up to speeds of 5000 rpm.

DEVELOPMENT OF A FLIGHT COMPUTER FOR SOUNDING ROCKET APPLICATIONS

David Wright

University of Cape Town

The South African Astronomical Observatory (SAAO) requires a flight computer for their sounding rockets. This flight computer is to replace the current commercial flight computer currently in use improving on its functionality and expandability. Based on SAAO's requirements a modular and expandable flight computer has been built. In order to achieve this the flight computer uses a master slave architecture. This allows the user to select the functions he wishes to use for a given rocket flight. It also allows future expansion of the flight computer without large modifications. Notable design elements include the use of a Control Area Network (CAN) protocol for the internal communications bus; USB for PC to flight computer configuration; 2Mbit/s bi-directional telemetry; Fail-to-safe design in the use of both hardware and software locks for critical systems; and Ten degree-of-freedom Kalman filtered inertial measurement. The basic functionality of the flight computer has been verified, however a number of simulation tests are still underway. These include the testing of filtering and detection algorithms with more flight datasets.

SOUTH AFRICA'S SPACE HERITAGE: THE HIDDEN DECADE OF THE 1980S

Keith Gottschalk

University of the Western Cape

To date, published works on space history in Africa have almost invariably focused on one country, or on only one project in one country. This paper seeks to explore how a continental perspective may indicate niches where the African whole could become greater than the sum of its parts. It starts with an inventory of Africa's space heritage infrastructure. This notes the historic evolution of these from colonial-era projects in Africa, to projects by and for Africa. Next, it analyses the current proliferation of African space-related institutions and initiatives, some with international partners such as UNESCO and the IAU. Last, it debates to what extent the African Resource Management Constellation (ARM) and RASCOM may serve as differing models for future cooperation, and where they have encountered difficulties. The conclusion will discuss future possibilities, with a focus on where African space may achieve a critical mass. It also discusses how corporate and other non-government space participants will become increasingly important.