

Contribution to Börje Langefors' Festschrift, 80 years on March 21, 1995 (pre-print version)
In B. Dahlbom (Ed.), *The infological equation: Essays in honor of Börje Langefors*. Gothenburg: Gothenburg University, Dept. of Informatics, 1995.

A subsystem in the design of informatics: Recalling an archetypal engineer

by Kristo Ivanov

Umeå University, Department of Informatics, S-901 87 UMEÅ (Sweden).

Phone +46 90 166030, Fax +46 90 166550

kivanov@informatik.umu.se

Early memories and academic environment

In 1969 a no longer so young electronic engineer at the age of 31 asked for an appointment with the professor of Administrative Data Processing in Stockholm, Börje Langefors. That engineer is now writing this paper.

I intended to discuss my plan to ask my employer, an international computer manufacturer and seller, for a leave in order to pursue graduate studies and research. My focus was a particular problem I had found at work. The issue was the quality of data inputted and stored in industrial databases for design and manufacturing of computers and peripherals.

My first impression from this first meeting would hold itself stable later throughout the years. It was dominated by the feeling of sympathetic openness and genuine childlike (not to be confused with childish!) ingenuous and ingenious curiosity that I experienced in Börje's attitude. He encouraged me to pursue my plan. That very same year I applied to, and was accepted to become a graduate student at his department, common to both the Stockholm University and the Royal Institute of Technology.

What follows does not claim to be an accurate historical rendering of hard facts, but rather a testimony of how these times can be remembered by a witness and participant in the context of that future which is our own present and our own future. In this sense it is less of a piece of historical research than a piece in the ongoing design of the discipline of informatics. This is also the reason why I limit my references of Börje's work to only three main papers which I still believe are the core of his message. In this way I hope to delineate some of the opportunities and challenges that I experienced in my contact with the man and his work.

At the time there were two main groups of researchers working at the department: one was more technical and "programming" oriented towards what came to be identified as databases and datalogy (computer science), and the other one was more oriented towards systems analysis and systems development (informatics – management information systems).

I soon approached the latter group and shared its academic activities but I always felt like a guest since I was not employed at the department. I was a sort of newcomer and outsider, and I planned to return to my former employer upon the completion of my studies. The main reason for feeling like a guest, however, must have been that I ultimately could not count upon being able to share my detailed research interests with any of the leading researchers in that environment. Perhaps this helped me to stay aloof of the various conflicts and tensions that I gradually learned were prevailing at the department mainly between those who were considered soft social guys and hard machine guys.

This tendency of feeling apart was also compounded by the fact that the local theory building was very helpful in initiating my studies but fell short of supporting my particular dissertation work. The local "THAIS-bible" – Theoretical Analysis of Information Systems (Langefors, 1973) would be dominating the disciplinary teaching in Sweden for many years to come. It offered a way out of sheer programming and computer science. It educated a whole generation of researchers to an understanding of what it could possibly mean to make a science out of the interaction of the computer and its users. Nevertheless it turned out to be insufficient for my purposes. I devoured its extension – System för Företagsstyrning (Langefors, 1968) – with burning hopes. As it was the case of Herbert Simon's work, I felt that the readings were interesting and stimulating but, in some way, they did not reach "further and beyond". In particular, I was not able to formulate my research problem, and I arrived to the point of suspecting that the core of my supposed problem was not "researchable", that it was a "non-problem", not amenable to research.

In any case Börje was always easily available and encouraging on those occasions when I needed a checkpoint and a "nihil obstat". I remember well how Börje reflected upon his System för Företagsstyrning (in English, roughly "Systems for Business Control"). He had departed from, and built upon the idea of applying his information precedence analysis as developed in Thais to the issue of goal analysis. He ended finding out that the issue was much more complicated than he had estimated it to be. What was supposed to be a short essay had turned into a book, and it was still not clear how it all would end up. Much later I would come to guess that Börje was touching upon value-problems that were akin to those attacked in the USA by C. West Churchman¹.

In the meantime Börje was doing a lot of useful pioneering work on the Swedish academic scene. It was a crazy period as all computer ages tend to be. That was the case, however, of facing those hordes of computer programmers who would approach Börje like I had done, but hoping that the Cobol or Fortran programs they had developed at work would be accepted outright as a PhD dissertation. Börje had to struggle writing research reports that explained what he meant by science and by scientific, and that it was not the case that "anything goes". Maybe something like that would be anew needed now, in A.D. 1995! The thing was not made simpler when, in the aftermaths of the 1968's student revolution students began to talk about Marxism and hermeneutics, and other concepts that were new, arcane, and "hermetic" for most computer researchers.

