Fortran 1957 – 2008 : A Language with a Past, Present and Future

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My Background

1968 - 1984	Industrial research chemist. Started programming in BASIC and Pascal in the late 1970s. Began to to use FORTRAN in the early 1980s.
1985 - 2001	Software developer for Computer Aided Design and Manufacturing systems using Fortran and C.
2003 - 2005	Civil servant in the Department for Work and Pensions.
1993	Joined the British Computer Society
1997 - 2002	Chairman of the BCS Birmingham Branch
2002 - 2008	Chairman of the BCS Fortran Specialist Group

Presentation Outline

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In the Beginning
Fortran Pioneers
IBM Films
Early Developments with example code
Standardisation
Modern Developments with example code
Applications
BCS Fortran Specialist Group

In the Beginning

In the beginning the only practical way to program computers was in machine code, which was extremely tedious. The source code used octal notation.

By the 1950s assembly code had been developed, which was less tedious but still error prone and required a detailed knowledge of the computer hardware.

FORTRAN Conceived

In late 1953, John Backus sent a brief letter to his boss at IBM, asking that he be allowed to search for a "better way" of programming computers, with a project timescale of six months. He got the nod and began the research project that would eventually produce FORTRAN.

As John Backus says in the film, “project completion was always six months away”!

Fortran Pioneers
John Backus' team in the late 1950s

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FORTRAN Delivered

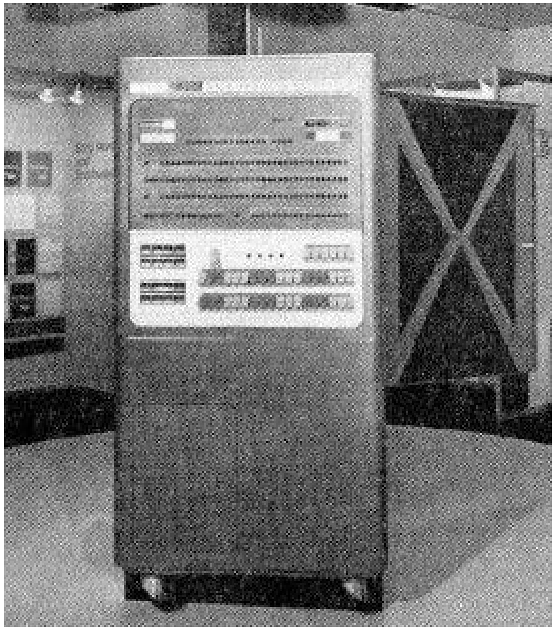
FORTRAN, the first high level programming language, was announced to the computing world by John Backus and his team from IBM at the Western Joint Computer Conference held in Los Angeles, California in February 1957

In mid-April 1957 the first documented delivery of the FORTRAN compiler for the IBM 704 took place to Westinghouse-Bettis for use in nuclear reactor design

