

Australian Industry Capability Statement Giant Magellan Telescope

SINCLAIR KNIGHT MERZ
EOS SPACE SYSTEMS
AUSPACE
VIPAC
AUSTRALIAN NATIONAL UNIVERSITY
ANGLO-AUSTRALIAN OBSERVATORY
SWINBURNE UNIVERSITY



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- 8 December 2006

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STATEMENT OF LIMITATIONS

'This capability statement has been prepared by Sinclair Knight Merz Pty Ltd on behalf of the Industry Working Group and Science/Technology Partners (collectively referred to as 'IWGP') for their client, the Giant Magellan Telescope (GMT). The sole purpose of this capability statement is to provide the GMT an indication of the capability of the IWGP to undertake project work on the GMT.

The IWGP derived the information and data used in this capability statement from the IWGP knowledge, publicly available information and through discussions with a number of interested parties. This capability statement is provided on 8 Dec, 2006 and the passage of time, manifestation of latent conditions or impacts of future events, may require further exploration and subsequent data analysis, and re-evaluation of any findings, observations or conclusions expressed in it.

In preparing this capability statement the IWGP relied upon and presumed accurate the information and data referred to in the previous paragraph. Except as otherwise stated in the capability statement the IWGP has not attempted to verify the accuracy or completeness of any such information.

The findings, observations or conclusions expressed in the capability statement are not an opinion concerning the quality of the project. No warranty or guarantee, whether express or implied, is made with respect of the data, findings, observations or conclusions expressed in this capability statement. Further, such data, findings, observations and conclusions are based solely upon information supplied as noted in the earlier paragraph and available in the public domain in existence at the time of the preparation of the capability statement.

This capability statement has been prepared on behalf of and for the exclusive use of GMT. The IWGP accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon this capability statement by any third party.'

1. Executive Summary

This Capability Statement represents the efforts of Australian institutions, companies and individuals over a period of nearly 4 years to develop an Australian Industry Capability Statement related to the GMT project. It is a work in progress.

Through Dr Charles Jenkins, the Deputy Australian Extremely Large Telescope (ELT) Project Scientist, the Australian ELT Working Group initiated the opportunity and through the support of the ANU found interest in a number of Industry partners. The real consolidation has occurred over the last two years with the formation of an ELT Industry Working Group (IWG) headed by Sinclair Knight Merz. The IWG has spent considerable time evaluating and understanding the opportunity that the GMT presents to Australian Industry. Additionally the IWG has endeavoured to understand the way that the international astronomical community does business and how best to structure a commercial response to the GMT opportunity.

At present the IWG has 4 partners in the team along with 3 science/technology partners. The main members of the team are:

- Sinclair Knight Merz (SKM)
- Electro-Optic Systems
- Auspace
- Vipac
- Research School of Astronomy and Astrophysics (ANU)
- Anglo Australian Observatory
- Centre for Astrophysics and Supercomputing, Swinburne University.

The IWG has extensive contacts with industry both within Australia and overseas. The team will be able to provide the GMT with a comprehensive and accurate assessment of design, manufacturing and fabrication capability in Australia. Additionally, the IWG opens up the opportunity of a coordinated approach that will provide a broad and well integrated portfolio of capabilities for the Design Development Phase (DDP) of the GMT project. The DDP is the next item on the critical path leading to the successful design and construction of the GMT.

The IWG team provides a unique opportunity for the GMT project. The Australian team is a committed group of companies that desire to share in the future that the GMT project presents to its partner institutions/countries.

We look forward to working with the GMT Board and the Australian science and technology partners over the coming months. Please contact Jeff Ruckman on +61 2 9928 2234, mobile +61 (0) 414 302 448, or email on jruckman@SKM.com.au for additional information.

2. Company Profiles

2.1 General

Four Australian companies have agreed to form a partnership in bidding for work associated with the Design Development Phase (DDP) of the Giant Magellan Telescope. They are:

- Sinclair Knight Merz (SKM)
- EOS Space Systems Pty Ltd (EOS)
- Auspace Ltd (Auspace)
- VIPAC Engineers and Scientists Ltd (VIPAC)

SKM is best placed to take the lead in dealing with the GMT project having the largest workforce along with a large engineering consultancy located in Chile.

The partners would bring to the project significant experience unique to their individual organisations along with a will and passion for participating in the GMT project.

This combined Capability Statement for the four companies highlights some of these skills along with examples of projects undertaken around the world.

2.2 Sinclair Knight Merz

2.2.1 General

At SKM, we have an inherent stability in the way we have developed our business over the years. It is a business which provides quality advice and embraces the services of feasibility, planning, design, implementation and project management, with an extremely broad range of contacts, clients and markets to provide total business solutions. The firm's operation is segmented into four generic market segments:

- **Industry** - Industrial, Mining, Energy, Defence, ICT
- **Infrastructure** - Transportation, Roads, Rail, Airports and Aviation, Maritime, Site Development
- **Resources** - mining, metals and mineral processing industry throughout the globe
- **Water and Environmental** - Environmental engineering, science, planning, Spatial and Geotechnical.
- **Buildings and Property** - Judicial, Education, Facilities Management Consultancy, Sports and Recreation, Commercial and Industrial, Health and Aged Care

Each of these market segments consists of expertise across a diverse range of services..

2.2.2 Industry

The SKM Industry Group has created centres of excellence in key areas of interest to industry, namely:

- Project Management
- Risk Management
- Structural Dynamics
- Automation

The Sinclair Knight Merz Industry Group provides a broad range of general and specialist engineering services across a wide range of industry market sectors, including:

- Communications
- Building Products
- Chemicals
- Marine Engineering
- Brewing and Distilling
- Metals
- Oil and Gas
- Pharmaceutical and Biotechnology
- Dairy
- Forestry Products
- Meat
- Textiles

2.2.3 Infrastructure

Sinclair Knight Merz has extensive experience in the planning, engineering design, construction and management of infrastructure elements. To service this market, our firm offers a strong combination of civil and structural engineers, along with transport planners, transport design engineers, environmental scientists, urban planners and economists. Along with our extensive track record in engineering, our breadth of expertise enables us to provide a unique service in strategic planning and concept plan development.

Our expertise lies in the following market segments:

- Roads
- Rail
- Airports and Aviation
- Maritime
- Urban Infrastructure
- Transport Planning



Our experience encompasses a broad range of projects such as award winning Tourist Resorts in Queensland, a wide range of operations in Antarctica, road maintenance on national highways, port developments in Malaysia, light rail projects in the United Kingdom, and airport lighting at Auckland Airport in New Zealand.

2.2.4 Resources

Sinclair Knight Merz provides whole of mine life services from feasibility, capital project delivery, to mine closure planning and decommissioning, tailored exactly to the needs of its chosen global mining leaders, where they operate.

Our Resources team, now well in excess of 1,000 personnel across the globe, is working on the development of facilities in many sectors. These include iron ore, coal, nickel, alumina, mineral sands and copper. As demand for these commodities intensifies, SKM's activities throughout the world are keeping pace through our main Resources sector offices located in Perth, Brisbane and Santiago.

We are able to offer clients a whole of mine life service, including the following services:

- Mining and Mineral Processing
- Project Delivery and Construction Management
- Major Project Capability
- Integrated Mine Infrastructure
- Environmental Management
- Materials Handling
- Study Services
- Engineering Services Agreement

- Environment, Health, Safety and Community
- Asset Management
- Specialist Services

SKM places a strong emphasis on client relationships and prides itself on its ability to create positive project scenarios that benefit our clients' operations. Our hard earned reputation as a leading service provider to the mining and metals industry has been gained following SKM's success in the delivery of a series of EPCM projects.

2.2.5 Water and Environmental

SKM provides a comprehensive range of environmental services through our innovative and experienced group of consultants. This approach has placed us as one of the leading environmental consultants in the Asia-Pacific region.



To provide a more structured business and meet the wide range of services required in the environmental market, the Environmental Unit is subdivided into five service segments that naturally overlap:

- Environmental Engineering
- Environmental Science
- Environmental Planning
- Spatial
- Natural Resource Management
- Geotechnical, acoustics
- Economics
- Surveying, mapping

SKM offers most of these skills in-house, with many of our personnel being leaders in their particular disciplines. We also recognise that the environmental field is very diverse and we can often provide the best service to clients by working with associated specialists from outside our group. This is achieved through our cooperative, marketing, and technology transfer associations with specialist consulting, research, and other organisations throughout the world.

The Spatial Division of SKM is one of Australia's leading spatial information consultancies with the group containing more than 200 professional, technical and support staff operating from offices across Australia and New Zealand.

An acknowledged key player in the Spatial Information Services Industry, SKM provides services - encompassing Photogrammetry, Remote sensing, Surveying, Data Conversion, Mapping, Spatial Databases, Systems Integration and Specialist Support Groups.

2.2.6 Buildings and Property

The Group is now undertaking major international building projects in locations as diverse as Dubai, UK, Malaysia, Thailand, India and throughout Australasia.

The Group offers leading edge skills in:

- Commercial and Retail
- Industrial and Defence
- Infrastructure and Transport
- Public Buildings
- Justice
- Health
- Sports, Events and Recreation
- Residential (high rise)

2.3 EOS Space Systems

EOS was founded in Australia in 1983 to commercialize space laser tracking technologies developed from 1974-1983 through joint programs of the Australian and U.S. governments. Developments in lasers, microcomputers, software, optics, electronics, and quantum devices were undertaken in parallel to produce optical space tracking systems with enhanced (1,000 times) tracking accuracy and capacity over earlier technology. The joint investment by these governments resulted in advanced infrastructure deployment and significant technology development in the area of active (by means of laser irradiation) and passive (by means of reflected sunlight) optical tracking of space objects.

By 1983 the technology was fully operational, and delivering excellent performance. In the period from 1983-1986 the Australian Government negotiated delivery contracts for space tracking systems in the U.S., Japan, Saudi Arabia, and Germany for execution entirely by EOS. This underwriting of its performance was a critical factor in EOS in its infancy obtaining major space tracking contracts.

Technology development in EOS was accelerated and enhanced from 1986 to 1996 by Australian taxation law which encouraged leading financial institutions to (effectively) purchase tax shelter by co-funding high risk research in technology companies like EOS with 150% deductibility, plus leveraging and gearing benefits. These provisions more than doubled any investment of EOS capital into research and development. By reinvesting its own operating profits (approximately \$16 million) in research over this period, EOS acquired approximately \$18 million of additional research funding from this scheme.

This funding was sufficient for EOS to deploy ambitious long-term strategies into emerging markets during a period when the aerospace industry was extremely risk-averse.

EOS today enjoys strategic market positions and has achieved technology breakthroughs out of proportion to its size because:

- Its core competencies and technologies were already well established at the Company's startup, as it was effectively a divestment of a major government program;
- Government performance guarantees facilitated initial contracts, which established market relationships and kept EOS ahead of the industry curve in terms of technologies and competencies; and
- The Company's extensive research and development investments, during a period when funding for space research was generally decreasing, allowed the Company to develop competitive positions in large emerging markets such as space surveillance and ballistic fire control, where it would normally have been outspent by major corporations.

2.3.1 Core Businesses

In 1992, EOS was principally a research company, with revenues from technology licensing and sales of laser space tracking systems. The corporate plan for the following decade was to use strong core competencies, high operating profit margins in existing businesses, tax incentives for research, and a loyal customer network to transition the Company to meet emerging market demands for large scale commercial space surveillance services and advanced ballistic fire control and surveillance systems.