¹ Cf. Churchman (1961; 1968a; 1968b, chaps 11-12).

The senior PhD student's research subsystem

By that time, midway in my PhD studies and struggling to formulate my research problem in detailed scientific terms, I had discovered on a bookshelf in a bookstore C. West Churchman's book *The Systems Approach* (1968). It opened my eyes in discovering how my research question could be formulated and elaborated in a convincing way. By the time I was also discovering for myself that Börje's systems approach was basically "positivist". A couple of my graduate student colleagues was reaching similar insights heading towards phenomenology, ordinary language theory, and critical social theory. A couple of other graduate students also challenged the positivism of the local systems approach. That was done, however on a rather broad ideological polemical basis, with obvious difficulties to relate to the hard facts of natural science and technology including, for instance, the definition of system or of information.

I recall sharing such newly won insights with the leader of a research group in our department, and referring further to logical positivism. He did not seem to have as yet appreciated what positivism in general, and logical positivism in particular, was all about. He answered seriously "I deem myself to be both logical in my thought and positive in my attitude, and I do not feel ashamed of being identified as a logical positivist!" Börje's own attitude was cautious and open. I realized for the first time that he had a high level of professional integrity and civil courage in that he – more than some of his closest people and research leaders – allowed criticism and the expression of different conceptions of research. Yet, he was far from falling into the relativist or nihilist trap of playing the "innocent bystander". He did never approve what we would eventually come to know thirty years later as allegedly postmodern perspectivist "anything goes".

I mention this in order to convey my perception of the level of philosophical and scientific-historical sophistication to be found in the research environment of the time.² Börje, however, knew better about positivism, even if he had not emphasized the issue. By means of the very few references to Herbert Simon and Yehoshua Bar-Hillel in his books it was finally possible for me to definitively identify Börje as heavily influenced

²For us Swedish readers, however, who nowadays feel excessively goody-goody in comparing our own assumed sophistication with the apparent naivety of the unconscious logical positivists of those days I would like to quote an insightful remark by a notable Swedish thinker: "Emellertid behöfver en filosofisk författare i våra dagar, som framträder med en definitiv åsikt, ingalunda vara en profet för att rätt klart kunna förutse sitt arbetes yttre öde. Yngre, lyckligare släkten, hvilka mödolöst insupa ett högre vetande med själfva den moderna kulturluft, som omsveper dem, skola nog frestas att gladeligen slå i vädret de resultat, hvartill en långsam och svår mogning har ledt. Redan åsiktens fasta skick måste bortstöta dem, som älska blott sväfvande, åt alla håll öppna möjligheter. Det är nästan, som om det – visserligen mycket relativa och hofsamma – anspråket på att vara färdig innebure ett attentat mot ungdomens egen framtid. Och de äldre vilja merendels ej veta af något annat än antingen hvad de i yngre dagar emottagit af vördade lärofäder eller hvad de själva anse sig ha åstadkommit. Mot sådana utsikter ämnar jag tillgripa endast en stillsam och enslig *consolatio philosophica*. Men ord har jag inga för det, som ligger bakom mitt verk och som drifvit det fram." (Norström, 1912, p. x)

by the logical positivist or logical empiricist school³. I began to investigate the gap and the bridges to Churchman's systems approach.⁴ This would eventually lead me to explain Börje's earlier mentioned difficulties with the analysis of values. It would also have far reaching implications for my own dissertation and later research.

My own contribution at the time was contained in my dissertation which, by the way, became the first Swedish dissertation in the discipline of administrative data processing – informatics (Ivanov, 1972). It turned out to be a silent but rather subversive complementing of the concept of elementary message of information with an error term "epsilon". The original "atomic" units or terms of an elementary message of information were the object or entity (identifier), the characteristicum (property part composed of variable type and variable value), and the time of measurement (or time during which the object is predicted to hold the characteristic). In the spirit of the Churchman-Singer teleological theory of measurement I supplemented or complemented them with the error term. At the time of writing I had not yet obtained access to Churchman's latest work in order to see how he himself had related that – in the context of the design of information systems (inquiring systems) to the Singerian concept of error⁵. I had myself "reconstructed" that development from what was already implicit in available earlier work.⁶ It was clear to me that error was the missing theoretical link between the concepts of information and of system, as well as the link to political social theory – from Lockean liberal consensus to the intricacies of democracy in its contacts with power, responsibility, and with the "ought" of ethics. Similar insights whose value is barely recognized as of today had been already advanced in the context of economics.⁷

