Formalism in the Forest

The 1964 IFIP *Formal Language Description Languages* Working Conference

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Before we start…
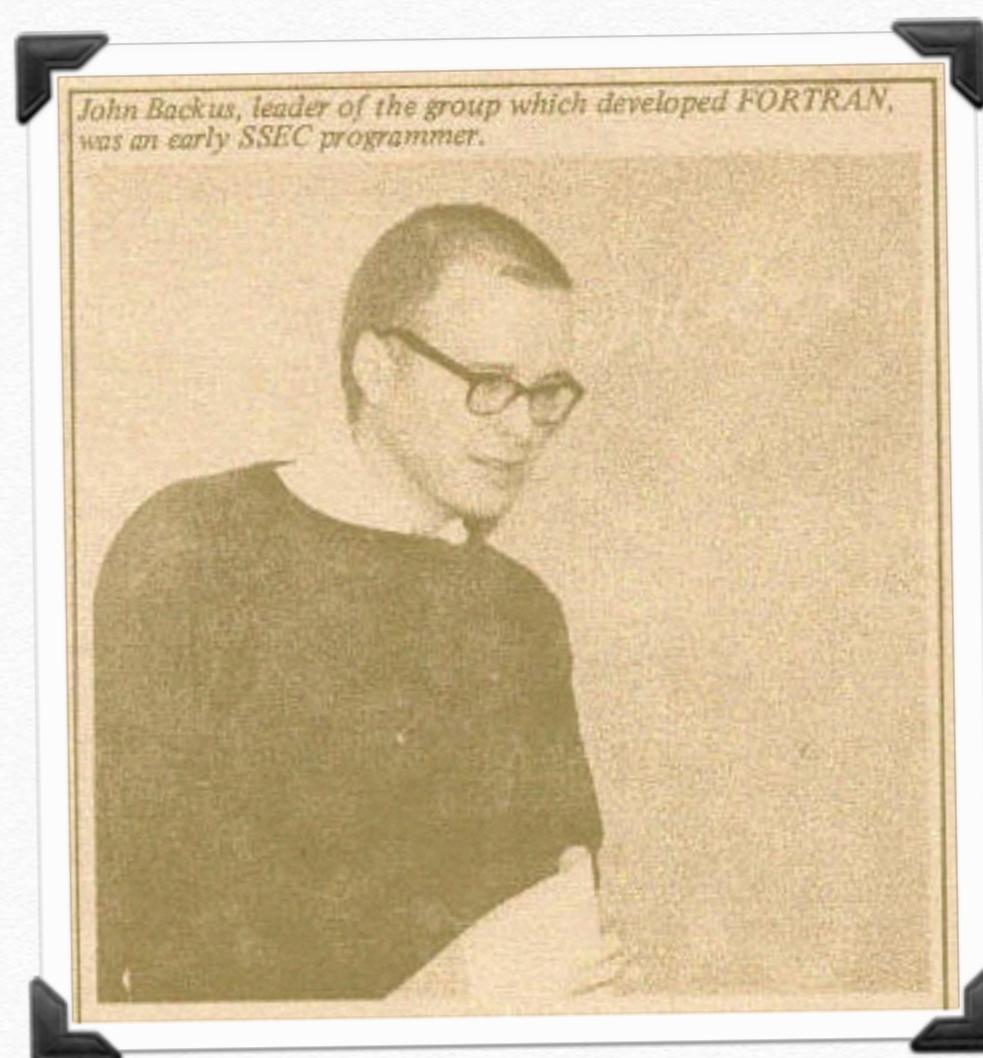
λ notation

- Alonzo Church (1932)

- Notation for un-named functions & set of conversion rules

- λ x. xx

- λf. λx. f x (1)

