Teacher Development Program
Bringing schools and Engineering together

Year 11 – Biomedical Engineering Module

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Engineering Studies syllabus structure

Preliminary modules *120 hours indicative time	HSC modules *120 hours indicative time
Engineering application module 1 Engineering fundamentals	**Engineering application module** Civil structures
Engineering application module 2 Engineered products	**Engineering application module** Personal and public transport
Engineering application module 3 Braking systems	**Engineering focus module** Aeronautical engineering
Engineering focus module 4 Biomedical engineering	**Engineering focus module** Telecommunications engineering

This Module

The Syllabus-HSC Modules

Student Learnings

Engineering focus module 4: Biomedical engineering
30 hours indicative time
This module will provide an introduction to the study of engineering focus modules.

One or more examples of biomedical engineering must be used to develop an understanding of the scope and nature of this profession. Some examples include: artificial joints, surgical equipment, artificial limbs, the bionic ear and artificial hearts.
Outcomes

A student:
P1.1 identifies the scope of engineering and recognises current innovations
P1.2 explains the relationship between properties, structure, uses and applications of materials in engineering
P2.2 describes the nature of engineering in specific fields and its importance to society
P3.1 uses mathematical, scientific and graphical methods to solve problems of engineering practice
P3.2 develops written, oral and presentation skills and applies these to engineering reports
P3.3 applies graphics as a communication tool
P4.1 describes developments in technology and their impact on engineering products
P4.3 identifies the social, environmental and cultural implications of technological change in engineering
P5.1 demonstrates the ability to work both individually and in teams
P5.2 applies management and planning skills related to engineering
P6.1 applies knowledge and skills in research and problem-solving related to engineering.

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Scope of the Profession

P1.1, P4.1, P4.3

Scope of the Profession

- Biomedical engineers apply **engineering analysis** and techniques to problems in medicine and life sciences
- Range of work:
  - Medical devices e.g. life support ventilators
  - Medical equipment e.g. imaging machines, blood pressure machines
  - Artificial limbs
  - Artificial tissues and organs
  - Orthopaedics
  - Biomechanics
  - Medical regulation

Current projects and innovation

- Large push towards how we can use the data from medical devices to improve healthcare and economic outcomes
- Use of new materials in the generation of replacement tissue to give to patients
- Bionic eye to help the vision impaired
- Use of wearable devices to seamlessly integrate into individuals' lives- companies like Verily are joining with medical device companies to capture and analyse this data

verily

Health and Safety Issues

- Risk to patient safety- need to balance the benefit vs the risk to their health
- Biocompatibility of materials used in devices and implants
- Privacy of patient data
- Electrical safety
- Risk associated with failure of the technology
  - E.g. breast implants with incompatible materials
  - Ventilators failing where patients require them to live
- The regulators such as the Therapeutic Goods Administration (TGA) monitor these to ensure that the products on the market are safe

TGA Health Safety Regulation

Training for the profession and career prospects

- Bachelor or Masters degree in Biomedical Engineering
- Career prospects
  - Academia doing research in the field
  - Medical device companies
  - Working in hospitals managing medical equipment
  - Start-up companies working on the commercialisation of new tech
  - Analyse big data from medical devices and trackers to gauge trends

Relations with the community

- The products and projects that you work on are used by everyday people to help improve their quality of life
- You’re able to impact a large number of people who experience the same issues
- There is a direct connection between the work you do and seeing the impact it has on people’s lives

Technologies unique to the profession

- Technologies are generally not unique to this profession, rather we use physical principles and technology for application in medicine and life sciences
  - Examples
    - Use of cellular, Bluetooth and wi-fi technology to transmit data from devices to the cloud
    - Use of motors to generate air that's used to ventilate patients
    - Use of polymers for the design of new materials for use in medical equipment

Ethics and engineering

- Risk-benefit ratio
  - We have to weight up the risk to the user/patient vs the benefit they are likely to receive from it
    - E.g. new chemotherapy treatments are given to those who don't respond to existing therapies as the risk-benefit ratio would be low in this scenario (not a lot to lose)
- Clinical trials and informed consent
  - Before a new device or technology goes on the market, it needs to be trialled in a clinical environment, there are ethics around the selection of participants for these trials and ensuring they are providing consent to participate
- Conflicts of interest
  - If you are trying to run a study in the academic environment and you are sponsored by a medical device company, these must be declared as potential conflicts of interest
- Patient autonomy- right to choose or refuse treatment
- Confidentiality of patient information