The subversivity which I did not advertise but was clearly spelled out was that the social definition of error required democratic participation. As a matter of fact it required more than democracy if, as it often is the case, democracy is narrowly interpreted in formal or in the well-meaning consensual terms of cooperation, cocreation or coconstruction. It also required more than the political correctness of a partisan attitude⁸ in favor of the poor and the oppressed. I even claimed that participation should be sought in order to enable disagreement or, rather, in order to enable agreement in the context of *maximum possible disagreement*. Why and how I did not turn to Marx, or, for that matter, to Apel-Habermas or to Heidegger, but rather to the humanism of Carl Jung, and later to Judeo-Christian thought, is the object of a later story (see below).

For the moment it should be enough to remark that the possibilities and limits of Börje's approach are related – in my opinion – to the fundamental assumptions of his concept of information and, consequently, of system. His concept of system had subtle but

³For an orientation about what all this is about, see a later publication by Bar-Hillel (Bar-Hillel, 1973), summarizing earlier work including the one which influenced more closely Langefors (Bar-Hillel, & Carnap, 1953).

⁴Some of this bridging would be put forth much later by Hirschheim(1985), when incorporating my earlier studies that followed the dissertation (Ivanov, 1984).

⁵(Churchman, 1971, pp. 201f)

⁶Cf. Churchman (1959; 1961, chap. 5)

⁷(Morgenstern, 1963)

⁸ As the term was launched by Hirschheim & Klein (1989).

enormously important differences from Churchman's conception of the same term.⁹ I would dare, however, to claim that the depth of Börje's intuition was hinted at as early as around year 1970 when he invited David Parnas to talk about software systems. One of Parnas' insightful remarks (free, as in my memory) was that the interface between software modules or subsystems was not constituted only by their reciprocal inputs and outputs but also by the *assumptions* that such modules made about each other. My point is that Börje's research environment both emphasized the importance of the concept of system, and the deepest problems of modularity. Modularity would be popularized, and often trivialized by others in the subsequent wave of structured programming, and, further, in today's software engineering.

Later developments: the infological equation

In the meantime Börje would courageously face the new waves of fashion, and in particular hermeneutics. I believe that his sympathies were stronger for hermeneutics than for Marxist variants proposed by self-appointed defenders of the oppressed working class who often did neither belong to that class nor had ever been employed as workers. Part of the reason for his sympathies may have resided in the vague form of the Marxist criticism with no detailed theoretical implications for anything but primarily the sheer political-social composition of the team that managed the systems development process (labour union participation). Börje's "management information systems" were suspected, if not downright accused, of serving the purposes of management and of capital against the interest of the workers and labour.

In several essays Börje attempted to relate the hermeneutical concepts to his own systems approach. It is possible to claim that he lived the image of the archetypal engineer who never really succeeded in abandoning the logical positivist basis of his archetype¹⁰. There is still the possibility that even not abandoning this basis he made a heroic attempt to expand it. I think that any possible failure in achieving this is not Börje's simple shortcoming, but, rather, a result of an ultimate and inscrutable ambition to relate his theorizing to computer technology. Computer technology may have to be inherently logical positivist to the extent that the computer is a logical mathematical machine or an embodiment of mathematical formal logic seen, as by Gottlob Frege, as a "useful tool for the philosopher"¹¹. The computer, then, becomes ultimately a philosophical tool for thought and its embodied philosophy will condition all related engineering thought. It is a matter of that very same engineering thought that still today lurks in all discussions about informatics. It happens every day whenever somebody dismisses an argument by countering it with the archetypal question "Yes, yes, but what has this to do with computers, and how can I apply it on or with computers?"

⁹The disregard of the far reaching implications of the difference between the various conceptions of system invalidates, by the way, the sweeping criticism of "system schools" advanced by some later Scandinavian authors, who like to oppose them to participatory or design-oriented ones. For a summary of differences between Churchman's and Simon's system designs, see Ulrich (1980) having in mind the closeness between Langefors' and Simon's positivist approaches.

¹⁰I have myself considered the possibility to pursue research on this "technological" issue along the line of, e.g., Frontisi-Ducroux (1975).

¹¹See Ivanov (1989, p. 296) quoting and commenting Frege (1967/1879).

