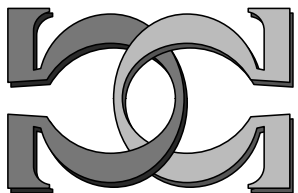
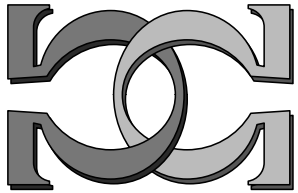
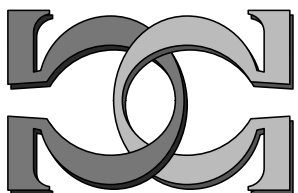
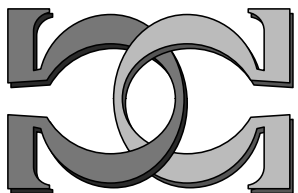


**CDMTCS  
Research  
Report  
Series**

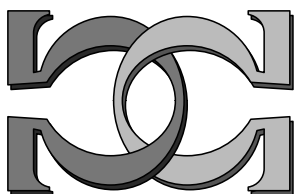


**Bibliography of Publications  
by John R. Womersley:  
Pioneer of Modern  
Computing and Applied  
Mathematician**

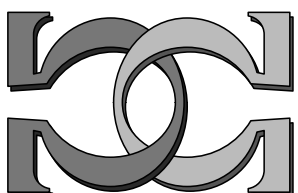


**Brian E. Carpenter and Robert W.  
Doran**

University of Auckland, NZ



CDMTCS-490  
October 2015



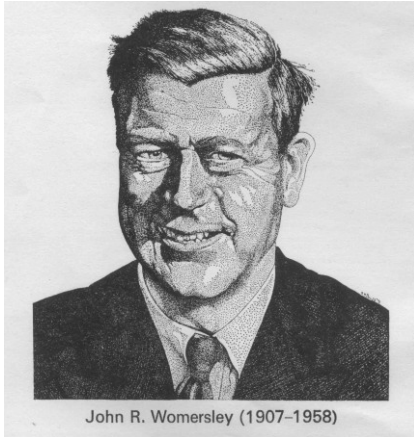
Centre for Discrete Mathematics and  
Theoretical Computer Science

# ***Bibliography of Publications by John R. Womersley: Pioneer of Modern Computing and Applied Mathematician***

Compiled by Brian E. Carpenter and Robert W. Doran  
*The University of Auckland*

October 2015

---



This bibliography was compiled in connection with a biographical article about John Ronald Womersley (1907-1958) [1]. He was an applied mathematician, then a manager of mathematicians and statisticians, in war and in peacetime. Then he was in at the beginning of electronic computers. Finally he made a difficult career transition in the mid 1950s from second-level management back to very successful applied mathematics research, before his early death.

(Engraving from Donald A. McDonald, *Blood flow in Arteries*, second edition, Edward Arnold, 1974.)

This list of Womersley's publications is the most extensive we could assemble, but the authors would be glad to hear of missing items. We have used publicly available indexes and bibliographies, as well as three partial and rather careless lists that Womersley included in his US job applications. In a few cases, Womersley gave slightly different titles. Here, the titles used in the formal publications are given. A short commentary is given on some of the items, and the reader is referred to the biographical article [1] for further details.

J. R. Womersley, *Two nomograms for calculating the fluidity of cellulose solutions*, *Memoirs of the Shirley Institute*, **XIII**, 95-100 (1934)

*Reprinted in:* *Journal of the Textile Institute*, **XXVI** (5), T165-T170 (1935)

J. R. Womersley, *The application of differential geometry to the study of the deformation of cloth under stress*, *Memoirs of the Shirley Institute*, **XVI**, 1-16 (1937)

*Reprinted in:* *Journal of the Textile Institute*, **XXVIII**(3), T97-T112 (1937)

*Reprinted again in:* F.T. Peirce and J.R. Womersley, *Cloth Geometry*, North Carolina State University (1978).

These two papers were written while Womersley was in his first job as an applied mathematician at the British Cotton Industry Research Association's Shirley Institute in Manchester, England. It was standard practice for Shirley Institute papers to be reprinted in the *Journal of the Textile Institute*. However, it is noteworthy that the second one was important enough to be reprinted again forty years later.

D.R. Hartree and J.R. Womersley, *A method for the numerical or mechanical solution of certain types of partial differential equations*, Proc. Roy. Soc. A, **161**, 353-366 (1937)

This – a collaboration with Professor Douglas Hartree on the use of Britain's first differential analyzer – was leading edge work at the time.

J. R. Womersley, *Preface* to E.H. Sealy, *A first guide to quality control for engineers*, Ministry of Supply, (1943, reissued by HMSO, 1945)

During World War II, Womersley became the manager of a statistics research team for the Ministry of Supply in London, and his team's advice on quality control was vital for the supply of reliable munitions.

S. L. Anderson, B. Cavaney, G. A. R. Foster and J. R. Womersley, *An automatic sliver and roving regularity tester and an automatic yarn regularity tester*, Memoirs of the Shirley Institute, **XIX**, 183-196 (1945)

*Reprinted in:* Journal of the Textile Institute, **XXXVI** (10), T253-T266 (1945)

G. A. R. Foster, J. Gregory and J. R. Womersley, Some calculations relating to the arrangement of fibres in slivers and rovings, *Memoirs of the Shirley Institute*, **XIX**, 197-209 (1945)

*Reprinted in:* Journal of the Textile Institute, **XXXVI** (12), T311-T323 (1945)

These two papers were delayed publications of pre-war work.

