Report from SSCSiP Biomedical Focus Group:

Development of a ‘Diploma of Biomedical Engineering’ for the Pacific region

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Abbreviations used in this document

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>SSCSiP</td>
<td>Strengthening Specialised Clinical Services in the Pacific (AusAID funded Project)</td>
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<td>AusAID</td>
<td>Australian Government Overseas Aid Program</td>
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<td>PIC</td>
<td>Pacific Island Country</td>
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<td>MOH</td>
<td>Ministry of Health</td>
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<td>CMNHS</td>
<td>College of Medicine Nursing and Health Science of Fiji National University</td>
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<td>APTC</td>
<td>Australia Pacific Technical College</td>
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<td>SRG</td>
<td>Stakeholder Reference Group (of SSCSiP)</td>
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<td>BEMI</td>
<td>Biomedical Engineering Maintenance Initiative (AusAID funded program)</td>
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<tr>
<td>NSW TAFE</td>
<td>New South Wales - Technical and Further Education Institution (in Australia)</td>
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<td>USP</td>
<td>University of the South Pacific</td>
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Executive Summary
The Biomedical Focus Group of SSCSiP has been asked to investigate the feasibility of setting up a training course to address the current shortage of trained biomedical technicians being experienced in every Pacific Island Country.

The conclusions of this report are that it is feasible to establish such a course and by using all available existing courses and resources it is possible to develop the required new training materials for a cost of between A$150,000 and A$200,000. This is a small fraction of the cost of medical equipment resources wasted across the region each year by the inability of PIC’s to successfully repair their faulty equipment.

The focus group has concluded that a three year ‘Diploma of Biomedical Technology’ accredited by the College of Medicine, Nursing and health Science (CMNHS) of the Fiji National University is possible to establish for a first intake start date early in 2014.

For this to occur a number of hurdles have to be overcome:

- Identify a source of development funding to cover the costs of developing the new courses required
- Apply for accreditation for a new programme to the Academic Board of CMNHS
- Select a provider organisation for an existing Certificate IV level course in Electronic Engineering
- Select a group or organisation to develop the new courses required
- Provide enough information to PIC MOH’s to allow them to select and employ suitable students for a 2014 start
Background
Pacific Island Countries (PIC’s) have always had problems managing their medical equipment. As the range of medical equipment becomes ever more complex, the ability to procure, maintain, repair and dispose of this equipment places a great restraint on the provision of cost-effective diagnosis and medical treatment for their people.

The PIC Ministers of Health meeting in past years have raised their concerns on technology management issues. The Stakeholder Reference Group (SRG) of the Strengthening Specialised Clinical Services in the Pacific (SSCSIp) project in their meeting in 2012 placed medical equipment as their second most important challenge after capacity building for their staff.

SSCSIp has undertaken some initial work on the feasibility of setting up a Pacific region Biomedical Technician training course to meet the needs of all PIC’s and this report is following on from that initiative.

Introduction
The SSCSiP project has assembled a Biomedical Engineering Focus Group to make recommendations on setting up a training course and other related issues. The group consists of:

Ms Nehal Kapadia – Coordinating Biomedical Engineer, SSCSiP

Mr Andy Lyons, Biomedical Engineer, Tonga

Mr Tawake Vuli, Biomedical Technician, MOH Fiji

Mr Bob Daly, Biomedical Consultant

(AusAID funded ‘Biomedical Engineering Maintenance Initiative’ (BEMI) Biomedical Engineers from various PIC’s were invited to attend but could not attend this particular meeting for a variety of reasons)

Discussions
The biomedical focus group met over three days from Wednesday 14th November to Friday 16th November 2012 in Suva Fiji.

Wide-ranging discussions were held on the feasibility, timing, level, delivery methods and necessary content of a proposed technician course. The aim of such a course is to provide PIC’s with practically competent biomedical technicians who could independently travel to a regional hospital or health centre and expect to repair around 80% of the faulty medical equipment they found there. It was recognised that there will always be high level technology items such as complex ventilators, X-Ray machines, CT and MRI scanners that will always need a level of technical competence and test equipment that it will not be viable to provide in each PIC. These items will need either a service contract or external repair visit from a skilled and factory trained repair person. The majority of repair and maintenance tasks on at least 80% of medical equipment items on each PIC inventory should be carried out in-country by technicians employed by the MOH of each PIC in the region as this is the quickest and most cost-effective method.
Care was taken to ensure maximum use was made of existing teaching courses and expertise already in the region so as not to duplicate work already done or to ‘re-invent the wheel’. The essential skills required of a competent technician were isolated and then assembled into a course which will include both academic and practical skills in all areas necessary to achieve the stated goals of being competent to test, calibrate and repair at least 80% of a standard PIC Hospital equipment inventory.

