THE CONTEST OF FACULTIES

Cybernetics vs. Informatik in German Universities

Wolfgang Coy
Humboldt-Universität zu Berlin, Germany
E-mail: coy@hu-berlin.de

Abstract: The discipline of cybernetics spans a field where information theory, general systems theory, or digital computers could be integrated. In a series of important conferences Norbert Wiener's approach toggled between the idea of a new universal science describing everything from radio receivers to psychology or ethnography and a formal mathematical model for well-defined information processes and control. In consequence cybernetics did not achieve the status of a faculty of its own.

The growing use of data processing equipment demonstrated a need for computer specialists on all levels of education. US-Universities reacted with the introduction of computer science, computer engineering, or information science courses and curricula. Germany followed US-curricula, but copied the name *Informatik* from the 1967 French Academy's definition of *informatique.* The new discipline started successfully 1969 in Germany with federal funding for eighteen university working groups, accelerating the decline of cybernetics.

Key words: Computer Science Curricula; Cybernetics; Informatics

1. INTRODUCTION

1.1 A New Field of Research: Electronic Brains

Alan Turing's epochal paper culminated in universal machines, a notion sometimes over-interpreted. John von Neumann transformed this logical construct into a set of practical guidelines. The von Neumann-architecture still serves as framework for actual computers though von Neumann investigated other concepts like cellular automata and self-reproducing machinery.

Norbert Wiener also thought about digital machinery and universal concepts, but Vannevar Bush, MIT-colleague and presidential advisor, declined Wiener's wartime proposal recognizing its engineering dimensions and directed him to the more promising concept of self-controlling anti-aircraft guns. Basic element of these machines was a "feed-back circuit," a notion not completely new (see fig. 1), but in its simple elegance applicable in many fields beyond anti-aircraft guns.

Figure 1. The Ouroboros, the "tail-devourer", an alchemistic symbol of the feed-back mechanism; here in a 15th century manuscript in Greek language.

Parallel to his wartime technological work, Wiener developed a theoretical approach that he published in 1948 in his text *Cybernetics, or Control and Communication in the Animal and the Machine.* His fresh approach, integrating information theory, general systems theory, and digital computers, was introduced into to a series of Macy-conferences with a number of investigators from very different fields. Wiener's concepts were not very focused at that time. They toggled between the idea of a new universal science describing everything from radio receivers to psychology and ethnography (represented e.g. by Gregory Bateson or Margaret Mead) and a strictly formal mathematical model for well-defined information processes and control. Wiener was not the only protagonist of these new concepts. Bateson (1967) notes: "The ideas were generated in many places: in Vienna by Bertalanffy, in Harvard by Wiener, in Princeton by von

Neumann, in Bell Telephone labs by Shannon, in Cambridge by Craik, and so on. All these separate developments dealt with communicational problems, especially with the problem of what sort of thing is an organized system." Rumors of the strange perspectives of cybernetics reached the general public, very often brought together with the new electronic computers ("giant electronic brains"), but its universal claims generated a certain reserve in academia. There was simply no place in the academic disciplines for such a vague field.

At the same time the growing use of data processing equipment demonstrated a substantial need for computer specialists on all levels of education. US-Universities reacted with the introduction of computer science, computer engineering, or information science courses and curricula, with ACM curricular recommendations starting in 1968. British universities followed and continental Europe introduced academic programming and systems engineering courses. Germany followed US-curricula, but took the name *Informatik* from the French *informatique*. As in other countries, *Informatik* prevented the possible academic career of cybernetics in West Germany, as there was no necessity to start two different but closely related disciplines.

2. CONSTRUCTING A NEW DISCIPLINE

2.1 Scientific Discussions – Political Decisions

It seems that Philippe Dreyfus introduced the name Informatique from the elements Information and Automatique or Éléctronique in 1962. It was used throughout the French press. After even *Le Monde* printed it, the *Académie Française* defined it officially in 1967: *"Science du traitement rationnel, notamment par machines automatiques, de l'information considérée comme le support des connaissances humaines et des communications dans les domaines technique, économique et social."*

This definition shows its peculiarities. Most interesting, it assumes that the newly defined *informatique* is already a science. Its object is the rational treatment of information, especially with automatically working machines (i.e. computers). This science should support human knowledge and skills as well as communication. Applications of that treatment are to be found in technical, economical, and social domains. Clearly this definition looks far beyond programming and use of computers. It embeds hardware and software in a field of applications and connects it with human work and communication.