- λf. λx. f f x (2) ... etc

Background: HLLs
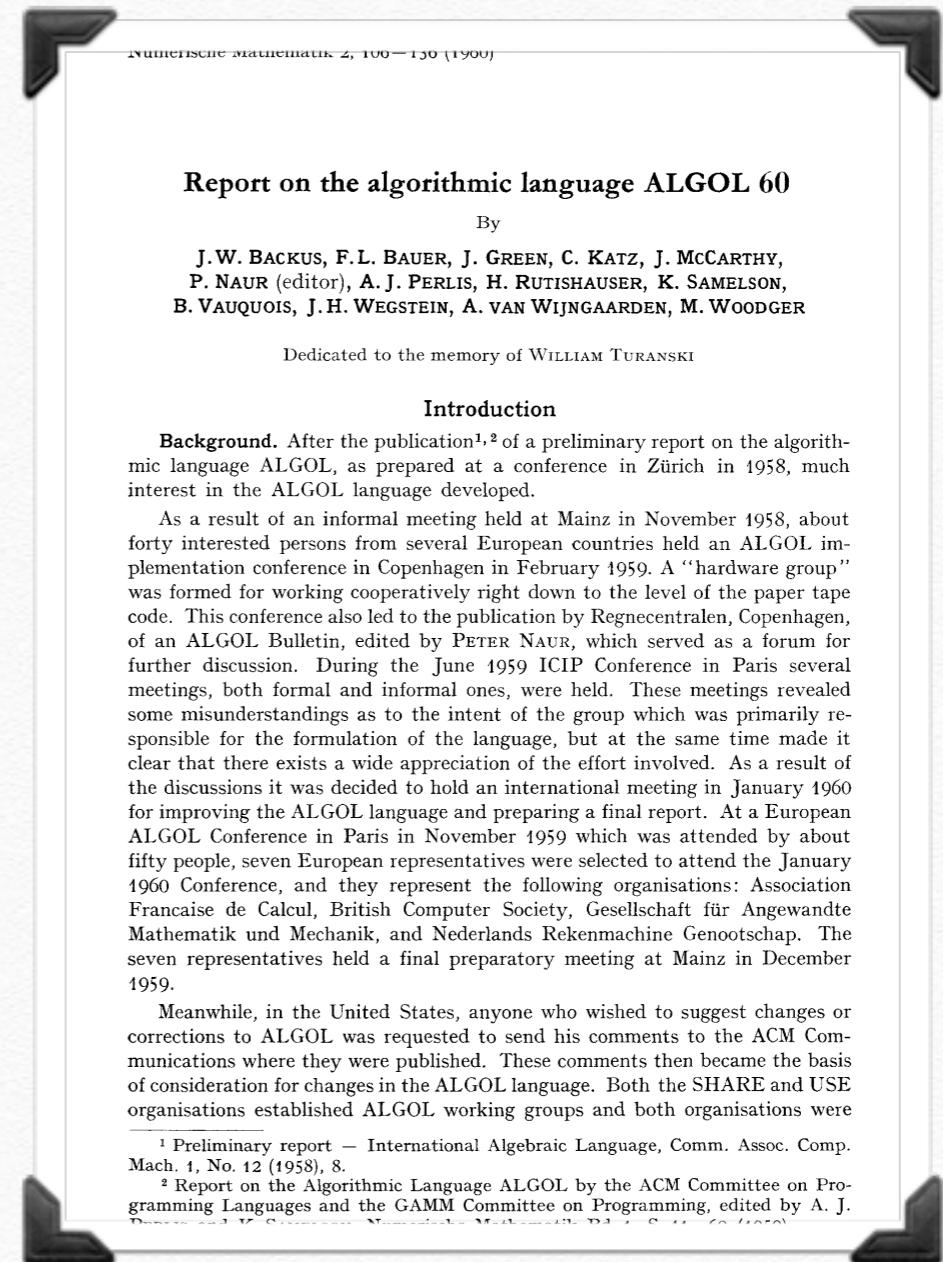
- Emerging complexity in control

- High-level languages:

    - FORTRAN 1954, B-O 1955

- Compiler correctness

- Understanding computation

John Backus, leader of the group which developed FORTRAN, was an early SSEC programmer.

Background: IFIP

- May 1958, ACM/GAMM project for 'International Algorithmic Language'

- = ALGOL 58

- TC-2, WG2.1

- = ALGOL 60

Numerische Mathematik 2, 106—136 (1960)

Report on the algorithmic language ALGOL 60

By

J.W. Backus, F.L. Bauer, J. Green, C. Katz, J. McCarthy,
P. Naur (editor), A.J. Perlis, H. Rutishauser, K. Samelson,
B. Vauquois, J.H. Wegstein, A. van Wijngaarden, M. Woodger

Dedicated to the memory of William Turanski

Introduction

Background. After the publication[1,2] of a preliminary report on the algorithmic language ALGOL, as prepared at a conference in Zürich in 1958, much interest in the ALGOL language developed.

As a result of an informal meeting held at Mainz in November 1958, about forty interested persons from several European countries held an ALGOL implementation conference in Copenhagen in February 1959. A "hardware group" was formed for working cooperatively right down to the level of the paper tape code. This conference also led to the publication by Regnecentralen, Copenhagen, of an ALGOL Bulletin, edited by Peter Naur, which served as a forum for further discussion. During the June 1959 ICIP Conference in Paris several meetings, both formal and informal ones, were held. These meetings revealed some misunderstandings as to the intent of the group which was primarily responsible for the formulation of the language, but at the same time made it clear that there exists a wide appreciation of the effort involved. As a result of the discussions it was decided to hold an international meeting in January 1960 for improving the ALGOL language and preparing a final report. At a European ALGOL Conference in Paris in November 1959 which was attended by about fifty people, seven European representatives were selected to attend the January 1960 Conference, and they represent the following organisations: Association Francaise de Calcul, British Computer Society, Gesellschaft für Angewandte Mathematik und Mechanik, and Nederlands Rekenmachine Genootschap. The seven representatives held a final preparatory meeting at Mainz in December 1959.

Meanwhile, in the United States, anyone who wished to suggest changes or corrections to ALGOL was requested to send his comments to the ACM Communications where they were published. These comments then became the basis of consideration for changes in the ALGOL language. Both the SHARE and USE organisations established ALGOL working groups and both organisations were

[1] Preliminary report — International Algebraic Language, Comm. Assoc. Comp. Mach. 1, No. 12 (1958), 8.
[2] Report on the Algorithmic Language ALGOL by the ACM Committee on Programming Languages and the GAMM Committee on Programming, edited by A. J.