The work of the Focus groups was presented to a wider group including representatives of the College of Medicine, Nursing and Health Sciences (CMNHS) of Fiji National University (FNU), AusAID Fiji, University of the South Pacific (USP), School of Engineering FNU and the SSCSiP management team. Wide-ranging discussions followed the presentations and the feedback and viewpoints of the participants are reflected in the conclusions and recommendations presented below.

Conclusions

1. **Viability**: It is possible to put together a suitable training course for pacific region biomedical technicians. It would require access to existing educational resources and the development of new educational resources specifically for the biomedical equipment area.

2. **Sustainability**: The number of biomedical technicians required in each PIC is relatively small. These people form a vital resource but not many of them are needed. We estimate an immediate requirement for between 25 and 30 technicians spread across all 14 PIC’s and an ongoing requirement for around 5-10 each year to replace technicians moving to other more lucrative areas of work, retirement etc.

3. **Level**: The most appropriate academic level for this course appears to be a three-year ‘Diploma in Biomedical Technology’. A ‘Certificate’ level trade course does not reflect the quantity and diversity of skills required to effectively maintain and repair a hugely diverse range of medical technologies. The academic levels for a degree in Biomedical Engineering are not required to maintain and service medical equipment and are more relevant to design and systems management. Degree courses in Biomedical Engineering are available from several academic institutions within the Australia/New Zealand region. There are no available courses that we can find for Biomedical Engineering technicians within the region.

4. **Mentoring**: The success of the proposed course is dependent to a large degree on having experienced, well-qualified biomedical engineering mentors available to assist and supervise the extensive work experience sections of the proposed course. Currently we have four such mentors around the pacific region: One on AusAID Bilateral Aid in Tonga and three BEMI positions based in Vanuatu, Samoa and the Solomon’s. There is a likelihood of a further position becoming available in Palau for the northern pacific region and one is likely to be required for Fiji at a later date.

5. **Course Contents**: The proposed course will utilise an existing Certificate IV level course in Electronic Engineering which will provide the electrical and electronic knowledge required. A total of four Biomedical Core subject courses will need to be developed, these include: ‘Introduction to Biomedical Engineering’, ‘Anatomy Physiology and Infection Control’, ‘Electrical and gas Safety in Hospitals’ and a course on ‘Computer-based Work Reporting’. Two externally provided courses on “Refrigeration” and ‘Surgical Instrument Maintenance’ will be required together with ten two-week computer based ‘Equipment Courses’. These ‘Equipment Courses’ will cover all the specific types of medical equipment you would expect to find in a PIC health system.
6. **Delivery Schedule:** A possible delivery schedule for a three-year ‘Diploma in Biomedical Technology’ is presented below. The exact delivery schedule would be drawn up at a later stage once the CERT IV Electronics provider has been selected and all delivery options assessed. This table illustrates a possible combining of five blocks of 8-9 week block-release Cert IV in Electronics, a set of Core Biomedical courses, a series of ten specific Equipment Courses and a total of around 70 weeks of mentored practical experience into a three year time scale.

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<td>Refrigeration Course</td>
<td>Equipment Course 5</td>
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<td>Jul</td>
<td>Work Experience</td>
<td>Equipment Course 8</td>
<td>Work Experience</td>
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<td>Sep</td>
<td>Electrical &amp; Gas Safety in Hospitals + Computer Record Keeping</td>
<td>Surgical Instrument Course</td>
<td>Work Experience</td>
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<td>Equipment Course 10</td>
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- **Biomedical Core Subjects:** (Introduction to Biomedical Engineering, Anatomy Physiology and Infection Control, Electrical & Gas Safety in Hospitals and Computer Based Work Reporting) Face-Face + Computer Delivery
- **Fiji Based CERT IV in Electronic Engineering:** (Classroom Lectures + Practicals)
- **Specialized Courses:** (Externally Provided)
- **Own-country based work experience with qualified mentor:** (approx. 70 weeks Relevant tasks – logbook assessment)
- **Ten Courses:** (Basic Diagnostic Equipment and Suction Pumps, Basic Dental Equipment, Autoclaves and CSSD Equipment, Basic Laboratory Equipment, Oxygen Concentrators and Infusion Devices, Maternal/Neonatal Equipment, Patient Monitoring Equipment, Operating Theatre Equipment, Basic Imaging Equipment, Endoscopy & Laparoscopy Equipment)
- **Computer interactive learning in own country with mentor assistance and backup:** – two-weeks per course
7. **Costs Involved:** The cost of setting up and delivering a new programme such as a ‘Diploma in Biomedical Technology’ fall into two distinct groups. Before the first course can be run there are one-off development costs in assembling the necessary educational material and putting it into the right delivery format, whether that is for a face-to-face lecture, a CD ROM based presentation or a full on-line interactive delivery. For each intake of students there are a number of course ‘delivery’ costs which will be similar for each new intake of students.