Space debris is a well-documented space hazard that has resisted all previous attempts to overcome it and which threatens investments of over \$400 billion in the next decade. The hazard arises from the probability of collision between one of over 130,000 pieces of lethal man-made debris and an operational spacecraft, such as a satellite or manned vehicle. In a series of technological breakthroughs, EOS has developed a debris tracking capability, providing for the first time a basis for collision avoidance services.

The EOS space business was originally conceived as providing systems to enable for the first time the accurate tracking of vast amounts of space debris. However, as the complexity of the operational task emerged, as well as the tight linkages required between technology developer, manufacturer, system operator, and customer, it was evident that the vertical integration of most of these roles was necessary. The EOS business plan is now focussed on providing space surveillance services (tracking, orbit support, debris management and avoidance) based on proprietary information collected by a proprietary network of tracking stations, dependent on EOS proprietary technologies for their effectiveness. EOS is now positioned to become a leading provider of space debris avoidance services to the space industry.

Laser Space Tracking: The system depicted is a mid-size laser space tracking system produced by EOS in 1992 and presently operational in Saudi Arabia. The green laser beam is tracking a satellite at 7,000 km. A second laser beam “calibrates” the first. The car gives a system scale.



The Fire Control Systems military business (FCS) is based on a new generation of lightweight, compact, rugged, and low cost ballistic fire control products, with origins in technology developed by EOS for space-based tracking systems. By reducing cost, size, weight, and power consumption of this technology, while making significant performance enhancements, FCS has opened large new military markets.

2.3.2 Resources and Facilities

EOS employs 113 full time personnel in Australia and 94 in the U.S. Over 10% of EOS Space Systems staff have engineering degrees or Ph.D. qualifications.

The Company operates from facilities in Australia, focussed on R&D and the production of electronics, lasers, software, and specialized optical systems. The Queanbeyan site produces the Fire Control Systems military product, and the Canberra facility houses EOS headquarters and EOS Space Systems. Off-site facilities are also used for production, typically with EOS owning proprietary tooling or equipment that is stored at subcontractor facilities for use on EOS production.

In the USA, two facilities are located in Tucson, Arizona, which manufacture optical telescopes and US-based production of Fire Control Systems products. The EOS Technologies telescope facility can meet all the production needs of the EOS space debris program, as well as additional telescopes for the wider market.

2.3.3 Quality Assurance

EOS is certified to ISO 9000(2000), the international quality standard for development and manufacture. This certification is independently assessed at all design and production centres by Det Norske Veritas.

EOS develops and produces products incorporating advanced electro-optic technologies for the aerospace market. EOS products are developed through internal research and development programs based on EOS core technologies in software, lasers, electronics, optics, gimbals, telescopes and beam directors, optical coatings and precision mechanisms.

EOS focuses on the space surveillance and control, and the military force protection sectors of the aerospace market. In space surveillance and control, EOS specializes in space information based on the use of EOS-developed instruments and sensors to detect, track, classify and characterise objects in space. This information is required for both military and commercial space applications.

To support its space business, EOS develops and produces a wide range of space-related infrastructure in the form of sub-systems, such as telescopes and beam directors. Some of these are sold commercially. An example is optical telescopes, where EOS is widely known as the largest producer of major optical telescopes in the world.

In 2005 EOS formed a strategic alliance with Northrop Grumman [USA] for the development and exploitation of certain segments of the space sector.

In the force protection sector, EOS develops and produces complete robotic or remotely-controlled weapon systems, based on existing weapons in customer inventory. This market is addressed by EOS through a range of activities, as both prime and sub-contractor, and in partnership with other entities active in the sector.

The US Army CROWS program is a major program where EOS participates as a sub-contractor to Recon optical Inc.

EOS has recently delivered the MCAO optics bench to Gemini South.

EOS operates research centres in Australia, the US and Germany, and has significant production facilities in Australia and the US. New production facilities are expected to come on line in Germany in 2007 to meet demand from both space and weapons sectors.

2.4 Auspace

Auspace Limited is an Australian engineering company that specialises in the three core areas of communications, space systems and electro-optics. With some 35 specialist engineering personnel located evenly between Adelaide and Canberra, Auspace is a wholly owned subsidiary of Astrium Limited, itself a division of European Aeronautics and Defence Systems (EADS).

Auspace capabilities include:-

- Applied research and development
- Provision of bespoke, precision integrated, sensor systems
- Specialised integration and test facilities suitable for up to space grade equipment
- Niche software development for simulation, sensor and communications applications
- Strategic studies for civilian and military systems

- Training and
- Consultancy services

2.4.1 Satellite Communications

Auspace has extensive capabilities to provide satellite communications expertise and technology for civil and military clients. Their communications systems team based in Canberra, is complemented by their advanced DSP technology group (located in Adelaide) which implements specialist modem technologies and electronic systems development for a number of major clients. This team of internationally experienced engineers makes Auspace unique within Australia in offering proven end to end satellite communications systems, equipment and services.

2.4.2 Electro-optics and Space Systems

Auspace has a distinguished track record of instrument level optical and electro-optical design for sensor system applied to spaceborne and terrestrial telescope systems. Using Zemax modelling and analysis software, Auspace has designed complex folded optical systems for compact sensor based instruments. Auspace optical experience is specific to ground based and airborne telescope sensors. This includes the design, integration, test and calibration of spaceborne and terrestrial electro-optic and optics systems, covering the ultraviolet, visible and infrared bands. The majority of this work has been in support of systems with stringent performance and operational requirements and features both ground based and space-borne, state-of-the-art instruments.

Auspace's recent key involvement in major Australian space engineering projects has demonstrated its expertise in engineering design, applied research and development of space hardware and systems. We have hardware in orbit on two European remote sensing satellites including ERS-2 and ENVISAT. The successful Australian FedSAT microsatellite was integrated in Auspace's facilities as part of a collaborative programme.

Auspace and the Australian National University have recently completed a successful collaboration to rebuild the Gemini NIFS spectrograph, after the nearly-complete instrument was destroyed in the 2003 Canberra bushfires.

Capabilities include:

- Electro-optic/optical systems design and assembly
- End-to-end satellite and terrestrial modelling using 'STK'
- Small satellite systems and launch analysis
- Remote sensing systems and applications
- Satellite earth stations
- Ground support equipment

- Mechanical, structural and thermal engineering
- High-reliability systems engineering
- Instrument design and development
- Precision assembly, integration and test
- Real-time software development
- Detector technologies
- Vacuum system implementation and exploitation
- High-reliability electronics design, analysis and assembly
- Class 100 cleanroom operation and management

2.5 VIPAC

VIPAC Engineers and Scientists Ltd is a wholly Australian-owned private consultancy company providing specialised engineering services and solutions to clients across a range of industries for over 30 years.

VIPAC is one of the leading vibration, acoustic and dynamics consultancies Australia and SE Asia, employing over 140 staff and with 10 offices throughout Australia, Singapore, Hong Kong, Dubai and USA. Turnover currently exceeds A\$20million per annum, of which around 15 percent is derived from overseas.

VIPAC specialises in providing consulting engineering design and support services in electro-mechanical engineering, with an emphasis on structural dynamics, structural design and fatigue assessments, vibro-acoustics and specialised measurement systems.

Key areas of expertise include:

- **Systems Engineering** in the areas of Design, Analysis and Development, Simulation and Modelling, Integration and Installation and Test and Evaluation.
- **Advanced Analysis** in the areas of Mechanical Dynamics and Vibration, Structural Integrity and Dynamics, Thermal and Fluid Dynamics, Air Flow, Ventilation and CFD and Vibro-acoustics
- **Testing**, with over 100,000 square feet of test laboratories in Melbourne and Sydney for Environmental and Structural Testing, Wind Tunnel Testing, Fault Diagnosis/Recognition and Condition Monitoring and Data Acquisition and Signal Processing. Extensive in-house instrumentation and advanced engineering software packages.

All VIPAC Offices in Australia implement a Quality Management System (QMS) fully compliant with the requirements of AS/NZS ISO 9001:2000. VIPAC operations in Adelaide, Sydney, Newcastle, Brisbane, Melbourne and Perth have successfully passed external third party audits and are ISO9001 certified (Certification No. 7690).

VIPAC also has Accreditation by NATA. Our Sydney and Melbourne offices and laboratories carry NATA accreditation for a wide range of testing and measurement services including: vibration, shock, acoustic, mechanical, electrical, thermal, pressure, air/gas flow, emissions, force-moment, wind loads.

VIPAC is currently expanding the quality management system to comply with the international standard AS9100 for Aerospace and Defence work.

As a result of excellence in their field, VIPAC engineers have won a number of prominent awards over the years: Australian Industry-Quality and Achievement Awards; Australian Industry-Award for Innovation; Australian Coal Association-Excellence In Research Award; Australian Industry-Excellence in Acoustics Award; Engineers Australia (IEAust)-Engineering Excellence Awards.

2.6 Science & Technology Partners

The Industry Partners have formed strong relationships with a number of prominent Australian science and technology associations. These include:

- Research School of Astronomy and Astrophysics, Australian National University (ANU)
- Anglo Australian Observatory (AAO)
- Centre for Astrophysics and Supercomputing, Swinburne University of Technology

These associations are world renowned organisations that have well recognised skills in the area of optical and radio astronomy. The Industry Partners particularly value the input and advice from the Science Partners in understanding the way international astronomy groups do business especially relating to the GMT.

Scientific and engineering synergies that form through this partnering arrangement assist all members of the partnership, who recognize the complexity of the GMT project. It is particularly important that industry clearly understands the part it plays in the overall cumulative effect of error budgets and ultimately the effective operation of the GMT facility as a single entity.

The Industry Partners have been able to apply commercial and industry skills to the thinking of the team. This introduces the opportunity to enlarge the teaming arrangement to other industry areas that could provide off-the-shelf applications that can be modified to suit the GMT project.

This particularly highlights the need for a constant and strong interaction between scientists and technologists to achieve project goals. This is already the norm between the academic partners, with a number of their senior personnel involved in the working groups responsible for the definition of the scientific, instrumental, operational and telescope design needs of the GMT project. Hence the teaming arrangement covers a large part of the GMT project, with participants from both academic and industrial sectors necessary to achieve the best outcome.

The Science Partners will shortly be forming an Australian GMT Project Office (AGMTPO) at the ANU, as a focal point for Australian GMT activities. The AGMTPO will liaise closely with the main GMT Project Office in the USA. This will be a critical link in achieving successful communication between the two offices and the Industry Partners in Australia. The AGMTPO will ensure that the GMT team approach is maintained and enhanced through the international cooperation of industry, technology and science.

One of the main objectives of the AGMTPO will be to assist Australian industry in making the most effective bids for GMT work packages. An important part of this effort will be to ensure that astronomical requirements are fully understood by industrial partners. Effectively, a select tender panel could be established consisting of companies that have a demonstrated capability and understanding of the particular requirements of the GMT. Tenders will then address the GMT requirements ensuring that time spent by the GMT in tender evaluation is well spent. The scientist with main responsibility for this liaison will continue to be Dr Charles Jenkins, Deputy Australian ELT project scientist, who has a background in both basic astronomical research and applied research in industry.

3. Specific Capabilities related to the GMT

3.1 Instrument Controls

The GMT facility will comprise a large array of controls that will perform a variety of functions operating the carousel operations, building services and other critical components of the equipment that supports the main telescope functions.

The Industry Partners have built up an extensive team of experienced staff able to lead and support client initiatives in all disciplines related to process control and automation including DCS, PLC/SCADA, telemetry, instrumentation, communications and business systems integration. We offer professional and independent consultancy services to assist clients in the latest open systems technology.