Background: formalism

- ALGOL 60 report

- Syntax definition: BNF

- McCarthy brings abstraction in 1962

The ALGOL Report

4.2. Assignment statements

4.2.1. Syntax.

⟨left part⟩ ::= ⟨variable⟩ :=

⟨left part list⟩ ::= ⟨left part⟩ | ⟨left part list⟩ ⟨left part⟩

⟨assignment statement⟩ ::= ⟨left part list⟩ ⟨arithmetic expression⟩ |

   ⟨left part list⟩ ⟨Boolean expression⟩

4.2.2. Examples.

$$s := p\,[0] := n := n + 1 + s$$
$$n := n + 1$$
$$A := B/C - v - q \times S$$
$$s\,[v, k + 2] := 3 - arctan\,(s \times zeta)$$
$$V := Q > Y \wedge Z$$

4.2.3. Semantics. Assignment statements serve for assigning the value of an expression to one or several variables. The process will in the general case be understood to take place in three steps as follows:

4.2.3.1. Any subscript expressions occurring in the left part variables are evaluated in sequence from left to right.
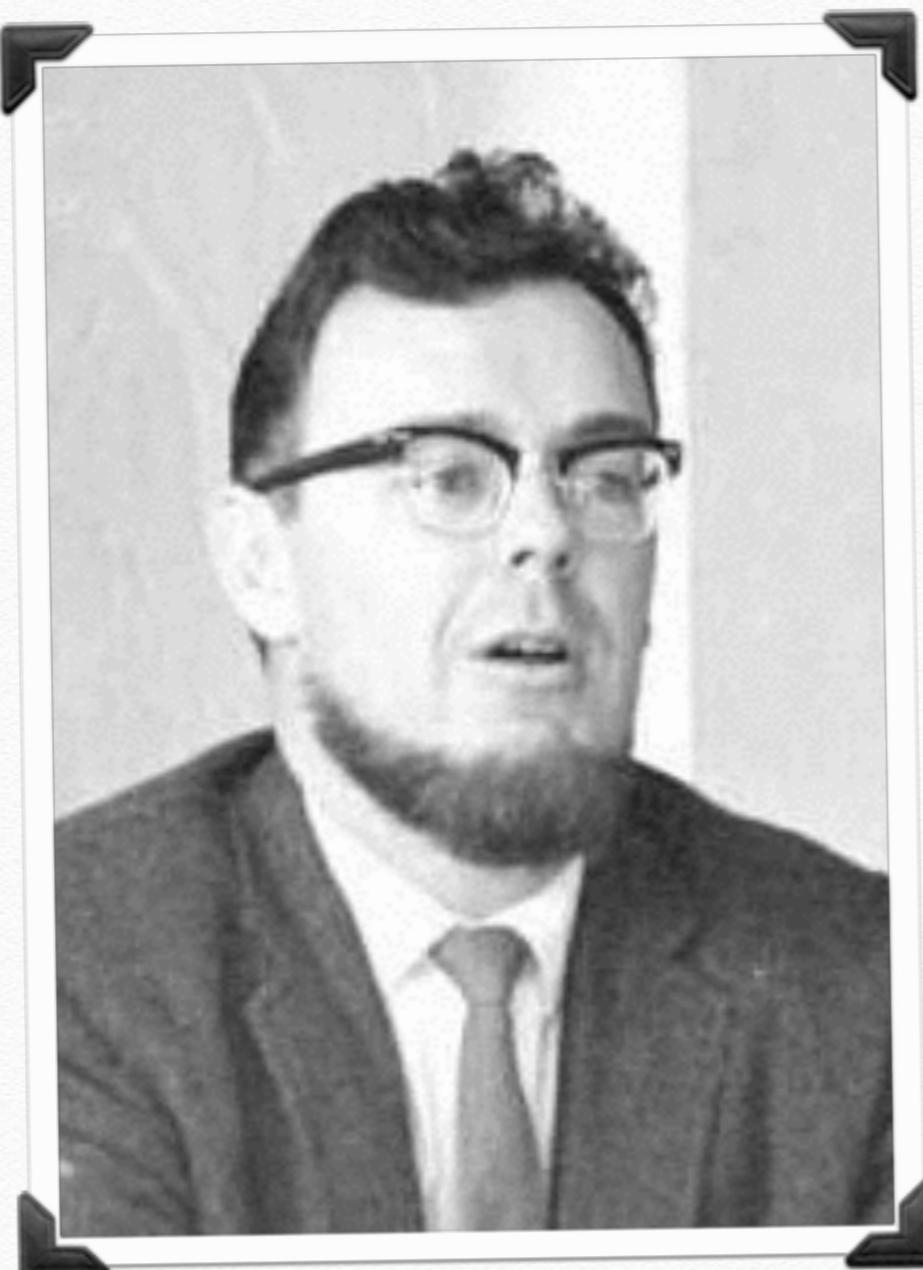
4.2.3.2. The expression of the statement is evaluated.

4.2.3.3. The value of the expression is assigned to all the left part variables, with any subscript expressions having values as evaluated in step 4.2.3.1.

