THE INNOVATION TRAIN

Mike Bruton pays tribute to Elon Musk and other South Africans who made train-related innovations

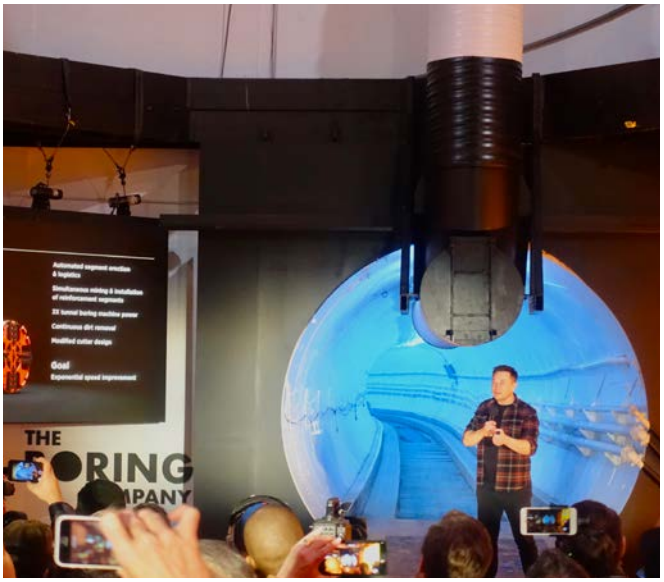
South African-born Elon Musk is credited with reviving the Hyperloop concept (see preceding article, 'Maglev'), and is recognised as one of the most influential innovators of today. His vision is no less than to change the world, reduce global warming through sustainable energy production and consumption, and minimise the risk of human extinction by setting up a colony on Mars!

Educated at Pretoria Boys High School, Musk taught himself computer programming and – at the age of 12 – developed and sold the code for a BASIC-based video game, 'Blastar'. At 17 he emigrated to Canada and started an undergraduate degree there in 1989, but subsequently transferred to the University of Pennsylvania in the United States. He later enrolled at Stanford University with the intention of doing a PhD in applied physics, but after just two days he decided to benefit from the internet boom and left to pursue a business career. He co-founded the software company Zip2 with his brother Kimbal and sold it four years later to Compaq for US$307 million.

Musk then started X.com that later became PayPal, which was bought by eBay for US$1.5 billion in 2002. In the same year he founded SpaceX, which over the years has developed a number of Falcon rockets, the reusable Grasshopper rocket and the Dragon spacecraft. The maiden flight of the unmanned 'Dragon 1' was in December 2010, but in May 2020 the first crewed flight took place on 'Dragon 2', which carried two astronauts to the International Space Station. Musk is also the brains behind Starlink, the SpaceX constellation of thousands of low-Earth orbit satellites designed to provide a high-speed, low-latency broadband internet system with global coverage.

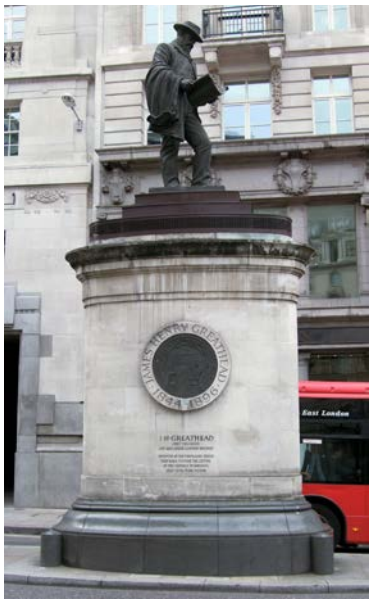
He provided some of the initial funding for the electric car company Tesla Motors when it was founded in 2003, then chaired the board from 2004 and became CEO in 2008. The company has since been renamed Tesla, Inc, having expanded into energy generation and storage, such as solar panels and roof tiles and new-age batteries. This was after Tesla's acquisition in 2016 of SolarCity, which Musk helped his cousins start in 2006 and remained involved as Chairman.

Musk also co-founded OpenAI, an artificial intelligence research laboratory, in 2015 and Neuralink, a neurotechnology start-up to integrate the human brain with AI, in mid-2016. At the end of 2016 he came up with the idea for his tunnelling venture, named The Boring Company, which aims to allow commuters to avoid city traffic on underground freeways. Currently, there is only the Hawthorne test tunnel in Los Angeles County and – as of April 2021 – a 1.83 km, dual-tunnel 'loop' providing a shuttle service in Tesla cars at the Las Vegas Convention Centre, but there are plans for this to be extended and negotiations are under way for more.



Steve Jurvetson, CC BY 2.0

South African-born Elon Musk at the unveiling of the Hawthorne test tunnel in California in December 2018.



Jim Linwood, CC BY 2.0

A statue commemorating engineer James Greathead was erected in London in 1994. The inscription on the plinth reads, "Inventor of the travelling shield that made possible the cutting of the tunnels of London's deep level tube system."

