

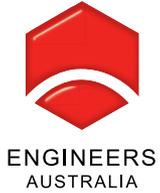


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Biomedical Engineering

Use of Graphical
Communication

David Sparkes



Graphical Communication

What is graphical communication

What is the relevance

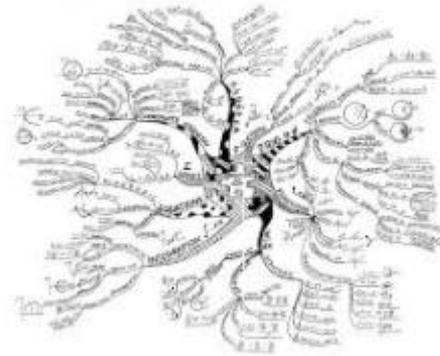
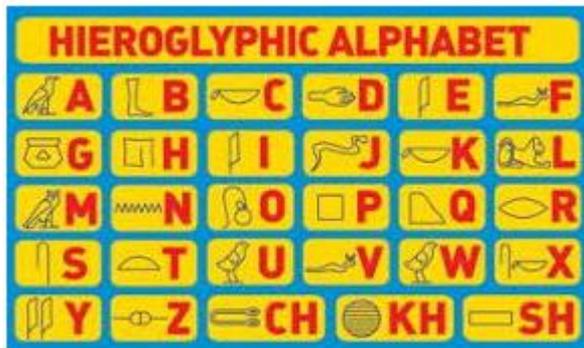
Recap on graphical communication focus in the syllabus for the preliminary modules

Biomedical unit and graphical communication

Future directions.

Graphical Communication

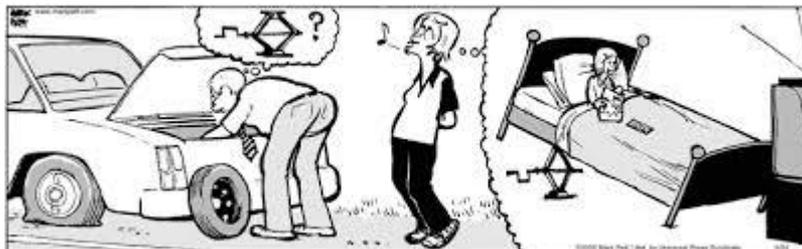
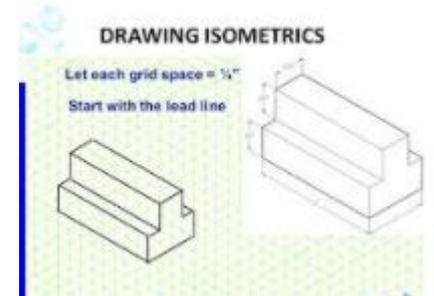
What is it?



A B C D
E F G H
I J K L
M N O P
Q R S T
U V W X
Y Z

$$u = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

茂 細 純 陰 陽 誠 款
 蓮 妍 秀 恪 忠 迷 愛
 夢 和 竊 悲 淚 懷 愁
 月 女 婦 妹 雙 忍 悼





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Graphical Communication

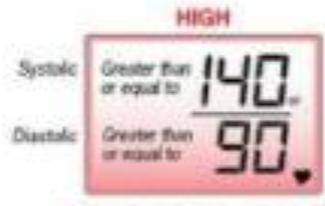
What is the relevance?

Why ? – Universal communication.

Why ? - Problem Solving



Versus

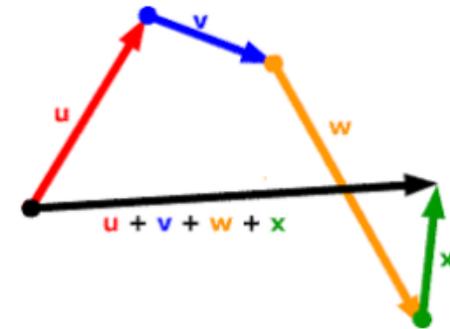
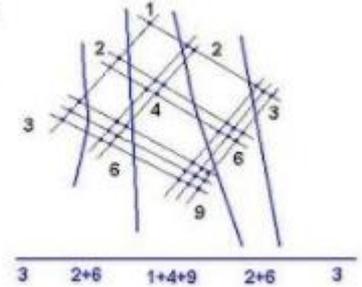


123 x 321 =

123
x 321

123
246
369

39483



Graphical Communication

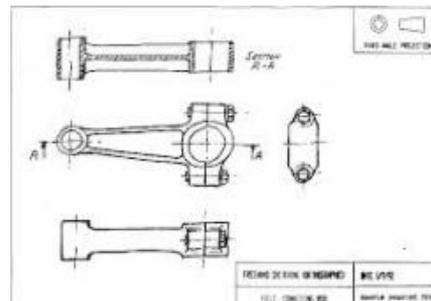
P3.3 applies graphics as a communication tool

H3.3 develops and uses specialised techniques in the application of graphics as a communication tool