Our team undertakes automation projects from business case development through concept and preliminary design, detailed design, system integration and implementation and commissioning of automation systems. These projects are deployed in process plant, mining, manufacturing, materials handling, water/waste water and power generation and distribution industries.

A major feature of our work is in project management and in particular the planning and implementation of upgrades on existing plant with minimal disruption to production. We provide integration and software development services to end-users, turnkey project contractors and vendors. These services range from Requirements Analysis and documentation through to Functional and Software Specification development, Software Development and Testing through to Commissioning, Training and Manuals preparation.

The team methodology provides a low risk solution with a strong emphasis on full system documentation and testing including plant simulation. We also place a high priority on training to ensure full system maintainability for our clients. These services have been provided on small industrial projects through to full scale Power Station Upgrade projects.

3.2 GMT Mechanical Design

The GMT facility will require mechanical plant for Heating, Ventilation and Air conditioning (HVAC) to control the work environment along with the operating conditions of instrumentation and research facilities associated with the GMT.

The IWG team has extensive capabilities in the design of machinery, plant and processes. We have design experience covering a very broad range of industries and technologies including, oil and petrochemical, plastics and polymers, building materials, mining installations, fertiliser plants, grain export facilities, coal handling plants and power stations.

Our team has extensive experience in the design of a wide range of special-purpose machines including steel handling equipment, specialised cranes, mechanised roofs and stands, amusement devices, bulk and piece materials handling and test rigs. SKM as team members have designed the twin 3000 tonne movable seating for the Olympic Stadium in Sydney. This included the controls, drives and monitoring systems for the operation.

Specialist members of our team offer mechanical design engineering in the areas of:

- Design - analysis & development
- Concept design - requirements and feasibility
- Preliminary design and specification
- Detailed design and test requirements
- Acoustic building fitout and design
- Vibration isolation of buildings/structures and mechanical services plant and equipment.

In conjunction with the mechanical services, VIPAC offers Systems development including:

- Complex system and instrument development
- Sensor and data acquisition systems development
- Simulation and modelling of system functionality and performance.

The speciality areas will assist our team in undertaking such tasks and providing independent technical review of tasks, including system level mechanical performance (especially regarding pointing budget), acoustic building fitout/design and vibration isolation.

3.3 Software Design

The IWG team uses our Real-time Software Development capability for industrial control and SCADA systems as well as transport information and control systems. Our capabilities include Operations Determination, Requirements Capture, Design, Code, Test, Integration, Analysis, Configuration Management, Source Maintenance, Performance Analysis, Performance Enhancement and Maintenance. The range of industries for which these skills have been applied include public transport, defence, power generation and distribution, water and wastewater treatment, metals and manufacturing, mining and minerals processing.

The IWG have skills in analysis of software requirements and performance for unique systems applications and real-time systems (control and operational systems). Typical systems require critical reliability, high availability, that are fault tolerant. We work with clients to develop an understanding of the operating 'environment'. Given our multi-disciplinary make up, we invariably have strong 'process' skills that assist with our understanding of system operational requirements.

The team is willing to use the clients' preferred development process and its real-time extensions, Keller and Shumate for example. Our preferred approach includes development and use of plant models for use in system testing and, where practical, client personnel training. Some team members generally use Systems Engineering Processes EIA 632 as a methodology to develop any systems or software, real-time or not. Real-time extensions are added as required depending on the system complexity. The team is not bound to any particular methodology.

The IEC1131 (for industrial control), QNX RTOS and similar platforms are also frequently used in real time system development. Other platforms are used depending on client, system vendor or application requirements.

3.4 Systems Engineering

All of the IWG team has been at the forefront of developing and applying systems engineering, in particular to the domain of commercial projects, but also in the area of defence projects. SKM for example has been involved in the system design for Project Parakeet, the tactical trunk communications system for the Australian Defence Force. The basis for the SKM processes and procedures in systems engineering is provided by the following two standards:

- ANSI/EIA 632-1998, Processes for Engineering a System
- IEEE Std 1220-1998, IEEE Standard for Application and Management of the Systems Engineering Process

The first one of these is somewhat broader in scope, addressing the totality of enterprise processes required for the engineering of a product, whereas the second one concentrates more on the design process. The following standards and documents have also been consulted and, where applicable, elements of these standards and documents have been incorporated:

- ISO/IEC 12207, Life Cycle Management - Software Life Cycle Processes
- ISO/IEC 15288, Life Cycle Management – System Life Cycle Processes
- ECSS-E-10A, Space Engineering – Systems Engineering
- MIL-STD-499B (draft), *Systems Engineering*
- *Systems Engineering Management Guide*, Defence Systems Management College, 1990
- Practical Software and Systems Measurement – a Foundation for Objective Project Management, Version 4.0b, 2000, US DoD and Army
- C4ISR Architecture Framework, Version 2.0

An early application of systems engineering outside defence was in the development of the Northparkes E26 Mine; a state-of-the-art underground copper mine with a high degree of automation. Other applications have been in the area of communications and control within the rail

industry, and a current example is the development of a new technology for the upgrading of sub-bituminous coal.

The systems engineering practice at SKM is led by Dr. Erik W. Aslaksen, who is a Fellow of the International Council on Systems Engineering, and he is supported by engineers in each of the major SKM offices.

Auspace has a track record in the development of complex multi-discipline systems used in airborne and spaceborne environments. A mature (since 1993) ISO 9001:2000 quality system incorporates the methods of the “EIA 632 - Processes for Engineering a System” standard. Structured system engineering methods are imbedded throughout Auspace processes.

VIPAC provide Systems engineering in the areas of:

- Design - analysis & development and simulation & modelling
- Concept design - requirements and feasibility
- Preliminary design and specification
- Detailed design and test requirements
- System R&D and instrument development
- Sensor and data acquisition systems development
- Simulation and modelling of system functionality and performance.
- Assembly and integration (mechanical, electronic) and commissioning, inspection, test and evaluation.

VIPAC will assist the team in undertaking such tasks and providing independent technical review of tasks, including system level performance, integrated system models and error budgets.

3.5 Project Management

Each of the Industrial Partners in the IWG has forged a reputation for delivering projects that create optimum value for their clients in industry. Collectively, we are able to provide a comprehensive range of services through all stages of a project, from initial concepts, through to implementation and operation.

- Pre-feasibility and definitive studies
- Detail design and EPCM implementation
- Commissioning and ramp-up
- De-bottlenecking and optimisation
- Infrastructure design and development

The IWG team provides a dynamic team of professionals dedicated to innovative project delivery within the engineering industry. It is committed to achieving the objectives established for the GMT project. Its experienced senior staff, supported by a broad range of professionals can assist the GMT Project to strategically assess its requirements and to plan and manage the project throughout all its phases including the procurement and implementation process.

We have a specific and systematic approach to the delivery of projects which focuses on value-adding services that will achieve a project's overall objectives. Our team has a well established communication philosophy which we believe provides an effective management environment; one which allows for critical review of concepts and assumptions, and provides for lateral approaches to the many competing critical imperatives. The generation of the best possible solutions is our planned outcome. This process is tried and tested and has been used successfully on many major projects. The major components of our project management system are:

- Establishment of close working relationships with the Client
- The development of detailed knowledge of the client's requirements and business objectives
- Implementation of effective management systems, clarification of responsibilities and articulation of project objectives
- Risk management and mitigation strategies
- Facilitation of the procurement process
- Planning, coordination and programming of the works
- Cost management and control
- Value Management Strategies
- Tendering and Contractor Management
- Client communication, approvals and reporting

At each stage of a project, we encourage and facilitate the client's input via regular and scheduled client reviews, agreements and approvals. Throughout the project our team remains committed to minimising project costs, managing risks, providing value managed outcomes and maximising client satisfaction.

Our strategy is to encourage a cooperative team approach to the delivery of projects and to involve all stakeholders to achieve the best results for the end users.

At the project outset, we develop specific methodologies to cover our complete project management capabilities. These methodologies set out all the tasks required to be undertaken to ensure the successful implementation and delivery of the project objectives.

Auspac uses mature structured project management processes for all project implementations, both in research and development as well as funded. Experience includes projects as large as multiple military satellite earth stations to astronomical instruments to space borne hardware. Auspace has a demonstrated history of successfully delivering complex multi-disciplinary projects.

VIPAC brings solid experience in project management of large complex jobs, such as the FedSat satellite and a range of large-scale/complex Defence projects.

3.6 Architecture

Our architects and interior designers are industry leaders delivering projects with professional acuity, expertise and commitment. SKM's architectural practice has a diverse portfolio of projects including commercial, community and infrastructure works.

SKM's architects are highly regarded for innovative building design that meets our clients' aesthetic and functional requirements. We provide leading Master Planning services including the undertaking Feasibility Studies and Property Analysis.

Our Services encompass each stage of the building design process including Concept Design, Sketch Design and Design Development to Documentation. SKM's Architects and Interior Designers work as an integrated team with our Sustainable Building Specialists and Building Engineers applying the required skills to each project.

3.7 Structural Design

The IWG team offers the full range of building engineering services, including structural and façade projects.

SKM provides an advanced analysis group located in Sydney and the other local SKM structural sections in Brisbane, Melbourne and Perth. Its structural engineering section in Sydney has been responsible for the 2000 Sydney Olympic Main Stadium and the Putrajaya Convention Centre in Malaysia.

Our IWG team offers the full range of structural engineering services including:

- Foundation design for rafts, piles, pad and strip footings
- Retaining walls and deep basement design
- Design of structural systems including stability cores, moment frames and shear walls
- Design and detailing of flooring systems constructed from insitu concrete, composite floors, prestressed and post tensioned systems
- Vibration analysis and assessment of flooring systems, stadium dynamics and building dynamic response

- Advanced seismic analysis of new and existing building structures
- Long span steel roofs, arch, dome and space frame systems
- Mast structures
- Cable nets and large span tension systems including cable and rod tension trusses
- Fabric structures
- Tall building design and analysis with either steel or concrete core systems
- Transfer and podium structures in concrete or steel.

Members of our team offer façade engineering as part of their structural engineering services. Our façade engineers offer the full range of services to owners, architects, specialist cladding and façade subcontractors. Services can either be prescriptive or performance based including:

- Glass wall design, including spider fixed systems, patch fittings and glass fin systems
- Cladding systems including aluminium panels and support system
- Curtain wall systems, including fully unitised systems or stick systems
- Lightweight tension trusses
- Precast and GRC cladding
- Stone and masonry cladding systems
- Performance mock-up design for visual, water testing and structural testing
- Re-cladding and Over-cladding systems
- Environmentally Sustainable Design ESD.

3.8 Dynamics, Vibration, Wind-shake Design

The IWG team offers Structural Dynamics capability as a specialist discipline specifically formed to promote the use of advanced engineering technologies within industry. With considerable worldwide experience in evaluating the dynamics of machines and structures, and using advanced analytical and testing tools, the Structural Dynamics Group is able to offer a wide range of services:

- Design
- Simulation
- Finite Element Analysis
- Vibration and Fatigue
- Testing

The dynamic simulation of components and systems can be undertaken using advanced Finite Element capabilities, in addition to the steady state and transient analysis of structures based on field vibration and strain measurements. Analyses performed are Modal Analysis, Forced response, Seismic analysis, Foundation Dynamics, Drive-train vibration and Highly non-linear analysis.