Börje's struggle with hermeneutics in order to renew its theory and meet the new upcoming challenges culminates with an extense paper, published about fifteen years after his main pioneering work (Langefors, 1980). In that paper (p. 22) he established the so called conceptual formula or infological equation

$I = i(D, S, t)$, where

D = data representing the intended information (as an elementary message)

S = the "receiving structure" or pre-knowledge of the user

t = the time available to the user for interpreting the data D

i = the information function.

I think it should be obvious that almost everything in that construction hangs on S, the so called receiving structure or pre-knowledge of the user, which, by the way should be related to the very same structure or knowledge of the data producer. Throughout the paper's discussion references are made to intended approximate synonyms of this receiving structure or pre-knowledge: user view, user view of data, personal world view, basic view vs. application procedure view, personal purposive inclination, view of the world, conceptional framework, background knowledge, semantic background, cognitive view of the world vs. goals views or intentions, problem environment, etc.

It would take me too far in this context to attempt to develop the problems hidden in the use of these difficult and rather obscure concepts which Börje heroically tries to tie down to hermeneutics. For our purposes it should suffice to remark that most of these concepts and the problems around them had motivated Churchman's expansion of information systems into inquiring systems. The intricacies of the relationship between, for instance, world views and Hegelian Weltanschauung, Leibnizian apperception, or Lockean logical positivist "sharing" user views, would require the whole arsenal of Churchman's philosophical and logical-statistical background¹². This is what Börje probably hints at when writing (p. 25) that "the phenomenon of concept formation and change is, of course, a profound psychological phenomenon", and tries to simplify it. It is indeed much more than a psychological phenomenon, depending upon what sort of psychology or psychological theory one has in mind here. Psychology has indeed long been a part of philosophy. Let me point to some core remarks by Börje stating, for instance one common opinion in computer science (p. 23-24, my italics),

An important consequence of the crucial role of the user view...is that all those who are to share some common data must hold the same (basic) view..., at least *approximately*, whereas they may hold distinct application procedure views (corresponding to what is commonly referred to as "user views"). It follows that it is necessary to manage to have all data terms defined in a common, *authorized* information/data dictionary. This dictionary has to be *verified by the relevant user groups*...It will then be necessary to have institutionalized a managerial procedure for how to introduce and authorize new names...to have a well established information management procedure.

And later, in the conclusions (p. 31f),

¹²See Ivanov (1994) attempting to relate these nearly synonyms of such words as Weltanschauung, apperception, view, perspective, and such, by means of a word-index for Churchman's book *The Design of Inquiring Systems*.

The idea of *one* community view, declared by *one* conceptual of infological schema has to be replaced by a system of conceptual (or infological) schemas. One or more of these schemas, infological/conceptual subschemas, may describe such information as has been possible to establish as "community" information. This cannot be decided by the "data base administrator". It must be determined through *learning and negotiation among the relevant users*....There will infological/conceptual subschemas declaring user views that are irreconcilable and that, hence, correspond to non-shareable data....There will be user views that are incompatible, [and]...information systems or data bases will contain "islands" of non-shareable data.

What "approximately" above means in the context of sharing (basic) views, who is to authorize or manage the negotiation process determining which views are irreconcilable, and what to do about them, etc. is the Hegelian-Singerian problem of learning while "personal views change continually" (p. 25). The "approximately" in the context of negotiation stands at the core of the concept of error in my own dissertation on quality control of information and of information systems¹³. For the rest it is a matter of power and responsibility, or politics and ethics, as I have attempted to advance in my later work, covering e.g. the process of "learning and negotiation among the relevant users"¹⁴. Unfortunately, however, this transcends the personal "purposive inclination" found in the archetypal engineering view which programatically avoids profound psychological phenomena (Langefors, 1980, p. 25), or finds certain works to be usually presented in a verbose and entangled prose (p. 28), or, still, aims at a very concrete, engineering type of understanding, and tries to bring the problem within the grasp of infology (p. 29).