Syllabus recap

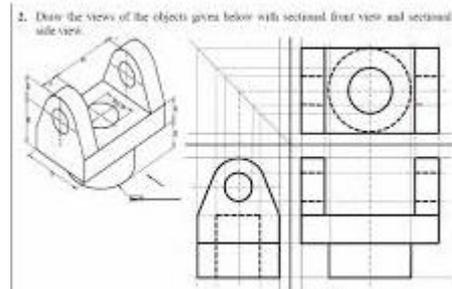
Engineering fundamentals

Freehand sketching
Vector solutions



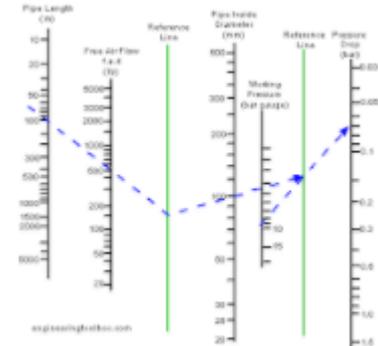
Engineering products

Orthogonal drawings
Australian standards



Braking systems

Graphic solutions
Exploded drawings
CAD

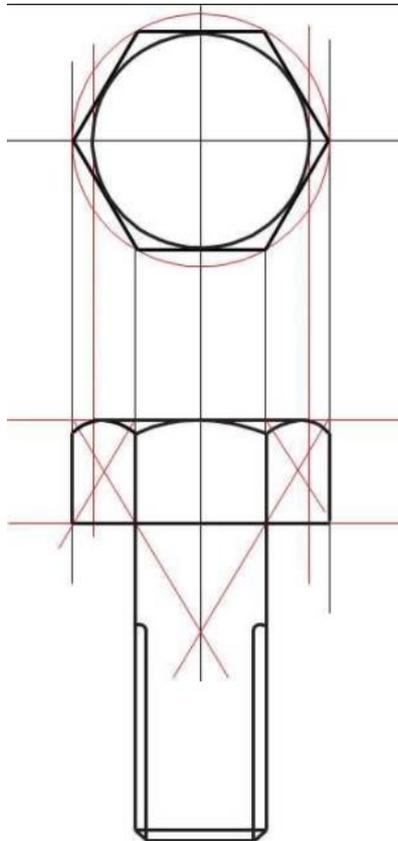




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Graphical Communication

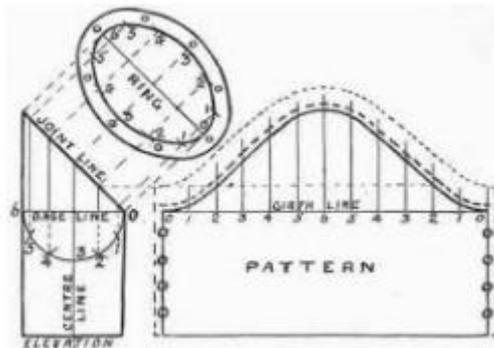
Biomedical Module



Communication

- sectioning of orthogonal drawings
- Australian Standard (AS 1100)
- dimensioning
- computer graphics, CAD
- graphical design

- produce dimensioned, sectioned orthogonal drawings applying appropriate Australian Standard (AS 1100)
- justify the use of graphics as a communication tool
- use appropriate application software to produce graphical designs.
- construct quality graphical solutions



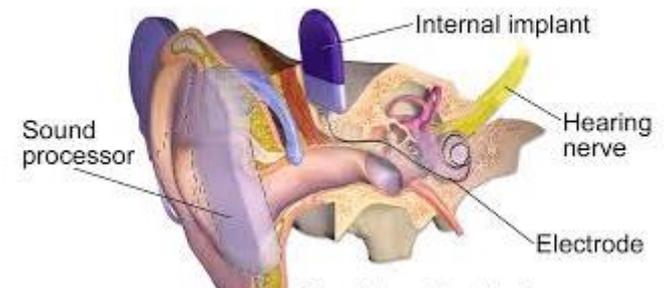
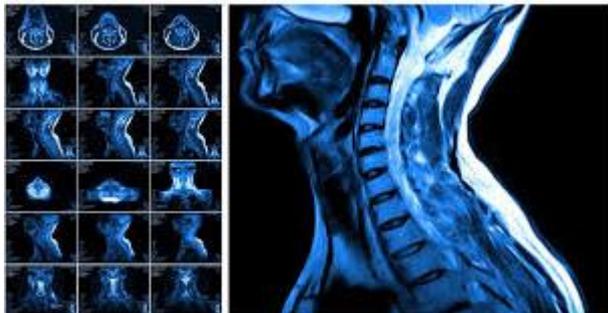
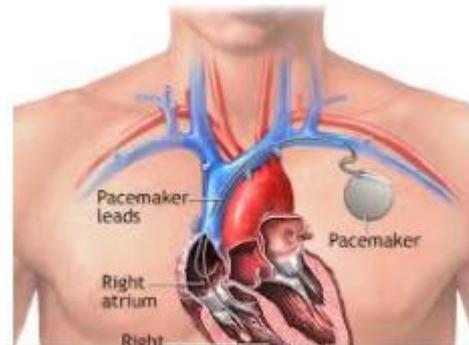
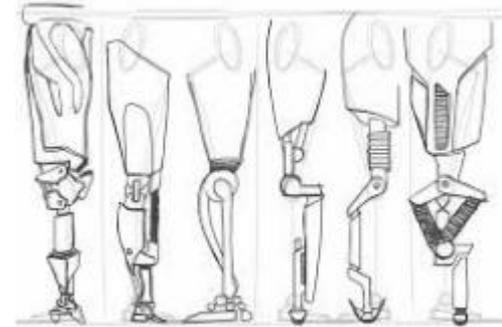
Graphical Communication

Biomedical Module

THE IMPORTANCE OF ENGINEERING GRAPHICS

Engineering graphics is a real and complete language used in the design process for:

1. Communicating
2. Solving problems
3. Quickly and accurately visualizing objects.
4. Conducting analyses.



Graphical Communication

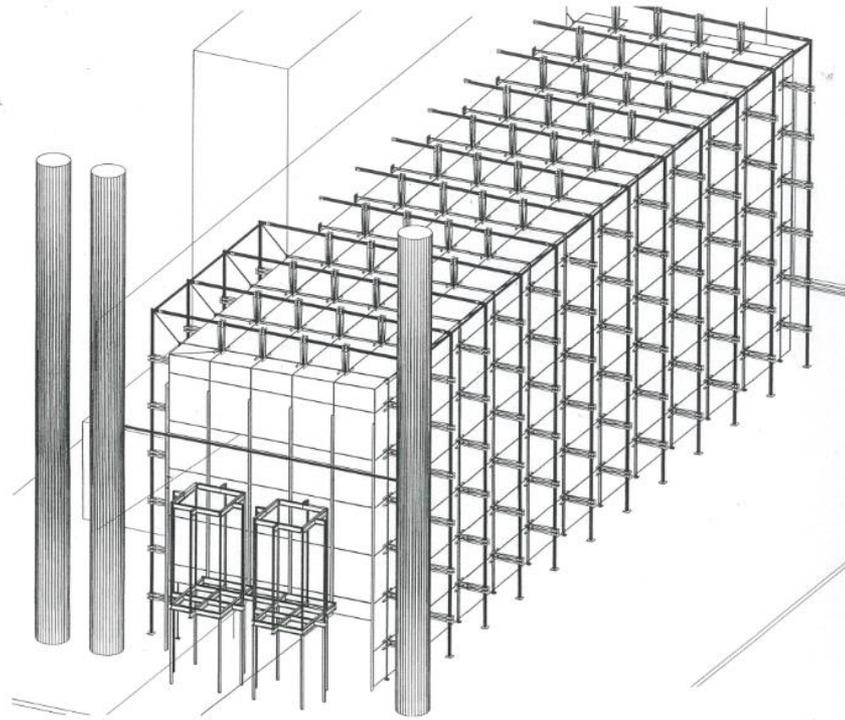
Biomedical Module –
Example of graphical communication
363 George street Entrance foyer
From concept to completion