In the context of the GMT we can assist with the following design and analysis tasks:

- Dynamic design of foundations including soil-structure Interaction
- Vibration of telescope superstructures due to micro-seismic events and wind buffeting
- Drive train and control system dynamics to minimise interference on pointing and tracking
- Alignment studies
- Investigate thermal distortion of telescope during diurnal temperature and solar radiation transients

Following development of the design concepts, our team has extensive capability in the area of advanced product design. Our technical resources cover the key design techniques including solid modelling and simulation, part visualisation, Finite Element Analysis, drafting and data translation. This yields a powerful design capability aimed specifically towards rapid solutions to design problems.

The Structural Dynamics Research Corporation's (SDRC) suite of Master Series CAD/CAM/CAE software is used in-house to provide a state-of-the-art design facility. This software is established as an integral part of the design process of major aerospace, defence and automotive equipment manufacturers and component suppliers around the world. Design analysis, 3D surfacing and solid modelling, data translation and interface to Computer Numerical Control (CNC) integrate to provide a complete design service.

VIPAC also provides analysis and design in the areas of mechanical dynamics & vibration, structural integrity & dynamics and vibro-acoustics. For structural integrity and dynamics investigations, they have extensive experience in detailed stress/loads analyses, fatigue and fracture analyses, finite element and statistical energy analysis, life prediction and life extension, natural modes and modal analysis, and vibration minimisation. Building/structure vibration isolation and tuned mass damper design.

For the GMT project, critical issues to be addressed in this area include:

- Fundamental modes of the telescope structure and maximise stiffness.
- Minimize structure-borne and wind-borne vibration of telescope structure.

- Minimise buffeting of telescope for all orientations and wind directions/loads.
- Isolation of building envelope/carousel from telescope structure.

VIPAC will assist SKM in undertaking such tasks and providing independent technical review of tasks, including dynamic loads determination (including seismic, aerodynamic, mechanical vibration), analysis (modal, frequency response) and control.

3.9 Wind Tunnel Testing and Environmental Testing

VIPAC provides test services in the areas of wind engineering and mechanical environmental testing.

The Boundary Layer Wind Tunnel (16m x 2m x 3m) in VIPAC's Melbourne Laboratory is one of the largest commercial facilities in the world. Wind tunnel scaled testing for structural loads (force balance, aeroelastic), façade wind loads, cladding pressures, pedestrian level winds, wind climate and turbulence, wind noise, wind driven rain, environmental dispersion, diffusion and reingestion, building components, topographic studies. Parameters include mean/peak velocity profile, longitudinal turbulence intensity, integral length scale and flow visualisation.

The full-scale Façade Test Rig at VIPAC's Melbourne Facility is used for full-scale performance testing of building façades and components. Verification of structural, wind, thermal, water proofing and condensation ratings.

Environmental Test Chambers (at VIPAC's Melbourne and Sydney facilities) include the following:

- Large Environmental Test Chamber (14m x 5.5m x 4.5m)
 - Temperature range –10C to +75C, humidity 40–95%.
 - Solar/sunlight loads simulator (30 lamp CSI to 1120 W/m²)
- Balanced Temperature and Humidity Chamber (3m x 3m x 3m)
 - Temperature range –40C to +150C, humidity 20–95%.
- High Temperature Test Chamber (2.2m x 2m x 2m)
 - Temperature range from ambient to +350C.
- Thermal Shock Chamber (600mm x 500mm x 400mm)
 - Temperature range –80C to +220C (transfer time <2 secs).
- Environmental impact/leakage tests
 - Rain/moisture ingress and resistance; salt fog; altitude.
 - Chemical corrosion (acid/alkali), sand and dust penetration.

- Emissions, energy, appliance, electrical/electronics tests.
- High intensity acoustic tests, sound power (up to 145dB).

Vibration / Shaker Test Facility:

- Hydraulic and electrodynamic shakers
 - Sine vibration, random vibration and shock (to 100kN).
 - Modal response; drop/bounce; static test (to 150kN).

For the GMT project, critical issues to be addressed in this area include:

- Clean aerodynamic performance of structures and enclosure.
- Buffeting of telescope for all orientations and wind directions/loads.
- Air over the site summit - Minimisation of disruption or influence from carousel enclosure and other buildings.
- Uplift and intrusion of atmospheric boundary-layer into telescope enclosure or line-of-sight.
- Turbulence generated by the telescope structure and enclosure.
- Wind driven ventilation via controlled vents in enclosure envelope.
- Controlled wind-forced flushing of the interior air.
- Expulsion of excess waste heat well away from enclosure and telescope line-of-sight.
- Validation of CFD modelling with wind tunnel testing.

3.10 Thermal Design

Auspace Limited has a demonstrated heritage of specialised thermal design for complex electronic and electro-optic systems operation in ambient and vacuum environments both for terrestrial and spaceborne applications. Its experience is limited to equipment and subsystem level design and analyses using finite difference modelling software tools. Associated with this level of expertise is an in depth knowledge of thermal design verification and validation methods.

VIPAC offers analysis and design in the areas of thermal and fluid dynamics, air flow, indoor air quality, heat transfer analyses and microclimate engineering. Computational Fluid Dynamics (CFD) for air/fluid flow distribution and separation, ventilation requirements, steady state and transient pressures/loads and turbulence, vortex, drag/lift analyses. In addition they offer:

- Thermal environment definition, thermal mass, thermal cycling, heat transfer analysis and multi-physics analyses. Design of passive/active control systems, cooling/insulation treatments, thermal chimneys and ventilation openings/louvres. Natural ventilation, energy efficiency assessments and environmentally sustainable design (ESD).

- Determination of thermal budget and structural distortion of telescope structure relative to pointing requirements, cooling of electronics, passive/active air control including use of CFD methods.

For the GMT project, critical issues to be addressed in this area include:

- Thermal distortion of the structure
- Cooling of electronics and sensors
- Thermal control for exterior and interior volume.
- Maintaining all external surfaces at temp near ambient air temp during nighttime.
- Maintaining all interior air temp near ambient air temp during nighttime.
- No actively heated spaces within the structure or enclosure.
- Controlled wind-forced flushing of the interior air.
- Wind driven ventilation via controlled vents in enclosure envelope.
- Active ventilation of base structure to remove waste heat.
- Excess waste heat generated by sources within enclosure.

3.11 Geotechnical Design

Our team recognises the importance of gaining a thorough understanding of soils, geology and land formations to reduce risk and improve design and construction efficiency. Our highly credible team of specialist engineers, geologists and earth scientists has a proven track record in the investigation, design and construction of large civil infrastructure works. Some of the key areas are listed below:

Ground Investigation	
<p>We place particular emphasis on understanding the background to the project, the options available to the designers and the constraints on the project. The best use is made of available information so that fewer carefully targeted, high quality investigation points can build on any pre-existing ‘model’ of ground conditions, hereby reducing costs.</p>	<ul style="list-style-type: none"> ■ Desk study of all available information ■ Fieldwork and site surveys ■ Laboratory testing ■ Interpretation and design input ■ Provision of ongoing technical advice to the project team.
Geotechnical Design Services	
<p>The IWG offers geotechnical analysis and design services for structures in the ground or for utilisation of the ground materials, including:</p>	

- | | |
|---|--|
| <ul style="list-style-type: none"> ■ Concept design, planning and feasibility studies ■ Foundations ■ Excavations ■ Earthworks ■ Ground improvement / modification ■ Slopes – natural and man-made ■ Reclamations and fills ■ Retaining walls | <ul style="list-style-type: none"> ■ Temporary support ■ Tunnels ■ Underground excavations ■ Road subgrades ■ Seismic evaluations ■ Construction supervision ■ Contaminated land assessment ■ Instrumentation and monitoring |
|---|--|

In terms of geotechnical analysis, we have expertise with the following computer programs, developed specifically for numerical slope stability analysis and ground engineering.

- | | |
|--|---|
| <ul style="list-style-type: none"> ■ SLOPE/W (slope stability analysis) ■ SEEP/W (groundwater seepage analysis) ■ SIGMA/W (stress and deformation analysis) | <ul style="list-style-type: none"> ■ GALENA (slope stability analysis) ■ PLAXIS (stress and deformation analysis) ■ WALLAP (stress and deformation analysis) |
|--|---|

We have skilled operators who can build the analytical models quickly and efficiently so that the application of this technology has now become routine and well within the reach of most medium-sized project budgets.

We regard the design process as an interactive process, which frequently requires options to be considered and feedback from the other design team specialists and the client. Increasingly these services are provided to contractors working under design and build contracts.

Geotechnical Design Services

In addition to the usual site investigation and design activities, staff of the Geotechnical Group have built up substantial experience of providing specialist geotechnical advice for a variety of applications:

- | | |
|--|--|
| <ul style="list-style-type: none"> ■ Site selection and planning related studies ■ Construction supervision ■ Earthworks quality control ■ Construction materials assessment ■ Chemical assessment of soils and | <ul style="list-style-type: none"> ■ Investigation of distress or failures (forensic investigations) ■ Land and groundwater contamination assessment and remediation ■ Disposal and reuse of dredged material ■ Ground movements |
|--|--|

<ul style="list-style-type: none"> ■ groundwater ■ Studies of settlement and heave to buildings ■ Liquefaction assessment and earthquake engineering ■ Construction instrumentation and monitoring ■ Contract claims and arbitration support 	<ul style="list-style-type: none"> ■ Rock excavation methods. ■ Engineering geological and geomorphological studies ■ Groundwater resource studies ■ Risk management.
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3.12 Spatial Design

SKM is one of Australasia's largest and most diverse spatial information consultancies. As a key player in the information services industry, SKM provides leading edge spatial information services encompassing Geographic Information Systems (GIS) consulting, systems integration, photogrammetry, remote sensing and image analysis, surveying, data conversion, mapping and spatial databases. SKM also develops related products to enable use of this information. As part of a multidisciplinary international consulting group, our team is able to utilise a wide pool of expertise comprising scientists, engineers, logisticians, economists, architects and planners to extend the services and capability available to clients. Collectively, the products and services provided by the SKM Spatial Division support public administration, defence and emergency services, resources and environmental management, agriculture, forestry, tourism, transport and communication, real estate, mining and construction.

- Geo-Spatial Information System Consulting Services, Feasibility Studies, Economic Analysis of System Implementation Options, Organisational Benchmarking, Alignment of Information Management Strategies with strategic business directives, Asset Management Strategies, Organisational Structure Reviews, Infrastructure Definition or Review, Post-implementation System Effectiveness Reviews, Open Standards Architectures
- Systems Integration integrating desktop and web based GIS with SAP R3/4, MIMS, and Oracle Financials using industry standard development software
- Applications Development using the APT and Fusebox methodologies, developing custom applications for the complete suite of ESRI and MapInfo products, as well as using industry standard Java, COM or Cold Fusion based development environments to build non-vendor applications.
- Data Hosting and Application Service Provision, access to terabytes of fully redundant Storage Area Network, SQL Server and Oracle database platforms, incorporating ESRI's Spatial Database Engine as required, Support for Java, ASP and Cold Fusion scripting languages, Replicated servers with automatic fail over

- Geo-Spatial Information Data Capture, scanning and vectorisation of existing maps and plans with sophisticated software tools designed to semi automate the process, Aerial photography and satellite imagery, including leading photogrammetric production workstations by LH Systems with a capability for ortho rectification and digital mozaicing and vector mapping from imagery, Structuring of existing digital spatial data using a range of GIS and database tools, Field survey with a substantial array of field survey equipment available including electronic total station theodolites, digital levels, unmanned robotic theodolites and real time geodetic (survey accurate) differential Global Positioning System (GPS) receivers (+/- 0.02m), SKM also develops and sells data conversion tools that convert paper documents into scanned images and scanned images into vectors, support multiple GIS platforms including Smallworld, ESRI, MapInfo, Autocad, Intergraph and Microstation.
- Remote Sensing and Imagery Services, extensive image analysis and photogrammetry team equipped with the latest in image processing software, analytical stereo plotters and digital soft copy photogrammetry systems.
- Digital Globe High Resolution Satellite Imagery, SKM is the regional distributor for Digital Globe high resolution satellite imagery throughout Australia, New Zealand and the Pacific. The Quickbird satellite, launched in October 2001 provides imagery anywhere with exceptional clarity.
- Field Surveying, Geodetic Real Time Kinematic GPS (Global Positioning System) Receivers, 3D Laser scanning for collection of complex objects and structures, Unmanned total station electronic theodolites, Reflectorless electronic distance measurement equipment

3.13 Building Services Design

Members of our IWG have developed a reputation as innovative, reliable, quality providers of professional advice, design, documentation, and construction administration of engineering in building services.

