

Background Research Report

Engineering Consultancy Report

Report Commissioned by:

University Of Technology Sydney

Report Produced by:

Adison Lu

Alexander Murphy

Ayah Ismail

Candong Peng

Eric Hu

Jion Rao

Richard Charestan

AUGUST 2014

Contents

	Executive Summary	i
1	Introduction	1
	1.1 Purpose	1
	1.2 Scope	1
	1.3 Preview	1
2	The Mind	2
	2.1 Engineering and Psychology	2
	2.2 Engineering and Ethics	3
3	The Body	3
	3.1 Engineering and Sport	4
	3.2 Engineering and Disability	6
4	Conclusion	7
5	Recommendations	8
6	References	9

Executive Summary

The principal objective of this research is to provide relevant and justified reasonings to why the University of Technology Sydney's faculty of Engineering and Science should introduce additional elective subjects, focusing on the human condition. A brief overview of the relevance of engineering and science to a contemporary society is provided within the opening remarks of this report. This is background to the ever expanding fields of society and humanity which requires rapid focus, development and concern from engineers and scientists - these are attested through the body and the mind. Engineers and scientists continue to expand and improve sectors of society. These sectors are distinguished mentally and physically. Mentally through areas of psychology and ethics where the intellect and onus of mankind is cached and transmitted whilst being the distinguishing factor within development. Physically through areas of sporting and disability where the aptitude, proficiency and ability to perform and function is of prime necessity to mankind. As this report proceeds, it focuses on each of these elements and presents applications, reasonings and linkages between these fields and engineering/science.

1.0 Introduction

Engineers and scientists benefit society through applying their theoretical and practical skills to benefit the wider society. With the ever increasing ties between humanity and technology, engineers and scientists strive to innovate solutions to push society forward and impact the human race as a group or as an individual. Engineers and scientists are responsible for various avenues of human existence. These avenues can be analysed from the viewpoint of the body and the mind; each markedly impacting the human condition. The human condition is a considerable factor that influences the deliverables that engineers and scientists produce; without considerations to the human condition, engineers and scientists would produce without important considerations into the variables that the solution accounts for. Engineers and scientists care about the human condition through a variety of avenues where the body and mind are paramount.

1.1 Purpose

The purpose of this report is to present relevant and justified reasonings to why the faculty of engineering and science at the University of Technology Sydney should consider elective subjects that focus specifically, on potential areas of human growth and needs.

1.2 Scope

The threshold of this research encompasses four potential avenues of human existence where engineers and scientists should better discipline themselves into - acceding to an enhanced human condition. This collated research reflects contribution from engineers and scientists from a variety of backgrounds and fields. These fields include: mechanical engineering, electrical engineering and civil engineering whilst bound together by the thesis of scientists. This investigation has led to tangible recommendations for future engineering and scientific elective subjects at the University of Technology Sydney.

1.3 Preview

This report explains the relationships between engineering and the various avenues of human existence and how this impacts the human condition. Engineers impact humanity mentally (the mind) and physically (the body) in a variety of ways. Engineers impact the mind through psychology: as it captures human behaviour and ethics: as it values professional conduct and safety guidelines. Engineers impact the body through sporting: as research and development improve athletes ability to perform and disability: through the development of aid assisting devices. The aim of this report is to examine these relationships and how they benefit society and as potential elective areas within the university curriculum.

2.0 Engineering and the Human Mind

The human mind is principle towards performing any cognitive task and acts as a processing centre whereby each individual is unique and different within themselves. The human mind is bridged together with the concept of the human condition through communication and patterns of thought.

2.1 Engineering and Psychology

Psychology in practice focuses upon the continual improvement of the human mentality. Through assessment of common states, characteristics and behaviours; psychologists continue to condition the human mind and an individual's ongoing quality of existence. Engineers and scientists assist in the generation of worthy applications that prescribe the chief philosophies and disciplines of psychology - enhancing the pursuits of individuals in both personal and corporate environments. These applications are shaped through the fields of electrical engineering, mechanical engineering, civil engineering and bonded by the principles of science.