Conference suggestion
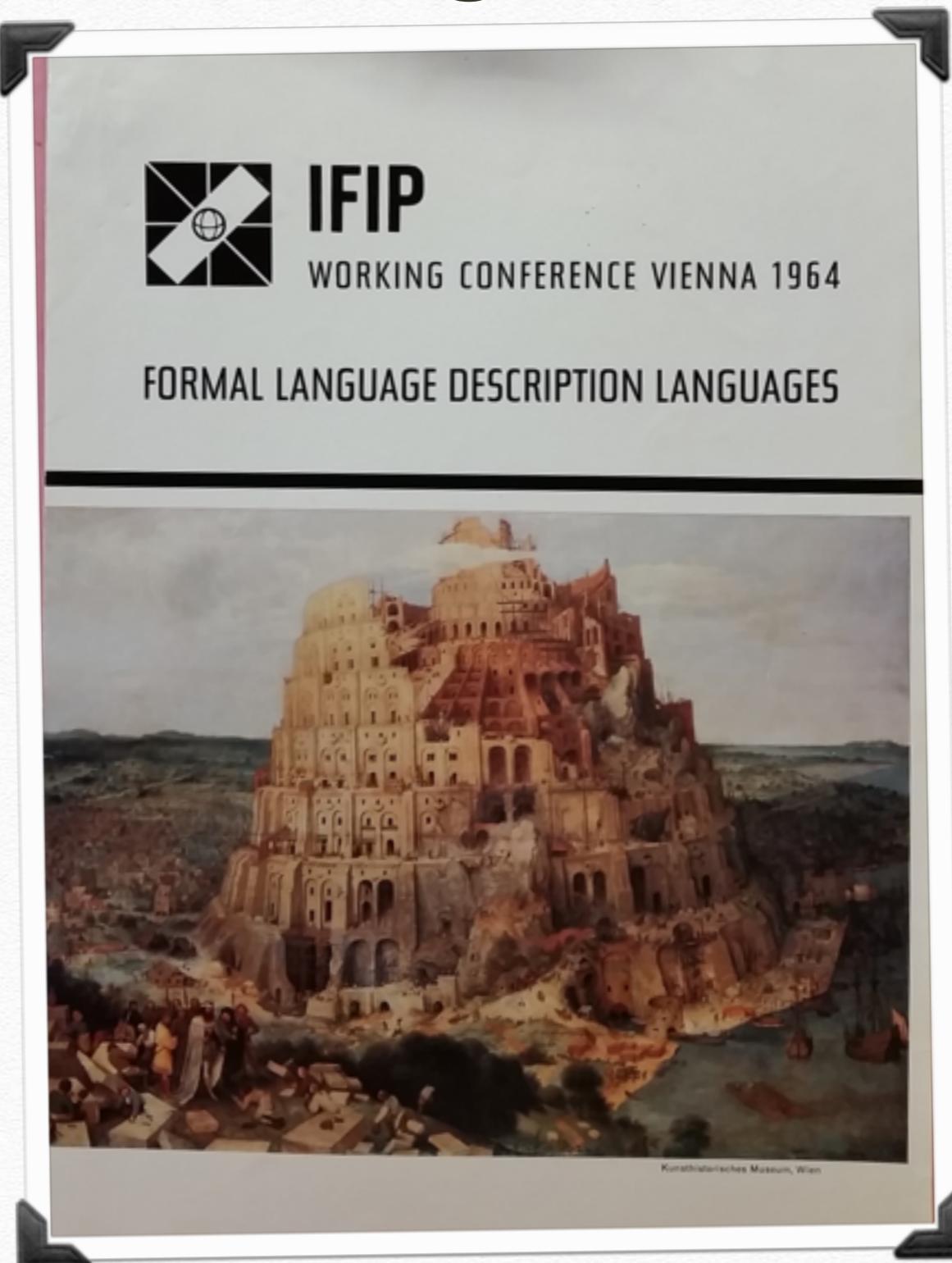
- TC-2 organised and sponsored; Zemanek chaired

- Partial IBM funding

- Minutes show narrowing of focus

- Friedrich Bauer: "the problem today is to find or develop suitable formalization to reduce recurrent languages and concepts to the usable level."