The main engineering areas to be covered include:

- Electrical Supply and Emergency Power Plant Generation
- Mechanical Ventilation, Air Conditioning
- Fire Detection and Gas Protection services
- Building and site egress
- Emergency and Exit lighting
- Other building services (Hydraulic, Architectural)

The work is based on accepted 'Market Practice' scientific and commercial design. They incorporate industry code compliance, OHS compliance and accessibility requirements. These standards are developed at the commencement of a project and form the basis for future works.

Team members have the following in-house skills:

- Mechanical Services including Building Maintenance systems
- Electrical Services
- Hydraulic Services
- Fire Services
- Architectural review of any proposed code requirements
- Structural review associated with any proposed installation
- Acoustic design (where appropriate)

We can provide advice and services on a large range of issues that result from the initial assessments. Additionally, we can advise and provide input into project budgets and the costs associated with the works.

The IWG have identified the key issues that form the focus of the approach to the review and design of facilities. A risk assessment approach will be applied to determine the criticality of the installation (based on the Client standards). This will affect the MTTF (Mean time to Failure) and MTTR (Mean time to Repair) for different installations.

VIPAC is able to assist through the provision of acoustics and vibration analysis, design and control for building and mechanical services plant. Vibration isolation of mechanical services plant/equipment will also be critical to the successful operation of the GMT facility. Both passive control methods and active methods such as tuned vibration absorbers will be considered during the design.

3.14 Electrical Design

Our team has extensive experience with the electrical design requirements for technical facilities. Typical requirements for a technical facility would include the following items. The actual requirements will be dependant on the GMT installation specifications.

- 1) Provision of uninterrupted power supplies (UPS)
- 2) Electrical installation, designed in accord with relevant Standards
- 3) General facility supply, usually three phase within normal commercial tolerances

- 4) Preferred supply from major supply authority sub-transmission network with at least one dedicated substation. Ideally a site should be supplied from two separate sub-transmission systems or ring mains dependant on availability due to remote location. Plant redundancy to meet the Client's system reliability and availability (MTTF, MTTR) requirements depending on criticality of installation.
- 5) Consideration of power supply, EPP, switchboards and substation requirements
- 6) Two main switchboards can be required, each supplied from one of two low-voltage systems. Each main switchboard to be connected to generator feeders. Each switchboard would be located in separate fire rated rooms depending on criticality of installation.
- 7) Two switchboards bus-tied together to allow supply if one fails
- 8) Separate switchboards for various classes of supply
- 9) EPP supply to provided to meet the Client's system reliability and availability (MTTF, MTTR) requirements.
- 10) UPS to supply critical no break equipment loads, paralleled on output switchboard with future expansion potential
- 11) UPS to be static solid state technology to meet the Client's system reliability and availability (MTTF, MTTR) requirements., with provision for regular load testing.
- 12) UPS located in separate fire rated rooms with minimum features as specified by client depending on criticality of installation.
- 13) Three individual sets of reticulation cabling (essential, UPS, non-essential) depending on criticality of installation.
- 14) Each reticulation system to comprise two fully rated submains
- 15) Duplicated submains to be segregated to prevent co-incident damage
- 16) Essential and UPS load centres to have at least one supply from each main switchboard
- 17) Consumer mains and essential cables to be two hour fire rated to AS 3013
- 18) Cable management system to comply with client's requirements
- 19) Lighting to comply with relevant standards.
- 20) Entire electrical network to be protected from faults with careful grading for minimum interruption in the event of a fault.
- 21) Earthing to provide safe cohesive network protecting personnel and equipment including static earthing
- 22) Bonding to be provided to avoid potential differences and earth loops.
- 23) RFI screening to be provided where background levels exceeds levels nominated by equipment suppliers with building envelope to provide attenuation of 60Db at 100KHz to 1GHz

SKM has extensive experience in undertaking power system studies, grid planning and generator interconnection assessments, transmission line and cable route development, substation planning and design protection coordination, and earthing design, for systems ranging from extra high voltage (EHV) transmission systems (up to 500kV AC) to sub-transmission and distribution (33kV, 22 kV, 11 kV, and 6.6 kV).

Power systems have also been engineered down to utilisation voltage levels, inclusive of all HV and MV switchgear and distribution reticulation and supervisory systems. Services extend to utility asset management and strategic advice considering the regulatory and business context.

Many of these transmission systems are for areas which experience high wind loadings, difficult soil conditions, the consequential foundation problems, poor earth resistivity and a high incidence of lightning. Measures necessary to overcome these problems are fully appreciated and the satisfactory performance that has been achieved with transmission systems now in service demonstrates that the design approaches employed by our team have been successful.

3.15 Security Design

SKM (SKM) security consultancy has operated for over 30 years and now comprises nearly 40 full-time security specialists. Our highly regarded industry professionals apply their security skills and services in a wide range of sectors and industries across the globe. Notably, we have significant experience in designing and implementing tailored security solutions for high value facilities of national and international significance.

SKM's security philosophy is based on the principle that security is not engineered by technology alone. Our holistic security approach ensures an integration of operations, management, physical attributes and the application of technology. We meet our clients' expectations for cost effectiveness, operational flexibility and ease of implementation and maintenance, while also adding value to their core business.

- While SKM has extensive experience in security for sensitive and high value facilities, in Australia and overseas, much of the detail of these projects remains classified.

SKM's security consultancy could make a significant contribution to the GMT project through the provision of the following range of services:

- security risk assessment (including an assessment of potential explosive effects) and development of a security risk management plan;
- the provision of security advice and design input into the general design and construction phase, in order to enhance the GMT's inherent security capabilities;

- design of a security system and development of a security master plan to integrate the effects of design, technology and management; and
- development and integration of disaster, emergency management and business continuity plans.

3.16 Communications Design

Our team has extensive experience in the feasibility analysis, planning, design, specification, evaluation and implementation of modern communications systems for telecommunications companies, defence applications, government departments, utility authorities, infrastructure development, the finance segment and private industry in a variety of applications. Our services are flexible to meet Client needs and range from provision of specific professional advice to total project management from conception to commissioning and performance monitoring.

An indicative list of the scope of our ICT activities is shown below (Reference Project details can be provided upon request or by visiting our web site at (www.skmconsulting.com):

- Mobile radio and mobile phone systems including antenna, tower and building structural design; Due Diligence and Economic Analysis reviews of systems;
- Microwave and satellite communications systems, digital subscriber and UHF/VHF services;
- Telecommunications Infrastructure solutions ranging from site specific to nationwide networks; IT Strategic Planning, Business Systems Integration and Technology Planning.
- ICT System review, planning, specification development and detailed design for upgrading or introduction of new technologies or assets;
- Data network switching facilities, PABX networks and associated facilities;
- Point-to-point, point to multi-point LAN/WAN communications systems;
- Specialised Energy systems - measurement of interference to telecommunications from electrical power plants and telecommunications to/from remote sites;
- Network/SCADA and remote control systems;
- CCTV Surveillance and security systems localised and wide area remote monitored and controlled systems;
- Audio Visual Information system design, cost development, specification, evaluation, project management and commissioning
- Command Control Rooms and Building Systems;
- Independent Engineering advice, evaluation, project management, commissioning, performance monitoring and maintenance planning;
- Electromagnetic and radio frequency interference and control (EMI/EMC) for complex and electrical/electronics systems. Design and analysis support.

- Asset Management Planning;

In addition to major works undertaken on behalf of clients our ICT team provide solutions and advice to clients on a daily basis for minor technical issues ranging from connectivity issues to configuration management of equipment.

Auspace Limited is a recognised Australian expert in the design of end-to-end satellite communications systems, providing specialist advice to the Australian Department of Defence on its bespoke requirements. Remote area communications requirements and frequency coordination are a speciality.

3.17 Civil Design

Our team has extensive experience in the planning, engineering design, construction and management of infrastructure elements. To service this market, our firm offers a strong combination of civil and structural engineers, along with transport planners, transport design engineers, environmental scientists, urban planners and economists. Along with our extensive track record in engineering, our breadth of expertise enables us to provide a unique service in strategic planning and concept plan development.

Our experience encompasses a broad range of projects such as award winning Tourist Resorts in Queensland, a wide range of operations in Antarctica, road maintenance on national highways, port developments in Malaysia, light rail projects in the United Kingdom, and airport lighting at Auckland Airport in New Zealand.

Our team is experienced in all aspects of Civil Design from initial planning and feasibility through to concept and detailed design and construction. We are equally at home in dealing with urban and rural roads and our expertise also covers the areas of road system management and policy formulation. Key areas of practice include:

- Community & Stakeholder Consultation
- Road and transport studies including road transport logistics
- Economic and environmental appraisals
- Road and bridge design including the performance of existing roads and bridges
- Geotechnical and pavement design
- Traffic engineering
- Contract documentation and tender evaluation
- Project management and site management
- Independent Project Reviews

- Total asset management, maintenance planning and programming
- Road lighting, road furniture design, road safety audits
- Tunnels & Bridges

The breadth of our team means that we hold the full range of skills needed in civil engineering. This provides the client with simplified project management control and also through improved activity coordination, more efficient design processes.

In addition, we use design packages that are fully compatible with systems used by our many varied clients. This allows us to produce efficient designs and present them in a format that is accepted by the contracting industry.

3.17.1 Environmental Design

The innovative and experienced teams of engineering and geotechnical specialists in our team offer a comprehensive range of services that have positioned the firm as a leading player in the environmental engineering market. Through collaboration with our environmental and social planners and community consultation specialists, we strive to ensure the delivery of environmentally and commercially sustainable project solutions.

Our team is at the forefront of developments in Environmental Engineering. The corporate systems of project management and quality control provide the foundation for all projects and facilitate the delivery of outcomes.

Individual projects range in size from small specialist studies into a particular issue for example odour emission or pump specification to major water treatment plants in Sydney and sewerage projects for Bangkok. In all cases the focus is to meet clients' needs and to provide the best team for the project.

Members of our team undertake investigation and design for all aspects of the water cycle. The overall focus is to provide water and manage wastewater in a sustainable manner

The range of services are:

- Contaminated Land Management Services
- Water
- Waste Water
- Solid Waste
- Dam Engineering
- Geotechnical Engineering

3.17.2 Planning and Management

Our team provides integrated services in many fields such as sustainable management and development of land and water resources and biodiversity, reflecting the diversity of challenges faced by environmental planners and managers.