Psychologies important connection and relevance is unfolded within the formation of the cognitive simulation model. This mechanical engineering prototype is a programmed replica of the human brain - encompassing the cognitive mechanisms, processes and abilities of an individuals intellect (Kong, 2013). This model provides four feasible frameworks that benefits the decision making process to a degree that exceeds the magnitude of comprehension considered by the human brain (Kong, 2013). Each model interconnects in accordance to a specific stem of the brain; frequently perceiving, screening and streaming information in an algorithmic manner - producing accurate and swift results to common queries (Kong, 2013). A conventional application of this model is 'auto piloting technologies' within a vehicle to reduce the rate of collisions caused by inept decision making - facilitating drivers with disabilities and micro sleep disorders (Kong, 2013).

Cognitive models are further enacted within the electrical field of computing networks. The electrical engineering prototype of cognitive networks further applies the notion that computing networks can have the same intellect as human beings (Thomas et al, 2006). Cognitive Networks applies the notion that complex network systems need to be able to rationalise decision making tasks, perceive current conditions and have the opportunity to plan, learn and take action similar to the aptitude of the human brain (Thomas et al, 2006). Through allowing networks to be more conscious (removing limitations) of its protocol environment, networks typically are more reactive to occurring problems (Thomas et al, 2006). Through education and experience, networks have the ability to self examine its surroundings and continually make cogent decisions hence removing any need for human control (Thomas et al, 2006). Cognitive network provide users a "forward-looking" and goal orientated user

experience that is adapted through the existing network infrastructure (Thomas et al, 2006). Cognitive networks bind psychology and electrical engineering together to provide a higher quality of service (QoS) in network reliability functionality and performance to benefit users undertaking daily tasks. The cognitive network prototype is an ever expanding model that will continue to provide automation features to corporations in the future with the aid of electrical engineers.

Psychology continues to benefit the efficiency and performance of mechanical engineers within their trade. Through analysis of the expertise and performance of mechanical employees within the workplace, psychologists can develop auditing strategies to identify potential hazardous workers - determining their risks, faults and flaws whilst providing effective support and professional development to reduce the uncertainty of potential drawbacks from occurring (Fujita et al, 2005). This systemised analysis advantages the wellbeing and safety of fellow mechanical workers through a reliable and productive atmosphere and a regulated workplace practising professional standards to reduce drawbacks from occurring (Fujita et al, 2005). The introduction of this system in the area of hydraulic excavation successfully reduced the number of skills related injuries in operators, detecting the issues before its occurrence (Fujita et al, 2005). Education into industry systems such as these will enhance the calibre of experience and knowledge of future engineers and the rapid development and application of this system.

Psychologists continue to provide research into potential sectors that appear to impact the calibre of commodities produced by engineers. Considerations of business expenditure is important within the field of civil engineering as it impacts the overall contriving process and the quality of the project (Aitkens, 2007). In order to bring out higher quality engineers, Aitkens (2007) states that the thoughts and ideas of engineers need to be mentored to allow continual valuation of expenditure throughout the production process to minimise overspending and to maximise cost management whilst allowing engineers the chance to examine skills in fine tuning their cognitive abilities to better deal with financial challenges. This preparation could provide considerable development to future engineers at the University of Technology Sydney.

2.2 Engineering and Ethics

Through the varied perspectives of unanimous colleagues, the concept of Ethics remains paramount to the definition of the Human Condition in relation to the mind. The two perspectives which extends on this idea entwine into the fields of Science and Engineering.

