Friedrich L. Bauer

Origins and Foundations of Computing

In Cooperation with
Heinz Nixdorf MuseumsForum

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With Editorial Assistance from Norbert Ryska

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Foreword

The Heinz Nixdorf Museum Forum (HNF) is the world's largest computer museum and is dedicated to portraying the past, present and future of information technology.

In the "Year of Informatics 2006" the HNF was particularly keen to examine the history of this still quite young discipline. The short-lived nature of information technologies means that individuals, inventions, devices, institutes and companies "age" more rapidly than in many other specialties. And in the nature of things the group of computer pioneers from the early days is growing smaller all the time.

To supplement a planned new exhibit on "Software and Informatics" at the HNF, the idea arose of recording the history of informatics in an accompanying publication.

My search for suitable sources and authors very quickly came up with the right answer, the very first name in Germany: Friedrich L. Bauer, Professor Emeritus of Mathematics at the TU in Munich, one of the fathers of informatics in Germany and for decades the indefatigable author of the "Historical Notes" column of the journal Informatik Spektrum.

Friedrich L. Bauer was already the author of two works on the history of informatics, published in different decades and in different books. Both of them are notable for their knowledgeable, extremely comprehensive and yet compact style. My obvious course was to motivate this author to amalgamate, supplement and illustrate his previous work.

Only one thing occasionally hindered the otherwise fruitful, almost daily exchange of information between Friedrich L. Bauer and myself – the incompatibility of our two computer systems: a situation that remains irritating even 60 years after the invention of the computer and which will never be entirely resolved.

I heartily thank the publishing houses Springer and Vieweg for permission to use their published material.

For a number of years now the HNF has been editing its publications jointly with the publishing house Schöningh in Paderborn, and my inquiry as to whether it was interested in this publication very promptly received a positive response, for which I sincerely thank Dr. Raimar Zons.

Many thanks to Alfred Wegener for procuring and archiving numerous text and image files. Dr. Jochen Viehoff dealt with the optimization

of numerous images for printing. And many thanks to Marcel Jaspaert for his substantial contribution to laying out the manuscript, for which task he – unwillingly but with his usual alacrity and competence – had to acquaint himself with Donald Knuth's computer typesetting program TEX, to which Professor Bauer remains faithful.

LS Language Services GmbH translated the text with great technical expertise and sensitivity.

I very much hope that this little book – "pauca, sed matura", as Carl Friedrich Gauss would have said – will in future be found on many computer scientists' bookshelves, and particularly on those of computer science and informatics students. No one can claim to have fully mastered his or her own technical discipline without knowledge of its history. Even the originators of the HNF had to begin their design process by directing their attention "back to the roots" in order to attain a vantage point from which they could observe the inception of later developments and evaluate their significance.

A scientific discipline such as informatics possesses numerous roots and is well grounded. But it is only natural to have doubts, to wonder whether, perhaps, one is not merely a sideshoot from some more significant rootstock. This feeling of uncertainty has accompanied informatics since it was established as an academic subject towards the end of the 1960s. Perhaps this "Brief History of Informatics" can also serve to give it more confidence and security.

Like the "Year of Informatics 2006", we hope this book will arouse both curiosity about the field of information technology and interest in current digital developments in our society.

Paderborn
August 2009

Norbert Ryska
Director
Heinz Nixdorf MuseumsForum

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Preamble

> Si daretur vel lingua quaedam exacta (qualem quidam Adamicam vocant) vel saltem genus scripturae vere philosophicae, qua notiones revocarentur ad Alphabetum quoddam cogitatio num humanarum, omnia, quae ex datis ratione assequi, inveniri possent quodam genere calculi, perinde ac resolvuntur problemata arithmetica aut geometrica.
>
> LEIBNIZ, De scientia universali seu calculo philosophico[1]

Informatics is a young science with a very young name. In Germany, the word *Informatik* was first used in this context in 1968 by GERHARD STOLTENBERG (1928–2001), at that time a federal government minister, at the opening of a conference in Berlin[2], not long after *informatique* had been coined[3] in France on 19th January 1968 and subsequently used[4] by the Académie Française. Since then corresponding terms have become common elsewhere in Europe: Dutch *informatika*, Italian *informatica*, Spanish *informatica*, Polish *informatyka*, and Russian информатика. Meanwhile, the English-speaking world generally prefers to avoid it altogether in favor of *computer science*[5], which has a more strongly theoretical connotation. For the purpose of this book we will use the word 'informatics' in its 'European' sense.