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Graphical Communication

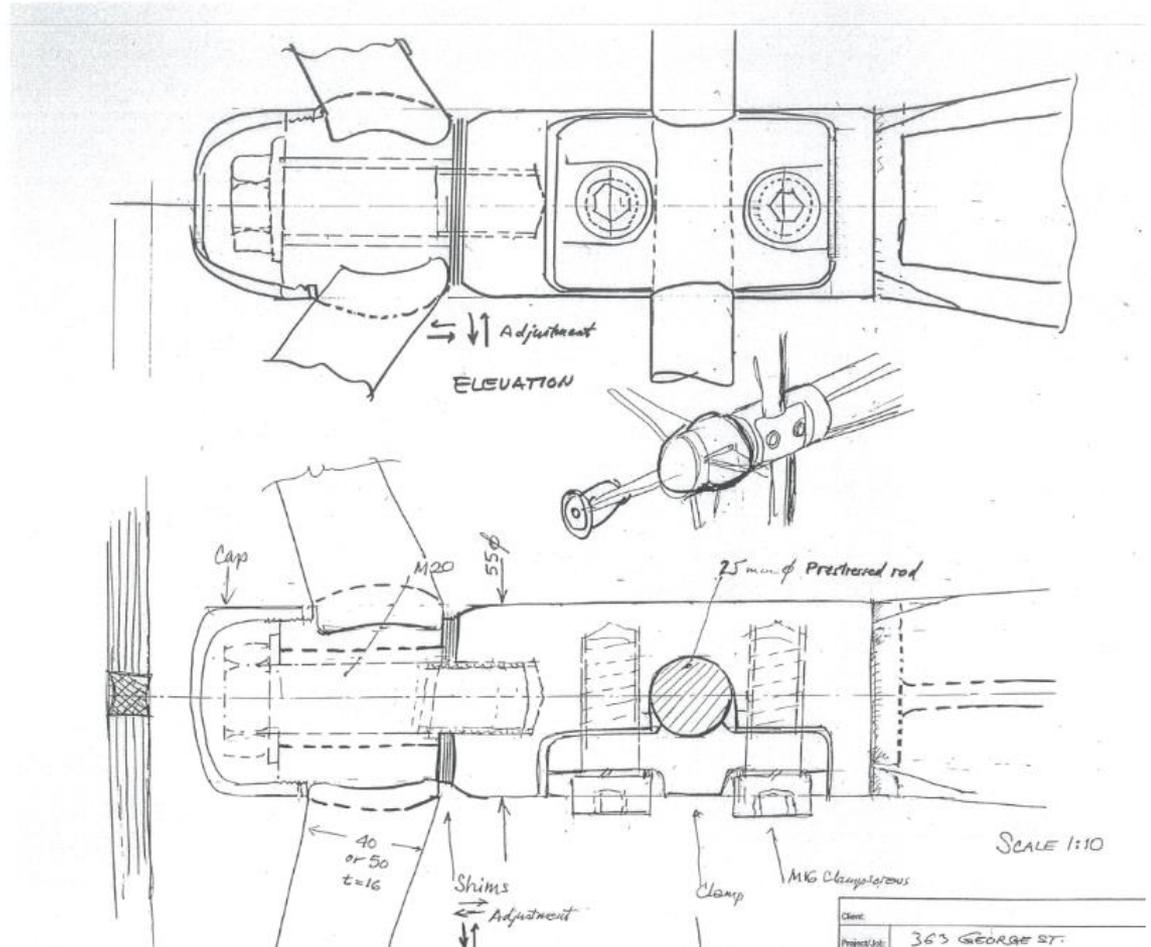




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Graphical Communication

Biomedical Module

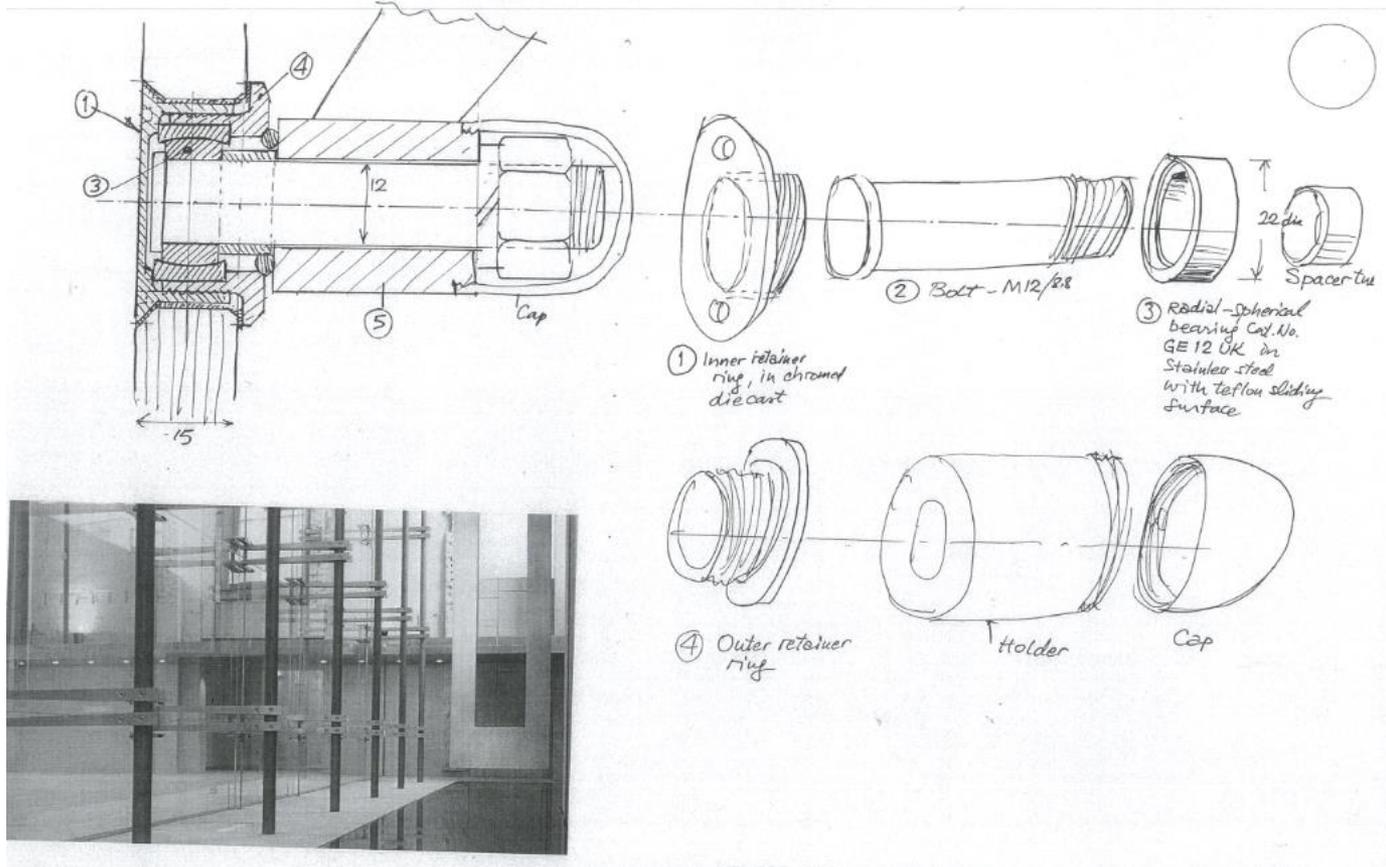




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Graphical Communication