8. **Development Costs:** The intention for this course is to utilise an existing Cert IV Electronics Engineering course and so there are no development costs applicable for that course. We do need to develop a series of Biomedical Core Modules and the series of ten two-week Equipment Courses. We have investigated what is available already and have located a teaching module on Anatomy, Physiology and Infection Control which we believe is adequate for the biomedical students. We will investigate the possibility of licensing the use of this module to avoid having to duplicate it. The other three Core Modules and the ten Equipment Courses will have to be developed. We have obtained informal quotations for this development work and have received quotes in the range of A$7,500 to A$15,000 for each 2 week module. This equates to an all-up development cost of around A$90,000 to A$180,000. We would also need some checking and editing input. This cost is not an entirely up-front cost as the course will be delivered over a three year time span and all modules do not have to be developed to start the course. A guarantee that the full development funding will be available at the required times will be needed. Our development cost cash-flow requirement is likely to be as in the table below using an average cost of $12K per two-week module. This cash-flow prediction is based on the module being paid for in the quarter preceding its first usage.

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<td>Q1</td>
<td>$12K</td>
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<tr>
<td>Q4</td>
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<tr>
<td>Annual Total</td>
<td>$12K</td>
<td>$34K</td>
<td>$36K</td>
<td>$48K</td>
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<td>Total development cost = A$150,000</td>
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9. **Delivery Costs:** For each intake of students which we would imagine to be between 10 and 15 there are a series of costs:
   
a. Transport for the student to travel to Fiji to undertake the course, at least five visits to Fiji will be required during the three year course.
   
b. Subsistence costs while in Fiji and possibly during work experience if undertaken in an alternative country. Current costs in Fiji are around F$20 per day per student.
   
c. Tuition costs for attending the Cert IV Electronics Engineering course.
   
d. Costs of a laptop computer and a basic tool kit for each student, estimated at around A$2,000 per student.
   
e. Cost for a Course Coordinator to oversee administrative requirements for course compliance and successful completion of all requirements prior to graduation.
   
f. Lecturers to present the 6 weeks of Core Biomedical Subjects
   
g. Cost of biomedical mentoring services should AusAID cease funding the existing BEMI and bilateral aid positions that will provide this essential part of the practical training
h. Costs for attendance at the two specialist practical courses identified in Refrigeration and Surgical Instrument Maintenance.

i. Independent Work Book assessment to determine adequate practical skills attainment.

10. **Student Selection:** This course is intended initially for trainee biomedical technicians, employed by their respective MOH’s and given scholarships to allow attendance at this course based in Fiji. A comprehensive student information pack will be needed to allow potential candidates to familiarise themselves with what the job involves and the details of what the academic course will contain. We envisage at this stage the entry requirements being: a Fiji Form 7 pass (or in-country equivalent) in English, Maths and Physics and one of either Biology or Chemistry with a score of greater than 250/400 or a GPA greater than 3.0 from a USP Foundation Science course. The course is aimed at bright school leavers with a practical aptitude and a good work attitude. Interviews and Aptitude tests would be applied to potential candidates identified by each PIC MOH. It may be possible to accept private students at a later date but there may be some issues in providing private students with the level of mentoring they require from the AusAID funded BEMI biomedical engineers around the pacific region.

11. **Equipment Courses:** A template for each course was developed so that consistency between individual course developers was ensured. Each course should be arranged in the following sections:

   a. In which departments will you find this type of equipment
   b. Basic Purpose of Equipment
   c. Basic Principles of Operation
   d. Standard accessories required for operation
   e. Safety Issues for biomeds
   f. Required test equipment and testing procedures
   g. Basic functional checks
   h. Common problems
   i. Fault finding and repair

A module review process will be established for each completed module to ensure that a pacific focus is achieved and the level and content are consistently adequate.