Long before Musk's involvement in the Hyperloop revival and tunnel construction, however, other South African-born innovators were making important inventions relating to tunnels or trains. One of the earliest was James Greathead, who was born in Grahamstown (Makhanda) in 1844. He attended St Andrews College from when it opened in 1855 and also spent a short period at Diocesan College ('Bishops') in Cape Town, but completed his schooling in London after the family moved to England in 1860. He subsequently apprenticed to a civil engineer there and became involved in the development of new railways.

At the age of only 24, he successfully tendered for a contract to construct the Tower Subway, the second tunnel under the Thames River. When it opened in 1870, it was the first underground tube railway in the world. Greathead later patented his Greathead Shield for underground tunnelling and the Greathead Grouting Machine. He was the resident engineer for the world's first underground electric railway (the City and South London Railway), joint design engineer for the first overhead electric railway (the Liverpool Overhead Railway), and was involved in three more tunnelling projects before he died of cancer in 1896 at the age of 52. He is commemorated in a towering bronze statue that was unveiled by the Lord Mayor of the City of London in 1994.

Another notable early inventor was John George 'Jack' Rose (1876–1973), an analytical chemist and accomplished cyclist before he joined the Cape Cyclist Corps during the South African War (1899–1902). Together with champion cyclist and bike builder, Donald Menzies, Rose developed a Rail-Mounted Bicycle Reconnaissance Vehicle using pairs of bicycles with flanged wheels riding on railway lines. These 'war cycles' were so successful for railway track inspections, espionage and dispatch riding that over 50 were built. Rose also mounted a small, air-cooled Ariel car onto one of his war cycles, thus creating the first motorised vehicle to operate on a military warfront.

During World War I he developed a Rail-Mounted Motor Tractor with a REO truck engine as well as small troop-carrying trains powered by Model T Ford engines that ran on narrow gauge railway tracks. In his 60s, Rose further distinguished himself during World War II by coordinating a massive campaign to mobilise the Allied forces in East and North Africa. When he died at the age of 97, he was celebrated as one of South Africa's most decorated sportsmen, inventors, engineers and military heroes.

City Cycling Club

Champion cyclist Jack Rose worked with the 'Springbuck' bike builder, Donald Menzies, to develop 'war cycles' that could travel on railway lines during the South African War ('Anglo-Boer War').

In the 1970s the South African Railways (SAR) engineer Herbert Scheffel re-designed the bogie, the four-wheeled undercarriage at either end of a railway carriage, so that it could run more efficiently on our relatively narrow-gauge railway tracks. He replaced the rigid, rectangular chassis that was previously used with a flexible, cross-anchor chassis that allows the wheels to adjust their position on corners, thus reducing lateral forces, vibrations and wear.

The Scheffel Bogie was introduced to the SAR fleet of ore wagons in 1975 with great success and has saved the country millions of Rands in maintenance and repair. It is also used on railways in eastern Europe and south-east Asia.

Transnet

Transnet's Trans-Africa Locomotive (TAL) is the first locomotive to be designed, engineered and manufactured in Africa.

In 2016 a South African company, DCD Rolling Stock, revolutionised the manufacture of railway bogies by moving away from traditional casting-based construction to fabrication using hot-rolled steel. This has resulted in significant weight reductions as exactly the right steel thickness is used to deliver the required strength without over-engineering.

South African parastatal Transnet has developed its first home-grown locomotive, the Trans-Africa Locomotive (TAL), specifically for African conditions. The diesel-powered locomotive, which was launched in 2017, offers a cost-effective solution for the majority of Africa's railway lines that are currently unused, and Transnet plans to sell the TALs to other African countries to promote rail traffic on the continent. Transnet Engineering also makes and sells railway bogies, passenger coaches and goods wagons that are suited to African conditions.

The CSIR has refined the Ultrasonic Broken Rail Detector (UBRD) to detect breaks in train rails and remotely communicate this information to rail engineers. Work began in 1996 when the Institute of Maritime Technology was contracted to develop the first version, which used the CSIR's piezoelectric ultrasonic transducers. UBRDs operate off solar power and scan lengths of rail up to a thousand metres long every three minutes. They are made from robust, rust-free components and can be installed without interrupting rail traffic.

- Read more about South African inventions in Mike Bruton's latest book, *Curious Notions. Reflections of an Imagineer*, published by Footprint Press. For further info, contact him at mikefishesbruton@gmail.com.

Prof. Mike Bruton was formerly head of the Department of Ichthyology and Fisheries Science at Rhodes University, Director of the then JLB Smith Institute of Ichthyology, and founding Director of the MTN ScienCentre (now the Cape Town Science Centre) in Cape Town. He currently operates a consultancy called Mike Bruton Imagineering, writes popular articles and books, and makes regular appearances as a guest speaker.

2021

Quest Volume 17 Number 3 2021

Academy of Science of South Africa (ASSAf)

Academy of Science of South Africa (ASSAf)