Champion athlete, inventor of the Cotton anti-g suit and pioneer of sports science

PROFESSOR FRANK COTTON (1890 – 1955)

By Lise Mellor

The Frank Cotton Laboratory in the Anderson Stuart Building is now home to a commemorative wall display to honour the late Professor of Physiology and his work. The laboratory has become a teaching room but sits above the foundations of the world’s first human centrifuge, built under war-time security, which led to the development of the Cotton anti-G suit during the Second World War. Post-war, Professor Cotton transformed his passion for athletics into a science which investigated the physiological effects of exercise. The wall display is now a permanent resource for students and visitors.

THE EARLY YEARS
PROFESSOR COTTON AS STUDENT AND ATHLETE

Frank Stanley Cotton studied science at the University of Sydney, graduating B.Sc. in 1912. He excelled in sport, particularly swimming, and developed a life-long absorption in athletic activity. He held all the University swimming titles from 220 yards (202m) to the mile for over twenty years.

In 1913, Cotton became a lecturer and demonstrator in the Department of Physiology but continued to compete as an athlete. He swam for the University of Sydney team and in 1921 he won the New South Wales 440 yards (402m) and 880 yards (805m) championships.
A FASCINATION WITH GRAVITY

By 1923, Cotton was chief lecturer and had begun to focus his love of physical activity towards scientific investigation. His first publications, in 1928, reported the occurrence of a trough in the pulse rate following its post-exercise acceleration. In 1931 he described a novel method for determining the centre of gravity of the body. This method made possible graphic recordings of the displacement of mass within the resting body under varying conditions of rest, respiration, posture and exercise. The early observations he made with this new method formed the basis of his thesis Changes to the Centre of Gravity for which he was awarded the Doctor of Science in 1931.

Cotton then left Australia for the United States on a Rockefeller Foundation Travelling Fellowship and spent eighteen months working in three of the world’s leading laboratories concerned with circulatory physiology and the physiology of exercise: he worked with C. J. Wiggers (Western Reserve University), H. C. Bazett (University of Pennsylvania) and D. B. Dill (Harvard University).

He returned to the Sydney Medical School in 1938 and was appointed Reader in Physiology. From 1939 he was also senior research fellow of the National Health and Medical Research Council for six years and became research professor in 1941.

Throughout these years, Cotton continued his studies into the effects of gravity. Using the centre of gravity method he had defined himself, much of his research focus was attempting to determine the additional amount of blood that can be accommodated in the vascular reservoirs of the lower limbs when the venous outflow is obstructed by graded compression of the thighs, and also to determine the speed with which the blood shift is restored following decompression. These observations were later used as an important basis for his subsequent war-time development of the gradient-pressure (anti-G) aerodynamic suit.

WORLD WAR II WORK

During World War II, with the Royal Australian Air Force, Professor Cotton was responsible for the invention of the ‘Cotton aerodynamic anti-G flying suit’, which minimized the effects of high-speed flying on pilots. Cotton had recognised the need for an anti-gravity suit during the 1940 Battle of Britain. It was estimated that 30% of pilot deaths were due to accidents, including black-out. Spitfires, in particular, were capable of rapid turns that generated high g-forces, causing black-out when diving to avoid or deliver enemy fire.

The anti-gravity suit was designed to provide protection for pilots against the black-out and loss of consciousness that may occur in high-speed aircraft turns as a result of the pooling of blood in the lower limbs and abdomen. By inflating air sacs in the suit, pressures proportional to the centrifugal force were rapidly and automatically applied to the legs and lower abdomen. Then, on the resumption of straight flight and the dissipation of centrifugal force, the gas escaped from the sacs, restoring the contents to atmospheric pressure.

The suit was developed at the Sydney Medical School. Cotton constructed the first human centrifuge in the
Anderson Stuart Building under tight wartime security. The volunteers, young airmen, were strapped by their legs to the centrifuge and subjected to high g-force and monitored until black-out occurred. All lost consciousness. It must have been a strange sight to those unaware of Cotton’s military work, to see volunteers arrive fit and well, all to be revived in the quadrangle some time later.

On February 19, 1942, the day of the major Japanese air attack on Pearl Harbour and Darwin, Cotton’s suit was approved by the Allied war chiefs. The Americans soon issued orders for manufacture of a suit based on Cotton’s design. The anti-G suits were used successfully later in the war and credited with saving many lives. At war’s end, Cotton received acclaim for his role in the development of the anti-G suit.

THE FATHER OF SPORTS SCIENCE
In 1946, he was appointed Professor of Physiology and returned to his pre-war interest in sports physiology, gaining a reputation as the ‘father of sports science in Australia’. Amidst an environment where sports training wasn’t measured or analysed, Cotton’s passion for sport drove his desire to be able to understand, in a scientific and measurable way, what happens to human bodies during exercise training and competition. This knowledge also enabled him to predict which athletes would be successful and in 1949 he used the ergometer he had designed to help select the victorious University of Sydney eight-oar crew.

With Forbes Carlile, who became one of Australia’s most successful swimming coaches, Cotton established the first sports science laboratory in Australia and continued to investigate the effects of varied training methods with the athletes on their program here at the University. Ideas that seem simple now, like shaving the bodies of swimmers and tapering the training programs down towards a major event, were radical innovations at the time. In the face of conventional training wisdom of the time, Cotton and Carlile ‘tapered’ the training programs of their athletes two to three weeks before a major event. This meant rather than training hard up to the event, the body was given more time to rest and recover from any injuries sustained through the training. In 1952, Cotton became scientific adviser to the Australian Olympic team at Helsinki. His ideas were also put into practice during the 1956 Olympics when, for the first time, Australian swimmers were required to ‘shave down’ for their competitions. Their ideas aided several Australians to become successful athletes. Of note are swimmers Denise Spencer, Judy Joy Davies and Jon Henricks, rower Peter Evatt and runner Edwin Carr.

Professor Cotton retired from the University of Sydney in 1955 and died the same year. A prize for Physiology in the Sydney Medical School has been instituted to perpetuate his memory and the Professor Frank Cotton laboratory is named in his honour. radius

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