Ethics continued

- Human enhancement
  - Devices and techniques developed by biomedical engineers often support therapy or diagnosis, but could be used to enhance humans beyond normal level
- Cellular, Genetic and Tissue engineering
- More examples here: https://ethicsandtechnology.eu/wp-content/uploads/downloadable-content/Brey_2009_Biomed_Engineering.pdf

Engineers as Managers

- This is quite a frequently trodden path for engineers
- Progress from a design/technical engineer to managing groups of engineers, and then moving up to manage larger departments and eventually whole business units
- Engineers can also choose to progress through a technical pathway, where they lead and influence key technical decisions on projects

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Historical and Societal Influences

P2.2

Historical background

- It goes back many centuries
- The first record was a mummy where they had the first known instance of a prosthetic wooden toe
- From there, biomedical engineering covers things from devices and tools used by doctors to technologies used to prolong life
- In the 19th century there were many discoveries including:
  - Stethoscope
  - X-ray imaging
- After the World Wars was when biomedical engineering became formalised within universities

Effect on people's lives

- Allows monitoring of chronic illnesses such as diabetes which allows medications to be taken at the right times/altered to help the patient
- Improved quality of life for those with illnesses such as sleep apnea, COPD (Chronic Obstructive Pulmonary Disease) and respiratory insufficiency by having machines which help them breathe
- Improved lifestyles for those who have defective limbs or organs through the use of prosthetics, implants and artificial organs
- Actigraphy and wearables encourage people to stay fit, record their health metrics and monitor their progress
- Automating manual tasks such as medication administration and recording patient data to increase their accuracy and leave doctors and nurses with more time to attend to higher risk patients

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Life of an engineer working in medical devices