Within the field of Science, Ethics is defined as a network of cognitive relationships to provide a justified decision to a controversial topic. The two articles "The good engineer: giving virtue its due in engineering ethics" and "The Good Engineer: Giving Virtue its due in Engineering Ethics" exemplify these aspects through examining the role of ethics within the scientific community and the implementation of the role within society in providing an unbiased perspective

(McGowan et al, 2013). 'Ethical considerations in science are many and complex and the purpose is to encourage discussion and debate' (McGowan et al, 2013). This statement from the first article captures the essence of ethics. Its purpose is to generate discussion which leads to developing a morally right decision for the betterment of society, (Harris Jr. et al, 2008) 'A virtue then is intimately connected with one's personality' (Harris Jr. et al, 2008). This statement in comparison to the first, offers a subjective outlook on Ethics in Science. It reflects that an individual's decision is shaped through life experiences and personal beliefs and this benefits society and human condition through providing an individual identity and a sense of purpose.

Within the field of Engineering, Ethics is recognised as a formal guideline in the maintenance of personal safety and establishing a sense of professionalism within the workplace through respect of thought and property. (Harris Jr. et al, 2008) 'The good engineer: giving virtue its due in engineering ethics' is the primary article which reinforces this concept as it encourages successful production and ensures the safety of the Operator and the worker. Ethics in Engineering governs a variety of sustainable practises within the field of engineering to protect and benefit society from preventable circumstances and professional misconduct from occurring (Harris Jr. et al, 2008). This statement illustrates the importance of personal wellbeing, in relation to a stable environment and atmosphere for workers. Adhering to a standard of ethics, (Harris Jr. et al, 2008) improves the standard of product, calibre of safety and level of product satisfaction. It also highlights the worth of minimising risks which reduces accidents in the workplace and helps develop a strong foundation of trust between workers. Overall this benefits human condition through building relationships by developing trust and drastically improving the quality of life through maximising safety and minimising accidents within the workplace. Future elective considerations should account for ethics within engineering as adhering to a code of practice and conduct drastically improve the engineering and science community for development within the future.

3. Engineering and the Human Body

The Human Body is of prime importance towards performing any physical activity and in its tangible applications towards the human condition. It is bridged together with the concept of human condition through the rapid improvements in science and technology, requiring human societies to adapt to new living conditions.

3.1 Engineering and Sport

Sporting is a major practice that directly shapes the human body. Engineers and Scientists strive to generate solutions that will enhance the standard of experience that sporting players encounter. These enhancements and advancements are experienced from a variety of vantage points; these are felt from the angles of the athlete, the environment and the appliance. This progress continues to diversify the opportunities

and experiences that athletes can undertake, together with the heightened quality of the action. Engineers and Scientists continue to apply their interest, skills and abilities to physically benefit humanity and allow sporting industries to propel forward whilst directly impacting a significant portion of societies interests.

Mechanical engineers have considerably impacted the recreational activity of soccer. Through the development of the Scanning Laser Doppler Vibrometer (SLDV), engineers and manufacturing firms have the ability to soccer balls with better flight and impact characteristics - generating accurate contact and flight results without interrupting the characteristics of the ball (Ronkainen, 2007). Through the adoption of the SLDV technology, sporting developers can trial various materials and designs to inspect which technology is appropriate for the sport (Ronkainen, 2007). This technology impacts a variety of other contact based sports where the material characteristics and player conduct are of prime concern (Ronkainen 2007). This technology is pivotal in the continuation of higher quality sporting equipment, affecting sporting players and competitive clubs alike (Ronkainen 2007). Potential tertiary schemes focusing on the rapid development of products and manufacturing technologies will enable a viable industry within the future.

When blue printing future stadiums, civil engineers consider a variety of structural aesthetics that improve the performance of athletes and the experience endured by spectators (Bouyer, 2007). Through considerations of atmospheric components such as physical location, angular positioning and material design, engineers can continue to enhance the encounter all parties of people experience within the centre (Bouyer, 2007). When factoring in the atmospheric components, engineers can initiate preferable building enhancements to allow effective heat radiation and minimal weather disruptions furthermore impacting the quality of experience within in the stadium (Bouyer, 2007). Scientific research has aided stadium development via the development of materials and research indicating towards strategies in minimising the disruptions caused by a stadiums location - providing infrastructure that impacts the performance of athletes and the comfort of the masses (Bouyer, 2007). Considerations of aesthetic features should continue to be of primary concern within the engineering industry; initially established from university education.