Modern informatics is the result of a stormy development over the last 40 years, but many of its roots extend much further back into history. We can say that informatics began when the first attempt was made to mechanize what we call 'intellectual activities'; this was undoubtedly not the work of a single individual. If we really wished to choose a single name, that name would have to be LEIBNIZ (1646–1716), who

[1] Quoted from *Gottfried Wilhelm Leibniz*, by ERICH HOCHSTETTER. In: *Herrn von Leibniz Rechnung mit Null und Eins*, printed privately in 1966 by Siemens AG.

[2] Joint conference of the Technical University of Berlin and the Massachusetts Institute of Technology, opened on 29th July 1968.

[3] *L'informatique: Science du traitement rationnel, notamment par machines automatiques, de l'information considérée comme le support des connaissances humaines et des communications, dans les domaines techniques, économiques et socials* (Académie Française, 1966).

[4] For example by the *Délegation à l' informatique*.

[5] As for instance in the ACM Curriculum 1968.

F.L. Bauer, *Origins and Foundations of Computing*,
DOI 10.1007/978-3-642-02992-9_1,

Fig. 1: Ramon Llull

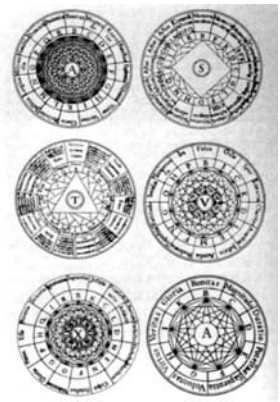

Fig. 2: Logic diagrams

Fig. 3: Athanasius Kircher

qualifies as one of the founders of informatics in a number of ways: his four-species adding machine, his dual system, and, following RAMON LLULL (1235–1315) and ATHANASIUS KIRCHER (1602–1680), the 'concept notation'. In particular, it was Leibniz who introduced the concept of "freeing humanity from the wearisome burden of monotonous mental activity".

The Roots of Informatics

> " ... eine allgemeine Methode, in der alle Wahrheiten der Vernunft auf eine Art Berechnung zurückgeführt sind[6]".
>
> LEIBNIZ, *De arte combinatoria, 1666*

> *"If I were to choose a patron saint for cybernetics out of the history of science, I should have to choose Leibniz."*
>
> NORBERT WIENER, *Cybernetics or Control and Communication in the Animal and the Machine*

Historically, the 'mechanization of allegedly mental activities' is first encountered in a number of extremely special cases: for numerical calculations – using the Arabic decimal digits that have been widely accepted throughout Europe since the beginning of the 16th century – and a number of other algorithmic processes that are nowadays also termed 'calculation', for instance the manipulation of terms formulated using symbols, and simple or compound logical propositions. The essence of informatics is characterised by the comprehensive elaboration of this program, parts of which were even outlined by LEIBNIZ. Questions of encoding belong here, particularly binary code, with cryptology as an interesting fringe area. The elaboration includes complete process automation, which Leibniz did not yet have, which manifests itself as algorithmic thinking and culminates in questions of the syntax and semantics of algorithmic languages.

As an applied science, the historical development of informatics is highly dependent on its technical and engineering realization poten tial, and runs parallel to the development of signaling, (mechanical, electrical and electronic) control engineering, and data storage tech nology – including devices for reading and writing.

Informatics and Mathematics

Informatics is somewhat out of place in the illustrious canon of mathematical disciplines, for two reasons. Firstly, it is extremely young.

[6] ... a generalized method in which all the truths offered by reason are deduced to a kind of calculation.