Conference intention
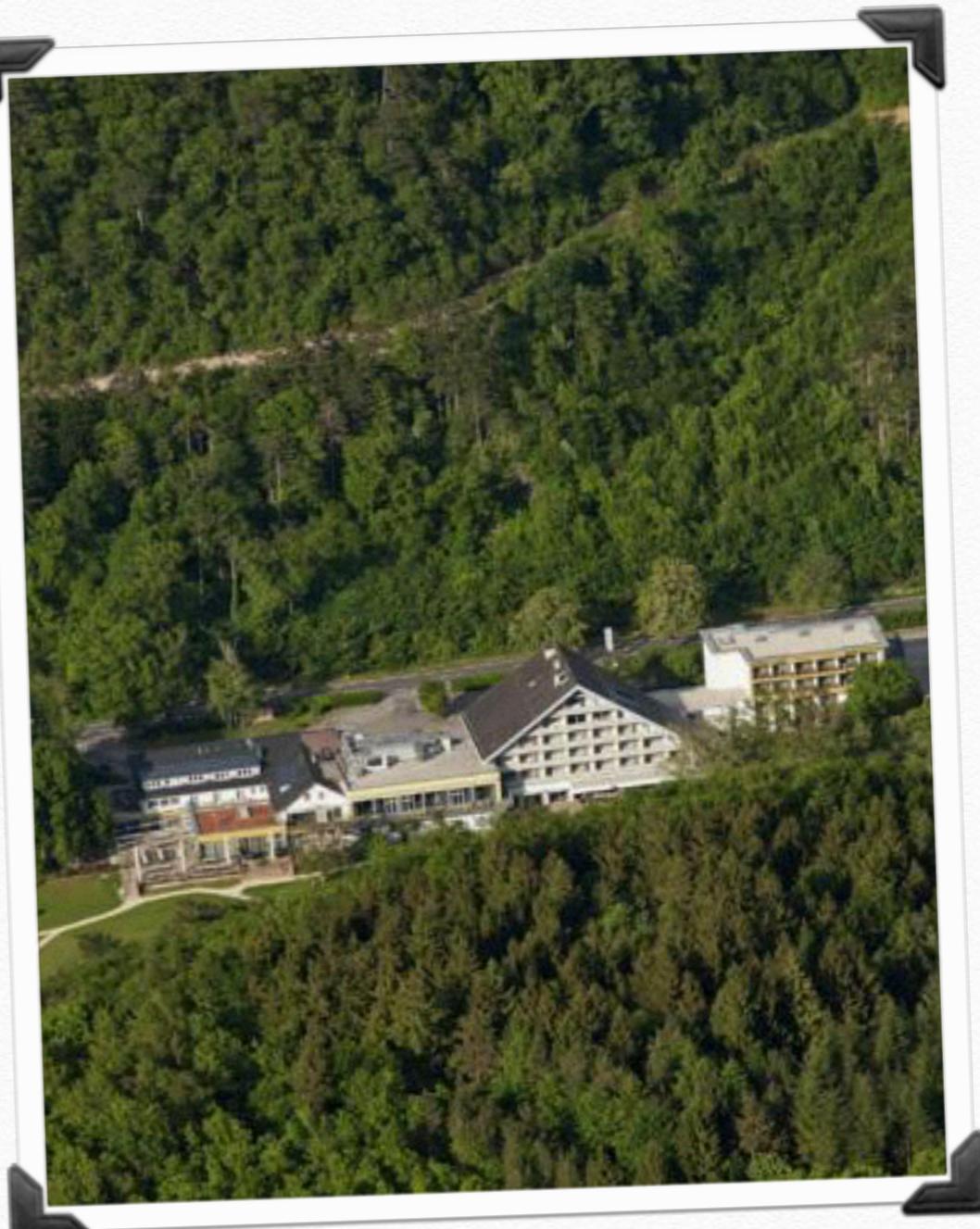
- Brian Randell: "meeting of minds" intended

- "I remember one or two of the theorists—I think Saul Gorn and another one […] —being overheard walking along, I think one with his arm around the other's shoulders […] saying something along the lines of 'Well there's them and there's us.'"