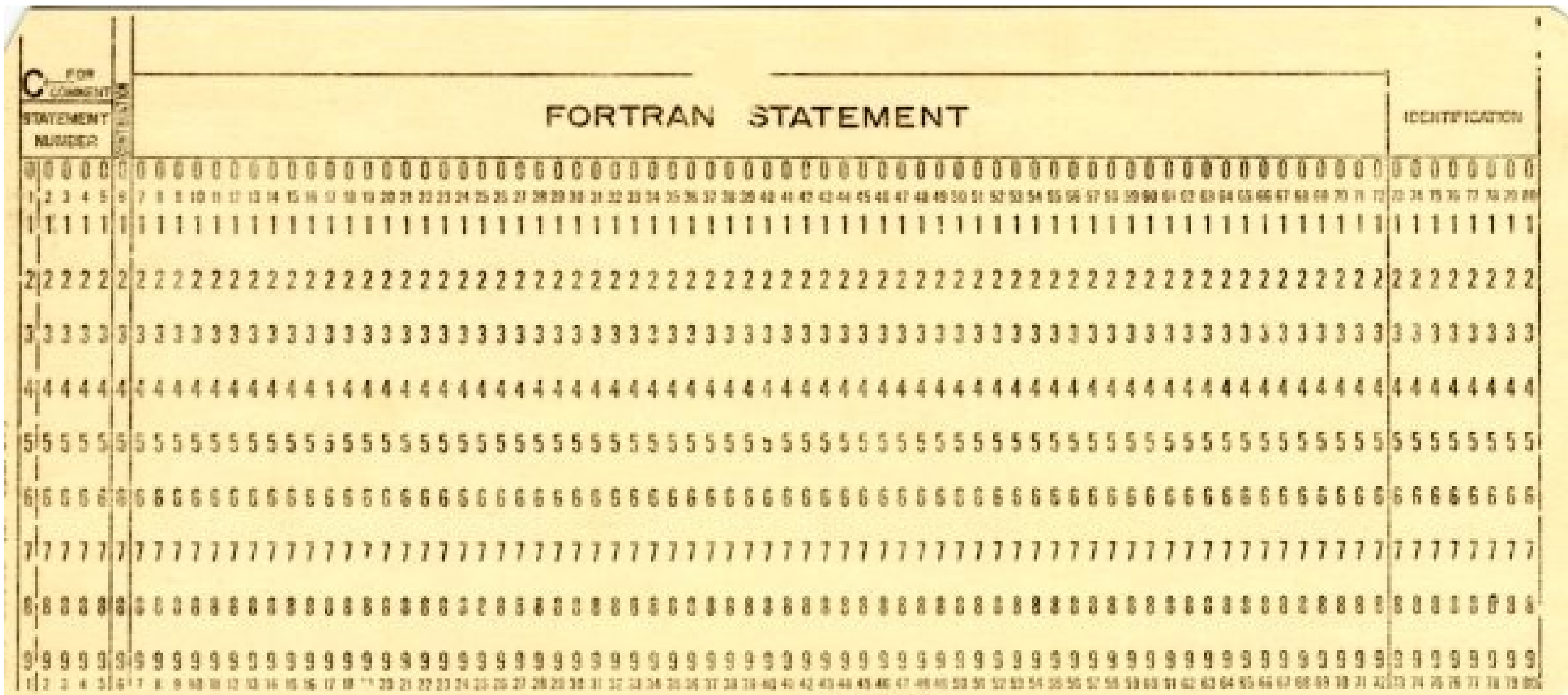
An IBM 704 mainframe

(image courtesy of LLNL)

An IBM 704 CPU from the 1950s



Hollerith 80 column card



Fortran Pioneers
25 years on, June 1982

Pioneer Day, 1982. Standing, from left: John Backus, Sheldon Best, Robert Nelson, Irving Ziller. Seated, from left: Richard Goldberg, Lois Haibt, Roy Nutt.

Pioneer Day Banquet, June 1982

Fortran pioneers gathered for a 25th anniversary banquet in 1982 include, from left, Richard Goldberg, Robert Nelson, Lois Habt, Roy Nutt, Irving Ziller, Sheldon Best, Harlan Herrick, John Backus and Peter Sheridan.

Alex Stepanov, John Backus and Paul McJones, February 2004

A FORTRAN anecdote

Frank Engel of Westinghouse, Pittsburg was concerned about the efficiency of the tape operations with the first FORTRAN compiler. He asked IBM if he could have a copy of the source code. They replied "IBM does not supply source code."

So Frank worked his way through an octal dump of the compiler and optimised the tape operations. The improvement so impressed IBM that they asked for a copy of the code, to which Frank replied "Westinghouse does not supply source code."