Many European languages adopted that word, though informatics has been used in the U.K. since 1967 as synonymous to information science. In (West-)Germany *Informatik* made a strange twist: While it uses the French word, it sticks firmly to the American usage of computer science (with elements from computer engineering). Computing machines are seen as the base of the newly formed discipline. Neither problems nor consequences of the rational treatment, i.e. rationalization of work force, nor the communicative aspects of the new technology are themes of the academic discipline. Technical problems and their mathematical foundations form the almost exclusive discourse in *Informatik,* while practical applications, as well as economics and social questions are generally left out. The new discipline started 1969 in Germany with federal funding for eighteen university working groups.

Wolfgang Giloi wrote 1969 in a pamphlet of the Technical University of Berlin: "It was obvious, right from the beginning, that the notion Informatik had to be synonymous with Computer Science, i.e., it should enclose approximately that, what is understood as Computer Science in the U.S.A." This referential definition unveils its recursive wit in the following sentence: "The problem one had to face there, was that in the U.S.A. there is no common and general understanding what this discipline should be."[1]

This non-definition shows clearly that the whole process of introducing the new discipline was not guided by the desire of precise definition. It was instead a matter of sciento-political cooperation between interested researchers who tried to establish an inner circle while excluding unwanted or presumably less important actors. *Informatik* was exactly what the members of the founding committees and the heads of the new departments and chairs did or intended to do. And this was deeply rooted in mathematics and electronic engineering. Important applications like business data processing were left out. The whole definition process of the discipline was much more a social selection than a scientific distinction.

2.2 Politics of Choice and Exclusion

Explicit definitions of the term "Informatik" were rarely given in the first years (perhaps with the notable exception of Heinz Zemanek's paper from 1971), and there was certainly no generally accepted common definition. But there is a common attitude in all definitions of the newly founded discipline: They all draw lines of distinction to the manifold of other emerging or

[1] As an additional note on confusion it should be mentioned that the Technical University of Berlin founded its Computer Science department under the name "Fachbereich Kybernetik."

competing sciences, like cybernetics, semiotics, numerical mathematics and instrumental mathematics, formal logic and theory of computation, control theory, business data processing, operations research, system theory, information theory, coding theory, cryptography, game theory, semi-conductor technology and (micro-) electronics, memory and storage technology, but also process automation, communication theory, and bionics. They were either excluded or thought to play only a marginal role in informatics – perhaps with the exception of formal logic and computation theory. The definition of the discipline was done primarily by exclusion. It seems that there was only one common sciento-political agreement among the founders of informatics, namely to become as independent as possible from the faculties they came from and where they found less resonance and cooperation than expected.

Of course, exclusion and distinction are necessary when something new is constructed. The process was however not driven by the inner necessities of the field, but primarily by political motives without much regard for the external demands, even when these were not unreasonable. Especially the hopes and demands of industry, finance companies and the public sector for academically educated data processing personnel, able to cope with the actual problems of information processing (including knowledge of COBOL and OS/360), were largely ignored in the academic field. As a result academic informatics generated an application gap quite beyond the unavoidable differences between practice and its scientific reflection. This application gap widened when many chairs in the newly founded discipline were given to academically trained mathematicians or engineers. Other fundamental aspects of system design and software construction like the study of organizations, teamwork, working conditions, psychology, economics, or application fields were generally ignored or considered to be less important. As a consequence methodological uncertainties show up wherever mathematical or logical foundations of informatics are insufficient to achieve a task. Though the application gap was recognized by many and often mourned, it is still not bridged.