12. **Accreditation:** We believe that the most appropriate institution to accredit the course is the College of Medicine, Nursing and Health Science of the Fiji National University. Biomedical Engineering fits quite neatly into Health Science alongside the other medical support services such as Laboratory, Radiology, Pharmacy and Physiotherapy. The deadline for submission of an application to accredit a new course or programme is the 31st March in the year before introduction. This gives us an absolute deadline of 31st March 2013 to have the funding commitment in place and the Accreditation Application forms completed and submitted. This will require a significant amount of discussion, documentation development and funding commitment very early in 2013 to ensure a smooth passage through the system. We also need to have a commitment for the course to allow the MOH’s of PIC’s to advertise and submit possible applicants to the College in time for an early 2014 start to the course.
Recommendations

1. Start discussions with the Academic Board of the College of Medicine, Nursing and Health Science (CMNHS) of the Fiji National University (FNU) on the feasibility of them accrediting the proposed three year ‘Diploma of Biomedical Technology’.

2. Prepare a schedule of development and administrative tasks with defined deadlines and suitable review procedures to ensure all aspects of the course are completed satisfactorily and on time.

3. Ensure the required application forms are completed and presented to the Academic Board well before the published deadline of 31st March 2013 for the course to start early in 2014.

4. Start discussions with both the CMNHS and potential funding organisations such as AusAID to ensure adequate development funding will be available when required (A$12,000 in 2013, A$54,000 in 2014, A$36,000 in 2015 and A$48,000 in 2016 – a total of A$150,000).

5. Start a selection procedure with the two potential providers of the Certificate IV in Electronics Engineering (School of Engineering FNU and Australia Pacific Technical College (APTC) to determine which can provide the best technical education at the best price.

6. Start an ‘Expression of Interest’ selection procedure for the development of the 4 Core Biomedical subjects identified and the 10 Equipment courses.

7. Prepare an ‘Information Pack’ to be distributed to PIC MOH’s to assist them in locating and employing suitable candidates for the ‘Diploma of Biomedical Technology’.

8. Liaise with NSW TAFE to allow the use or licensing of the Anatomy, Physiology and Infection Control module used in the NSW TAFE Course – NUE924.
Annexes:

Annexe 1: Biomedical Core Subjects
Four Core subjects have been identified:

1. **Introduction to Biomedical Engineering**

This will be a one week face-to-face course which will include a half day hospital visit and a written assessment of knowledge learned.

**Hospital Organisation:**
- How departments are organized, patients entry – triage, outpatients, Specialist outpatients, ER, Community health; admission, management, patient discharge
- Record keeping
- Compliance with standards, standard departmental operating procedures

**Hospital Etiquette** – patient respect, personal grooming, patient confidentiality, Inter-personal Communication: respect, understanding each person’s function and role in the hospital, and where biomedics stand. Patient focus

**Medical Terminology** – encountered in biomedical environment: proximal, distal, systole, diastole, supine, prone, body planes and movements, cardiac terminology, ventilation terminology, radiology terminology, laboratory terminology, dental terminology, physio, triage, etc.

**Biomedical Workshop Organisation & Workflow**

**Structure** – definitions and roles of engineer, technician, trainee and their responsibilities,

**Work Flow:** 1. Regular Preventive Maintenance (PM) and Safety and Performance tests (S&PT) 2. Breakdown repair

1. PM/S&PT: Intervals, importance, according to Manufacturers recommendations, importance of test equipment being calibrated.
2. Breakdowns: equipment assessment (triage) - diagnosis (testing & test equipment, investigation of fault, assessment of urgency, investigation with clinical complaints & communication with equipment users on status of equipment & repair), Parts requirement (ordering procedures, quotations), assessment of economic viability of repair (age of equip, depreciation), documentation (labels), storage of equipment, S&PT before dispatch

**Hospital Safety:**
Basic Infection control – universal precautions of hand-washing, understanding danger of handling used equipment, hygiene requirements (personal, food in workshop, etc.), use of personal protective equipment (gloves, masks, safety shoes), immunization – prevention of infections.

**Outcomes:**
1. Understand how a hospital is organized
2. Understand how a biomed department is organized
3. Understand work and patient flow
4. Have a basic understanding of hospital safety issues

**Assessment:**
1. Assignment: Field Visit
2. Quizzes
2. Anatomy, Physiology and Infection Control

This course will be computer-based education with assessment and quizzes embedded in the material. The course will take 2 weeks full time to complete.

A suitable course to teach this subject area has already been developed by NSW TAFE (NUE924) and is used as part of the ‘Medical Equipment Servicing and Technical Support’ Course - 2897 offered by Tamworth TAFE College NSW Australia.