The Environmental Planning and Management team at SKM assists clients to achieve sustainable environmental outcomes for their projects. We do this firstly by seeking the best possible use of land, with the most desirable environmental, social and economic outcomes, while minimising impacts on the environment. We encompass the outcomes of our investigations in effective and feasible environmental management plans and develop environmental management systems for their efficient implementation. Environmental Planning and Management involves a wide range of disciplines and skills. Our services include the following:

- Defence Environmental Management
- Mining Environmental Management
- Sustainability Advisory Services
- Statutory and Master Planning
- Integrated Land Use and Transport Strategies
- Social Planning and Community Consultation
- Environmental Impact Assessment
- Environmental Management Systems
- Site Investigation
- Soil and Water (Freshwater and Marine) Sciences
- Waste Management
- Air Quality Modelling/Monitoring and Acoustics

3.17.3 Natural Resource Management

SKM has demonstrable expertise in developing strategies, technologies and capability for adaptive management of natural resources and landscapes. The traditional approach to development and the demands of modern society have placed enormous stress on our natural resources and the environment. Today we recognise the need for careful resource management, rehabilitation of natural ecosystems and the maintenance of productive uses as they underpin our economy and quality of life. Natural resource managers are required to balance the variety of economic, social and environmental demands on the land, rivers, forests, minerals, the coast and oceans. Our experienced specialists provide quality service and innovative solutions, helping business, government and the community to manage the complex interactions and demands on natural systems.

Our services include the following:

- Integrated Catchment Management
- Surface Water Management (Hydrology)
- Groundwater Resource Management
- Ecosystem Management
- Salinity Management
- Flooding and Floodplains
- Irrigation and Drainage
- Water Use Efficiency
- Forestry

3.17.4 Sustainability

Adopting a sustainability approach presents an opportunity for business and organisations to improve their financial bottom-line while reducing risks, enhancing their public profile and satisfying employee expectations.

Our commitment is to help clients pursue and improve sustainability of their operations. We have developed a high level of expertise and experience in sustainability – from public policy development and corporate strategy, to its translation into practical solutions.

Consideration of sustainability is particularly important in developing major infrastructure projects where a balance needs to be achieved between functional requirements and the direct and flow-on environmental, social and economic outcomes. In short, SKM provides the skills and technology to develop strategic and technical solutions for sustainability. This ensures that our clients can achieve remarkable success now and the sustainability of our own operations.

3.18 Safety Engineering

The Safety Performance Group (SPG) in SKM is a team of professional OHS practitioners (refer Appendix A) which assists companies of all sizes and stages of development to manage their OHS management obligations. The group provides specialist advice and support systems designed to suit the specific needs of individual companies or government enterprises and to help them progress towards workplaces free of injury and disease. SPG has offices in all states of Australia, Europe, Asia and South America.

The SPG offers proven capability in all aspects of OHS management systems, with recognised experts in:

- Safety in design

- Management systems
- OHS Risk assessment, auditing and management of contractor safety
- Construction safety
- Occupational health and hygiene
- Learning and development

Our safety and health specialists add value by applying their expertise to all phases of engineering, procurement and construction management (EPCM) projects, from feasibility studies through design and construction to commissioning, operation and maintenance.

SKM currently provides comprehensive OHS management support to major projects for BHP Billiton, Rio Tinto, Iluka, BP, Sydney Water, Road Traffic Authority (NSW), Western Power, and many more.

The traditional approach to project safety management has had some success and must be a core component of project management; however it does not in itself guarantee incident-free projects.

The SKM approach is to promote a safety environment where characteristics such as the individual's care and enthusiasm are an identifiable aspect of project safety culture. To achieve these outcomes, SKM implements specific activities aimed to align the Client and Company values, beliefs and work practices of companies and individuals that make up the project team.

Central to the SKM approach is the implementation of the SKM Project Health and Safety Practices Program. The health and safety practices program is designed to:

- Trigger a distinct quantum shift in the health and safety thinking of personnel appointed to the project
- Create a recognisable and effective project safety culture
- Create a personal commitment and belief in the most sustainable safety outcome for individuals and the project.

In addition the SKM Safety Performance Group can provide tailored support programs for clients including;

- A Unique induction program
- Supervisory Education and mentoring
- OHS Risk Management Workshops
- Specialised programs including-

- Work at heights
- Fitness for Work
- Manual Handling
- Incident investigation
- Confined Spaces
- Hazardous Substances Management

All training programs delivered by the SKM Safety Performance Group are outcomes focused and in accordance with the relevant national training framework, competencies and qualifications.

3.19 Construction Management

Our Project Management team relies on having effective processes established at the beginning of a project as this is critical to overall delivery. The success of a construction project depends on carefully managing the following items:

- Project quality
- Engineering disciplines and contractor management
- Prior planning and the extent to which the objectives, scope, strategy and project execution plan have been defined.

The major elements of the construction execution development stage are:

- Strong, consistent and effective environmental, health and safety policy applied to the entire project.
- Effective detailed engineering and specification processes aimed at meeting the critical construction deliverable dates.
- Design strategy to make use of opportunities for standardising, modularising and preassembly of components.
- Participation in the Risk Management Process, including the development of mitigation plans, as necessary.
- Clear identification of Owner requirements for approval, approval cycles and turn around times.
- The early assessment of key issues related to construction and constructability.



PACE) project for BHP Billiton Iron Ore

- Ensure that the project facilities can be constructed, commissioned and started in an efficient, safe manner and subsequently operated as designed.
- Details of scope, work packages, schedule, estimation, budget and resources included as part of the overall project plan.
- Employment of solid processes to monitor, report and review progress.
- Controls for safety, environment, quality, cost, schedule, labour relations and document control management.
- Organisation of construction activities in a sequential and logical, efficient manner.
- Effective construction organisation (including organisation structure and responsibilities) combined with programmed materials management.
- Ensuring that inter-relationships operate effectively and that contractors, subcontractors and suppliers operate as part of the team aligned to the overall project goal.

3.20 Logistics Management

SKM Logistics and Supply Chain Consulting has a primary business objective to assist clients achieve optimum performance in their business logistics and supply chain activities. This encompasses all business processes from the determination of requirements, through strategic procurement, transport, warehousing and distribution, to the disposal of waste.

SKM Logistics has assembled a highly experienced team of logistics and management professionals. The group has extensive practical industry experience and demonstrated consultancy capabilities to assist clients achieve bottom line benefits. Our capability includes optimising existing systems, as well as assessing feasibility and designing new operations and services.

Efficient supply chains for private industry are often very dependant on many shared / public infrastructure assets. Many of our assignments assist private companies improve the efficiency and cost effectiveness of existing operations. Others are directed to assessing the feasibility of new developments. Having a comprehensive appreciation of industry needs our consultants have assisted owners and operators of shared infrastructure such as ports, railways and road networks to develop strategies that improve industry efficiency overall.

The team at SKM recognises the critical role of supply chain management for our clients. From distribution strategies incorporating the latest e-commerce sales and delivery channels, through to operational audits and trouble-shooting projects, our logistics and supply chain professionals are ready to assist. We provide independent advice to help clients in developing and maintaining world class supply chains. Backed by the wider SKM group we help clients create solutions – and achieve them.

Total supply chain management strategies include:

- analysis of opportunities to improve business efficiency, reduce costs and increase customer service performance through consideration of all aspects of the management of materials, from raw materials sourcing to disposal of waste.

Logistics Strategies:

- development and implementation of integrated logistics processes, including inwards and outwards transport, inventory management and materials handling.

Transport Management:

- development of cost effective transport arrangements via road, rail, sea and air.

Routing and Scheduling

- ensuring customer delivery requirements are consistently met while minimising costs of fleet provision and operation.

Fleet Management:

- assistance with the specification, acquisition management, maintenance and changeover of vehicle fleets to ensure operational requirements are met at minimum cost.

Warehousing:

- design and implementation of new facilities and optimisation of existing facilities.

Materials Handling:

- task analysis and specification of appropriate equipment and/or work practices to ensure safe and efficient operations.

Outsourcing:

- analysis of functions to assess benefits from outsourcing logistics services, specification of requirements, of the best service and order for the role selection and negotiation with service providers,
- assistance with preparation of tender responses for both in-house and external organisations.

Feasibility Studies:

- the analysis of costs and benefits of proposed developments, including option identification, facility location comparison and determination of optimum arrangements.

International Logistics:

- import and export strategies covering both sea and air, including transport, intermodal operations, depot management and related functions.

Customer Service:

- customer surveys and strategies to enhance service levels.

3.21 Strategic Asset Management

Strategic Asset Management can be described as the art of directing assets through their entire life to maximise the benefits in the service delivery they provide. Asset Managers are facing increasing challenges that include growth in large asset portfolios and an increased focus on accountability and the performance of assets. To assist our clients to meet these challenges our team has assembled and established a highly experienced and knowledgeable Strategic Asset Management team to deliver the services required by our clients and their asset management requirements. We possess extensive experience in the management and delivery of large-scale portfolio assessments, programs and the implementation of Government policy, corporate plans and business objectives.

Our approach to Strategic Asset Management applies a continual improvement process that considers all aspects of an asset and asset portfolio life cycle. This encompasses the stages of Planning, Acquisition, Operation and Maintenance and Disposal.

Services include:-

- Advice to public and private sector clients on policies, principles and practices related to Asset Management, including the creation of peak policy documents
- Creation of asset management guidelines
- Creation of asset management systems
- Preparation and implementation of asset management training programs
- Assessment of client's assets including total portfolios of built assets to determine and inform financial liability exposure, risk management mitigation strategies, budgeting, service delivery strategies and portfolio rationalisation

- Reviews and rectification advice for existing asset management systems
- Linking of asset management systems to graphic and spatial databases providing leading edge information and planning tools.

In developing Asset and Facility Systems for our clients, SKM considers the key life-cycle elements of assets and asset portfolios; being:

- **Planning**

Master, Strategic, Disposal, Functional Briefs, Guidelines, Needs Analysis, Building Economics, Statutory Planning, Portfolio Analysis, Utilisation Studies, Benchmarking.

- **Acquisition**

Design Services, Regulatory Advice, Brief Development, Strategic Assessment, Cost Studies, Modular Buildings, Quantity Surveying, Project Management, Life Cycle Costing, Post Occupancy Evaluation, Regulatory Advice, Construction Management, Value Management, Due Diligence, Suitability Reports, Pre Purchase Reports, Hazardous Materials, Condition Reports, Compliance Reports, Financial Modelling, Infrastructure Design, Infrastructure Procurement.

- **Operation and Maintenance**

Benchmarking, Project Management, Maintenance Management, Works Management, Database Development, Data Capture / Recording, Design Services, Lifts Management, Condition Audits, Compliance Advice, Compliance Assessment, Hazardous Material reports, Energy Audits, Asset Register Development, Asset Register Management, Risk Management, Performance Analysis, Asset Management System Development, Remote condition monitoring (manual and automated) of mechanical systems, plant and equipment. Commissioning measurements and audits of systems and plant.

- **Disposal**

Pre Disposal Advice, Disposal Management, Regulatory Advice, Cost Advice, Land Redemption, Due Diligence.