2.3 Politics First: Cybernetics in East Germany

While the USSR was keen to copy US-successes in science and technology there was also some reserve to enter a common technological framework. This resulted in a series of publications on cybernetics, starting with a paper by Jaroschewskij (1952), denouncing its inhumane nature and the obscure and bourgeois character. About the same time Norbert Wiener (1950) wrote his book *The Human Use of Human Beings,* a pathetic pamphlet for a moderate modernization of production technology, deeply

concerned about the influence of automation on employment and social balances. But his earlier verdict "Information is information, neither matter nor energy. No materialism which does not take this into account can survive the present day", was considered as an open attack to dialectical materialism. In addition his preference of feedback to deterministic cause-effect models and the mere thought of non-deterministic self-organization with possible political implications were additional offences to the Stalinistic understanding of scientific development. But these contrapositions were rarely found in engineering or natural science departments as the power of the new thoughts about control and computation were considered to be promising challenges.

Though this fight against a political philosophy of science may be seen as hard times for all contemporaries, it was only period of less than a decade, ending with the process of de-Stalinization. In 1957 Khinchin's book *Mathematical Foundations of Information Theory* was published and in 1958 a book by I.A. Poletajew *Signal* changed the Russian perception of the field – in parallel to the successful launch of the Sputnik. In 1962 Poletajew's book was translated to German with the more appropriate title *Kybernetik.* But there was also a vivid perception of western literature in the socialist countries – it was more a question of access than an ideology.

The most prominent protagonist for a Marxist interpretation of cybernetics was Georg Klaus, who chaired a research group on logic and epistemology at Humboldt-Universität in East-Berlin. He explained and defended the new cybernetic approaches in a series of books and articles. But even after his interventions the field with its fuzzy borders kept some "ideological haut-gôut" that remained despite the high esteem of its technical virtues in space and military. Under the verdict of demarcation the curricular introduction of *Informatik* was beyond reach in Eastern Germany. Instead *cybernetics* and *automatic control technology* were considered to open roads towards computerized planning and control. For a while, cybernetics was regarded higher in Eastern Germany than in the West, leading to some faculties that took these names.

3. HALF A CENTURY LATER …

3.1 Informatik – Still in a State of Transition

Classification oscillates between submission and omnipotent phantasies, result of the "radical novelty" (Edsger Dijkstra) and the rapid development of the discipline and its underlying technology. It is obvious that the real definition of the discipline *Informatik* was chiefly done by academic

practice, by teaching courses, by teaching manuals, by workshops, conferences, and research journals. It should be noted, however, that it was only occasionally influenced by practical data processing outside academic institutions. As a result *Informatik* is generally considered to be "theory" from the outside, whereas it is in fact the sum of academic practices, in which theoretical aspects are reduced to mathematical foundations.

Ironically, the newly founded German *Informatik*-departments were so successful in excluding suspicious looking and deviant content that they had to start with a bare minimum of lectures. The curricular plan developed by GAMM/NTG, which was adopted by nearly all faculties, filled only 18 hours per week (of a total of 80) in the first two academic years with genuine informational content and only 24 hours (of a total of 72) in the second two years. If the other disciplines would have been more tolerant they could have easily included the new discipline as a specialization.

But after a short warm-up period the discipline made many further distinctions and generated a plethora of new sub-fields. Already in 1985 it was no longer possible for the then more than 20 faculties to agree on a general scheme of practical informatics in the Bundesrepublik as demanded by the federal "Rahmenrichtlinien" (frame of reference). The discipline had entered its adolescence.

After becoming an academic discipline informatics went through a series of paradigmatic shifts. While computers started as automatic calculating devices their recognition changed completely with the advent of smaller and cheaper equipment, especially with PCs. Desktop applications like Wordstar, Dbase, or Visicalc made small computers a tool for office. With the enormous growth of computing power, main memory and auxiliary storage computers became multi-media machines with direct manipulation interfaces. Networked computers are universal media machines, demonstrating that all media, despite differences in origin and use, may be stored, processed, and distributed as binary numbers: An ongoing shift from the Gutenberg Galaxy towards a coming Turing Galaxy.

3.2 Cybernetics, Are You Still There?

Cybernetics underwent other paradigmatic shifts, from feedback loops to Heinz von Foerster's "second order" self-organization. Additional application areas fulfilled Norbert Wiener's prophetical subtitle - *Communication and Control in Animal and Machine* - moving cybernetic ideas into biology and sociology – in Germany under the influence of Niklas Luhmann. But cybernetics never reached the status of a self-contained discipline as it was in the case of computer science or Informatik. As a consequence the field as a whole went into agony. While informatics became

an acceptable answer to a lack of academically educated workers since decades, the proponents of cybernetics hardly found a way to establish a field of study – with exceptions. There are still some magazines and congresses on cybernetics, and there are departments at the University of Magdeburg and the University of Stuttgart, though this faculty is part of the mechanics department, originating from control theory.