Program
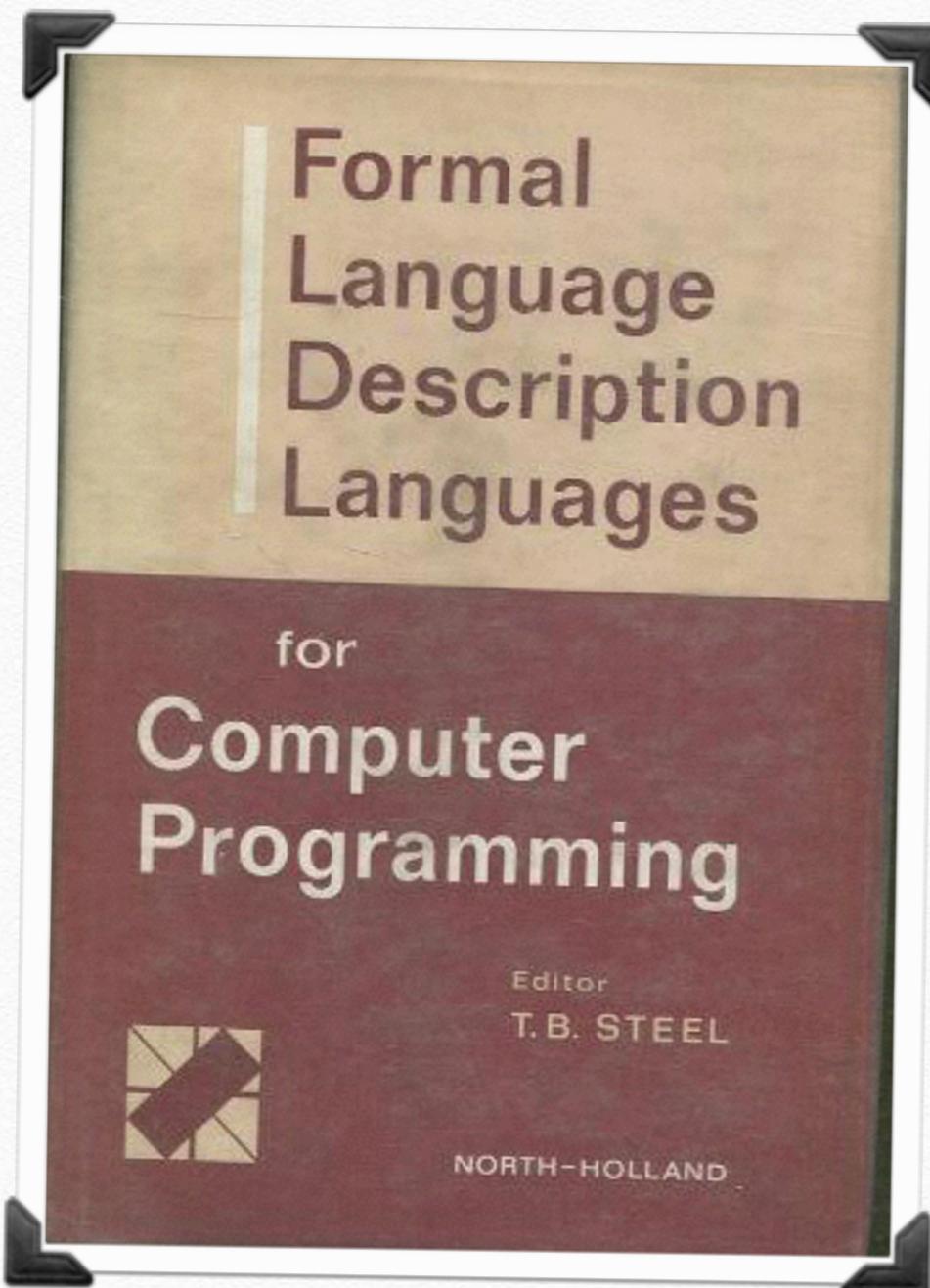
Location

- Baden-bei-Wien, Krainerhütte hotel

- 15th–18th September 1964

- Sandwiched in between WG2.1 meetings

Structure & proceedings

Formal Language Description Languages for Computer Programming

Editor
T.B. STEEL

NORTH-HOLLAND
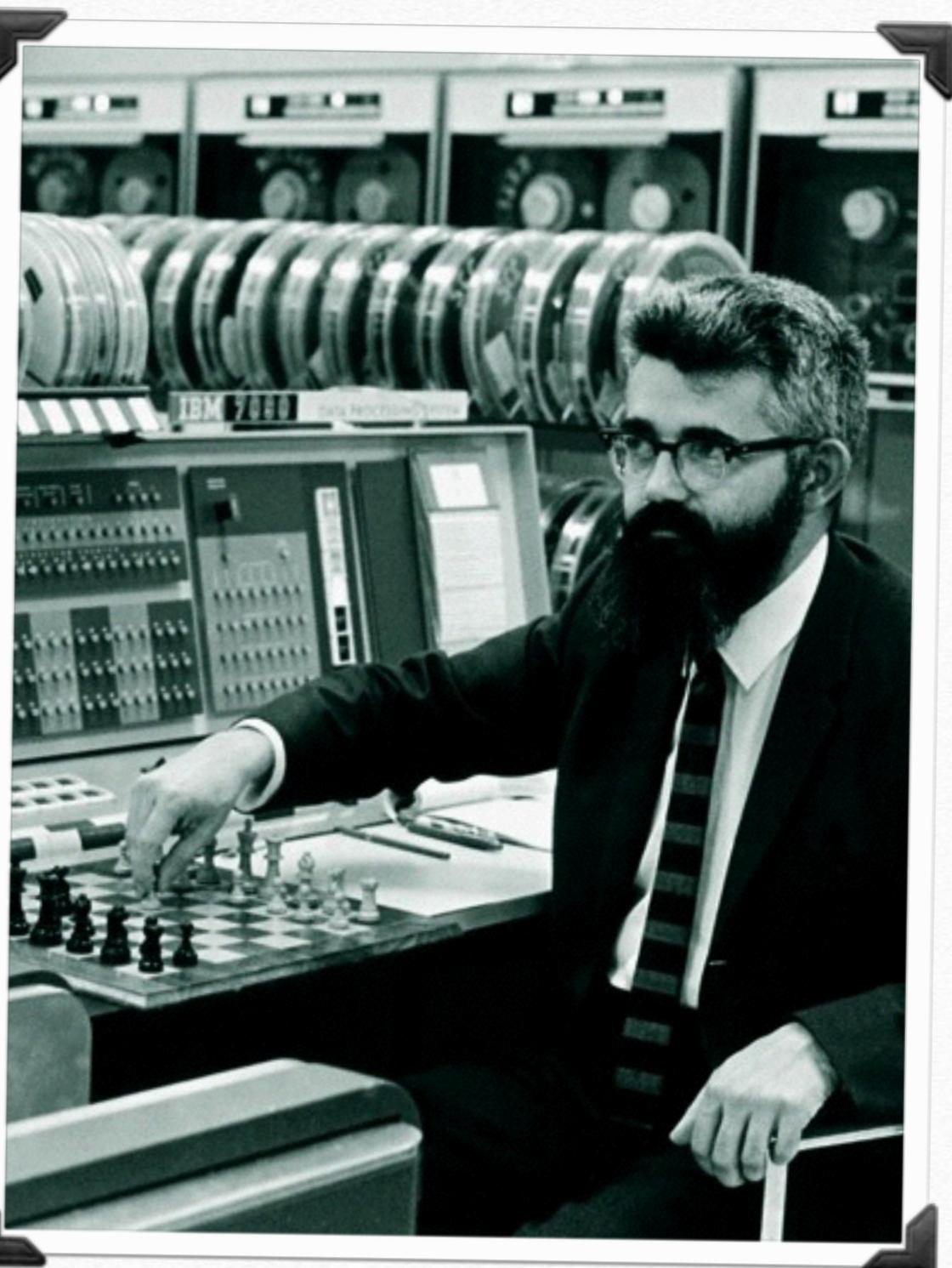
- ❖ Multisession

- ❖ Proceedings edited by Tom Steel include discussions

- ❖ Scientific secretaries

- ❖ Excursions

John McCarthy

- Member of WG2.1

- Previous: LISP, science of computation

- 'A formal description of a subset of ALGOL'

