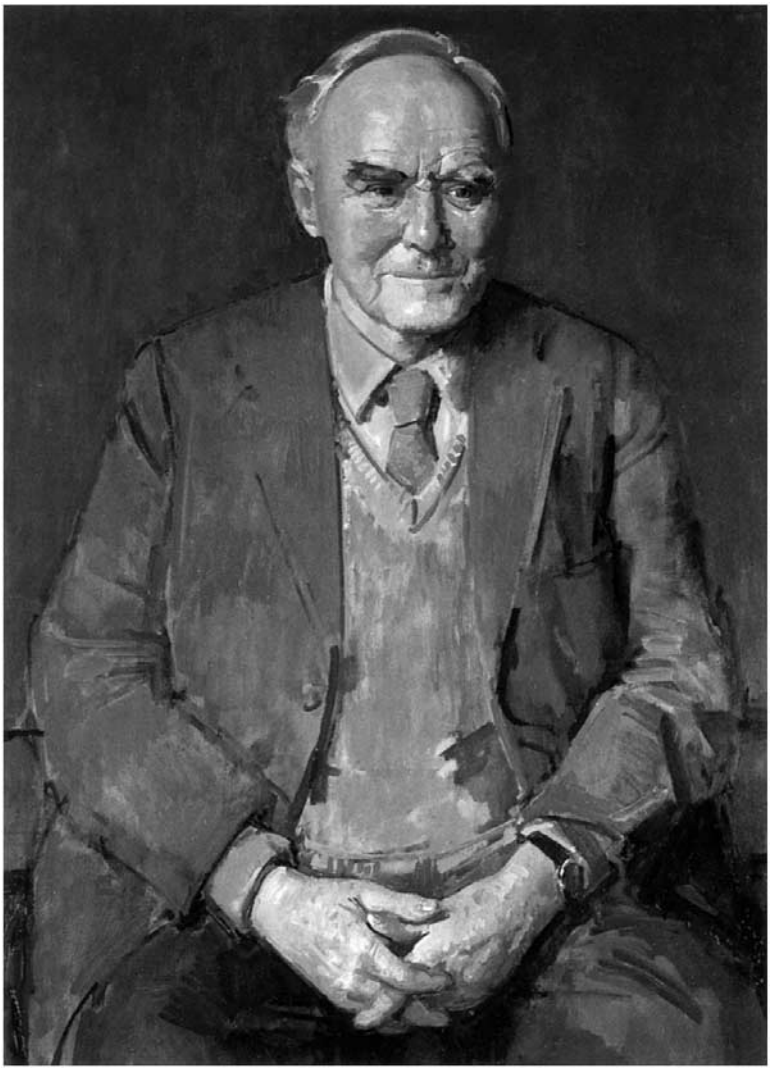
G. I. Taylor was one of the great physical scientists of this century, and was notable for the originality and independence of his thinking. He made outstanding contributions to the mechanics of fluid and solid materials, and his ideas have had wide application in meteorology, oceanography, mechanical, civil and chemical engineering, hydraulics and materials science. He was both an experimenter and a theoretician of distinction, and saw instinctively the simplest approach to the investigation of a new phenomenon. He was involved in the early development of meteorology, aeronautics and metal physics, and was consulted widely on the problems in mechanics arising in the two World Wars. He was a keen small-boat sailor, and helped himself and thousands of others throughout the world by his brilliantly imaginative new design of an anchor. As a man he was gentle and lovable, with needle-sharp wits which hurt no-one..

How was Taylor able to be so innovative? This interesting and unusual mix of science and biography helps us to answer that question. The author was a graduate student of Taylor and a friend for 30 years, and is well placed to describe his achievements and his life, most of which was spent in Cambridge. He does so without introducing mathematical details, making this book understandable and enjoyable, especially for those whose own interests have brought them into contact with the scientific legacy of G. I. Taylor.

The Life and Legacy of G. I. Taylor



Frontispiece: photo of oil painting of Geoffrey Taylor by Ruskin Spear, 1966

The Life and Legacy of G.I. Taylor

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Contents

Preface

I have wanted for some years to write a book about G. I. Taylor, who died in 1975. He was one of the great physical scientists of this century, and was notable for the originality and independence of his thinking. He made outstanding contributions to the mechanics of fluids and solids and their applications, and pioneered several important fields in mechanics. He was both an experimenter and a theoretician of distinction. On the personal side Taylor generated great admiration and affection among those he met. I believe that the physical-science community would be enriched by more knowledge of what he accomplished in mechanics, and also of how he did it, for this too is part of his legacy. Since I am greatly indebted to Taylor for his friendship and for his influence on my own research life, I felt I owed it to him to write his biography. I saw this book as a posthumous tribute to a great man, as a source of insight stimulated by Taylor's work, and as a picture on paper of a truly simple, good, man. And writing the book has been a labour of love for me.