In the meantime, while Börje was struggling with the hermeneutical expansion of this view as represented by the infological equation, some of the systems analysis oriented researchers at the department kept the "C" of their project-acronyms while reading "change" instead of the suddenly outmoded earlier "control". Eventually they would drift towards phenomenology and such, but not so far as to touch the hermeneutic intricacies with which Börje had struggled. Others, displaying occasional Marxist inclinations or sympathies, felt they had to leave the department in order to have a chance to tap the financial resources of the labour unions in the beginning era of labour union participation. With the political research support of Kristen Nygård and his work with Norwegian labour unions, analogous efforts were started in Sweden based on the Center for Working Life.¹⁵

¹³(Ivanov, 1972, chaps. 4-5)

¹⁴(Ivanov, 1986; Ivanov, 1993b)

¹⁵This development, with some "heroic-romantic" overtones, is summarized by Ehn (1988). In order to see, for once, the often overemphasized participatory approach in a relaxed context please see Mowshowitz (1986) and Whitaker et al (1991), to be completed by a reading of Mowshowitz's early conceptualization of social research in informatics (1981). The practical – if not theoretical – content of the Scandinavian participatory approach was not new, as I hinted by telling its partisans about an essay up to then unnoticed in Scandinavia (Ackoff, 1970). Its Marxist theoretical content – if not form – ultimately seemed to be superfluous, as indicated by what I perceive as the participatory school's late de-emphasizing of Marxism in favor of so called design theory, eclecticism, and postmodernism.

I claim that the initial effort in the direction that would ultimately become the Swedish twist of so called participatory systems development was, however, inspired by my basic model of participatory systems development¹⁶. I perceive it as having evolved from my own introduction of "Hegelian-Singerian" features that I myself had introduced into the concept of information and information system. In this sense it can be said that Börje's original contribution has kept a running thread down to the latest developments in systems thinking and design. It loses the grip where I myself also lose it, at the passage to so called postmodernism, or, rather its variants.

Open issues

To those who wish to re-evaluate the importance of Börje's work today I would suggest as one main issue a revival of the study of the concept of information, and the bridge between his and West Churchman's concept of information (inquiring) system. It is symptomatic that old knowledge seems to be lost in the "hysteria" about the Internet, the world-wide-web, cybers-space, and whatnot. Those few who dare or muster to criticize the empty technological optimism of the new buzzwords barely succeed in echoing old lessons about drowning in data but missing information, knowledge, and wisdom.¹⁷

For the rest, attention must be paid to the further uses of Börje's work in statistical information systems, where the issues are serious but do not seem to muster the deserved interest in an age of glamorous multimedia and such. I have already attempted

¹⁶See Ivanov (1972, chaps. 4-5, pp. 4.33 ff), the basic model of quality, summarized in later publications (1986, pp. 47ff; 1987a; 1987b), and lately developed into the concept of hypersystems (Forsgren, & Ivanov, 1990; Ivanov, 1993b). The original basic model was adapted by Ehn (1973) and used as the original frame of the model for participation and negotiations based on union involvement in information systems development. This model was, in turn, taken up later by Mathiassen (1982, 2nd ed., p. 137, fig 6.7), where the original link to my work is effaced, probably because of the fact that the reference was dropped in further uses of Ehn's paper, in making more ideologically explicit the "resource" dimension (Ehn, 1988, pp. 271ff, and esp. 316ff; Ehn, & Sandberg, 1979, p. 34, fig. 2.1). The Marxist view saw, for instance, the conditions of production as "objective". I objected, however, that the explication or determination of resources throws us, paradoxically and recursively, into the need of having an "information system" for such a purpose. The recursivity towards "fundamental assumptions" cannot be done away with the help of ideology or secular philosophizing. The concept of quality of information (systems) – as a link to Churchman's and Singer's work – includes also the basic idea of the more consensual co-creative co-constructiveness as it appears in later approaches of constructive systems development at the department of informatics of Umeå university.

¹⁷Ackoff (1967), writing in a tradition close to Churchman and close to Börje's intentions in goal precedence analysis, raises the most pertinent questions that today's young and less young Internet (World-Wide-Web cyber-space) surfers do not or cannot acknowledge. It could be a question of rediscovering the information wheel, or of realizing the nakedness of the information emperor.

to open some paths who hopefully may be object of interest and commitment of young enthusiastic researchers.¹⁸

At the more academic conceptual level it seems interesting to compare emerging working practices in systems design with Börje's original idea of precedence analysis. We could ask ourselves what happened to precedence analysis, after all. Perhaps it is unconsciously done anyway, under other labels like work-flow in reengineering, or cinema-like hypertext sequencing of images, sound and text¹⁹. Such insights could revive the question of the unexplored relation between precedence, causation, and correlation. My hypothesis is that most of this should be subsumed under the concept of production and co-production, and relations between morphological, functional, and teleological classes. (Churchman, 1971, chap. 3). That might include the intricacies of describing "activities" for information systems design *and* job design.