- Introduced abstract syntax & abstract interpretation

- Interesting subset choice; operational semantics

Aadrian van Wijngaarden

- ❖ "Founding father of Dutch computer science"

- ❖ 'Recursive definition of syntax and semantics'

- ❖ Syntactical rewriting approach

- ❖ Transformation of procedures particularly noteworthy

Vienna Lab
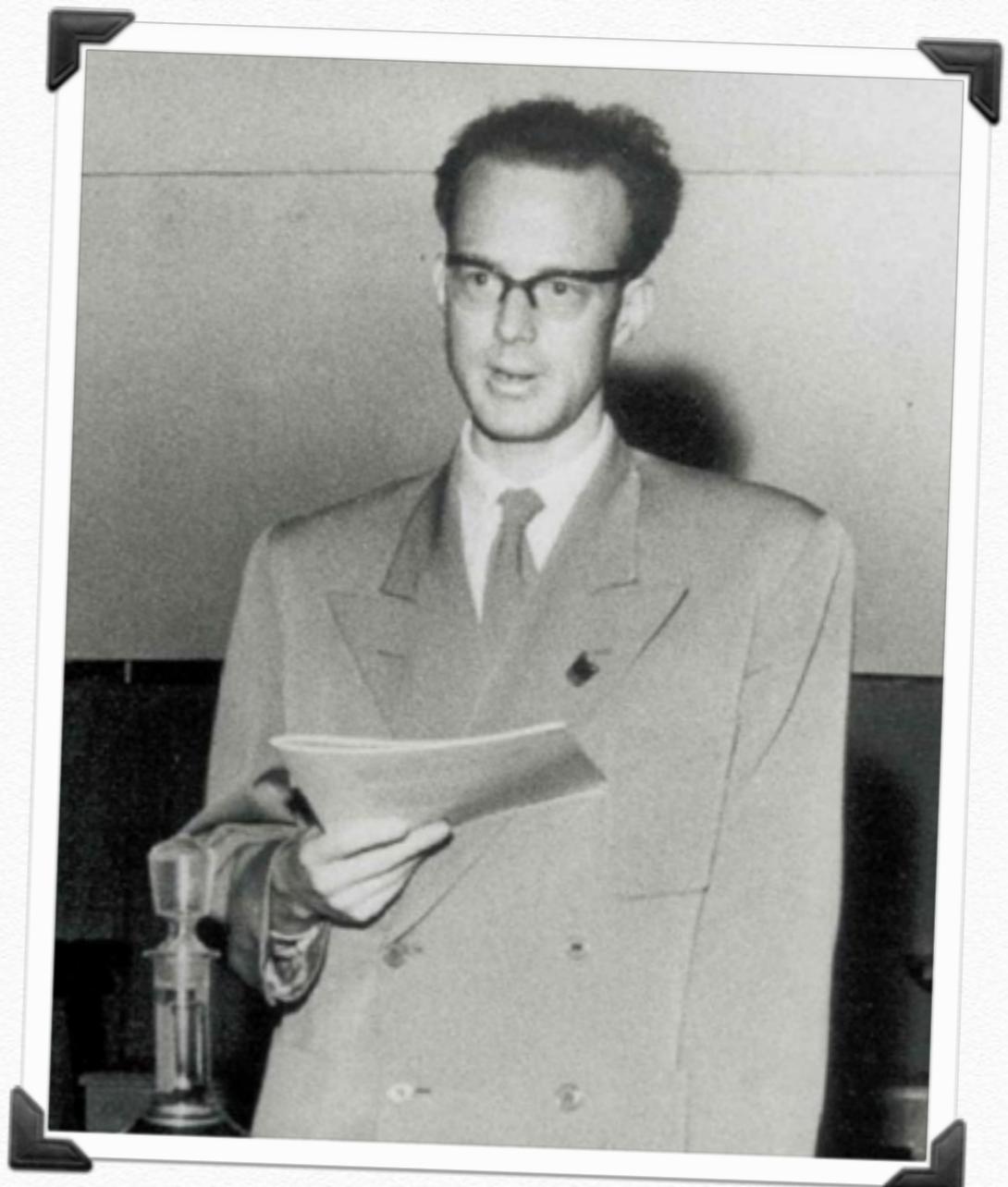
- ✤ Staffing and organising

- ✤ One talk: Kurt Walk 'Entropy and Testability of Context-Free Languages'

