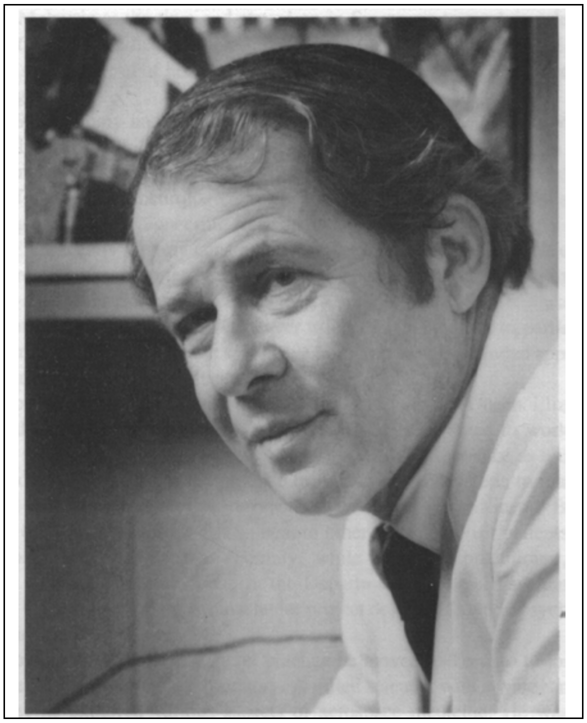
Biography of Edward Llewellyn-Thomas, BSc, MD CM FRSC, 1918-1984

First Associate Director of the Institute



Dr. Llewellyn-Thomas, or "Tommy" as he was known to many, was born in Salisbury, England, December 15, 1918. Shortly before the start of World War II he graduated in electrical engineering from the University of London. At the war's outbreak in 1939, at the age of 21 he joined the British Army. As a specialist in radar and communications he served with the Royal Electrical and Mechanical Engineers and saw action in North Africa and the Far East. Rising to the rank of Captain, he subsequently spent time in Gibraltar and was the officer on the island responsible for communications. Here, one cannot doubt, he developed a practical view of instrumentation, and the ability to improvise, since new equipment and spare parts were not so readily available.

Subsequent to the war he was attached to the British War Office, and it was while he was attending a Staff College course in Virginia that he met his wife Ellen. He was demobilized from the army in 1947 – the same year that he married Ellen. For a time he was in Malaysia and stayed on in Singapore to work in telecommunications. While in Singapore he decided to pursue training in Medicine.

In 1951 Tommy and Ellen moved to Montreal where he entered McGill Medical School. While in medical school Tommy was employed as an Electrical Engineer at the Montreal Neurological Institute where he worked with some of the giants of neurological science such as Carl Jasper and Wilder Penfield, who, at that time were engaged in their pioneering work on mapping the electrical activity of the brain. Ellen recalls Tommy constructing some of the recording devices on the dining-room table. He often remarked that he considered himself privileged to work in this environment as a medical student, and I am sure it was that experience that later made him so eager to encourage students to participate in research while undergraduates, and gave him such an open-minded approach to undergraduate medical education. Following graduation from McGill he interned at the Queen

Elizabeth Hospital in Montreal and during that time decided to work as a general practitioner in a small community, in order to experience as much as he could of the breadth of the practice of medicine.

Always one to make an unusual choice, for two years he practiced on a small island in the Bay of Fundy, often traveling in a fishing boat to other islands to visit patients. Working in these isolated conditions, it was often necessary to handle difficult medical cases without immediate help. However, he was never one to neglect science. It was during this time that he also worked as a Research Associate in the Department of Social Psychiatry of Cornell University, taking part in a major project designed to study psychiatric illness in small communities.

An opportunity to work on man and the environment related to aerospace medicine attracted him, and the family moved to Toronto in 1958, where he joined the Defence Research Medical Laboratory. Here, amongst other things, he initiated research into human eye movements. As a gifted scientist with a wide range of interests, he also explored various aspects of aerospace medicine, psychopharmacology, and how man responded to his environment. Along with Norman H. Mackworth he designed a head-mounted camera to record eye movements. He used this to study eye movements under a variety of physical conditions, such as driving an automobile, flying a small aeroplane, or perusing art. Subsequent to his appointment as Associate Director of the then Institute of Biomedical Electronics, a picture of a much improved version of this camera was used as the front-cover for an issue of Scientific American (August 1968, see figure at the end). In this issue he was the author of a full description of the camera design and its application in a variety of studies that he and his graduate students at the Institute continued to conduct.