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IBM FORTRAN Films, 1958 and 1982

A copy of the 1982 IBM film in Windows Media Video format at 320 x 240 pixels resolution with a file size of 12.8 MB can be downloaded from the FORTRAN pages of the Computer History Museum website,

www.softwarepreservation.org/projects/FORTRAN/video

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Early Developments

1957 FORTRAN I

1958 FORTRAN II

1958 FORTRAN III - Not released to public

1961 FORTRAN IV - A "cleaned up" version of FORTRAN II

1962 First ASA FORTRAN standardization committee meets

Example code - FORTRAN I

```
C        THE TPK ALGORITHM
C        FORTRAN I STYLE
         FUNF(T)=SQRTF(ABSF(T))+5.0*T**3
         DIMENSION A(11)
  1      FORMAT(6F12.4)
         READ 1,A
         DO 10 J=1,11
         I=11-J
         Y=FUNF(A(I+1))
         IF(400.0-Y)4,8,8
  4      PRINT 5,I
  5      FORMAT(I10,10H TOO LARGE)
         GOTO 10
  8      PRINT 9,I,Y
  9      FORMAT(I10,F12.7)
 10      CONTINUE
         STOP 52525
```

Example code - FORTRAN IV or 66

```
C         THE TPK ALGORITHM
C         FORTRAN IV STYLE
          DIMENSION A(11)
          FUN(T) = SQRT(ABS(T)) + 5.)*T**3
          READ (5,1) A
  1       FORMAT(5F10.2)
          DO 10 J = 1, 11
             I = 11 - J
             Y = FUN(A(I+1))
             IF (400.0-Y) 4, 8, 8
  4              WRITE (6,5) I
  5              FORMAT(I10, 10H TOO LARGE)
             GO TO 10
  8              WRITE(6,9) I, Y
                 FORMAT(I10, F12.6)
 10       CONTINUE
          STOP
          END
```

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What FORTRAN 77 did for us

FORTRAN 77 added:

DO loops with a decreasing control variable (index)

Block IF statements - IF ... THEN ... ELSE ... ENDIF

Before F77 there were only IF ... GOTO statements

Pre-testing of DO loops

Before F77 DO loops were always executed at least once, so you had to add an IF ... GOTO before the loop if you wanted the expected behaviour

CHARACTER data type

Before F77 characters were always stored inside INTEGER variables

Apostrophe delimited character string constants – 'Hello'

Main program termination without a STOP statement

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Example code - FORTRAN 77 (1)

```
      PROGRAM TPK
C     THE TPK ALGORITHM
C     FORTRAN 77 STYLE
      REAL A(0:10)
      READ (5,*) A
      DO 10 I = 10, 0, -1
         Y = FUN(A(I))
         IF (Y .LT. 400) THEN
         WRITE(6,9) I,Y
 9       FORMAT(I10. F12.6)
      ELSE
         WRITE (6,5) I
 5    FORMAT(I10,' TOO LARGE')
      ENDIF
10     CONTINUE
       END
```

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Example code - FORTRAN 77 (2)

```
REAL FUNCTION FUN(T)
REAL T
FUN = SQRT(ABS(T)) + 5.0*T**3
END
```

Fortran Standards Revision History

1962	First ASA (later ANSI) standardization committee meets
1966	Publication of ANSI X3.9-1966 (FORTRAN 66) - first programming language standard
1978	Publication of ANSI X3.9-1978 (FORTRAN 77) – also published as ISO 1539:1980 – relatively minor revision
1991	ISO/IEC 1539:1991 (Fortran 90) - major revision
1997	ISO/IEC 1539-1:1997 (Fortran 95) - minor revision
2004	ISO/IEC 1539-1:2004 (Fortran 2003) - major revision
2010	*ISO/IEC 1539-1:2010 (Fortran 2008) – minor revision?*

Modern Developments

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Fortran 90 added:

- Free format source code form (column independent)
- Modern control structures (SELECT CASE & DO WHILE)
- Records/structures - called "Derived Data Types"
- Powerful array notation (array sections, array operators, etc.)
- Dynamic memory allocation
- Operator overloading
- Keyword argument passing
- The INTENT (IN, OUT, INOUT) procedure argument attribute
- Control of numeric precision and range
- Modules - packages containing data and code