3.22 Economic and Business Case Studies

The SKM Economic and Financial Advisory Unit provide a range of economic analysis services to its clients across Australia and New Zealand. Our clients include public and private sector organisations which are seeking to improve their overall sustainability, whether by improving

resource efficiency, increasing revenues, testing new markets, by developing new pricing models or seeking capital for growth. Our work portfolio covers a diverse range of sectors:

- Econometrics and economic modelling
- Economic Impact Assessment
- Financial Risk Analysis
- Utility and Infrastructure Pricing
- Environmental and Natural Resource Economics
- Regional Economic Development Advice
- Transport Economics
- Management Consulting
- Property and Building finance
- Agricultural and farm economics
- Tourism and leisure economics

These fields and techniques are applied as:

- Documentation of Initial or detailed Business Cases
- Pricing models
- Cost Sharing Analysis / Advice
- Project Feasibility Analysis
- Business Plans
- Cost Benefit Analyses
- Environmental Impact Assessments
- Public – Private Partnership Advice

Appendix A Work Capability Summary

Appendix B Company experience

B.1 SKM

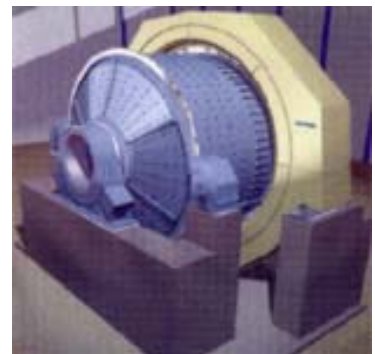
B.1.1 Telescope projects

SKM personnel have extensive experience in the design of radio telescopes, optical telescopes, and satellite tracking antennas. Relevant, previous projects include:

- The Square Kilometre Array concept design
- The Australia Telescope.
- National Mapping Optical Telescope (feasibility study).
- 26 metre diameter satellite tracking antenna for the Department of Defence.
- Safety and reliability audit of Parkes Telescope.
- Parkes Telescope upgrade
- 18 metres C/K band satellite tracking antenna, for OTC.
- 7.5 metre C-band satellite tracking antenna, for OTC.
- 2.3 metre telescope rotating building, for ANU.
- 7, 9, 11 and 13 metre diameter K-band satellite tracking antennas, for Romtel.
- Sydney University Stellar Interferometer.
- 20 metre TTC and M satellite tracking antenna, for OTC.

B.1.2 Project Management

- As an example, innovative solutions to improve efficiency and reduce project costs contributed to the success of the West Angelas project for Rio Tinto Iron Ore.
- In our work for the Dampier Port Upgrade, SKM has applied technological innovation through the use of 3D modelling and other advanced design techniques to assist in the efficient delivery of the A\$1.0 billion project.
- Clients are recognising our strong project management and systems expertise that has led to the successful delivery of projects such as BHP Billiton's Area C and associated Products and Capacity Expansion (PACE) project (in joint venture with Fluor).
- In addition, we completed the award-winning EPCM (in joint venture with Roberts and Schaefer) of BHP Billiton's Mount Arthur North Coal Mine. This complex project included a high capacity coal preparation plant.



10.5 m diam. mill powered by 2x5.2 MW variable speed drives

- In assisting Rio Tinto Coal Australia with the expansion of the Hail Creek coal facility, SKM was able to apply the extensive coal industry capabilities of its Brisbane office in the study and implementation of this major expansion.
- Iluka Resources commissioned SKM to complete engineering and cost studies together with EPCM implementation of the Gingin Mineral Sands project.

B.1.3 Significant buildings and structures

Signature projects include:

- The Eden Project Cornwall UK (recently announced as the UK's Building of the Decade),
- Stadium Australia - the Main Stadium for Sydney's 2000 Olympics with a capacity of 110,000 people and consisting of twin 3000 tonne movable seating sections.
- Putra Jaya Convention Centre – a building on which our Group acted as the engineering design consultant
- As part of the Mott Stadium consortium, a multinational structural engineering team, participated in the design of the seating bowl and roof for the new Wembley Stadium in London. The stadium, constructed over the footprint of the original 1960s Wembley Stadium, is designed with a seating capacity in excess of 90 000. It is a multipurpose stadium, designed to host football and athletics events as well as concerts and rallies.



Stadium Australia
Olympics 2000

B.1.4 Systems Engineering

- System design for Project Parakeet, the tactical trunk communications system for the Australian Defence Force
- Northparkes E26 Mine; a state-of-the-art underground copper mine with a high degree of automation, Communications and SCADA systems
- Control and Monitoring System (CMS) for Equipment in the Underground Loop of the Melbourne Metropolitan Trains, PTC Victoria - Victoria
- Southern Goldfields Load Shed Project, WMC Resources Ltd -
- Melbourne Metropolitan Station Communication Facilities Upgrade, PTC Victoria
- Communications System, Mt Newman Mining - Port Headland
- RFT for ADCNET, Department Foreign Affairs & Trade - Australia
- Jindalee Over-the-Horizon Radar Network (JORN), Department of Defence
- Relocation to Homebush Bay, Royal Agricultural Society of NSW - Sydney

B.1.5 Instrumentation & Control

- Edison Mission - Valley Peakers Facility, Balance of Plant
- Southern Hydro – Kiewa Supervisory SCADA System
- Southern Hydro - Eildon G3, G4 Recommissioning Automation
- Alcoa Ltd - Anglesea Power Station Distributed Control System Installation
- Loy Yang Power - Coal Handling Plant Upgrade
- Hazelwood Power Station - Morwell Open Cut AutoBunkering System
- SANTOS Moomba Review of Instrumentation for conformance to Hazardous Area Classifications and development of Upgrade Program
- Internal Overburden Dump – Morwell Open Cut

B.1.6 Electrical Engineering

Major power transmission systems engineered by SKM personnel include:

- 500kV transmission networks in Argentina and Indonesia
- 330 kV and 132 kV networks in Nigeria
- 245 kV Perlis interconnection to the Kota Setar Chupung Line, Malaysia
- 220 kV Dampier- Tom-Price-Paraburdoo transmission system, Australia
- Monasavu Hydro Electric Scheme, Fiji
- Hudson Creek Terminal Station, Australia
- Mica Creek Power Station and Mount Isa Mines Power System Upgrades
- Some aspects of the Cape Lambert – Pannawonica System for Robe River Iron Associates.

B.1.7 Security Design

Our work has included major facilities and projects in Australia, New Zealand, Malaysia, UAE, Singapore, Thailand and Sri Lanka, (among others) and includes the following:

- Australian Nuclear Science and Technology Organisation (ANSTO) facilities;
- National Biosecurity Centre, Australia;
- numerous overseas facilities for AusTrade;
- Changi Prison Complex, Singapore;
- Dubai Central Prison;
- Bank of Thailand;
- Dubai International Finance Centre;
- Buddha Tooth Relic Temple, Thailand; and
- The Burj, Dubai.

B.1.8 Environmental Engineering

We draw on our extensive skill base and expertise to deliver signature projects including:

- The groundwater management strategy for China (providing specialist advice on artificial recharge)
- Salinity mitigation and management works for the Murray-Darling Basin and other Australian and overseas localities
- The Sustainable Diversion Limits, and bushfire impact assessment, for rivers across South-Eastern Australia
- Sophisticated extreme flood estimation techniques and design inputs with application to over 100 large dams
- Capacity building, social and scientific advice in developing a coastal protection belt for the Mekong River in Vietnam.

B.2 EOS Space Systems

EOS Space Systems' commercial activities were initially focused on the business of developing, manufacturing and installing laser space tracking infrastructure for government agencies worldwide and the design of advanced laser satellites under U.S. Government contracts. The combination of these activities generated a unique technology base and core competencies which underpin the businesses today.

The technologies and core competencies of EOS have been developed over 25 years of continuous activity in electro-optic imaging and tracking. Key personnel have operated as a team in federally funded R&D and major government projects since 1974. The eight key areas of competency are:

- **Laser Systems.** EOS is a global center of excellence in the development of lasers for space tracking. These lasers require performance at the limits of technology for laboratory lasers, but with the reliability and environmental requirements of an industrial laser. There is no other commercial source for these lasers.
- **Electronics.** High reliability electronics for space, military and automated terrestrial applications have been designed and developed by EOS for over a decade. The emphasis here is on size, weight, power consumption, reliability and manufacturability.
- **Software.** EOS' space tracking solutions are dependent on real time acquisition and processing of data, and its real time distribution, validation, and application. The EOS software teams work across a range of platforms, operating systems, and languages such as C and ADA. EOS software capabilities have been specifically developed over decades for the task of global space tracking.

- **Modelling.** The effectiveness of EOS solutions is largely dependent on the intellectual input of its advanced mathematical modelling capabilities in orbit dynamics and ballistic modelling. In both areas, the EOS approach is unique, giving EOS a strong means of differentiating its products in the space and military markets.
- **Project Management.** EOS' project management group has managed projects as prime contractor throughout the world, operating in diverse cultures (Japan, Europe, Saudi Arabia, Australia, and the US) and across various language barriers.
- **Opto-Mechanical Systems.** EOS' opto-mechanical systems for manipulation of optical energy, such as telescopes and laser beam directors, are basic building blocks for EOS products. The accuracy requirements of these systems go beyond all commercially available technologies.
- **Systems Analysis.** Electro-optic systems are multi-technology, multi-disciplinary systems requiring specialized systems analysis. The capability evidenced by the scope and performance of EOS' products is the result of 25 years experience at the leading edge of systems technology.
- **Production Design.** EOS has incrementally improved its production capabilities in concert with R&D to allow manufacturability and maintenance issues to become progressively more infused into the technology development culture of the organization. This impacts time-to-market for new developments, providing strong competitive advantages.

B.3 Auspace

Auspace is able to provide independent or collaborative astronomical instrument design services and support from concept definition through to detailed design, development, integration and test. Our highly structured processes ensure rigorous control over all aspects of design, manufacturing, integration, verification and validation.

Our class 100 clean room facilities have been used relatively recently to integrate and test the NIFS instrument now successfully operational on the Gemini North Telescope on top of Mauna Kea in Hawaii.

Specialist processes applied to space projects actually enhance terrestrial instrument projects and ensure rigorous compliance with cost schedule and performance criteria.

Our close collaboration with the Mt Stromlo Observatory group has been a demonstrably successful partnership that ensures relevance to the astronomy community.

Auspace terrestrial astronomical instrument projects include:

NIFS: Near Infrared Integral Field Spectrograph (Gemini North)

WFI: Wide Field Imager (ANU 2.3m & AAT)

WIFES: Wide-field Integral Field Spectrograph (ANU 2.3m)

Auspace Space borne instruments include:

The Australian UV telescope project Endeavour flown twice on Shuttle flights STS-42 and STS-67.

Along Track Scanning Radiometer (ATSR) Focal Plane Array (FPA) for European Space Agency (ESA) project ATSR-2 orbiting on ERS-2.

Advanced Along Track Scanning Radiometer FPA, fore optics and electronics for the ESA AATRS project orbiting on ENVISAT.

Danish Space Research Agency Project MONS space based astronomical telescope.

B.4 VIPAC

B.4.1 Dynamics of Complex Systems, Structures and Vehicles: (Structural Loads, Analysis, Design, Fatigue Life, Ruggedisation, Reliability, Vibration Isolation)

FedSat Satellite (Cooperative Research Centre for Satellite Systems)

Project manager, system engineering, mechanical design, dynamic analysis and design, vibration testing, mission planning, ground control.

Kistler K-1 Reusable Rocket Launch Vehicle (Kistler Aerospace Corp.)

Aerodynamic and vibro-acoustic structural loads analyses, FE/SEA/CFD analyses, vibration/drag.

Joint Strike Fighter Aircraft (Lockheed Martin Aerospace-USA)

Aerodynamic/structural loads analyses, CFD/FE analyses, vibration/drag, fatigue life, equipment qualification testing (vibration, thermal).

C130/P3C Aircraft (Lockheed Martin Aerospace-USA, RAAF)

Aerodynamic/structural loads analyses, CFD/FE analyses, vibration/drag, fatigue life, equipment qualification testing (vibration).

Parakeet Transportable Communications Shelter (British Aerospace Systems)

Structural design and analysis, pointing requirements in high wind conditions, passive thermal design in the field (to MIL-STD-810).

Mach 5-50 Advanced Artillery Weapon (DSTO, Dept of Defence)

Systems engineering, structural analysis and design, structural loads analyses, testing.