He joined the University of Toronto as a part-time lecturer in Pharmacology in 1959 and became a full-time member of the Faculty in 1963, and here pursued his research in pharmacology and biomedical engineering. He was appointed as the first Associate Director of the Institute of Biomedical Electronics that had been established in 1962 under the direction of Norman Moody. In this capacity he provided a direct link to the Faculty of Medicine as well as to the many associated medical research groups in the surrounding hospitals. These were responsible for establishing new interdisciplinary research projects for the Institute staff and graduate students. Tommy was a gifted teacher capable of making a potentially dull subject an exciting new venture. For example, in his introductory lectures to a course on Biomedical Engineering, introduced by the Institute around 1967, he presented basic physiology from an engineering perspective. He also introduced an Internship course in which graduate students in the Institute spent time in hospital departments experiencing first-hand some of the problems faced by these departments. He was responsible for supervising a considerable number of graduate students, many of whom themselves became academics.

Tommy's unusually wide interests are reflected in the range of academic appointments he held. In addition to his appointment in Pharmacology and the Institute he had a professorial appointment in the Faculty of Applied Science and the department of Electrical Engineering. At one time he was a Lecturer in design in the Ontario College of Art and a Professor in the Psychology Department of the University of Waterloo, where he taught the first course in Canada on Human Factors in Engineering. He also pursued his clinical interests and held appointments in the Department of Family and Community Medicine at Women's College Hospital and in the Department of Anaesthesia at the Toronto General Hospital.

He was the author or co-author of some sixty scientific papers, and in addition was a co-editor of the first comprehensive text on biomedical engineering. About six years prior to his retirement he commenced writing science fiction books. Six of these were published under the pseudonym of Edward Llewellyn. They are:

Douglas Convolution Series

1. The Douglas Convolution (1979)
2. The Bright Companion (1980)
3. Prelude to Chaos (1983)

Also the novels:

4. Salvage and Destroy (1984)
5. Fugitive in Transit (1985)
6. Word-Bringer (1986, posthumously)

He also published a number of poems written in Welsh: a truly remarkable achievement.

He was a member of the Institute of Electrical Engineers and at the same time a member of the Royal Society of Arts. He was a member of the Human Factors Association of Canada and served a term as the President of that organization. In 1974 he won the Engineering Medal, a major award from the Association of Professional Engineers. He served as consultant to the Royal Ontario Museum, the Ontario Science Centre, the World Health Organization, the National Research Council, the Medical Research Council, the Defence Research Board of Canada, the National Design Council, and several other major firms and government agencies in Canada and the United States. His election as a Fellow of the Royal Society of Canada was in recognition of his outstanding contributions to science. Always active, at the time of his death he was preparing a submission to the Federal Commission investigating the Ocean Ranger disaster.

Throughout his career he was known as an excellent lecturer, but in addition he developed a real interest in undergraduate teaching. He demonstrated this interest by his active participation in the reorganization of the undergraduate medical curriculum in the late 1960s and for several years served as Co-Ordinator of Period I. Not only was he interested in teaching and the curriculum, he was interested in the individuals involved in the process, the teachers and the students. His particular talents with people, students especially, were recognized in 1974 when he was appointed Associate Dean, Student Affairs, a position he occupied with distinction until his retirement.

Throughout those years as Associate Dean he touched the lives of many; to the students he was counselor and guide, but most importantly a friend to whom they could turn for advice in personal and academic matters; to faculty members he was also a wise counselor whose broad experience could be brought to bear on a wide variety of issues. The Board of Examiners in particular turned to him repeatedly for his opinion regarding students in academic difficulty and he could be depended upon to provide sound advice. For all his success in research he was proudest of the years in which he served the student body. In all his activities he demonstrated warmth, compassion, and humour. An academic who always pursued excellence and who demonstrated his pleasure at a student's excellent performance, he always recognized the need for physicians to possess personal qualities that would allow them to practise with warmth and understanding. He was proud of his students. He taught ethics by his personal behaviour long before it became a required topic in the undergraduate medical curriculum.

Edward Llewellyn-Thomas died 5 July 1984, only a few days after his retirement as Associate Dean for Student Affairs, Faculty of Medicine, University of Toronto. He was survived by his wife Ellen, three children, Caroline, Roland, and Ned, and a host of friends. The University, through the Faculties of Medicine and Applied Science and Engineering, established a memorial fund in his honour. This fund supports the annual Edward Llewellyn-Thomas Memorial Lecture Series of the IBBME.