In 1890 it was unheard-of, and not only by name. The greater part of its development falls into the 20th century, between 1940 and 1990. But this is a good opportunity to give a more detailed account of its relatively unknown early history, which began centuries ago and consolidated itself in the second half of the 19th century. If not entirely, this development is to a considerable extent associated with mathematicians.

And this brings us to the second peculiarity: at its best informatics is a mathematical science, if we may be permitted to use the term. It belongs to mathematics just as much or as little as does theoretical physics or geodesics. Where it differs from mathematics is that mathematics is a purely intellectual science, and this really also ap plies to what is called applied mathematics. Informatics, by contrast, is an engineering science, and this should be taken to include even theoretical informatics.

It is characteristic of mathematicians that they are able to create a purely intellectual, abstract structure. For them, true reality lies only in the mind: images and (plaster) models are permitted 'only' as illustrations, as didactic crutches: one is immediately warned not to let them get the upper hand; they really ought to be unnecessary and are therefore considered not quite respectable.

Typical for computer scientists is the ability to come up with unexpected ideas for the resolution of difficult problems. They are creatively target-oriented, they possess ingenuity, astuteness and inventiveness; their objective is to see a piece of machinery doing useful work; one is immediately warned against purely intellectual speculation such as transfinite induction; bald existence theorems are useless, because they are unproductive, and are therefore frowned upon among computer scientists.

To exaggerate somewhat, and regardless of the derisive laughter that is to be expected from the Boeotians, we can say: 'Mathematics serves to edify man with the fruits of his intellect'. CARL GUSTAV JACOB JACOBI (1804–1851) went so far as to say: "*Die Mathematik dient einzig und vor allem der Ehre des menschlichen Geistes*"[7].

By contrast, the purpose of informatics is to relieve humanity from the burden of monotonous mental activity.

Just because something possesses a number of objectives it does not follow that they are irreconcilable. Naturally there are (more or less) pure mathematicians in this sense, and (more or less) pure computer scientists in that sense, but there is also a *Homo faber* in almost every

[7] The principal and only purpose of mathematics is to honor the human spirit.

mathematician, just as there is a *Homo cogitans* in almost every computer scientist.

Mathematics is the only one of the humanities that can be described as an 'exact' science; it therefore undoubtedly comes closest to that branch of engineering science which deals with intangible, non-physical *ingenium*.

Mathematics and computer science simply are both abstract, are both intangible. And this binds them together, making informatics the sister of mathematics, if not its daughter.

The following discussion will principally consider the development of the core areas of informatics:

- problem-oriented practical informatics ("algorithmic programming"),
- machine-oriented practical informatics ("systems programming") without neglecting the branches,
- theoretical informatics, and
- technical informatics.

This dissertation does not include the field of numerical mathematics, which, in the USA, is considered a branch of computer science. Noted figures that could be mentioned in this context include VERA NIKOLAEVNA FADDEEVA (1906–1981), ALSTON SCOTT HOUSEHOLDER (1904–1993) and WALLACE GIVENS (1910–1993), JAMES HARDY WILKINSON (1918–1986) and GEORGE FORSYTHE (1917–1972), PE-

Fig. 4: Eduard Stiefel

Fig. 5: Olga Taussky-Todd

Fig. 6: From left to right: James Hardy Wilkinson, Wallace Givens, George Forsythe, Alston Scott Householder, Peter Henrici, Friedrich L. Bauer (Gatlinburg Committee)

TER HENRICI (1923–1987), and both EDUARD STIEFEL (1909–1978) and OLGA TAUSSKY-TODD (1906–1995).

Before LEIBNIZ, and for a number of decades afterwards, there were only a few rivulets contributing grains of sand and occasionally gravel to the as yet unstructured informatics. These were quite specific, specialized and still completely isolated tasks aimed at relieving mankind from the burden of monotonous mental activity:

- the mechanization, automation and algorithmization of numeri cal calculations,
- the mechanization and automation of symbolic operations, with the origins of cryptology, logic, security and communications technology,
- process control and the regulation of automatic systems.