Scientists apply their research findings to develop technologies and strategies that fast track an athletes performance standard (Haake, 2012). Through incorporating their research and development together, scientists improve the capabilities of sportspersons to achieve higher standards within their sporting career. Research has proven that that scientific aid improves the capabilities of individuals to reach higher physical standards thus benefiting the human body (Haake, 2012). Through the contribution of both scientists and engineers alike, business models such as robotic soccer players continue to develop products that affect the human condition, without the strain of testing research commodities on athletes (Victor, 2012).

In future consideration towards potential tertiary electives; it would be beneficial to the international community if successful products and experiences such as these could be a direct field focus in future studies to ensure a furtherance of products and experiences to shape the human body. Through a refined focus towards the physical and sporting community, industry improvements and success is sure-fire.

3.2 Engineering and Disability

In a society with an ever increasing number of citizens suffering from ailments; engineers and scientists continue to focus on reducing the number of obstacles that impact daily life - boosting the quality of living and opportunities for impaired and care reliant citizens. The field of disability is subject to an ever growing reliance due to an exponential rise in ageing generations bound also with the constant number of citizens affected by developmental disorders. Engineers and Scientists consistently bolster higher standards of technologies and solutions that endeavour to instil afflicted citizens into ordinary society, reducing any barriers surrounding people with disabilities.

Mechanical engineers develop products that allow immobilised individuals access to elevated and obstructed locations (Hijazeen 2010). Through the formation of ramps, both aided and unaided pedestrians can access overhead locations with ease (Hijazeen, 2010). Engineers continue to examine new design and development methodologies to allow individuals to ascend and descend with minimal mechanical force - allowing aided individuals the best opportunities to commute in comfort without barriers in transport. The hypothesis of this research field continues to expand its support for individuals with restraining disorders such as blindness.

Electrical engineers aid students with visual impairments within the classroom. Haptics motion simulators allow students to distinguishing objects without visualising them in real life (Jones et al 2014). Heat and motion simulators create particle vibrations allowing object impressions to be transformed - allowing students to gain deeper fundamental levels of visual awareness and understanding within the classroom. Traditional classrooms rely upon visual modes of learnings, Haptics Simulators however provide equal opportunities for aided students to participate in the learning culture and comprehend the educational topics undertaken. This technology improves the quality of living of citizens rendered by reduced capabilities and increases their educational opportunities.

Scientific research provides the basis of progressive technologies that improves the safety, control and participation of individuals that suffer from functional limitations (Freedman, 2011). Assistive products such as sit-to-stand (STS) manoeuvring frame allows elderly people to spring their bodies in and out of certain positions. STS assistive devices are mechanically demanding in daily tasks for elderly mobile individuals seeking the same quality of living and opportunities as regular citizens.

This technology provides the basis of further assistive technology designs that fasten the opportunities available to care reliant citizens (Freedman, 2011). Prosthetic limbs continue to allow individuals to expand upon their physical restrictions, resulting in a viable future industry that continues to impact individuals physical wellbeing (Chorost, 2012). Technologies such as STS and prosthetic limbs create foundations for future research and development and are relevant for future studies.

A Quality-of Life Scale for Assistive Technology is an indicator utilised to determine the success and benefits assistive technologies have upon care reliant citizens (Jeyasurya, 2013). This scale analyses the impact assistive technologies have upon aided citizens and indicates further areas where an individual could be supplemented to improve their quality of living (Jeyasurya, 2013). Examples of potential technologies included bathroom features (grab bar, shower seat), mobility devices (crane, walker) and environmental features (ramp, elevator) (Jeyasurya, 2013). This scale rapidly improves an individuals wellbeing whilst suggesting further areas of development.