So great is my respect for Taylor that it seems audacious to make value judgements about him. Even so, I have tried to avoid making this book simply a long eulogy. I have not hesitated to point out what I believed to be a weakness of character or of – rarely – a scientific development. I admire him greatly but I hope that has not rendered me incapable of seeking the truth.

I should present here my credentials as a biographer of Taylor. So far as the technicalities of writing are concerned, I have written previously two scientific books, one a research monograph and one a textbook for students, and a number of papers on different aspects of fluid mechanics, and I believe that the requirements of a biography are not very different from those of a scientific book. In both spheres one tries to organize and present the material in a way which is clear, precise and – if possible – elegant. The essential difference is that the

biography contains a human element whereas scientific writing normally does not. My experience of compositions containing a human element is not zero, but is limited to a few obituary memoirs, the longest being a memoir on G.I. Taylor for the Royal Society in 1976[1]. This present biography of Taylor can be regarded as, roughly speaking, an enlarged version of the Royal Society memoir, and the reception given to that memoir encourages me to think that this larger-scale description of both his life and his work is on the right lines. I take this opportunity to thank the Royal Society for permitting me to incorporate extracts from my Royal Society memoir of G.I. Taylor in the present book.

Readers will wish also to know whether I knew Taylor well and whether I have had access to the existing papers about Taylor and his life. The short answer to these queries is a definite 'yes'. I first met Taylor when I arrived in England in April 1945. He was 59 at the time, I was 25, and he and I were both in Cambridge for the remaining 30 years of his life. He was scientifically active during that period, being only a little less prolific in his output than in the years before 1945. He supervised my work for a PhD during the period 1945–48, and as a friend later I was aware of what he was doing scientifically. During the period 1958–1971 I edited and Cambridge University Press published in four volumes *The Scientific Papers of Sir Geoffrey Ingram Taylor*. When he died in 1975 he left the paper records of his life and work in a disordered state in one room of his house. At the request of Miss Gladys Davies, who lived in the house with Taylor, and to whom he left the house on his death, I sorted Taylor's papers roughly, and learnt a great deal about the man while doing so. The documents and records and correspondence regarded as being of some interest were then arranged and classified by officers of the Contemporary Scientific Archives Centre to form a collection which the Council of Trinity College agreed could be deposited in the College Library. The Librarian has kindly allowed me easy access to the papers in the collection for the purpose of writing this book. The collection is extremely valuable, although it suffers from the

1. *Biographical Memoirs of Fellows of the Royal Society*, vol. 22, 1976, pp. 565–633.

drawback that it is by no means complete and in particular contains relatively few letters written by Taylor since he usually wrote letters by hand without keeping copies.

The author of a biography of a scientist faces a difficult question of selection of material. At what level of scientific education should the scientific developments described in the book be understandable? The problem is especially acute in the case of a physical scientist like Taylor whose work involves mathematical relations and ideas. Going deeply into his papers would have made the book both long and hard-going for the non-specialist reader. I therefore adopted the working rule that my description of Taylor's scientific work should be concise and generally intelligible to a graduate student who has had some introduction to fluid or solid mechanics. To this end I have avoided all mathematical manipulations and have concentrated on conveying a qualitative understanding of the more important investigations made by Taylor. I have tried to reveal the physical ideas involved and to show the nature of his reasoning and the ingenuity of his experiments. Some readers may find my explanations too brief, and there will be experienced readers who find my explanations too superficial. However, a reader whose interest in one of Taylor's publications is stirred will be able to consult the appropriate reference in the complete bibliography of Taylor's works at the end of this book.

The magnitude of Taylor's total scientific output also demands some selection of the papers to be described in this book. Volume I of his *Scientific Papers* contains 41 previously published papers on aspects of the mechanics of solid materials, and Volumes II, III and IV together contain 152 papers on fluid mechanics. It is not feasible to describe them all, and I have chosen for brief description the more significant papers, in particular those which are representative of a group.

The relatively small representation of papers on the mechanics of solid materials in this book reflects my limited competence in that field. I am greatly indebted to my colleagues Rodney Hill and Nevill Mott for being willing to contribute descriptions of Taylor's very important work on plasticity of crystalline materials to chapter 11. As a consequence of these two authoritative contributions, from the

continuum and the microscopic (or dislocation) viewpoints respectively, and the reproduction of a historical note by Taylor on the early stages of dislocation theory, chapter 11 gives a clear and interesting account of Taylor's research on plasticity. However there are relatively few references to Taylor's work on mechanics of solids outside chapter 11, which I regret.

In his later years, Taylor wrote a number of 'popular' articles and texts of addresses which I found to be attractive and informative additions to his scientific works. Their subjects include his gifted family, his experiences at the Royal Aircraft Factory helping to lay the scientific foundations of aeronautics, his participation in the *Scotia* expedition, his sailing exploits, his travels in remote parts of Indonesia, the history of some important scientific developments in which he was involved, and his personal philosophy of research; and many are unpublished. All these articles are clear and entertaining, and they tell us a good deal about the man. There would be some loss of insight if I tried to condense them, and I concluded that the most satisfactory plan would be to reproduce several of the articles in full, at appropriate places in the text. If the book consequently seems to some readers to be a quasi-autobiography, so be it; I have no doubt that readers will enjoy Taylor's popular writing and will find it rewarding.