Navy Frigate (Newcastle)

Structural and vibro-acoustic loads analyses, vibration minimization and isolation.

Platinum 160m Luxury Yacht (Platinum, Dubai)

Vibro-acoustic analysis and design, FE/SEA/CFD analyses, vibration minimization and isolation.

Defence Headquarters Joint Operations and Command Centre (ACP)

Electromagnetic emission levels and interference (EMI) impact assessment on MOST Telescope.

Boyer Paper Mill (Boyer)

Structural analysis and design, structural loads analyses, foundation design.

Oil and Gas Platforms (Malaysia, Singapore)

Structural analysis and design, structural loads analyses.

Torrens Island Power Station (TXU)

Condition monitoring of turbines, machines and bearings; vibration isolation/control.

B.4.2 Wind Tunnel and Environmental Testing:

(Structural Loads, Cladding Pressures, Aeroelastic Tests, Force-Moment Tests, Wind Studies – More Than 25 Years Of Wind Tunnel Test Experience):

Adelaide International Airport Terminal (Adelaide) - structural loads, cladding pressure, pedestrian level winds, exhaust dispersion/ingestion.

Darwin Convention Centre (Darwin) - structural loads, pedestrian level winds.

Adelaide Convention Centre (Adelaide) - structural loads, cladding pressure, pedestrian level winds, exhaust dispersion/ingestion.

Federation Square (Melbourne) - structural loads, cladding pressure, pedestrian level winds.

American Express Tower (Sydney) - structural loads, cladding pressure, pedestrian level winds.

Bondi Junction (Sydney) - structural loads, cladding pressure, pedestrian level winds.

Brisbane Airport Hangar (Brisbane) - structural loads, cladding pressure, pedestrian level winds.

State Office Tower (Brisbane) - structural loads, cladding pressure, pedestrian level winds.

Westralia Square (Perth) - structural loads, cladding pressure, pedestrian level winds.

Foxwoods Casino (CT, USA) - structural loads, cladding pressure, pedestrian level winds.

Burj Dubai High Rise Residences and Tower (Dubai, UAE) - structural loads.

Mall of the Emirates (Dubai, UAE) - structural loads.

Park Place Tower (Dubai, UAE) - structural loads.

Al Mankhool Towers (Dubai, UAE) - structural loads.

Wafi City Development (Dubai, UAE) - structural loads.

Dubai Marina (Dubai, UAE) - structural loads.

Qatar Science Technology Park (Qatar, UAE) - structural loads.

Singapore Airlines Headquarters (Singapore)- structural/wind loads, cladding pressure.

Guoman Hotel/Office Tower (Kuala Lumpur, Malaysia) - structural loads, cladding pressure.

Charenakom High Rise (Bangkok, Thailand)- structural/wind loads, cladding pressure.

Sukhumvit Towers (Bangkok, Thailand) - structural loads, cladding pressure, pedestrian winds.

Tseung Kwan Tower (Hong Kong) - structural loads, cladding pressure, pedestrian winds.

Other Projects: Stadium Australia, Melbourne Docklands, Melbourne Cricket Ground, Saida Stadium, Sharm Airport and other Convention Centres, Office Towers, Airports, Hotels, Theatres.

B.4.3 Thermal and Airflow/CFD Analyses:

Changi International Airport (Singapore) – thermal loads, internal airflow/climate, ventilation.

Park Place Tower (Dubai, UAE) – thermal loads, internal airflow/climate, ventilation.

Gate Garden Towers (Dubai, UAE) – thermal loads, internal airflow/climate, ventilation.

Dubai Festival City (Dubai, UAE) – thermal loads, internal airflow/climate, ventilation.

Institute of Technology (Qatar, UAE) – thermal loads, internal airflow/climate, ventilation.

Adelaide International Airport Terminal (Adelaide) – thermal loads, internal airflow/climate, ventilation.

Adelaide Convention Centre (Adelaide) – thermal loads, internal airflow/climate, ventilation.

Darwin Convention Centre (Darwin) – thermal loads, internal airflow/climate, ventilation.

Riverbank Precinct (Adelaide) – thermal loads, airflow.

Australian Science and Maths School (Adelaide) – thermal loads, internal airflow/climate, ventilation, environmentally sustainable design.

Mawson Lakes School (Adelaide) – thermal loads, internal airflow/climate, ventilation, environmentally sustainable design.

B.4.4 Vibration and Thermal Testing:

Projects for wide range of equipment and components in aircraft, defence, aerospace, automotive, appliance, building industries. NATA accredited laboratories.

B.4.5 Instrument/Sensor Design and Development:

Atmospheric Pressure Sensor - APS (Australian Space Office)

Satellite optical spectrograph/sensor design, system modelling, prototype development, lab testing.

Greenhouse Gas Monitor - GGM (CRCSS)

Satellite optical spectrograph/sensor design and system modelling.

Remote Methane Sensor (ACARP)

Lidar laser ranging sensor design and system modelling.

Tracking Mount System (DSTO)

Optical and infrared tracking system, precision pointers, positioners/controllers; design, development and testing.

RailBAM Bearing Condition Monitor (ARTC/Australia, China, Brazil, USA)

Remote bearing sensor development for freight/coal/passenger train wheel and bearing fault detection and recognition.

Appendix C Science/Technology Capability

C.1 RSAA – ANU Capability

Design and construction capabilities at the Research School of Astronomy and Astrophysics

C.1.1 General experience

- Imager, spectrograph and telescope design and construction
- optical, mechanical and electrical procurement, national and international
- close working relationships between scientists and engineers

RSAA hosts the Advanced Instrumentation and Technology Centre (AITC). The AITC, which was opened in October 2006, is a modern state-of-the-art workshop facility purpose-built for ELT telescope and instrumentation projects, and replaces and enhances the facilities that were destroyed in the 2003 Canberra bushfires. Its facilities include:

- Large integration hall
- Detector laboratories and clean room
- Optical laboratories
- Office space for engineers and astronomers

C.1.2 Current and recent projects

- Gemini near-infrared integral field spectrograph NIFS, now operational
- Gemini South adaptive optics imager GSAOI, commissioned off-sky
- Integral-field spectrograph WiFeS, being constructed for the SSO 2.3-m telescope
- Wide-field 268Mpixel camera for the SSO SkyMapper telescope, under construction

C.1.3 Electronics

- Software control of instruments and telescopes
- ESD trained staff, construction to MIL-STD2000
- Design of surface mount multi-layer (up to 8 layers) circuit boards
- Populate components on surface mounted boards
- Experience using latest AutoCAD, Protel, and CUPL software

C.1.4 Detectors

- Implementation & Control of low-noise CCD & IR arrays
- Characterisation and testing CCD and IR arrays
- Software and hardware developments for detector arrays.

- R&D effort to implement large focal plane arrays (SkyMapper)
- Design of low temperature cryogenic components for CCD & IR arrays
- Liaison with manufacturers for contractual specifications for detector arrays

C.1.5 Optics

- Optical design and evaluation, close relationship with world expert Australian optics designer
- Experience using Zemax software

C.1.6 Computing

- System-level support of Unix/Solaris (Sparc,X86), Linux, Windows, and Mac OS X platforms
- Programming expertise with C, C++, Fortran, Pascal, Java, Perl, and Tcl languages
- Software design and implementation for major instruments, including CICADA, WFI, and NIFS.
- Expertise in implementing and using major astronomical applications, including Image Reduction Analysis Facility (IRAF), Interactive Data Language (IDL), and Astronomical Image Processing System (AIPS)

C.1.7 Mechanical design

- Opto-mechanical design and procurement
- CNC computer control mill with full range of tools; software to import CAD drawings
- Full range of manual lathes and mills
- Full welding capability for MIG/TIG for fabricating structures
- Clean room facilities
- Access to campus EDM machines and CNC lathes

C.2 AAO

The Anglo-Australian Observatory (AAO) is internationally recognised as a pioneer of fibre-based spectrographic instruments and techniques having had extensive experience and highly successful outcomes with the design, development, and operation of instruments such as 2dF (for the AAT), 6dF (for the UK Schmidt), and OzPoz (for the ESO VLT). The AAO is also now in the final stages of construction of the FMOS Echidna fibre positioner, an instrument designed for the Subaru telescope.

Not only does the AAO design and develop fibre-based instruments, but it has extensive experience in the production of optical and infra-red imagers and spectrographs. The Australian Engineering Excellence Award for 2002 was given to the AAO for its development of the IRIS-2 infra-red imaging spectrograph that is in routine use on the AAT. This past year has also seen the successful commissioning of the AAOmega

optical spectrograph that is a dual beam, VPH-based spectrograph fed by the 2dF fibre positioner.

Expertise also resides in the development of detector systems and in instrument control and telescope control hardware and software. In particular, the PTCS telescope control environment was initially developed at the AAO and is in use at a variety of observatories around the world (UKIRT, UNSW APT, JCMT) and is now being implemented on the AAT.

The AAO's instrument science group is actively developing revolutionary new technologies for future astronomical implementation. Most notable is the development of a fibre Bragg grating that matches the night sky OH spectrum for its removal prior to insertion of the light into either an imaging or spectroscopic instrument. Other developments include small photonic based spectrometers and autonomous robotic actuators (Starbugs) for the deployment of IFU's, beam steering mirrors, etc. across a large focal plane.

The AAO has recently performed numerous design studies that include: concepts for the WFMOS instrument for Gemini, ELT instrument concepts, and telescope designs for use at Dome C in the Antarctic.

List of Trade References:

<p>ESO Instrumentation Division Karl-Scharzschild-Straße 2 D-85748 Garching bei München. GERMANY Telephone: (+49) 89 3200 6274 Contact: Guy Monnet</p>	<p>Gemini Observatory 670 N. A'ohoku Place Hilo, Hawaii 96720 USA Telephone: (+01) 808 974 2500 Contact: Doug Simons (director)</p>
<p>Subaru National Astronomical Observatory of Japan 2-21-1 Osawa,, Mitaka-shi, Tokyo, JAPAN Contact: Prof. Toshinori Maihara.</p>	<p>Institute of Astronomy, University of Cambridge, Madingley Road, Cambridge CB3 0HA, UNITED KINGDOM Telephone (+44) 1223 337548 Contact: David King</p>

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C.3 Swinburne University of Technology

The Center for Astrophysics and Supercomputing at Swinburne University of Technology in Melbourne, was established in 1998 and is Australia's newest and fastest growing astronomy center. It is the largest astronomical research group in Victoria, and is one of the largest in Australia. Underpinning its world-leading research activities and programs is its major 2.0 Tera FLOPS supercomputing facility, which is used for computationally intensive simulations and modeling in theoretical and observational astrophysics, as well as in telescope performance and design. The Centre is also a leader and innovator in the development and use of virtual reality technologies, and operates a state of the art virtual reality theatre. The current Australian Extremely Large Telescope Project Scientist, Warrick Couch, is a Distinguished Professor within the Center.

In the area of telescope design and development, the Centre is playing a major part in the Square Kilometre Array (SKA), the next generation radio telescope that is currently being planned and designed by an international consortium of radio astronomy institutes, in cooperation with universities, governments, and the private sector. Here its supercomputer is being used to simulate the performance of the SKA and to identify new modes of computer-controlled operation that will maximize its sensitivity and efficiency. New baseband recording and processing equipment is also being developed for the SKA, which will be used for RFI studies, VLBI and eVLBI, pulsar timing and surveys and other experiments. Prototyping and testing of such equipment is being carried out on the existing Parkes and the Australia Telescope Compact Array radio telescopes within Australia.