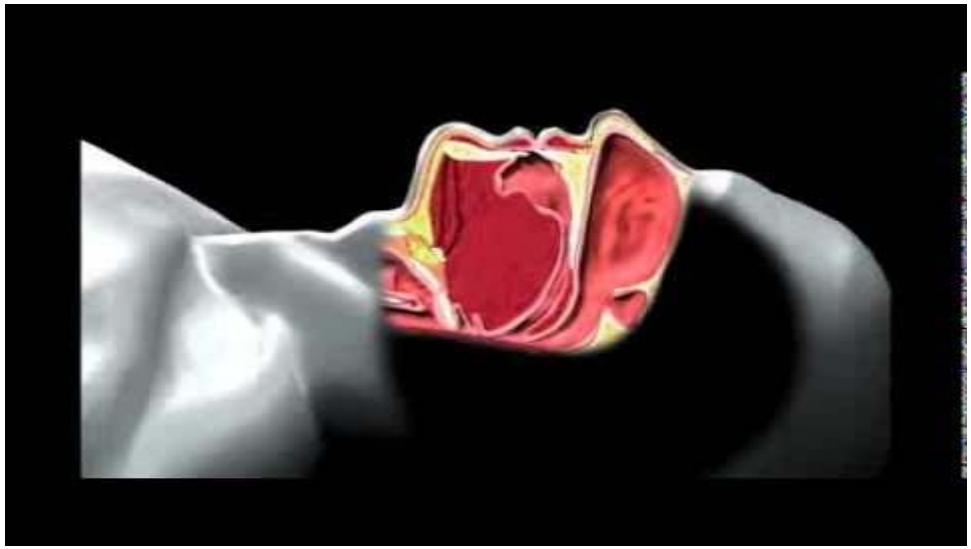
Working in biomedical engineering

Varuni Fernando
Systems Engineer, ResMed

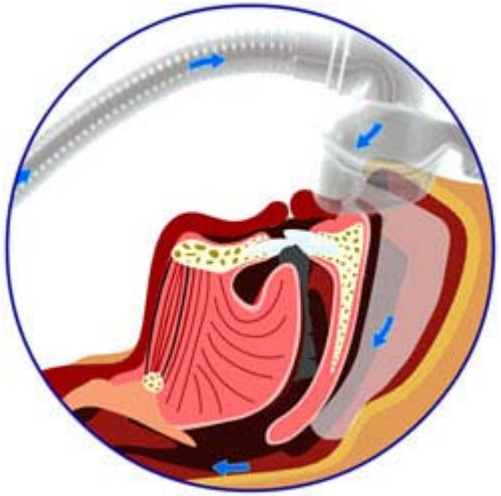
- ResMed is the world's most connected healthcare company in the world
- ResMed works on treating chronic diseases including
  - Sleep apnea
  - Chronic obstructive pulmonary disease
  - Other illnesses resulting in respiratory insufficiency
- **Over 6 million** devices report patient therapy data to the cloud **on a daily basis**
- **Over 3 billion nights of sleep data in the cloud**

What do I work on?

- The next generation of devices to treat sleep apnea
- What is sleep apnea?



How do you treat it?



- Continuous Positive Airway Pressure (CPAP) Therapy
- By taking air from the atmosphere and pressurizing it, we are able to keep the airways open and prevent them from collapsing
- This stops the apneas from occurring and allows the patient to sleep through the night without waking up, potentially 100s of times

Some devices I have worked on in the last few years

What does my everyday work involve?

- Working with electrical, mechanical and software engineers on designing and developing the next generation of devices
- Writing requirements to make sure they meet all the regulatory, clinical and market needs so that they make a device that can treat patients effectively and can be sold
- My role is to make sure when all the parts of the device come together, it is able to perform the way it is expected to and treat the patient

Summary

- Engineers Australia is your link with the Engineering Profession / Industry
- These Presentations and forums can provide important networking opportunities with other teaching professionals
- Engineers Australia can assist in providing exciting ways of presenting concepts with real world examples and applications.
- We encourage a link of support with exam assessors
- We emphasise that pathways to engineering exist for all students- Professional, Technical, Trade, VET

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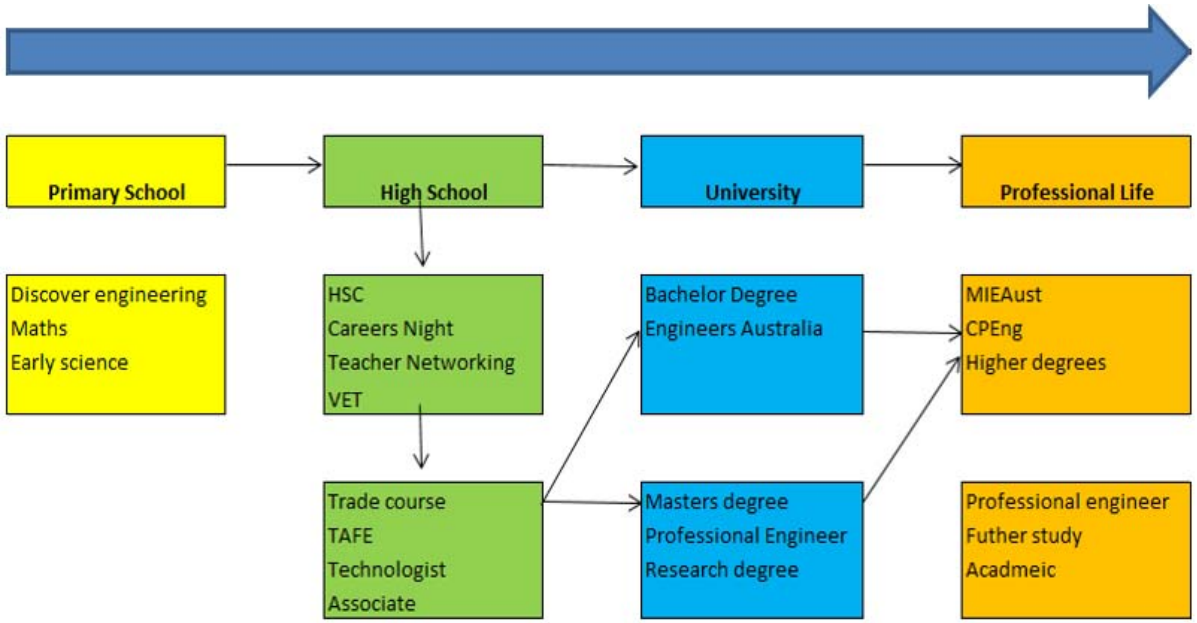
Pathways to Engineering

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