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MOVEMENTS OF THE EYE

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MOVEMENTS OF THE EYE

In which a special camera records where people look in the course of such activities as driving and looking at pictures. It appears that the eye fixes on many things of which the viewer is not aware

by E. Llewellyn Thomas

To look closely at something is to turn one's eyes so that the image falls on the fovea, a specialized area smaller than the head of a pin that lies near the center of the retina. Only in this tiny region are the receptor cells concentrated with sufficient density to provide detailed vision. As a result not more than a thousandth of the entire visual field can be seen in "hard focus" at a given moment. Yet the human eye is capable of discerning in considerable detail a scene as complex and swiftly changing as the one confronting a person driving an automobile in traffic. This formidable visual task can be accomplished only because the eyes are able to flick rapidly about the scene, with the two foveae receiving detailed images first from one part of the scene and then from another.

Therefore most of the time our eyes are jumping from point to point. These movements and fixations can be recorded in various ways. One method is to photograph the bright spot you can see when a light shines on the eye. This bright spot is the reflection from the convex surface of the cornea. Because the radius of curvature of the cornea is smaller than the radius of the spherical eyeball, the angle of reflection changes when the eyeball rotates and the bright spot appears to move. These movements can be correlated with the movements of the eye's line of sight.

When such a photographic record is combined with a motion picture of the scene ahead of the viewer, it reveals the features that attracted his notice, held it or were overlooked. Such records have useful applications, for example in the design of highway signs and radar displays. They can show how critical details in an X-ray plate or an aerial photograph are sometimes overlooked, even when the viewer thinks he has scanned the picture carefully. In our laboratory at the University of Toronto we have been using developments of this method to study how the human eye attacks such visual problems. We have also been interested in how the patterns of eye movement are affected by psychological disturbances and drugs, and how a sequence of eye movements and fixations can be related to the processing of information in the brain.

The most common major eye movement is the saccade: the rapid jump the eye makes as it moves from fixating one part of a scene to fixating another. The fixations themselves usually last less than half a second, but their duration depends on the character of the scene and what the viewer is doing. The jump between fixations takes only a few milliseconds. Vision is greatly reduced not only while the eye is actually moving during the saccade but also for a short period before it starts to move. One can appreciate this reduced vision if one tries to observe one's own eye movements in a mirror.

The speed of the saccade depends on the saccade's length and direction, and the speed also differs from individual to individual. The flick may be so rapid that the eye's angular velocity may reach more than 500 degrees per second. This velocity is not under conscious control; an effort to slow it will only break the saccade into a series of shorter movements. If at the end of the saccade the fovea is not "on target," the eye adjusts by making one or more small corrective jumps. The path the eyes follow between two fixation points may be straight, curved or even hooked, but once the eye is launched on a saccade it cannot change its target. It is as if the points in the visual field were recorded as a set of coordinates in the brain. The difference between the coordinates of a fixation point at one instant and the coordinates of the next fixation point constitutes an "error" signal to the eye-movement control centers, and the resulting movement of the eye is directed in a manner analogous to what an engineer would call a simple position servomechanism.

The eye moves so frequently and rapidly that the pattern it weaves can be recorded only by instruments. Methods of recording eye movements include contact lenses, suction cups and photoelectric devices. When the head must be left as unencumbered as possible (as in recording the eye movements of astronauts during flight or in recording eye movements under closed lids), the method of choice is the electro-oculograph. Early investigations of eye movements in reading (by Raymond Dodge) and in the ex-

VIEW THROUGH WINDSHIELD, shown in the sequence of photographs on the opposite page, indicates (*white spot*) where the viewer inside the automobile was looking as it moved along the street. The photographs were made with a device that records both the scene before a viewer's eyes and a spot of light reflected from one of his eyes. This device is worn on the head of the viewer, as shown on page 91. A vertical line in the optical system of the device appears at the center of each photograph. It indicates, by its position with respect to the scene, when the observer's head has moved. Reading from left to right and top to bottom, the features of the scene that drew the eye were (*1*) the street pavement, (*2*) a pile of snow, (*3*) the broken line painted on the pavement, (*4*) a parked automobile, (*5*) the street pavement, (*6*) a moving automobile, (*7*) a patch of snow in the street, (*8*) a storefront, (*9 and 10*) an automobile as it is overtaken, (*11*) the base of a telephone pole, (*12, 13 and 14*) the shoulder and face of a pedestrian as he crosses the street and (*15*) the roadside ahead.