I would also like to point out the issue of values and value measurement as pertaining to Börje's struggle with goals and goals analysis in *System för Företagsstyrning*. That was the original impetus of Churchman's own attempts concerning philosophical issues of a science of values in the context of the early information systems implicit in models of operations analysis²⁰. The challenge as of today is immense if it is to be taken seriously instead of letting it to get submerged in the trivialization of the concern for interactive market-orientation och customer-orientation. I myself have not been able to do more than to help to scratch at the surface, and I deem that my efforts still bear Börje's message about the potentialities and troubles of the systems approach. The challenge in an age of hypermedia is, of course, enormous.²¹

These are only a few hints, without having the ambition that they are the most important. They should, however, show that Börje's questions like those of all creative scientists are living realities and can be reinterpreted in new continuously arising context. In order to avoid the pitfalls of relativism and postmodernism the course of such a series of reinterpretations must, however, be designed, monitored, and, possibly, evaluated.

And, a final word. It is a pity that so many researchers today in the age of postmodern eclecticism and relativism seem to be afraid of disclosing or acknowledging intellectual "fatherhood" and lines of influence.²² I hope that this is not a symptom within the

¹⁸(Ivanov, 1976a; Ivanov, 1976b; Ivanov, 1976c; Ivanov, 1977; Ivanov, 1979). Cf. with the almost simultaneous attempts by Dunn (Dunn, 1974), in sharp contrast with Sundgren's application and developments of Langefors' original framework (Langefors, & Sundgren, 1975).

¹⁹Ivanov (1995) attempts to expand the Churchman-framework in order to encompass the aesthetics and ethics of such contexts.

²⁰(Churchman, 1961).

²¹(Ivanov, 1993a; Ivanov, 1993b; Ivanov, 1995)

²²Cf. Hillman who writes (Bly, Hillman, & Meade, 1993, p. 269), quoted in an essay of mine (Ivanov, 1993a, p. 26n):

The missing father is not your or my personal father. He is the absent father of our culture, the viable senex who provides not daily bread but spirit through meaning and order. The missing father is the dead God who offered a focus for spiritual things. Without this focus, we turn to dreams and oracles, rather than to prayer, code, tradition,

framework of what I have called "Don Juan syndrome", and others have called "pathological narcissism"²³. In any case I wish to state the following. A few people with a high degree of integrity, knowledge, courage, and respect for others, have changed me or rather helped me in my quest to find myself and to direct my life. This was achieved indirectly, thanks to their own decisions and their work: Langefors, Churchman, and Jung, to name the main ones. Thank you, Börje.

References

- Ackoff, R. L. (1967). Management misinformation systems. *Management Science*, 14(4, December), B147-B156.
- Ackoff, R. L. (1970). A black ghetto's research on a university. *Operations Research*, (September-October),
- Bar-Hillel, Y. (1973). *Language and information: Selected essays on their theory and application*. Reading, Mass: Addison-Wesley.
- Bar-Hillel, Y., & Carnap, R. (1953). Semantic information processing. *British J. for the Philosophy of Science*, 4, 147-157.
- Bly, R., Hillman, J., & Meade, M. (Ed.) (1993). *The rag and bone shop of the heart: Poems for men*. New York: Harper Perennial. (Orig. publ. by HarperCollins, 1992.)
- Churchman, C. W. (1959). Why measure? In C. W. Churchman, & P. Ratoosh (Ed.), *Measurement: Definitions and theories* (pp. 83-94). New York: Wiley.
- Churchman, C. W. (1961). *Prediction and optimal decision: Philosophical issues of a science of values*. Englewood Cliffs: Prentice-Hall.
- Churchman, C. W. (1968a). *Challenge to reason*. New York: MacGraw-Hill.
- Churchman, C. W. (1968b). *The systems approach*. New York: Delta. (Page references are to the 2nd ed., 1979.)
- Churchman, C. W. (1971). *The design of inquiring systems: Basic principles of systems and organization*. New York: Basic Books.

and ritual. When mother replaces father, magic substitutes for logos, and son-priests contaminate the puer spirit.

Unable to go backward to revive the dead father of tradition, we go downward into the mothers of the collective unconscious, seeking an all-embracing comprehension. We ask for help in getting through the narrow straits without harm; the son wants invulnerability. Grant us protection, foreknowledge; cherish us. Our prayer is to the night of dream, to a love for understanding, to a little rite or exercise for a moment of wisdom. Above all we want assurance through a vision beforehand that it will all come out all right.