Biomedical Module

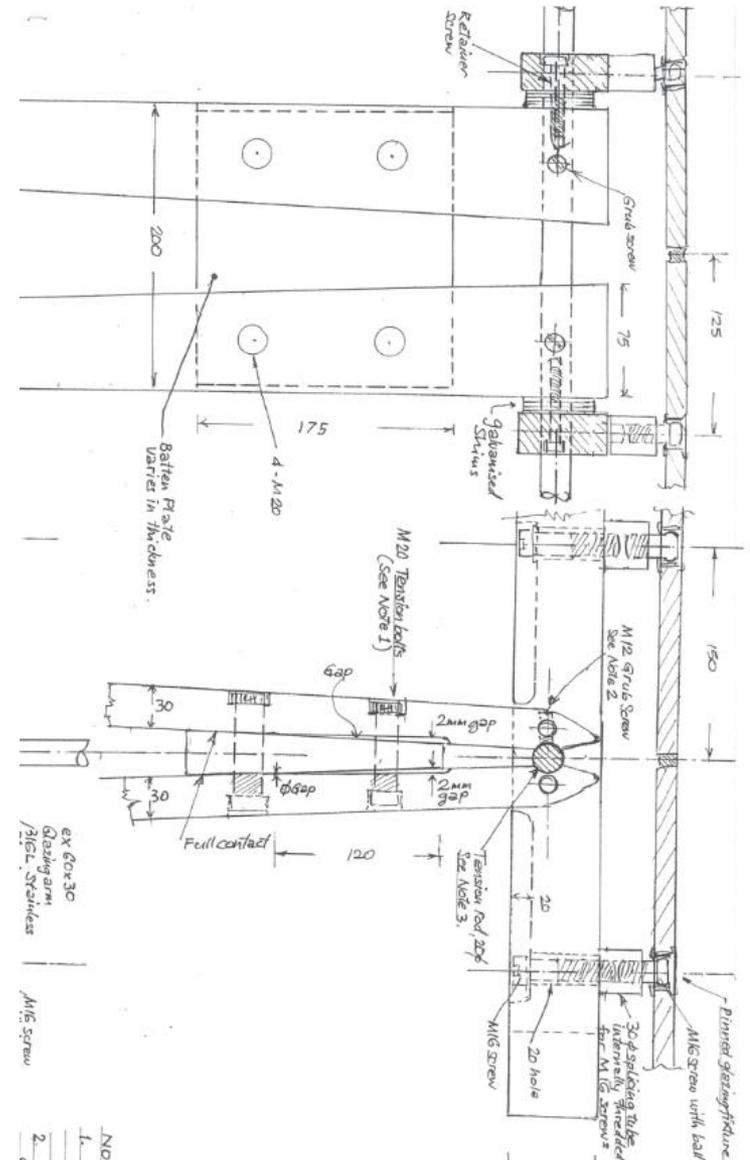
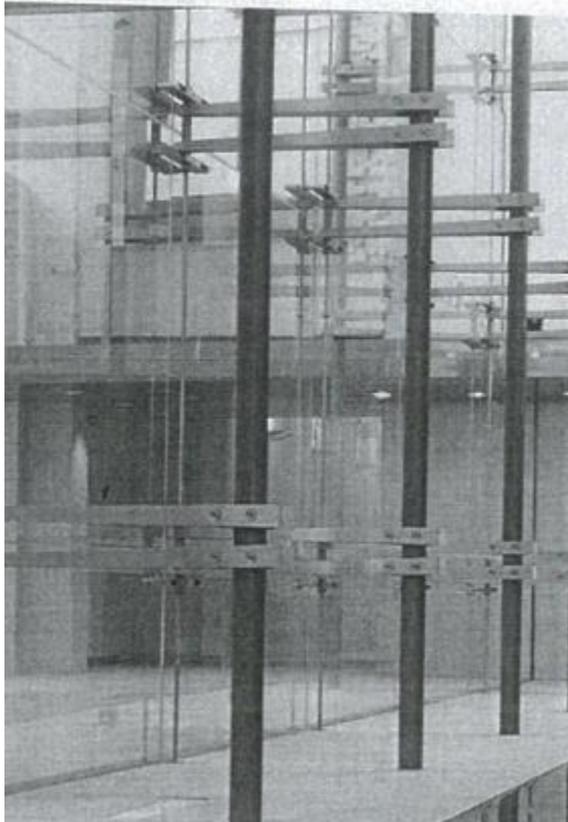




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Graphical Communication

Biomedical Module



Graphical Communication

Future directions

3D modelling – REVIT
Augmented Reality
Virtual reality
Immersed training
Next ?