4. Conclusion

Engineers and scientists continue to benefit society through applying their theoretical and practical skills to propel society forward. Engineers are responsible for various avenues of human existence. These avenues are analysed from the viewpoint of the body and the mind; each markedly impacting the human condition. The human condition is a considerable factor that influences the deliverables that engineers produce; without considerations to the human condition, engineers and scientists would produce without important considerations into the variables that the solution accounts for.

Engineers and Scientists care about the human condition through a variety of avenues where the body and mind are paramount. This report explained the relationships between engineering and the various avenues of human existence and how this impacts the human condition. Engineers impact humanity mentally (the mind) and physically (the body) in a variety of ways. Engineers impact the mind through psychology: as it captures human behaviour, ethics: as it values professional conduct and safety guidelines and through the creative arts: as aesthetics are of primary concern. Engineers impact the body through health: as research and development improve society's wellbeing and disability: through the development of aid assisting devices. The aim of this report was to examine these relationships and how they benefit society and as potential elective areas within the university curriculum.

This report presented relevant, justified and tangible reasonings to why the faculty of engineering and science at the University of Technology Sydney should consider elective subjects that focus specifically, on potential areas of human growth and needs.

This collated research reflects contribution from engineers and scientists from a variety of backgrounds and fields. These fields include: mechanical engineering, electrical engineering and civil engineering whilst bound together by the thesis of scientists.

This investigation has led to tangible recommendations for future engineering and scientific elective subjects at the University of Technology Sydney.

5. Recommendations

The Human Body:

- Disability: The implementation of this topic within the UTS Engineering syllabus will help undergraduates understand several different conditions of disability and help them have access to more opportunities; physically and mentally. This benefits the human condition through continually making rapid improvements to the human body as the human race is continually evolving with science and technology.

- Sport: The implementation of sport within the UTS Engineering syllabus will help undergraduates discover the importance of maintaining a healthy lifestyle and the benefit of exercise to the human body, as it continually involves us testing our limits. This benefits the human condition as it effectively allows engineers to improve sport through finding new ways to increase the efficiency of a sport (e.g. manufacturing new materials to make a soccer ball lighter).

The Human Mind:

- Psychology: The implementation of this topic within the UTS Engineering Syllabus will help undergraduates comprehend the nature of the human mind, such as cognitive processes and behaviour. This benefits the human condition as it translates into a better personal and corporate environment as it enhances our pursuits, efficiency and reliability as we each understand where each individual operates at optimal standard.

- Ethics: The implementation of this topic within the UTS Engineering Syllabus will help undergraduates differentiate between a personal benefit over a decision beneficial to society. It will also teach undergraduates how to respect human thought and property through adhering to an individuals personal standards. This benefits the human condition as it creates an effective and productive working environment through maximising efficiency and minimising risk and harm.

