Pioneers in Computer Science - Niklaus Wirth

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1 Personal Life

Niklaus Emil Wirth is Swiss computer scientist. He was born in February 15, 1934 in Winterthur, Switzerland. Wirth’s mother tongue is German and he is only German speaking Turing award winner alive. His father was a teacher of Geography in Winterthur school. Wirth was married twice and he has three children. Currently he is a widower. [1]

Wirth got B.S electronic engineering in 1959 from Swiss Federal Institute of Technology. He then moved to Canada for higher studies and got his master’s degree from Laval University, Quebec, Canada in 1960. Wirth earned his Ph.D. in Electrical Engineering from University of California, Berkeley in 1963. His Ph.D. advisor was Harry Huskey [2]. At the time of writing this report both are alive. Wirth started his professional career as Assistant Professor at Stanford’s newly founded computer science department. He remained in Stanford from 1963 to 1967.

Wirth returned back to Switzerland in 1968 and became professor of Informatics at ETH Zurich. During his stay at ETH Zurich he was most influential for creating computer science department at ETH Zurich. ETH Zurich’s department of computer science is one of the influential computer science department in world. He was also head of ETH Zurich computer science department in 1980s. He is living life of retirement since April 1999 but he still frequently visits his old department. [4]

Gustav Pomberger writes about Wirth’s personality in [11]. He first met Wirth when he got research position in the department. He went to see him and was too afraid to even knock at the door. When they met face to face Wirth forwarded his hand for shaking and this dissipated all the tension. During first meeting he found Wirth a good-natured and friendly gentle man.

Wirth was a very modest man and he never showed his superiority in conversation or attitude. Gustav remember occasions when he was amused by Wirth sense of humor. Wirth was also a keen reader and regularly brought books of literature in discussion and Gustav was always amazed how many different books he had read. During a ceremony Gustav accompanied Wirth it became evident that Wirth was also very found of music. When the orchestra started playing music he immediately recognized it one of Mozart’s not so famous work.

Wirth was regular pipe smoker and never considered himself as a sportsperson but he was in extra ordinary physical health. It was demonstrated when Gustav was challenged for a run in South America in 1987. Gustav lost race to Wirth, who was
15 years senior to him. Wirth was not only fluent in computer languages but he was demonstrated command over spoken languages. German was his mother tongue, he spoke English and also demonstrated skills of Spanish during a trip in Lima, South America.

Unlike other scientists Wirth was very good in manual work. In his home, he had tools for software and hardware and also for engineering and craftsmanship. He enjoyed building model of airplanes and he was also trained in flying from a school in USA.

![Figure 1: Picture of Niklaus Wirth](image)

## 2 Scientific Contributions

Wirth is one of the most influential computer scientist. He developed several programming languages, compilers, operating systems and also worked on development of personal workstation. He is one of few computer scientist who are both comfortable and excellent with software and also with hardware development. He not only designed languages on paper but also implemented them along with their compilers and even operating systems.

Wirth was also chief designer of many programming languages like Euler, ALGOL-W, Pascal, Modula, Modula-2 and PL360. He also participated in design and implementation of Lilith and Oberon operating systems. Wirth is creator of many programming languages and most influential of these language was Pascal.
2.1 ALGOL

Wirth Ph.D. dissertation topic was "A Generalization of ALGOL". He became part of the core team for designing and developing ALGOL programming language. ALGOL team was an elite group of people who have previously shown interest and contribution in development of programming language, compilers or system software. ALGOL group was pioneer in formalizing language syntax.

The most important work done by ALGOL team was creation of ALGOL-60. It defined recursive functions, local variables and code blocks. In 1966 Wirth proposed extension of ALGOL-60 which was based on Euler, a programming language which he developed. The proposal was rejected and ALGOL-68 was developed, which used more complex design and implementation decisions. Wirth resigned from ALGOL project in 1968 and he pursued the proposal which he originally presented in 1966. Wirth along with Tony Hoare published their work independently as ALGOL-W.

