Strachey 100



Celebrating the life and research of Christopher Strachey

University of Oxford Department of Computer Science

 $18\mathrm{th}{-}19\mathrm{th}$ November 2016



Wolfson Building, Parks Road Oxford OX1 3QD United Kingdom http://www.cs.ox.ac.uk

Organisers:

Samson Abramsky Troy Astarte Karen Barnes Alex Kavvos Cliff Jones Bernard Sufrin (samson.abramsky@cs.ox.ac.uk)

(t.astarte@newcastle.ac.uk)

(karen.barnes@cs.ox.ac.uk)

(alex.kavvos@cs.ox.ac.uk)

 $(\tt cliff.jones@newcastle.ac.uk)$

 $(\tt bernard.sufrin@cs.ox.ac.uk)$

Introduction

Christopher Strachey (1916–1975) was a pioneering computer scientist and the founder of the Programming Research Group, now part of the Department of Computer Science at Oxford University. Although Strachey was keenly interested in the practical aspects of computing, it is in the theoretical side that he most indelibly left his mark, notably by creating with Dana Scott the denotational (or as he called it, 'mathematical') approach to defining the semantics of programming languages. Strachey also spent time writing complex programs and puzzles for various computers, such as a draughts playing program for the Pilot ACE in 1951. He developed some fundamental concepts of machine-independent operating systems, including an early suggestion for time-sharing, and was a prime mover in the influential CPL programming language. Strachey came from a notable family of intellectuals and artists, perhaps most famous for Christopher's uncle Lytton, a writer and member of the Bloomsbury group.

The conference will open with a morning of talks dedicated to a historical exploration of Strachey's life, chaired by Cliff Jones. The morning session will end with a panel chaired by Bernard Sufrin. After lunch, there will be a video presentation from Strachey's long-time collaborator Dana Scott, who regrets he is unable to be in the United Kingdom for this event. The afternoon session will consist of talks about the future of research inspired by Strachey at Oxford and further afield, which will be chaired by Samson Abramsky.

This booklet will provide some information on the proceedings of the conference, including a schedule of talks and short abstracts from those contributors who provided them. There is also a series of appendices with some longer papers, and a list of the items shown at an exhibition at the Bodleian Library.

Program

Start	Name	Title
	Morning session	(Chair: Cliff Jones)
09:00	Mike Wooldridge	Introduction
09:15	Martin Campbell- Kelly	Strachey: the Bloomsbury years
09:45	Joe Stoy	Strachey and the Oxford Programming Group
10:15	Martin Richards	Strachey and the development of CPL
10:45		break
11:15	Peter Mosses	SIS, a semantics implementation system
11:45	Robert Milne	Semantic relationships: reducing the separa- tion between practice and theory
	David Hartley	
12:15	Michael Jackson	Panel (Chair: Bernard Sufrin)
	Roger Penrose	
	Chris Wadsworth	
13:00		lunch
	$Afternoon\ session$	(Chair: Samson Abramsky)
14:15	Dana Scott	Video presentation
14:45	Jane Hillston	A mathematical approach to defining the semantics of modelling languages
15:15	Philip Wadler	Christopher Strachey, first-class citizen
15:45	break	
16:15	Hongseok Yang	Probabilistic programming
16:45	Uday Reddy	Parametric polymorphism and models of storage
17:15	Jeremy Gibbons	What are types for?
17:45		Closing remarks

Talk abstracts

Martin Richards: 'Christopher Strachey and the Development of CPL'

Christopher Strachey was the most significant contributor to the design and implementation of the programming language CPL. At the time there was little understanding of the complexities of computer language design and how type systems could cope with lists and the kinds of structures needed to represent, for instance, parse trees. The CPL project cannot be regarded as being successful since it did not result in a usable CPL compiler. The reasons being that the language became too large and complicated, there were insufficient people to implement the compiler and, in the middle of the three year project, all work had to be transferred from Edsac 2 to Titan, a newly designed version of the Ferranti Atlas computer which as yet had no operating system. Even so, we can be proud of the work that went into CPL and its influence on the design of many later languages.