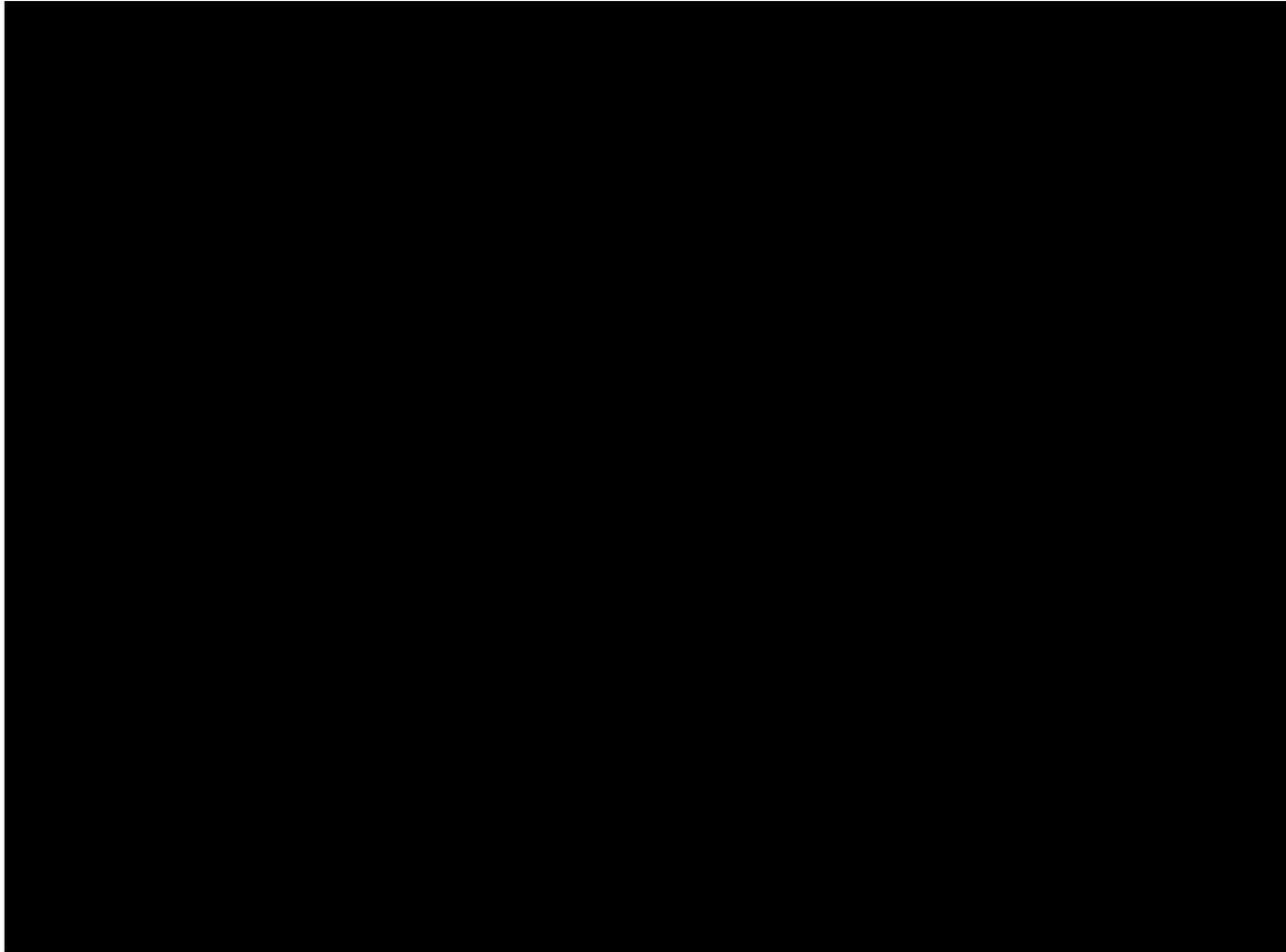


Graphical Communication





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<https://www.youtube.com/watch?v=JGiVVObY0Ew>



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Biomedical Engineering

Barry Finlay,
Michael Scott,
Joe Townsend,
Michael van Koeverden



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Branches of Biomedical Engineering

Clinical Engineering

A specialty within Biomedical engineering responsible primarily for applying and implementing medical technology to optimize healthcare delivery.

Roles of clinical engineers include :-

- Training and supervising biomedical equipment technicians (BMETs)
- Working with governmental regulators on hospital inspections/audits
- Serving as technological consultants for other hospital staff (i.e. physicians, administrators, I.T., etc.)

Clinical engineers also advise medical device producers regarding prospective design improvements based on clinical experiences, as well as monitor the progression of the state-of-the-art in order to redirect hospital procurement patterns accordingly.



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Branches of Biomedical Engineering

Bioinformatics

Bioinformaticians conduct research and develops methods and software tools for understanding biological data in areas such as :-

- Pharmaceuticals
- Medical technology
- Biotechnology
- Computational biology
- Proteomics (the large-scale study of proteins)
- Computer information science
- Biology
- Medical informatics (the resources, devices, and methods required to optimize the acquisition, storage, retrieval, and use of information in health and biomedicine [source: https://en.wikipedia.org/wiki/Health_informatics])