2.2 Euler

Euler programming language was designed and developed by Niklaus Wirth and Helmut Weber. It was influenced by ALGOL-60 and had two main purposes. \[8\]

1. Creation of a simple and flexible language as compared to ALGOL.

2. An efficient programming language can be defined in a formal way.

Euler is a dynamically typed programming language and it had procedures which can produce a return value which can vary from one call to another. Since it is dynamically typed language it provided type test and conversion operators. In Euler a list can have data of any type and a list elements can also be of different data types.

2.3 Pascal

Wirth designed Pascal programming language and it was released in 1970. It was named after French mathematician and philosopher Blaise Pascal. The idea behind creation of Pascal was creation of structured and efficient programming language. Pascal was influenced by ALGOL and it has many new features like dynamic variables with pointers, sets and records. It has features which allow programmers to
define complex data structures and creating of complex recursive data structures like trees, graphs etc became easy due to this.

Wirth also developed first compiler for Pascal. At first he tried to build compiler in Fortran but it was not feasible because of complex data structures were not expressed in Fortran. Wirth than made compiler for Pascal in Pascal itself. This technique is called as self-hosting and was first used in Lisp. Self-hosting compiler has ability to recompile itself when it is ported to new environment or new features are added to language itself. A virtual machine was also developed for Pascal to port it to different hardware.

Pascal was adopted by ETH Zurich in 1971 for teaching purposes and many other universities adopted it afterwards. Pascal was used by large number of students as their first programming language. Major break through for Pascal was invention of minicomputers in 1975. Minicomputers had limited resources and Pascal became a natural fit of it because it was very efficient. Pascal is one the most important and influential High level programming language in 1970s.

Pascal was used by in number of very popular software and operating systems. Apple’s Lisa mainly used Pascal as its high level programming language and in early Macintosh due to its resources constraints Pascal was translated to assembly language manually. [5]

2.4 Modula

Modula programming language was developed by Wirth based on Pascal. Advantage of high level languages for developing software is well established. High level programming languages do not care about exact hardware specifications and defines all features at abstract machine level. Process control system and device drivers are usually written in assembly language as the main goal is to use the system with existing hardware and not to worry about future devices. Modula was designed for those systems which mainly uses assembly language.

Programming language to operate these kind of systems should have at least these two characteristics.

1. Communication with different peripheral devices.

2. Multiprogramming i.e. to do more than one task at a time.
Some features of Pascal are removed from Modula to make it lightweight but it has an additional feature called module. A module is a code block which consists of traditional variables, data types or procedure over which programmer have precise control. For using in a process controllers a programming language also have to communicate with other peripheral devices. To communicate with these devices there is need of machine dependent module for every machine or even for different configuration of same machine. Another requirement of this domain is executing of multiple tasks at the same time. Modula overcomes both these problems by providing a block of code called module which can implement this kind of functionality for a specific code block.[9]

2.5 Modula-2

The driving force behind development of Modula-2 was a single programming language for Lilith systems. Lilith is explained more in section 2.6. Modula-2 was used for development of operating system, editors and all other applications of Lilith. It was successor of Wirth earlier programming languages Pascal and Modula. Its syntax was largely like Pascal but it also had features which were developed in Modula. Modula-2 was a multiprogramming procedural language designed for system software development.

The module system was developed as a separate compilation unit. Module structure was used to restrict information where it is only needed. Module system was used for information hiding, the term was first coined by David Parnas and it was implemented in Simula language. New procedures were added which can access hardware information. Modula-2 was developed on a PDP-11 and it was ported to Lilith in three weeks which is a significant software engineering task. Modula-2 was released for public after 1 year in house use.[10]

Modula-2 was quickly adopted by many universities and companies also started to distribute their own versions. Operating system, editors and all other programs for Lilith were developed in Modula-2. It showed that it is not only possible to develop all software for a system but it is also very advantageous[6].
2.6 Lilith

Wirth spent first sabbatical year at Xerox Park, Palo Alto. There he witnessed a new paradigm shift in computing it was development of personal workstations. It was more useful for every one including programmers, system designers and normal computer users. In past there were only a main frames which were shared by everybody but progress in electronics made it cheaper to develop personal computers which everyone can afford.