Why did cybernetics fail as a general academic endeavour? Probably its proponents aimed too high and too low at the same time, sometimes confusing even friendly supporters. Self-organization as second-order cybernetics is a really complex challenge, certainly beyond our actual technological possibilities and still not in the mainstream of deterministic technical thinking. As a practical approach beyond the laboratory, cybernetics aimed too low. Feed-back loops are a very narrow instrument compared to the plasticity of computer software.

But there is still an open question: Where is a general theoretical framework for computer science as the science of the information age?

REFERENCES AND RELATED LITERATURE

Bateson, Gregory, 1967, Cybernetic Explanation, *American Behavioral Scientist* 10, pp. 29-32.

Bauer, Friedrich L., 1974, Was heißt und was ist Informatik? Merkmale zur Orientierung über eine neue wissenschaftliche Disziplin, in: *IBM Nachrichten* Nr. 223, pp. 333-337

Bauer, Friedrich L., Goos, Gerhard, 1970/71, *Informatik: Eine einführende Übersicht,* 2 Bde., 1. Aufl. Berlin, Heidelberg, New York; 2nd Ed. 1973/74; 3rd Ed. 1982/84; 4th Ed. 1990

Beer, Stafford, 1966, Kybernetik und Mangement, Frankfurt/Main: S.Fischer, 1966 (orig. Cybernetics and Management, London: English Universities Press, 1959)

Brauer, Wilfried; Haake, Wolfhart; Münch, Siegfried, 1973, *Studien- und Forschungsführer Informatik,* Bonn: GMD und Bad Godesberg: DAAD, 2nd Ed. 1974, 3rd Ed. 1978, 4th Ed. 1980

Brauer, Wilfired; Haake, Wolfhart; Münch, Siegfried, 1982, *Studien- und Forschungsführer Informatik,* 1. Aufl. Berlin, Heidelberg, New York, 2. Ed. 1989

Brauer, Wilfried; Münch, Siegfried, 1996, *Studien- und Forschungsführer Informatik,* 3. Ed. Berlin, Heidelberg, New York

Bundesminister für wissenschaftliche Forschung, 1968, Empfehlungen zur Ausbildung auf dem Gebiet der Datenverarbeitung, in: *Internationale Elektronische Rundschau* 8, S.211

Communications of the ACM, 1989, A Debate on Teaching Computer Science, in: *CACM* 32:12, pp. 1397-1414

Coy, Wolfgang; Nake, Frieder; Pflüger, Jörg-Martin; Rolf, Arno; Siefkes, Dirk; Seetzen, Jürgen; Stransfeld, Reinhard. (Hrsg.), 1992, *Sichtweisen der Informatik,* Braunschweig, Wiesbaden: Vieweg

Couffignal, Louis, 1962, *Kybernetsiche Grundbegriffe,* Stuttgart: agis, (french orig. Les Notions des Bases, Paris: Gauthier-Villars)

Denning, Peter J.; Comer, Douglas E.; Gries, David e.a., 1989, Computing as a Discipline, in: *CACM* 32:1, pp. 9-23

Donth, Hans H., 1984, Der Aufbau der Informatik an Deutschen Hochschulen, in: *Elektronische Rechenanlagen* 26:5, pp. 223-228

Friedrich, Jürgen, Harro Schweizer, Eberhard Sens, 1975, *Marxismus und Kybernetik,* Kronberg/Ts.: Scriptor

Foerster, Heinz von (ed.), 1974, *Cybernetics of Cybernetics.* Biological Computer Laboratory, University of Illinois, Urbana, Illinois

GAMM/NTG, Stellungnahme zu den "Empfehlungen zur Ausbildung auf dem Gebiet der Datenverarbeitung" des BMF vom 20.6.1969

Giloi, Wolfgang K., 1970, Was ist Informatik?, in: TUB 2 1, pp. 4-15

Gries, David, 1991, Teaching Calculation and Discrimination: A more Effective Curriculum, in: *Communications of the ACM* 34 3, pp. 44-55

Hartmann, B., 1959, Die elektronische Datenverarbeitung in Lehre und Praxis. Ergebnisse einer Studienreise nach den USA, Berlin, Köln, Frankfurt a. M.