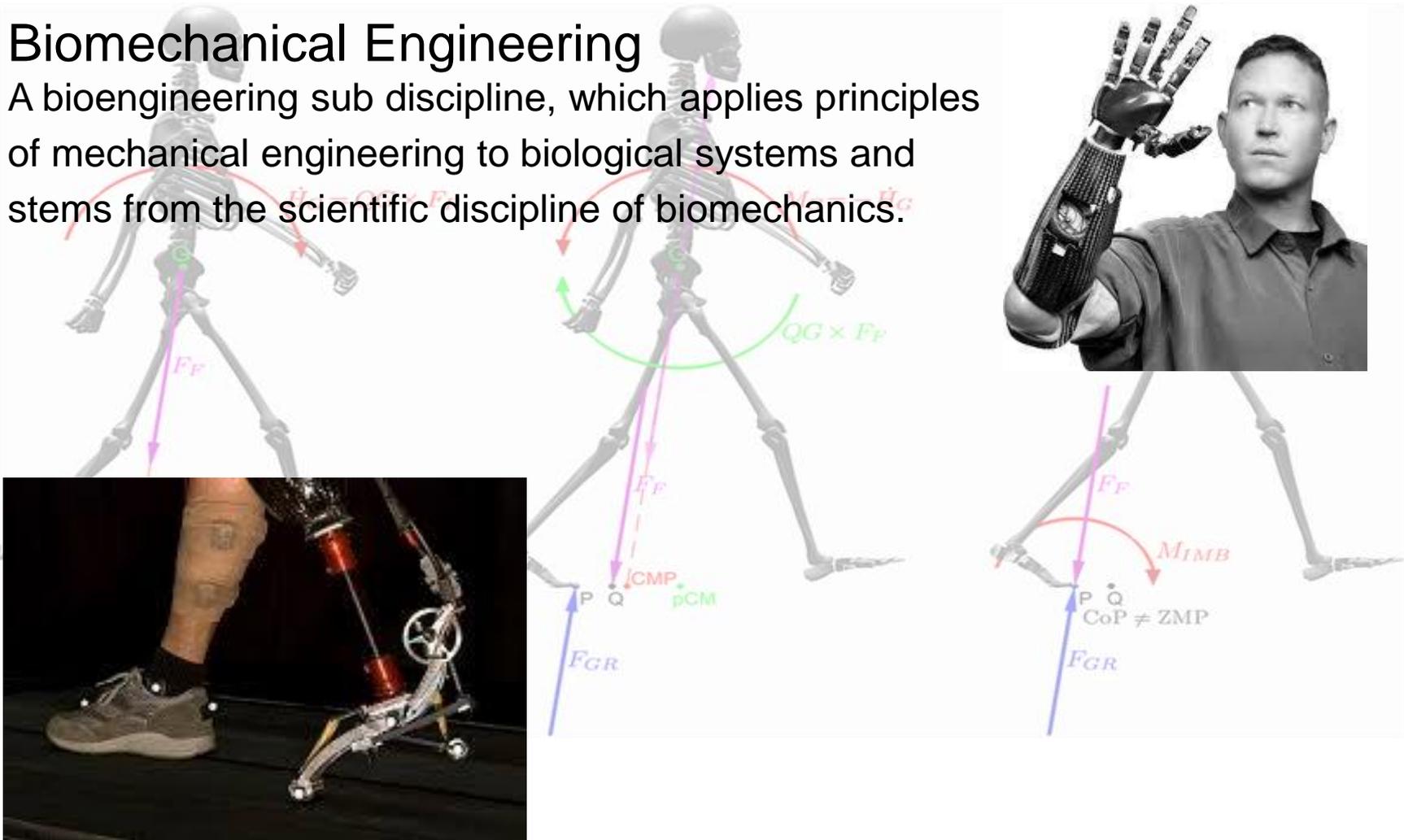


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Branches of Biomedical Engineering

Biomechanical Engineering

A bioengineering sub discipline, which applies principles of mechanical engineering to biological systems and stems from the scientific discipline of biomechanics.





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Branches of Biomedical Engineering

Rehabilitation Engineering

The use of engineering science and principles to

- Develop technological solutions and devices to assist individuals with disabilities, and
- Aid the recovery of physical and cognitive functions lost because of disease or injury.





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What is Biomedical Engineering

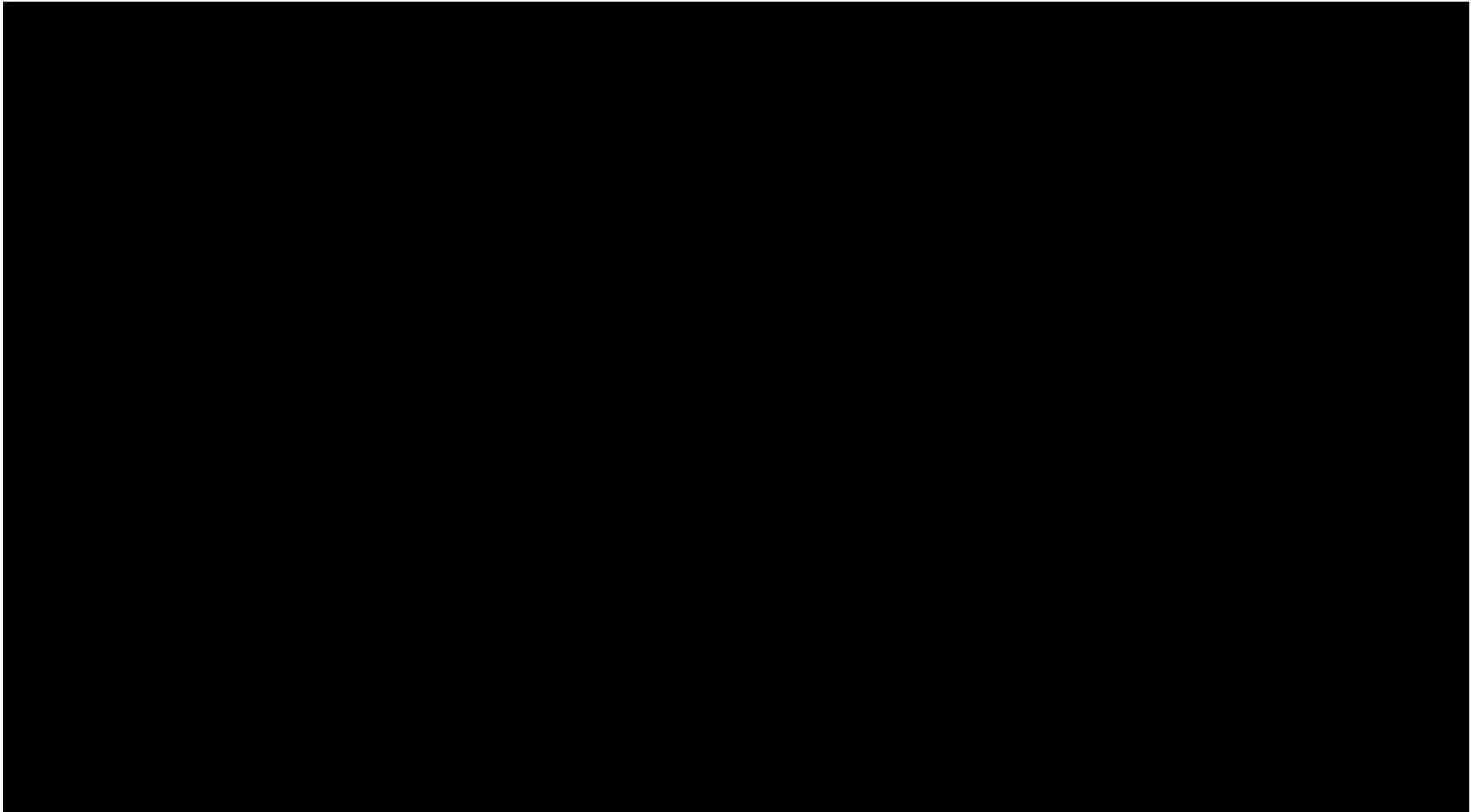
Biomedical Engineering combines a knowledge of electronic, mechanical, chemical and materials-engineering, with the life sciences of medicine, biology and molecular biology. Biomedical devices:

- Support and enhance human life
- Help individuals to overcome physical disabilities
- Aid in delivering medical procedures
- Test and deliver data which improve health and safety.