This course covers basic Anatomy, Physiology and Infection Control to a level adequate to teach biomedical technicians enough to understand the anatomical and physiological context of the equipment that they will be testing and repairing. It will enable them to understand what the equipment users (doctors and nurses) tell them about problems in using the equipment on patients and also equip them to understand the risks and precautions necessary to avoid infections from medical equipment and their normal work environment.

3. Electrical and Gas Safety in Hospitals

This course will be face-to-face delivery from an experienced biomedical engineer and will be mainly practical

Practical and hands-on – AS3551:2012
Overview of AS3003:2011
Gas standard – AS2896
Colour recognition, cylinder sizes

Outcomes:
1. Understanding of basic electrical safety
2. Understanding concepts of insulation resistance, earth leakage, patient leakage, applied parts
3. Understanding of anomalous readings and practical solutions to resolve them
4. Understanding of correct acceptance testing
5. Safe handling and storage of gas cylinders and associated equipment
6. Recognition of different gas types and cylinders

Assessment:
Practical Tasks, Written Exam on core knowledge

4. Computer Based Work Reporting

Introduction – WHO PowerPoint Presentation
Examples of different Asset Management Systems
Legal issues/implications

Outcomes:
1. Understanding the necessity/importance for record keeping
2. Understanding equipment lifecycle
3. Benefits of record keeping
5. Specialised Practical Courses
2 specialised practical courses will be included
- Surgical Instruments – Sharpening & basic repair
- Refrigeration

Outcomes:
1. Ability to assess and carry out basic sharpening of surgical instruments
2. Ability to diagnose, evacuate, re-gas, & calibrate medical refrigeration units

Assessment
Practical & Written Exam
Proof of external assessment (for existing courses)
Annexe 2: Equipment Course Template and Details

Template for each equipment course to ensure consistency of approach irrespective of developer:

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<th>Required Sections for each Equipment Course Module</th>
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EQUIPMENT COURSE 1

Equipment: Basic Diagnostic Equipment (scales, Blood Pressure machines, stethoscopes, medical torches), Suction Pumps, Basic Oxygen Equip (Regulators, Flow-meters & Humidifiers) and Nebulisers (Air & ultrasonic)

EQUIPMENT COURSE 2

Equipment: Basic Dental Equipment (Compressors, Chairs, turbine handpieces, suction, lights, dental x-ray, scalers, amalgamators, dental lathes, mobile dental units, curing lights)

EQUIPMENT COURSE 3

Equipment: Bench autoclaves, CSSD autoclaves, ultrasonic cleaners, CSSD Quality control, bag sealers, sanitisers, Scope washers, hot air ovens (dental)

EQUIPMENT COURSE 4

Equipment: Basic Laboratory Equipment (Microscopes (including fluoroscopy), Centrifuges, balances, Rotators, Water baths, Incubators, Fridges (calibration), Distillers, safety cabinets, Stainers, Tube sealers, Histology equipment – tissue processor, microtome, paraffin (wax) bath, cryogenic techniques)

EQUIPMENT COURSE 5

Equipment: Oxygen Concentrators (portable to hospital size), Cylinder-filling compressors, Manifolds, Infusion (general, PCA) / Syringe pumps (general/TIVA)

EQUIPMENT COURSE 6

Equipment: Maternal/Neonatal Equipment (Infant Warmers/Resus, Incubators, Phototherapy, Foetal Doppler, CTG, Delivery Beds, Colposcopes, Transilluminator)

EQUIPMENT COURSE 7

Equipment: ECG Recorders, Patient Monitors (ECG, NIBP, IBP, SpO2, EtCO2, Temp, Resp), Anesthetic Monitor, Pulse Oximeters, Holter Monitor, Stress test machine & Treadmill
EQUIPMENT COURSE 8

**Equipment:** Theatre Lights (mounted/mobile), Operating Tables, ESU, Defibrillators, Warmers – fluid/patient, Operating microscopes, Anesthetic Machine - vaporisers & ventilators (basics), Nerve stimulators, Scavengers

EQUIPMENT COURSE 9

**Equipment:** Slit-lamps & Basic Imaging - Ultrasound Scanners, basic X-ray (Radiation safety, basic principles, X-Ray testing, Film Processors – conventional/CR/DR)

EQUIPMENT COURSE 10

**Equipment:** Endoscopy, Laparoscopy, Insufflator, Light Source (including headlamps), Camera Units, Monitors, Flexible Scopes, Storage cabinet