6. References

- Agree, M., Freedman, A. 2011, *A Quality-of Life for Assistive Technology: Results of a Pilot Study of Ageing and Technology*, Physical Therapy Journal, vol. 91, no. 12, pp.1780-86.
- Aikens, T. 2007, *Briefing: The Psychology of Managing Project Cost*, Management, Procurement and Law, vol. 160, no. 2, pp.51-3.
- Bouyer, J., Vinet, J., Delpech, P. & Carre, S. 2007, *Thermal comfort assessment in semi-outdoor environments: Application to comfort study in stadia*, Journal of Wind Engineering and Industrial Aerodynamics, vol. 95, no. 9-11, pp. 963-976.
- Browning, B., Searock, J. Rybski, P.E. & Valoso, M. 2005, *Turning Segway into Soccer Robots*. The Industrial Robot, vol. 1, no.1, pp. 249-256.
- Burke, T., de Paor, A. & Coyle, E. 2010, *Disability and Technology: Engineering a More Equitable Ireland*, IEEE Technology & Society Magazine, vol. 29, no. 1, pp. 35-41.
- Chang, T.S. 2012, *From artificial Red Blood Cells, Oxygen Carriers, and Oxygen Therapeutics Biotechnology*, Science Journal of Australia, vol. 40, no. 3, pp. 197-199.
- Chorost, M. 2012, *Waiting for the Bionic Man*, Wired magazine, vol. 13, no. 17, pp. 94.
- Fujita, M., Kamata, M. & Miyata, K. 2005, *Clarification of Cognitive Skill in Mechanical Work and Its Application*, International Journal of Human-Computer Interaction, vol. 18, no. 1, pp. 105-124.
- Gardner, J.W., Shin, H.W. & Hines, E.L. 2000, *An electronic nose system to diagnose illness*, Sensors and Actuators B: Chemical, vol. 70, no. 1-3, pp. 19-24.
- Haake, S. 2012, *Sports Engineering*, New Scientist, Vol. 215, no. 2872, pp. 8-9.
- Harris, C. 2008, *The Good Engineer: Giving Virtue its Due in Engineering Ethics*, Science and Engineering Ethics, vol. 18, no. 1, pp. 268-80.
- Hijazeen, A & Al-Nimri, B. 2010, *Ergonomic Wheelchair Ramp Slope Design for Disabled Populations*, IIE Annual Conference. vol. 2, no. 3, pp.1-6.
- Manning, A. 2013, *Industrial Engineering-Concepts, Methodologies, Tools and Applications*, Information Resources Management Association, vol. 2, no.4, pp. 60-64.

- Jeyasurya, J., Machiel Van, L., Hodgson, A. & Croft, A. 2013, '*Comparison of seat, waist, and arm sit-to-stand assistance modalities in elderly population*', Journal of Rehabilitation Research & Development, vol. 50, no. 6, pp. 835-44.
- Jones, G., Childers, M., Emig, G., Chevrier, B., Hong, J., Stevens, T., List, V., & Jonathan, B. 2014, '*The Efficacy of Haptic Simulations to Teach Students with Visual Impairments About Temperature and Pressure*', Journal of Visual Impairment & Blindness, vol. 108, no. 1, pp. 55-61.
- Kong, F & Sui, J. 2005, '*Computer simulation of driver working memory processing*' Proceedings of the Institution of Mechanical Engineers, vol. 219. no. 7. pp - 219-222.
- McGowan, A. 2013, '*Teaching Science and Ethics to Undergraduates: A Multidisciplinary Approach*', Science & Engineering Ethics, vol. 19, no. 2, pp. 535-43.
- Ronkainen, J. & Harland, A. 2007, '*Soccer ball modal analysis using a scanning laser Doppler Vibrometer (SLDV)*', Sports Engineering, vol. 10, no. 1, pp. 49-54.
- Shakeirn, S. 2003, '*Microcontrolled Water Fountain: a Multidisciplinary Project*' International Journal of Engineering, vol. 20, No. 4, pp. 654-659.
- Savage, G., Bomphray, I., & Oxl. M. 2004, '*Exploiting the fracture properties of carbon fibre composites to design lightweight energy absorbing structures*' International Journal of Engineering, vol. 15, No. 7, pp. 654-659.
- Thomas, R.W., Friend, D.H., DaSilva, L.A. & MacKenzie, A.B. 2006, '*Cognitive networks: adaptation and learning to achieve end-to-end performance objectives*', Communications Magazine, IEEE, vol. 44, no. 12, pp. 51-71.
- Harris, C. 2008, '*The good engineer: giving virtue its due in engineering ethics*', Science and Engineering Ethics, vol. 14, no. 2, pp. 153-64.
- Victor, C.R., 2012, '*Loneliness in Care Homes: a Neglected Area of Research?*', ageing health, vol. 8. No. 6. pp. 637-646.