Wirth believed that in future everyone who had a personal computer would be ahead of others in the field. He came back home after spending one year at Xerox park with a new research project. It was development of a work station called Lilith. Lilith project was not only creation of personal workstation but also a complete ecosystem which included development of operating system, editors and all other utility software for it.

Lilith project was developed in a very short time of three years by a team of 7 dedicated people. It is an amazing software engineering achievement within such a small time. Even today Lilith workstations are used in ETH Zurich, universities and companies. Development and usage of Lilith workstation showed that personal computers is a very cheap and efficient replacement for doing programming, design and normal usage which was only done previously in main frames.

With development of mouse user interface, bitmap screens and high resolution there was need to develop interactive editors which efficiently use these resources. Wirth himself developed a text editor Dina and graphical editor Sil for drawing lines, figures and diagrams.

2.7 Project Oberon

Wirth spent second sabbatical year at Xerox Park in 1984-1985. He got to know about Cedar operating system and it was designed for personal workstations unlike all other OS which were derived from main frames. But like other big software systems it had huge code base, managing and understanding this large code was very difficult. Wirth started working on development of a new Operating System whose code base is easy manage and understand. At start Modula-2 was selected for development but soon it was realized that Modula-2 lacked a crucial component which is i.e type extension.
It was decided to develop a new programming language derived from Modula-2 which includes type extension and some less important features were also stripped off from Modula-2. Project Oberon was creation of operating system but it also developed a programming language. Oberon system had compilers, editors and utility applications written by Wirth.

Late in his career Wirth developed a hardware and software system to control a helicopter in Oberon. Again he showed that high level programming languages can be to develop low level and specialized systems.

3 Academic Honours and Publications

3.1 Honours

Niklaus Wirth was one of the most influential computer scientist. He has been awarded with 10 doctorate degree from universities like University of York, Laval University etc. Like his honorary degrees Wirth has been awarded with a long list of awards. Few of these honors and awards are mentioned below [7]

1. In 1983 Emanuel Piore Prize for his work in Informatics

2. Turing award is the highest achievement which a computer scientist can get. Wirth received it in 1984.


4. Max Petitpierre Prize 1989 in recognition for his scientific achievements which improved Switzerland relations with world

5. Marcel Benoist Prize in 1990 was presented for his work in development of new programming concepts and languages.

6. In 1992 Wirth was selected as member of Swiss Academy of Engineering

7. US Academy of Engineering selected Wirth as their Foreign Associate in 1994

8. In 1997 ACM SIGSOFT awarded Wirth with Outstanding Research Award in Software Engineering
3.2 Publications

Wirth had published many articles and books on programming which are considered classics and they were used for decades as teaching material in different universities. Wirth had written on subjects of programming, algorithms, compiler construction and also on Circuit design. A few of selected books are mentioned in following paragraphs.

Wirth’s first book titled "Systematic Programming: An Introduction" was published in 1973. This book explained structured programming which was an very popular in 1970s and 1980s. It was mostly targeted to people who have mathematical aptitude and want to learn structured programming.

Second book which Wirth wrote was "The Pascal User Manual And Report" which is book which influenced development of many different programming languages. Wirth published "Algorithms + Data structures = Programs" in 1976. In first version of this book example programs were written in Pascal programming language. Later versions of book were published with example programs in Modula-2 and Oberon. Wirth’s book titled "Theory and Techniques of Compiler Construction" is classical book in field of compiler construction.

4 Conclusion

During his professional career Niklaus Wirth designed and developed many different programming languages, compilers, editors, operating systems and even workstations. Very few computer scientists are so comfortable and high level command in both hardware and software systems. Wirth always strived for efficiency and simplicity in his career. He improved compilers for modula-2 even when they were significantly smaller and faster than all other available compilers. He had long lasting effects on language designs and software engineering.
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