Works by Taylor in the complete bibliography at the end of this book will be referred to in the text simply by the year of publication or production, with the addition of letters a, b, c ... to distinguish between works produced in the same year; for example (1954d). The further designation in the bibliographical list, SP IV, 34 for example, indicates that a paper has been reprinted in volume IV of Taylor's *Scientific Papers* and is paper number 34 within that volume. References to publications by other authors are usually given in footnotes to the text.

Many people have helped me to produce this book about Geoffrey Taylor and his work. Some have helped by being encouraging, some have provided information about G.I., some have helped me to understand pieces of his research, and some have provided helpful comments on my drafts. It has been my good fortune that everyone approved of the proposal to write a book about G.I., and everyone was willing to contribute in some way. I have of course benefitted

from the universal admiration and affection in which the memory of G.I. is held. Many times I have reflected that my task would have been much more difficult, and less pleasant, if my subject had been a lesser man.

In the early days when I was uncertain about the structure of the proposed book I received valuable comments and advice from Philip Drazin, Tim Pedley, and David Tranah of CUP.

Sir Arnold Hall, Rodney Hill, the late Harry Jones, Sir Nevill Mott, and the late Lord Penney all knew G.I. and his work, and at my request kindly contributed descriptions of areas of G.I.'s research unfamiliar to me. These contributions were incorporated first in the Royal Society Biographical Memoir I wrote in 1976 and now again, with the consent of the Royal Society, in the present biography.

Other people who told me what they knew about G.I. are Albert Green, Sir William Hawthorne, Bertha Jeffreys and Dick Scorer.

I thank John Stewart for making for me a translation into English of Prandtl's letters to Taylor in the twenties and thirties, my secretary Karen Stringer for coping patiently with the endless revisions, and my wife Wilma for delving into the records concerning the foundling who was given the name Taylor and became G.I.'s grandfather on his father's side.

There were many draft descriptions of particular aspects of G.I.'s life or work on which I needed a second opinion, and people who gave me valuable comments, sometimes concerning a paragraph or two and sometimes about whole chapters, were Grisha Barenblatt, Barbara Garlick, Julian Hunt, Anne Keynes, Frans Nieustadt, and John Willis. I owe a particular debt of gratitude to Keith Moffatt who generously undertook to read a complete draft and whose comments were both encouraging and critical.

G.I. Taylor: Chronology

22 April 1885	Marriage of Margaret Boole and Edward Ingram Taylor
7 March 1886	Birth of Geoffrey Ingram Taylor in London
1897–1899	Attended University College Preparatory School at Holly Hill
1899–1905	Attended University College School, in Gower Street, London
1905–1908	Studied mathematics and physics at Trinity College, Cambridge
1908	Awarded a major scholarship by Trinity College and began research at Cambridge on a problem suggested by J.J. Thomson
1910	Published first paper on fluid mechanics, on the structure of shock waves, for which he was awarded a Smith's Prize at Cambridge
October 1910	Elected to a Prize Fellowship at Trinity College
April–July, 1911	In Linford Sanatorium, Ringwood, with pleurisy
1 January 1912	Appointed to a Readership in Dynamical Meteorology at the University of Cambridge for three years
1913	Served as a meteorologist on an expedition, on the sailing ship *Scotia*, to report on icebergs in the North Atlantic, following the sinking of the *Titanic*
August 1914	Joined a group of civilians at Farnborough helping the Royal Flying Corps to put the design and operation of aeroplanes on a scientific basis
1915	Awarded the Adams Prize for the period 1913–14 at University of Cambridge for an essay on 'Turbulent motion in fluids'

1917	Appointed meteorological advisor to the Royal Flying Corps
1918	Advisor on meteorology and navigation to the Handley Page group trying to be the first to fly across the Atlantic
1919	Elected to Fellowship of the Royal Society
October 1919	Appointed to a Fellowship and Lectureship in Mathematics at Trinity College, Cambridge
1923	Appointed to a Royal Society Research Professorship at Cambridge. Walter Thompson becomes Taylor's technician
15 August 1925	Married Stephanie Ravenhill, a school teacher in Birmingham
1927	Cruise to the Lofoton Islands on *Frolic* with Stephanie
1929	Participation in 4th Pacific Science Congress in Java. Tours in Borneo and Japan with Stephanie
1933	Awarded a Royal Medal of the Royal Society
1944	Knighted. Awarded the Copley Medal of the Royal Society
16 July 1945	Witnessed the first test of an atomic bomb in New Mexico
1946	Awarded the US Medal for Merit
1951	Retired from Yarrow Research Professorship
4 June 1967	Stephanie Taylor died
July 1969	Appointed to the Order of Merit
April 1972	A severe stroke and some loss of mobility
27 June 1975	A second and fatal stroke at Farmfield