Without the father we lose also that capacity which the Church recognized as "discrimination of the spirits": the ability to know a call when we hear one and to discriminate between the voices...

The mother encourages her son: go ahead, embrace it all. For her, all equals everything. The father's instruction, on the contrary, is all equals nothing – unless the all be precisely discriminated."

²³(Ivanov, 1986), (Kernberg, 1980, part III).

- Dunn, E. S., Jr. (1974). *Social information processing and statistical systems: Change and reform*. New York: Wiley.
- Ehn, P. (1973). *Bidrag till ett kritiskt socialt perspektiv på datorbaserade informationssystem* (TRITA-IBADB-1020). Dept. of Information Processing, University of Stockholm.
- Ehn, P. (1988). *Work-oriented design of computer artifacts. (Doctoral diss.)*. Umeå-Stockholm: University of Umeå, Arbetslivscentrum and Almqvist & Wiksell International.
- Ehn, P., & Sandberg, Å. (1979). *Företagsstyrning och löntagarmakt: Planering, datorer, organisation och fackligt utredningsarbete*. Stockholm: Prisma.
- Forsgren, O., & Ivanov, K. (1990). From hypertext to hypersystem. In R. Trappl (Ed.), *Cybernetics and Systems '90. Proc. of the Tenth European Meeting on Cybernetics and Systems Research, Vienna, April 17-20, 1990* (pp. 275-282). Singapore: World Scientific. (Also as report UMADP-RRIPCS 9.90, University of Umeå, Inst. of Information Processing.)
- Frege, G. (1967/1879). Begriffsschrift: A formula language, modeled upon that of arithmetic, for pure thought. In J. Van Heijenoort (Ed.), *From Frege to Gödel: A source book in mathematical logic*. Cambridge, Mass.: Harvard University Press, 1967. (Originally published, 1879.)
- Frontisi-Ducroux, F. (1975). *Dédale: Mythologie de l'artisan en grèce ancienne*. Paris: François Maspero.
- Hirschheim, R., & Klein, H. K. (1989). Four paradigms of information systems development. *Communications of the ACM*, 32(10), 1199-1216.
- Hirschheim, R. A. (1985). Information systems epistemology: A historical perspective. In E. Mumford et al. (Ed.), *Research methods in information systems*. Amsterdam: North Holland. (Also in R. Galliers (Ed.) *Information systems research: Issues, methods and practical guidelines* (pp. 28-60). Oxford: Blackwell Scientific Publications, 1992.)
- Ivanov, K. (1972). *Quality-control of information: On the concept of accuracy of information in data banks and in management information systems*. The University of Stockholm and The Royal Institute of Technology. (Doctoral diss. Diss. Abstracts Int. 1974, Vol 35A, 3, p. 1611-A. Nat. Techn. Info. Service NTIS No. PB-219297.)
- Ivanov, K. (1976a). *Från statistisk kontroll till kontroll över statistiken: Systemisk redovisning av fel i undersökningar inklusive avvägningar mellan kvalitet och medborgerlig integritet* (Research report No.1976:9, ISSN 0347-2108). University of Stockholm, Dept of Statistics.
- Ivanov, K. (1976b). *Statistik för datorer: Centraliseringen av svensk statistik, konsekvenser av en organisatorisk anpassning till datoriserad statistikproduktion* (Research report No.1976:7, ISSN 0347-2108). University of Stockholm, Dept. of Statistics.
- Ivanov, K. (1976c). *Statistiska informationssystem: Framväxten av en svensk skola om data och information och dess förhållande till en kunskap om sociala informationsprocesser* (Research report No.1976:8, ISSN 0347-2108). University of Stockholm, Dept. of Statistics.