J. R. Womersley and M. R. Hopkins, *Suggestions concerning the use of the correlogram for the interpretation of measurements of surface finish*, proceedings of Journée des Etats de Surfaces, Commission Technique des Etats et Propriétés de Surfaces des Métaux, 135-139 (Paris, 1945)

M. R. Hopkins published several papers, including this one, on the surface finish of metals in 1944-1948. Hopkins worked for the Taylor, Taylor and Hobson Company in Leicester, England, experts in precision metrology. We assume that Womersley's involvement was due to his wartime work on quality control.

J. R. Womersley, *Scientific computing in Great Britain*, Mathematical Tables and Other Aids to Computation, **2**, 110-117 (1946)

This was Womersley's only publication from his time as the founding head of the Mathematics Division of the National Physical Laboratory at Teddington, England. This was the period when, among many others, he hired Alan Turing to design the ACE computer, and Donald Davies, who later invented packet switching.

The BTM Co Ltd, John Ronald Womersley and Ralph Townsend, *Improvements in Electronic Adding Devices*, British Patent 678427, March 1951.

From late 1950 until mid 1954 Womersley managed electronic computer development for British Tabulating Machines in Letchworth, England. This patent shows that he was fully involved in the technical work.

J. R. Womersley, *Flow in the larger arteries and its relation to the oscillating pressure*, J. Physiol. **124**, 31-32 (1954)

J. R. Womersley, *Oscillatory flow in arteries: effect of radial variation of viscosity on rate of flow*, J. Physiol. **127**, 38-39 (1955)

J. R. Womersley, *Method for the calculation of velocity, rate of flow and viscous drag in arteries when the pressure gradient is known*, J. Physiol. **127**, 553-563 (1955)

J. R. Womersley, *Oscillatory motion of a viscous fluid in a thin-walled elastic tube: I: the linear approximation for long waves*, Phil. Mag **46**, 199-221 (1955)

J. F. Hale, D. A. McDonald, and J. R. Womersley, *Velocity profiles of oscillating arterial flow, with some calculations of viscous drag and the Reynolds number*, J. Physiol. **128**, 629-640 (1955)

J. F. Hale, D. A. McDonald, M.G. Taylor and J. R. Womersley, *The Counter Chronometer Method for Recording Pulse-Wave Velocity*, J. Physiol. **129**, 27-28 (1955)

In 1954-1955, Womersley spent an extraordinarily productive year as a researcher at St. Barthomew's Hospital, London, where he essentially created the mathematical theory of blood flow in the above six papers.

J. R. Womersley, *Oscillatory flow in arteries: I. the constrained elastic tube as a model of arterial flow and pulse transmission*, Phys. Med. Biol **2**, 178-187 (1957)

J. R. Womersley, *An Elastic Tube Theory of Pulse Transmission and Oscillatory Flow in Mammalian Arteries*, Wright Air Development Center Technical Report 56-614, sometimes referred to as WADC TR56-614 (1957, sometimes cited as 1958)

From mid-1955 until his death early in 1958, Womersley held a senior research position at the Wright Air Development Center, Dayton, Ohio, USA. This report contains a compilation of Womersley's writings and results on blood flow, amounting to a book of 254 typed pages, including hundreds of equations, the results of calculations from "the 1103 computer" (presumably WADC's UNIVAC 1103), and more than 100 pages tabulating numerical results from 40 hours work by "the [Harvard] Mark IV Calculator". It neatly illustrates the arc of Womersley's life from applied mathematics to numerical analysis and electronic computers. The draft title *The mathematical analysis of the arterial circulation in a state of oscillatory motion* is sometimes cited. The report was formally declassified and made public only in July 2015, thanks to the efforts of Aric Ahrens of the Paul V. Galvin Library at the Illinois Institute of Technology. It can be obtained as a file of 129 MB at

<http://contrails.iit.edu/DigitalCollection/1956/WADCTR56-614.html> .

J. R. Womersley, *Oscillatory flow in arteries: II. the reflection of the pulse wave at junctions and rigid inserts in the arterial system*, Phys. Med. Biol **2**, 313-323 (1958)

J. R. Womersley, *Oscillatory flow in arteries. III. Flow and pulse-velocity formulae for a liquid whose viscosity varies with frequency*, Phys. Med. Biol., **2**, 374-382 (1958)

Finally, in his job applications for WADC, Womersley listed two pending publications that we have been unable to trace:

J. R. Womersley, *Oscillatory motion of a viscous fluid in a thin-walled elastic tube: II: the correction for the inertia terms*, Phil. Mag. (in press).

D.A. McDonald, J.F. Hale and J.R. Womersley, *Oscillatory flow in arteries: velocity profiles in the femoral artery of the dog* (in press).

Probably this was in fact the above paper in J. Physiol. **128**.

[1] B.E. Carpenter and R.W. Doran, *John Womersley: Applied Mathematician and Pioneer of Modern Computing*, IEEE Annals of the History of Computing, 36(2) (April 2014) 60-70.