Example code - Fortran 90 & 95 (1)

```
  PROGRAM TPK
! The TPK Algorithm
! Fortran 90 style
    IMPLICIT NONE
    INTEGER                     :: I
    REAL                        :: Y
    REAL, DIMENSION(0:10)       :: A
    READ (*,*) A
    DO I = 10, 0, -1            ! Backwards
      Y = FUN(A(I))
      IF ( Y < 400.0 ) THEN
        WRITE(*,*) I, Y
      ELSE
        WRITE(*,*) I, ' Too large'
      END IF
    END DO
```

Example code - Fortran 90 & 95 (2)

```
CONTAINS                          ! Local function
  FUNCTION FUN(T)
    REAL   :: FUN
    REAL, INTENT(IN) :: T
    FUN = SQRT(ABS(T)) + 5.0*T**3
  END FUNCTION FUN
END PROGRAM TPK
```

Example code - F (1)

```
module Functions
public :: fun
contains
  function fun(t) result (r)
    real, intent(in) :: t
    real  :: r
    r = sqrt(abs(t)) + 5.0*t**3
  end function fun
end module Functions

program TPK
!The TPK Algorithm
!F style
```

Example code - F (2)

```
  use Functions
  integer                 :: i
  real                    :: y
  real, dimension(0:10)   :: a
  read *, a
  do i = 10, 0, -1         ! Backwards
    y = fun(a(i))
    if ( y < 400.0 ) then
      print *, i, y
    else
      print *, i, " Too large"
    end if
  end do
end program TPK
```

Fortran 2003

Fortran 2003 added:

- Support for object orientated programming
- Derived type enhancements
- Interoperability with C
- Data manipulation enhancements
- I/O enhancements including stream access
- Procedure pointers
- Support for IEEE 754 exceptions
- Support for international usage
- Enhanced integration with the host operating system including access to command line arguments

Fortran 2008

Fortran 2008 should include

- Coarrays as an extension for parallel processing
- Submodules to reduce compilation cascades
- Enhancements to aid optimisation
- Data enhancements including long integers, maximum array rank increased to 15, available kinds, hyperbolic and other functions
- I/O enhancements including getting unique unit numbers, new edit descriptors
- New BLOCK construct
- Bit manipulation procedures
- Execution of command line commands

Some application areas for Fortran

- Weather forecasting and climate prediction
- Analysis of seismic data for oil and gas exploration
- Financial analysis
- Vehicle crash simulation
- Analysis of data from space probes
- Modelling of nuclear weapons and test ban verification
- Computational fluid dynamics, the “Numerical Wind Tunnel”

NEC SX-8 supercomputer as used by UK Met Office

BCS Fortran Specialist Group

The Group was founded in 1970 with the objectives of:

Forming a focus in the United Kingdom for work concerned with establishing and maintaining FORTRAN standards.

Working in association with national and international standardisation bodies.

The convenor (chairman) of the ISO WG5 committee responsible for the Fortran language is a member of the FSG committee as is the convenor of the BSI (UK) Fortran panel.

For the last few years the Fortran SG has provided financial support to enable several UK representatives to attend ISO meetings abroad.

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Fortran's Fiftieth Birthday - 2007

In 2007 the Fortran SG was involved in a number of events and publications, as listed at

www.fortran.bcs.org/2007/jubileevents.php.

The largest of these was the 'Fifty Years of Fortran' meeting in January organised with the Computer Conservation Society. An audience of almost 60 heard 11 speakers talk about Fortran from the 1950s to the present day and into the future. The next two slides show some of the attendees and speakers.

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'Fifty Years of Fortran' meeting January 2007

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'Fifty Years of Fortran' meeting Roger Johnson, Miles Ellis & Lawrie Schonfelder

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If you want to know more

Modern open source and free Fortran compilers are available from a number of sources as are online tutorials.

The latest information on the next ISO Fortran standard is also available online.

Links to the above and more are available from the Resources page of the Fortran SG website at www.fortran.bcs.org/resources.php.

Acknowledgements

My grateful thanks go to Paul McJones of the Computer History Museum, Mountain View, CA, for providing me with the DVD version of the two IBM films.

Also I must thank my colleagues in the Fortran Specialist Group for their assistance and encouragement during my time as Chairman.