- ✤ Conference as a learning experience

Vienna Lab

Tony Hoare

- Present as new member of WG2.1

- No paper, but valuable comment

- "First, we must give a great deal of thought to deciding which things we want to leave imprecisely defined. Second, in any formal or informal description of a language, we must have a mechanism for failing to define things."
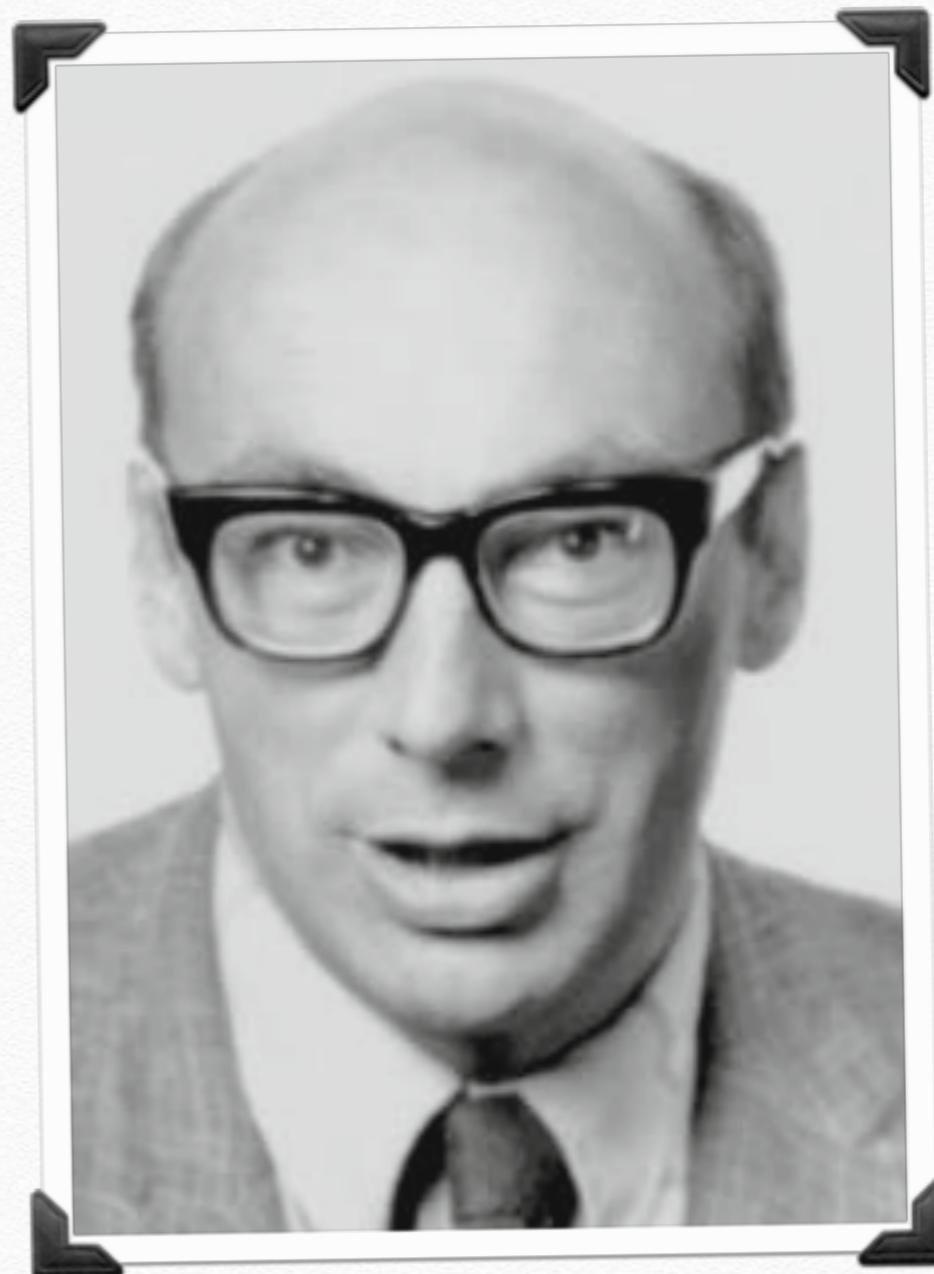
Christopher Strachey

- Computing science pioneer

- 'Towards a formal semantics'

- Early ideas which led to denotational semantics

- Mapping to known domain of functions

Peter Landin

- Working for Strachey's consultancy business

- 'A formal description of ALGOL 60'

- Lambda-based IAEs

- SECD machine

Fraser Duncan

* After-dinner speaker: 'Our ultimate metalanguage'

* Went missing, and was reluctant to speak

* 'Encouraged' to speak: talk was amusing but made a serious point

Aftermath

- WG2.1: Reception somewhat lukewarm! ALGOL 68

- Vienna: PL/I

- Strachey: Denotational semantics

- Hoare: Axiomatic basis

Exegesis

Newcastle University

!

COMPUTING
SCIENCE

An Exegesis of Four Formal Descriptions of
ALGOL 60

Cliff B. Jones, Troy K. Astarte

Thanks

- To supervisors:

    - Cliff Jones, Brian Randell, John Tucker, Martin Campbell-Kelly

- To people who have shared recollections:

    - Peter Mosses, David Beech, Brian Randell, Erich Neuhold, Hermann Maurer, Kurt Walk

- To funders:

    - EPSRC

    - Strata platform grant