Peter Mosses: 'SIS, A semantics implementation system'

During my DPhil studies, supervised by Christopher Strachey, I developed a prototype of a system for executing programs based on their denotational semantics. It involved partial evaluation of lambda-notation, implemented using Wadsworth's call-by-need algorithm. I continued the development of the system as a postdoc at Oxford, and subsequently at Aarhus, Denmark. The system was called SIS: Semantics Implementation System.

Robert Milne:

'Semantic relationships: reducing the separation between practice and theory'

Christopher Strachey believed that the gap between theory and practice was impeding the development of computing science. In my talk I shall consider how our work together on the essay that ultimately became our book tried to narrow the gap, by formalising, and reasoning about, the implementation concepts for programming languages. A particular focus will be the proof techniques for imperative programs that use storage, which were implicit, but not very easy to discern, in the book.

Jeremy Gibbons: 'What are types for?'

Types in programming languages are commonly thought of as a way of preventing certain bad things from happening, such as multiplying a number by a string. But this is only half of the benefit of types: it is what types are *against*. Types in programming languages are also what enable some good things to happen, such as selecting the right implementation of a heterogeneous operation like comparison or printing based on type information; this is what are types *for*. This ability is surprisingly powerful, and gives rise to a variety of highly expressive generic programming techniques. I will illustrate with some examples based on the rank-polymorphic array operations introduced in Iverson's APL: not only does the type information prevent array shape errors, it is what directs the lifting of operations across array dimensions.

Exhibition items

Some information here has been taken from the catalogue of the Strachey archive at the Bodleian Library, collected by the Contemporary Science Archives Centre. This is available online at http://www.bodley.ox.ac.uk/dept/scwmss/wmss/online/modern/strachey-c/strachey-c.html.

 Account of Strachey's life and work. Date: 1926–1964. Tabulated account of his life and activity, drawn up by Strachey.

The information, itemised by year and by month, is compressed in Strachey's very tiny handwriting on to 2 and a half sheets of writingpaper. The earliest entry is for 1926, and the entries have been added in blocks of two or three minutes at a time, to the end of 1964.

Personal and professional events are recorded, and the account is remarkable for the amount of information encompassed.

2. Pictures of Strachey. Dates: 1923, 1925, 1973.

A photo of Strachey aged 6 lying by the side of the pool at Mud, the Strachey holiday home in Sussex. Another of Strachey aged 8 wearing a hat and carrying a forkful of hay. Four photos of Strachey looking relaxed reading a newspaper in 1973, probably also taken at Mud. One computer generated image of Strachey, composed of various symbols including a moustache of λ s.

 Diagrams of the school gramophone at St. Edmund's School, Canterbury. Date: late 1940s.
Strachey was employed as a schoolmaster at this small public school, where he taught physics and mathematics. He was also involved in extra-curricular school activities, including the school's radio club, where he designed and built a combined radio and gramophone.

 Interplanetary travel'. Article in Harrow School magazine. Date: 1950.

After leaving St. Edmund's school, Strachey took a post at the rather more prestigious Harrow. Here as well he took part in a number of activities, including teaching musical appreciation, and often gave lectures at the science society, including on the topic of interplanetary travel.

- 5. Items related to the 'Draughts' program. Date: 1950–1952. During the last years of his time at Harrow, Strachey became interested in computers, and spent some time at the National Physical Laboratory learning about their Pilot ACE machine. He then spent quite a few years working on a program which would enable a computer to play draughts.
- 6. Letter to Alan Turing. Date: May 1951.

Strachey's copy of his letter to A.M. Turing, 15 May 1951. Written immediately after hearing Turing's talk 'Can Digital Computers think?', broadcast on BBC Third Programme on same day. In his letter Strachey discusses the general problems of 'thinking machines', their application to the Manchester machine, and his modification of his ACE draughts program.

- 'Specification of the machine'. Date: 1957. Whilst working at the National Research Development Corporation, Strachey was responsible for large parts of the design of Ferranti's new computer, the Pegasus.
- 'Time sharing in large fast computers'. Date: 1959. Typescript abstract, and 2 typescript versions of a paper read at the UNESCO Conference on Information Processing, Paris, July 1959.