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Historical Background to Biomedical Engineering

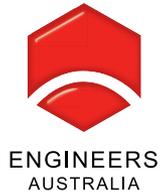




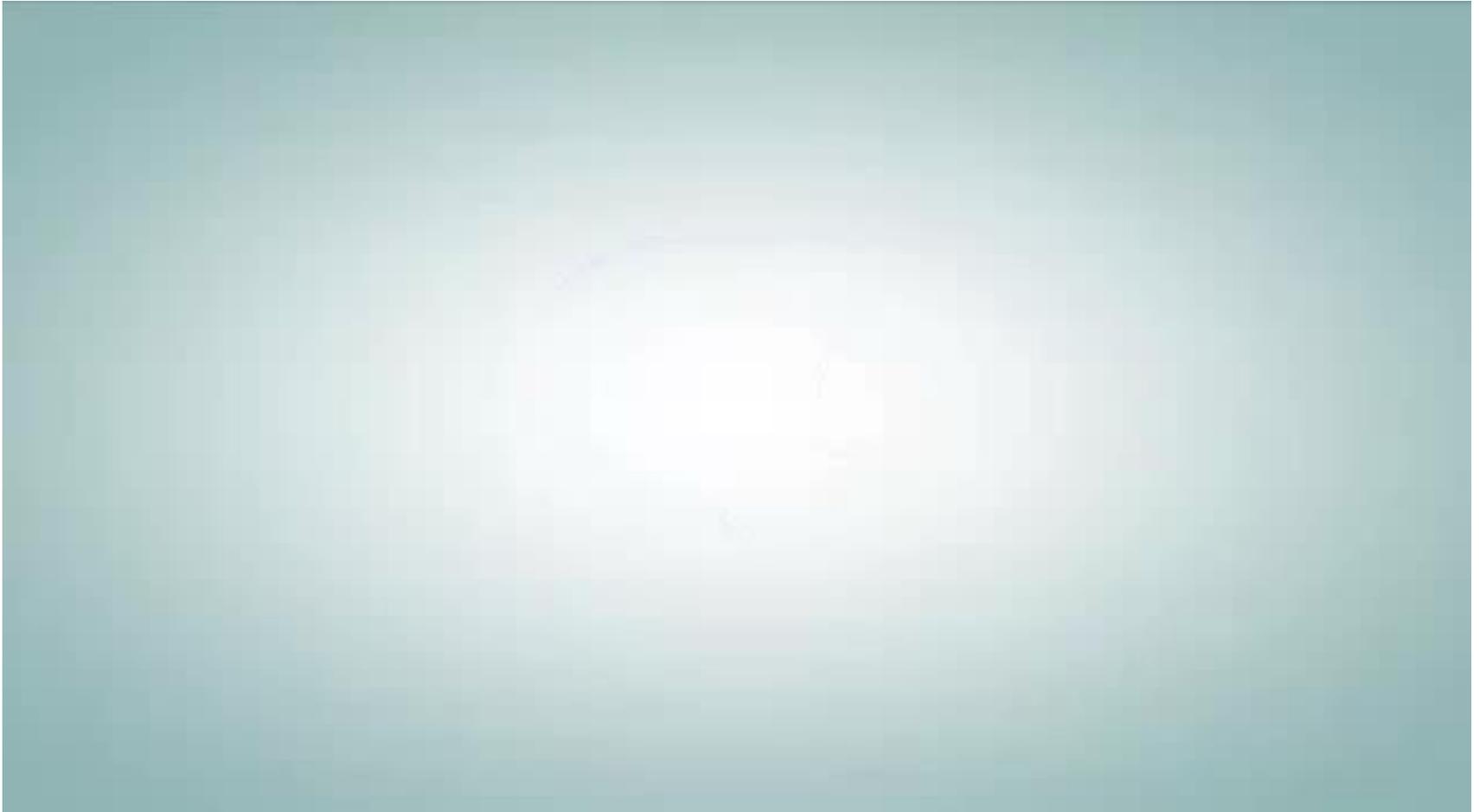
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Historical Development of the Products





The Effect of Biomedical Engineering on Peoples' Lives





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Ethics

General Ethical Issues

- Ethical issues regarding human and animal experimentation and the use of biomaterials
- Truthfulness and the avoidance of conflicts of interests
- Ethical principles for medical practice
- Beneficence (benefiting patients), non-maleficence (doing not harm), patient autonomy (the right to choose or refuse treatment), justice (the equitable allocation of scarce health resources), dignity (dignified treatment of patients), confidentiality (of medical information) and informed consent (consent to treatment based on a proper understanding of the facts)



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Ethics

Cellular, Genetic and Tissue Engineering

- Cellular engineering is a field that attempts to control cell function through chemical, mechanical, electrical or genetic engineering of cells.
- Germline engineering, which is not currently used therapeutically but which is being studied, is a more controversial practice in which genes in eggs, sperm or very early embryos are modified.
- Tissue engineering is a field that aims to restore, maintain or improve the functioning of tissues or whole organs by means of biological substitutes that repair or replace these tissues or organs.



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Ethics

Biomaterials, Prostheses and Implants

- The use of prostheses and implants raises issues of human identity and dignity because it involves the addition of artificial structures and systems to human biology, or even the replacement of human tissues and organs with artificial versions. Cyborg vs Human
- Should certain organs or functions not be replaced by artificial systems?

Biomedical Imaging and Optics

- Diseases may be revealed that were not under investigation or for which no therapy is available, or conditions may become visible that indicate an increased probability to develop a disease.
- Moral controversy also extends to brain imaging, which is reaching the point that it can reveal information about a person's mental states or plans for action.

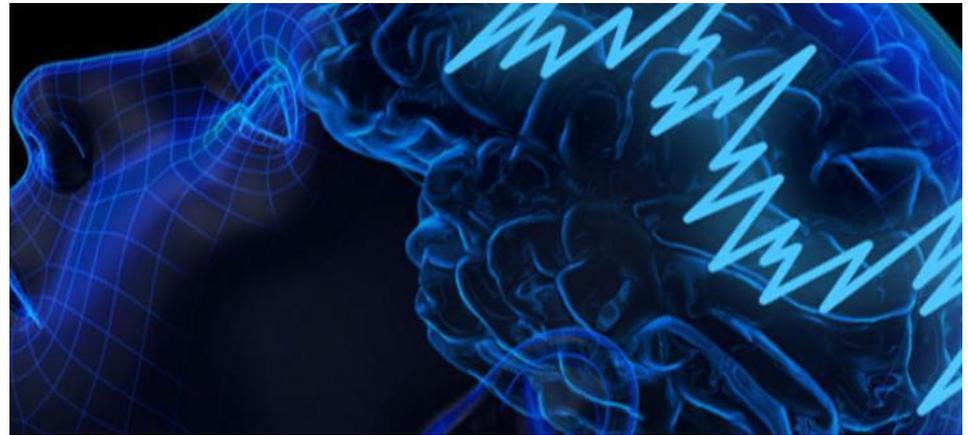


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Ethics

Neural Engineering

Ethical questions arise regarding the integrity and dignity of persons, as artificial neural devices may affect personal identity and make the human mind or brain partially artificial, thus turning humans into cyborgs.



