The Royal Academy of Engineering

Engineering for health

The Royal Academy of Engineering brings together the country's most eminent engineers from all disciplines to promote excellence in the science, art and practice of engineering. We work to enhance the UK's engineering capabilities; to celebrate excellence, inspire the next generation and lead debate by guiding and influencing public policy. Working closely with engineering institutions, our aim is to promote and enhance the contribution of engineers at the centre of society, public life, business and the economy.

The UK Focus for Biomedical Engineering, a group hosted by The Royal Academy of Engineering, provides a forum through which the principal organisations concerned with biomedical engineering (also known as medical technology) can communicate, debate and jointly act upon important issues. The group produces policy papers, organises briefing seminars and engages with the policy community.

Summary

Modern medicine and healthcare rely heavily on engineering to deliver improved prevention, diagnosis and treatment of illness. These technologies are vital to the delivery of efficient health services through the NHS. However the contribution of engineering is often hidden within the health sector.

This paper looks at key areas of medical science and uses example to show the contribution of engineering in each area.

Medical Imaging

Imaging enables clinicians to discover information about normal and pathological conditions non-invasively. Initially, it was confined to giving information about anatomy - most obviously broken bones. Anatomical imaging using ultrasound, x-rays (including x-ray CT, the imaging of 'slices' to build up 3D pictures) and MRI continues to provide increasingly high resolution images of organs. However, pathology is primarily associated with physiology and metabolism, and so functional imaging has been a major recent development of medical imaging. This includes nuclear medicine (Spect, PET), contrast-enhanced MRI, Doppler and contrast enhanced ultrasound. At the same time, methods to analyse such images, to align them, and to combine images of different types, have also been developed by engineers to measure the progression of disease or the response to therapy.

Surgery

Almost every aspect of surgery depends on engineering, from operating theatre design to the instruments used for surgery. Keyhole surgery and other minimally-invasive techniques depended on engineers to develop miniature cameras and lighting systems to insert into the body.

Endoscopes (probes to look inside the body), and other instruments enable surgeons to operate on patients via tiny incisions, allowing much quicker healing and better patient recovery than traditional surgery. Medical robots are already used in eye, prostate, orthopaedic, cardiac and other areas of surgery, ensuring that fewer mistakes are made and that surgeons can carefully pre-plan surgical procedures, knowing that the robot will perform consistently.

Artificial joints

One million artificial hips, and a similar number of knees, are implanted in people world-wide each year. These are designed, developed and manufactured by engineers. The rehabilitation equipment used to help patients following surgery is also designed by engineers, as are the many instruments which are used to assess quantitatively the results of surgery.

Artificial pacemakers

A pacemaker is a medical device that is inserted in the chest using minimally-invasive surgery, to regulate the beating of the heart. It uses low-power electrical pulses to speed up a slow heart rhythm or help control an abnormal or fast rhythm.

Pacemakers are externally programmable so that the optimal pacing mode can be selected for each patient. Sometimes, a pacemaker and defibrillator are combined in a single implantable device. The development of the silicon transistor made it possible for electrical engineers to produce the first pacemaker to be implanted in man in 1958. Currently, there are 600,000 pacemakers implanted each year world-wide.

Drug production and delivery

Drugs are developed by chemists and biologists; yet large-scale drug manufacture is heavily dependent on chemical and process engineering. Due to tighter clinical and safety regulations, the cost of analysing and purifying drugs has increased vastly. Automated techniques have been developed by engineers to produce the cost-effective drugs on which patients' lives depend.

Patient monitoring

Many of us are familiar with intensive care units and the way that patients are constantly monitored following major health problems or surgery. Patient monitors designed by engineers have helped to improve survival rates for these acutely-ill patients. Individuals suffering from long-term conditions such as diabetes, asthma or hypertension can lead relatively normal lives using self-monitoring and modern technology such as mobile phones for the self-management of their condition.

Healthcare IT

Healthcare IT solutions, designed and implemented by software engineers, enhance patient care in the modern hospital and reduce operational costs. Examples range from Picture Archiving and Communications Systems (PACS) which allow x-rays and scans to be stored electronically and viewed on computer screens, to prescriptions which can be generated, transmitted and dispensed electronically. Other examples are less obvious: the great advances in fundamental understanding of health and disease that have come from the human genome project were made possible by the engineering development of automated DNA sequencing machines.

Independent living

The UK has an ageing population. In 2007, there were about 9.8 million people aged 65 or over in the UK, but by 2032 this number is projected to be as high as 16.1 million. There were 1.3 million people in the UK in 2007 aged over 85, which is projected to increase to 3.1 million by 2032. For elderly people living at home, new developments in monitoring technology can provide safety and security. Simple sensors can monitor health and be capable of summoning help in an emergency, without requiring action from the user. Engineers have developed other home modifications such as self-closing taps and assistive devices that allow older people to remain in their own homes, with reasonable independency, for longer. This is important as it reduces pressure on social and medical services and ensures a better quality of life for older people.

Conclusion

Engineering has a vital, underpinning role in improving health and healthcare services. The Royal Academy of Engineering is active in the field of biomedical engineering through the UK Focus for Biomedical Engineering The group produces policy papers, organises briefing seminars and engages with the policy community to promote awareness of new technologies, their applications and implications.

Contact

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