- Ivanov, K. (1977). Datoriserad statistik och statistiska system [Computerized statistics and statistical systems]. *Statistisk Tidskrift*, (5), 377-388. (Summary in English.)
- Ivanov, K. (1979). Datorbaserad social kommunikation: Inskränkt till ett högnivåspråk för programmering av motsägelselösa samhällsbeskrivningar [Computer-based social communication: Reduced to a high-level language for programming of unambiguous descriptions of society]. *Statistisk Tidskrift*, (3), 173-187. (Summary in English, pp.237-238.)
- Ivanov, K. (1984). Systemutveckling och ADB-ämnets utveckling. In G. Goldkuhl (Ed.), *Systemutveckling, av vem, för vem och hur? (Report No. K4/84)*. Stockholm: Arbetskyddsfonden. (Also as report LiU-IDA-R-84-1, University of Linköping, Dept. of Computer and Information Science.)
- Ivanov, K. (1986). *Systemutveckling och rättssäkerhet : Om statsförvaltningens datorisering och de långsiktiga konsekvenserna för enskilda och företag [Systems development and rule of law]*. Stockholm: SAF:s Förlag.
- Ivanov, K. (1987a). Public records and trade-offs. In P. Tuominen (Ed.), *Legal Informatics* (pp. 174 ff). Rovaniemi: The Inst. for Nordic Law at the University of Lapland. (Abstract.)
- Ivanov, K. (1987b). Rule of law in information systems research: The role of ethics in knowledge-building procedures, especially in the updating of inference networks. In P. Järvinen (Ed.), *Proc. of the Tenth Information Systems Research Seminar in Scandinavia, Tampere-Vaskivesi, Aug.10-12 1987*. Tampere: University of Tampere.
- Ivanov, K. (1989). Computer applications and organizational disease. In C. W. Churchman (Ed.), *The well-being of organizations* (pp. 283-312). Salinas, Calif.: Intersystems.
- Ivanov, K. (1993a). *Belief and reason, power and heroism in the task of the systems designer: Commented selections on presuppositions of participatory cooperative argumentative design and change* (UMADP-WPIPCS-47.93.2, ISSN 0282-0587). Umeå University, Inst. of Information Processing. (2nd rev. ed.)
- Ivanov, K. (1993b). Hypersystems: A base for specification of computer-supported self-learning social systems. In C. M. Reigeluth, B. H. Banathy, & J. R. Olson (Ed.), *Comprehensive systems design: A new educational technology* (pp. 381-407). New York: Springer-Verlag. (Also as research report, Umeå University, UMADP-RRIPCS-13.91, ISSN 0282-0579.)
- Ivanov, K. (1994). Inquiring systems as an "ecumenical" research platform in the age of hypermedia. In P. Kerola, A. Juustila, & J. Järvinen (Ed.), *Quality by diversity in information systems research* (pp. 17-32). Oulu: University of Oulu, Dept. of Information Processing. (Proc. of the 17th Information Systems Research Seminar in Scandinavia, Syöte, Finland, 6-9 August 1994. Vol. 1.)
- Ivanov, K. (1995). The search for a theory of hypermedia. *Social contexts of hypermedia and hypermedia in social contexts* (pp. 17-27). Umeå: Umeå University, Dept. of Informatics. (Workshop on Social Contexts of Hypermedia, Umeå, February 17-18, 1995.)
- Kernberg, O. (1980). *Internal world and external reality: Object relations theory applied*. New York: Jason Aronson. (See esp. part III. Swedish trans.: *Inre värld och yttre verklighet: Tillämpad objektrelationsteori*. Stockholm: Natur och Kultur, 1986.)

- Langefors, B. (1968). *System för företagsstyrning [Systems for management control]* . Lund: Studentlitteratur.
- Langefors, B. (1973). *Theoretical analysis of information systems* . Philadelphia: Auerbach. (Originally published, 1966.)
- Langefors, B. (1980). Infological models and information user views. *Information Systems*, 5, 17-32.
- Langefors, B., & Sundgren, B. (1975). *Information systems architecture* . New York: Petrocelli/Charter.
- Mathiassen, L. (1982). *Systemudvikling og systemudviklingsmetode* . Aarhus University, Datalogisk afdeling. (Doctoral diss., DAIMI PB-136, DUE-report No. 5, 2nd ed.)
- Morgenstern, O. (1963). *On the accuracy of economic observations* (2nd ed.). Princeton: Princeton University Press. (1st ed. 1950.)
- Mowshowitz, A. (1981). On approaches to the study of social issues in computing. *Communications of the ACM*, 24(3), 146-155.
- Mowshowitz, A. (1986). Social dimensions of office automation. *Advances in Computers*, 25, 335-404.
- Norström, V. (1912). *Religion och tanke* . Stockholm: Gebers.
- Ulrich, W. (1980). The metaphysics of design: A Simon-Churchman "debate". *Interfaces*, 10(2, April),
- Whitaker, R., Essler, U., & Östberg, O. (1991). *Participatory business modeling* (Research report TULEA 1991:31). Luleå Institute of Technology and Umeå University.