Strachey describes the paper as follows: "Time Sharing in Large Fast Computers' was probably the first paper to discuss time-sharing and multi-programming as we now know them. It is a matter of history that the time-sharing idea became extremely fashionable in the middle sixties and dominated much of the work on computing at that time. When I wrote the paper in 1959 I, in common with everyone else, had no idea of the difficulties which would arise in writing the software to control either the time-sharing or multi-programming. If I had I should not have been so enthusiastic about them."

9. 'CPL working papers' (Introduction). Date: 1966.

The CPL Working Papers were issued in July 1966 following a meeting of the CPL authors in Oxford on 24 June. They consisted of 2 parts: 1. The second edition of the Elementary Programming Manual and 2. An unfinished Reference Manual. The concluding paragraphs of the minutes of the 24 June 1966 meeting state: "The circulation of the CPL Technical Report will conclude the phase of effort on CPL which has continued for the past four years, and at this stage most authors will probably wish to discontinue their efforts in a formal way... CPL of course needs major further work, particularly on data structures and program segmentation. C.S. (Strachey) and D.P. (Park) propose to study this at Oxford, and M.R. (Richards) may implement it at M.I.T."

Strachey's preface to the Working Papers, which gives a useful account of the history of CPL and its documentation, is on display here.

 'A general purpose macrogenerator'. Date 1965. In an autobiographical note written in 1971, Strachey described this as follows:

"An interesting by-product of the work on CPL and its compiler was the General Purpose Macrogenerator which is in effect a simple but very general string processor. This program has now been implemented in almost every country in which computing is a research subject—I certainly know of implementations in Australia, Japan, Poland, Norway, Denmark, Germany, France, Italy, Holland as well as several in England and America. It gives an elegant example of the use of a stack and shows the power of functional composition to construct complicated operations from simple primitives. It is not, however, of any very deep theoretical interest and I now regard it as a rather beguiling time-waster."

- 11. Time sharing patent. Date 1965. Strachey's work on time sharing culminated in US and UK patents, filed at the end of the 1950s and only awarded in the mid 1960s.
- 12. 'Systems analysis and programming', in *Scientific American*. Date: 1970.

Strachey described this as 'a popular article ... it describes, amongst other things, a draughts-playing program'. Strachey found difficulty in writing, and in adequately illustrating, the article, of which many drafts, revisions and alternatives survive in the folders both of working papers and editorial correspondence.

13. Single-page language semantics. Date: early 1970s. One of the features of Strachey and Scott's mathematical semantics which must have particularly pleased Strachey is the compactness with which languages could be defined. This is an example of such a single page (two-sided) definition.

- 14. 'A theory of programming language semantics'. Draft manuscript (with Robert Milne). Date: 1974. Strachey was determined to be elected to the Royal Society towards the end of his life, and partly in an attempt to increase his publication count and win some notoriety, he co-wrote with one of his students this extremely lengthy essay and submitted it for the Cambridge Adams prize. It represents the ultimate achievement of Strachey's work on semantics, and explains the concept and metalanguage as well as giving exhaustive worked examples on a sizeable programming language. The Strachey archive contains a large quantity of manuscript material, written in both Strachey's and Milne's hands. Displayed here is only the introduction and the note to the assessor's apologising for the length of the essay.
- 15. 'A theory of programming language semantics'. Draft typescript (with Robert Milne). Date: 1974.A preliminary typed version of the essay, although still not completed. Strachey continued to revise the essay extensively, and there were plans to publish in 1975, although these were changed by Strachey's sudden death. The submission did not win the prize.
- 16. A Theory of Programming Language Semantics. Book, two volumes (Robert Milne and Christopher Strachey). Date: 1977. After Strachey's death, Milne rewrote the material of the Adams Essay and it was published in book form.
- 17. 'The word games of the night bird'. Date: 1974. An interview with Nancy Foy, published in *Computing Europe*.

Appendix: papers

Martin Richards. Christopher Strachey and the development of CPL. 2016.

Martin Campbell-Kelly. Christopher Strachey, 1916-1975: A biographical note. IEEE Annals of the History of Computing, 1(7):19–42, 1985.