# Saluting the engineers

## The design and development of gadgets like the mobile phone and tablet depend very much on the experts of various engineering domains.

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IN our previous article, we briefly discussed the importance of cultivating and sustaining an interest in Science, Technology, Engineering and Mathematics (STEM).

By developing a keen interest in STEM-related subjects amongst younger students, the intention and hope is that they will eventually lead them to pursue STEM-related fields of study in higher secondary and tertiary education.

This is a crucial endeavour as it has become obvious from current global trends that STEM-related expertise is essential in driving our nation's global competitiveness as we progress into an increasingly technology-dominated future.

In this article, we will show how deeply involved engineers (the E component of STEM) are in the design and development of some of the most widely-used products today. The example that we will use for our narrative is the ubiquitous mobile phone/tablet: the one single device that best exemplifies global technological progress in the last decade.

Mobile phones communicate with other devices by transmitting a signal that carries information to a special receiving site called a base station

A designated area with mobile coverage is divided into smaller units called cells; where a base station within each cell communicates with all mobile devices within the cell area.

Upon reception of the mobile signal, a further connection is made from the base station to the wider, existing voice or data network (e.g. the Internet); allowing the mobile user to make a call to a landline number or surf websites on the Internet.

### Signals

There are several technologies utilised in mobile networks to allow transmission of this information by thousands of users simultaneously within a small geographical area; they all rely on allocating and sharing the frequency spectrum at which these signals are transmitted.

The signals on the mobile phone are transmitted from an antenna that is connected to a printed circuit board within the phone that has a few microchips mounted on it.

Microchips are miniaturised electronic circuits that are responsible for performing the variety of complex functionalities associated with a modern mobile device: ranging from signal processing to transform between digital and analog signals for transmission purposes, up to running the latest software app downloaded from Google Play or the iPhone App Store.

The functionalities described above are made possible through the expertise of electronics, communications and networking engineers. These engineers study the bandwidth spectrum available for transmitting signals and implement allocation schemes to share this.

They design the layout of the circuit board using complex modelling software in order to ensure that electrical signals are appropriately routed between the various components and chips mounted on the surface.

The design process is repeated at a more complex level for the fabrication of the microchips; which in turn involves engineering expertise from other domains. Microelectronic components are created by chemically fabricating wafers of semiconductors such as silicon to obtain the desired transport of electronic charge and control of current.

This process involves a significant mastery of quantum mechanics, chemistry and material science: all of which fall within the purview of materials and chemical engineers.

The physical shape and size of a phone (known as its form factor) is achieved through a creative design process; where design engineers conceptualise a model using software which is subsequently evolved into a prototype.

This is repeated several times until the desired form factor is achieved; a delicate balancing act between aesthetics and functionality.

The casing of most phones is made of a protective plastic shell; as are the cell phone keypads, hinges and accessories. Plastic is an important product of the petrochemical industry; where chemical engineers design and control industrial processes that convert crude oil into useful products such as solvents, detergents, adhesives, plastics and lubricants.

### Rechargeable batteries

Mobile phones draw their power from their rechargeable batteries; these are synthesised from a combination of elements such as lithium, nickel, cobalt, cadmium, zinc and copper. The batteries are produced through a specific chemical engineering process that combines these elements in the right quantity to create the ability to store and transport electrical energy.

Screen displays on a mobile phone combine liquid crystal display technology with touch screen capabilities that are common in newer smart phones and tablets.

The former uses thin layers of glass with liquid crystal sandwiched between them that are illuminated at the different intensities when an electric charge is passed between them.

The latter relies on electrical capacitance resulting from the interaction of weak electrical fields generated just below the display, which allows accurate tracking of a human finger in contact with the surface.



These two technologies are again the result of a chemical engineering endeavour.

It is then further improvised by engineers who utilise their expertise to select the appropriate materials, as well as evaluate and devise the best processes for creating these components as well as disposing of them at the end of their life cycle.

The mass production of mobile phones takes place in a factory where a significant portion of the assembly work is automated through the use of robotic equipment.

The design, creation and operation of these robots are intricate and complex processes in and of themselves.

It involves specialised motors and actuators that move the various mechanical appendages of the robot; all working under the control of software programmes embedded within a microchip.

This requires expertise from a wide variety of different engineering domains: from the electrical and control engineers who design the motors, to the mechanical and materials engineers who mold and structure the moving parts from the appropriate materials, up to the electronics and software engineers who design the logic of the microprocessor and its controlling programme that moves the robot in the desired fashion.

### Different techniques

Their efforts as a whole can be classified as a mechatronics engineering endeavour: an interdisciplinary approach to engineering that combines techniques from different areas.

The synthesis of what used to be traditionally disparate disciplines is an emerging trend in engineering work today; and is a reflection of the growing complexity and interdependence between the different key areas of engineering.

Finally, the manufacturing engineer is responsible for overseeing the smooth interworking between all the different automated processes in the factory; ensuring that the production and integration of all the various components of the mobile phone proceeds as efficiently and error-free as possible.

Towards this end, he or she will need to draw upon knowledge from a variety of other non-technical fields such as Japanese lean production systems, total quality management and project management.

It is truly awe-inspiring if one pauses to ponder the amount of knowledge, skill and equipment involved in the creation of this tiny, revolutionary device.

Consider that only 40 years ago, the complex circuitry required to power a Samsung Galaxy or Apple iPhone would have taken up most of the space within an office block!

Surely, there is no better testament to the creativity and resourcefulness of engineers, whose ingenuity in applying scientific principles to develop new products and processes is foundational to the continual enhancement of our quality of living.

In recognition of the importance of the engineering endeavour, Universiti Tunku Abdul Rahman (Utar) currently offers a total of 13 different engineering undergraduate programmes: ranging from traditional disciplines such as chemical, mechanical, civil and electrical to more innovative, cutting-edge courses such as mechatronics, materials, manufacturing and biomedical engineering.

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