Jaroschewskij, M., 1952, Die Kybernetik – Eine 'neue Wissenschaft' der Obskuranten, *Neue Welt,* (russ. Orig. in Literaturnaja Gazetta, 5.4.1952)

Khinchin, A, 1957, *Mathematical Foundations of Information Theory,* Dover, New York.

Klaus, Georg, 1961, *Kybernetik aus philosophischer Sicht,* Berlin (DDR): Dietz

Klaus, Georg, 1969, *Kybernetik und Erkenntnistheorie,* Berlin (DDR): Deutscher Verlag der Wissenschaften

Klaus, Georg, 1973, *Kybernetik – eine neue Universalphilosophie der Gesellschaft?,* Berlin (DDR): Akademie-Verlag (Series: Zur Kritik der bürgerlichen Ideologie #27; ed. M. Buhr)

Kuhn, Thomas, 1962, *The Structure of Scientific Revolutions,* Chicago: University of Chicago Press

Möhring, Manfred, 1990, *Zur Frühgeschichte der Informatik in der DDR,* in: 1. Ribnitzer Informatikhistorisches Kolloquium (Rostocker Wissenschaftshistorische Manuskripte, H. 19), Universität Rostock, Sektion Geschichte, pp. 18-31

Naur, Peter, 1992, *Computing: A Human Activity,* New York, Reading, Mass.

Nora, Simon; Minc, Alain., 1978, *L'informatisation de la Societé,* Paris

Nygaard, Kristen, 1986, Programming as a social activity, in: Kugler (Hrsg.) *Information Processing '86:* Proceedings of the IFIP 10th World Computer Congress, Dublin, September 1-5, 1986, Amsterdam e.a.

Parnas, David, 1990, Education for Computer Professionals, in: *IEEE Computer* 23:1, pp. 17-22

Pflüger, Jörg-Martin, 1994, Informatik auf der Mauer, in: *Informatik Spektrum* 17:6, pp. 251-257

Pias, Claus (ed.), 2003, *Cybernetics \ Kybernetik, The Macy-Conferences 1946-1953,* Band I, Reprint of the conferences originally edited by Heinz von Foerster 1949-1953, Zürich-Berlin: Diaphanes

Poletajew, I.A., 1964, *Kybernetik,* Berlin (DDR): VEB Deutscher Verlag der Wissenschaften, 1964 (russ. Orig. *Signal,* Moscow 1958)

Scharf, Joachim-Herrmann (Ed.), 1972, Deutsche Akademie der Naturforscher Leopoldina, *Informatik,* Proc. Jahresversammlung vom 14. bis 17. Oktober 1971 zu Halle (Saale), Leipzig

Schinzel, Britta (Ed.), 1996, *Schnittstellen – Zum Verhältnis von Informatik und Gesellschaft,* Braunschweig, Wiesbaden

Steinbuch, Karl, 1963, *Automat und Mensch,* Berlin-Heidelberg e.a.: Springer

Wilhelm, Reinhard.. 1996. *Informatik – Grundlagen, Anwendungen, Perspektiven,* München

Wiener, Norbert, 1948, *Cybernetics, or Control and Communication in the Animal and the Machine.* Paris: Hermann & Cie, Cambridge, Massachusetts: The Technology Press; New York: John Wiley & Sons, Inc.

Wiener, Norbert, 1950, *The Human Use of Human Beings,* Houghton Mifflin, Boston Mass.

Winograd, Terry; Flores, Fernando, 1986, *Understanding Computers and Cognition: a New Foundation for Design,* Norwood, N. J.

Zemanek, Heinz, 1971, Was ist Informatik?, in: *Elektronische Rechenanlagen* 13:4, pp. 157-161

Zemanek, Heinz, 1992, *Das geistige Umfeld der Informationstechnik,* Berlin, Heidelberg, New York: Springer