Fielder, J. (2007). Biomedical Engineering Ethics. Morgan & Claypool.

Varello, D. (2007). Biomedical Ethics for Engineers: Ethics and Decision Making in Biomedical and Biosystem Engineering. Academic Press.



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Where Are Biomedical Engineers ?

- Research
- Hospitals
- Private Companies



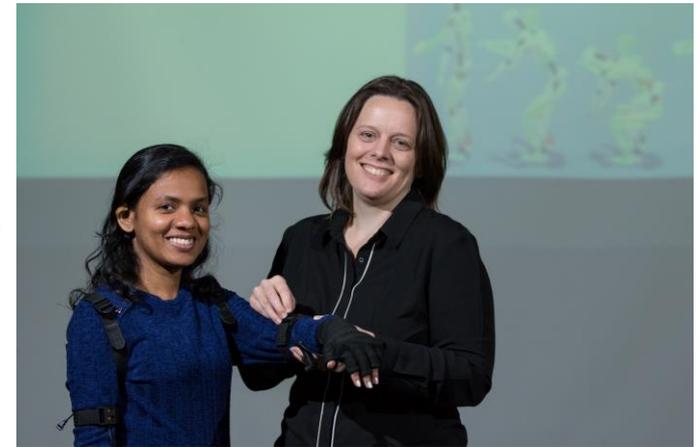


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Research

Neuro-feedback Driven Stroke Rehabilitation

- Physiotherapy exercises for a stroke patient aim to shift brain function from the 'dead' part of the brain to another area, however, recovery is often compromised due to limited medical access
- Systems engineering is applied to develop a sensor enhanced motor learning approach to augment physiotherapy treatment and improve rehabilitation outcomes
- A visual model of the ideal movements for each exercise is modelled through readings from a movement tracking suit, which uses gyroscopes that track range motion. This expert model is then incorporated into software that the patient can use in their home.



Lead researcher: A/Prof. Sarah Johnson
Centre or group: Priority Research Centre for Stroke and Brain Injury
Partners: A/Prof. Rohan Walker, Prof. Michael Nilsson

Information & Images courtesy A/Prof. Sarah Johnson



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Research

Neuro-feedback Driven Stroke Rehabilitation

- The system also records the patient's performance for review by an expert
- Non-invasive NIR (near-infrared) imaging is used to shine light on the brain to measure activity in different areas. As a particular part of brain becomes active blood flow increases oxygen levels.
- Because the oxygenated areas reflect and refract the light differently, the infrared image can show which areas of the brain are active. If the infrared imaging is captured during the physiotherapy exercises, feedback can be provided on which movements are working to stimulate brain function.



Lead researcher: A/Prof. Sarah Johnson

Centre or group: Priority Research Centre for Stroke and Brain Injury

Partners: A/Prof. Rohan Walker, Prof. Michael Nilsson

Information Courtesy A/Prof. Sarah Johnson



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Private Companies

ResMed

In 1981 Professor Colin Sullivan and colleagues at the University of Sydney described and developed nasal continuous positive airway pressure (CPAP), the first successful, noninvasive treatment for obstructive sleep apnea (OSA).

Based upon Prof Sullivan's technology, ResMed was founded in 1989 and has been pioneering new and innovative devices and treatments for sleep-disordered breathing, chronic obstructive pulmonary disease, and other chronic diseases.

ResMed's products and innovative solutions improve the quality of life for millions of patients worldwide, reduce the impact of chronic disease, and save healthcare costs.





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Private Companies

Cochlear

- 1967 Inspired by his close relationship with his deaf father, Graeme Clark begins researching the possibilities of an electronic implantable hearing device.
- 1977 Baha® recipient Mona Andersson is the first recipient of a bone conduction hearing implant (Baha) in Gothenburg, Sweden.
- 1985 FDA approves Nucleus implant system Nucleus established as the first multi-channel cochlear implant system to obtain clearance from the FDA for use by profoundly deaf adults 18 and over. The Nucleus Mini22 implant with the WSP (Wearable Speech Processor) was the first multi-channel device to receive FDA pre-market application approval.
- 2010 Cochlear Baha 3 BI300 implant is the first bone conduction implant to utilise an advanced surface technology (TiOblast™), which can reduce the time it takes for the implant to bond with bone. This allows the recipient to access sound sooner.





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Biomedical Engineers as Managers

- Oversees and dispatches requests for service while evaluating responsiveness, courtesy, and customer satisfaction. Works with hospital clinical management to ensure needs are met, capital issues are researched, and equipment incidents are investigated.
- Ensures that appropriate departmental informational system documentation is completed by the technical staff.
- Manages technical resource issues, skill development, user prioritization and the daily PM/inspection program to ensure compliance with regulatory agencies and internal standards.
- Supervises staff, evaluates work efficacy and efficiency, recommends and implements approved disciplinary action as needed.



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Biomedical Engineers as Managers

- Supervises staff, evaluates work efficacy and efficiency, recommends and implements approved disciplinary action as needed.
- Serves as Clinical Engineering representative for the Environment of Care, local safety committees by attending meeting, audit inspections and meetings, and providing corrective follow-up when needed.
- Provide clinical engineering project management capabilities to project teams as needed.



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Engineering Mechanics and Hydraulics

Orders of levers

Mechanical advantage, velocity ratio and efficiency





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Engineering Materials

Forming methods

- Forging
- Casting
- Cutting
- Joining

Structure and properties of appropriate materials

- Alloy steels such as stainless steel, titanium
- Polymers
- Ceramics



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BioMaterials Considerations

- Toxicology
- Biocompatibility
- Functional Tissue Structure and Pathobiology
- Healing
- Dependence on Specific Anatomical Sites of Implantation
- Mechanical and Performance Requirements
- Industrial Involvement
- Ethics
- Regulation



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Electricity / Electronics

- Ohm's Law
- Series and parallel circuits
- Power source
- Microcircuits/integrated circuits
- Digital technology



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Relevant Australian Standards

AS3551 Management programs for medical equipment

AS3003 Electrical installations - Patient treatment areas of hospitals and medical and dental practices

AS2500 Guide to the safe use of electricity in patient care

AS1100 Standard for technical drawing

A nighttime cityscape with light trails from traffic on a highway in the foreground. The background shows illuminated buildings and a dark sky. A large, semi-transparent red geometric shape, resembling a stylized 'E' or a large triangle, is overlaid on the left and top portions of the image.

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