

APPLIED RESEARCH

Empirical research and case studies

(by Kristo Ivanov <http://www.informatik.umu.se/~kivanov/Research.html>)

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Development projects

In the context of a research program in information technology and administrative data processing one main subject for applied research will be the development of software packages of computer programs that embody the ideas of social systems science. The kernel of the applications will not be programming "virtuosism" and the development of new formalisms or new programming languages that often rather belong to the field of "rhetorical mathematics" (Davis, & Hersh, 1986, pp. 57-73). The applications will not emphasize the algorithmic thinking when considered as an intellectual component of computation, but rather modular thinking, and especially systems thinking (ibid., pp. 127-129). Programming will follow the modern trends of assemblage from available building blocks in the sense of e.g. the HYPER technique that is subordinated to the idea of system and system metaphors such as soft systems methodology, information quality, interactivity, co-constructivity and critical systems theory (Checkland, 1981; Forsgren, 1988; Ivanov, 1972; Nilsson, 1987; Ulrich, 1988), as well as system primitives such as objective, measure of performance, client, decision maker, planner, resource, environment, morphological-functional-teleological classes, etc. (Churchman, 1971, chap. 3; Churchman, 1979).

An outline of detailed work that has been done and is to be done (Forsgren, 1989; Ivanov, 1989b) centers on the use of computer support for documentation and update of systems description according to the above metaphors and primitives. The idea is the creation of an interactive computer application that keeps track of the relations between system primitives in the course of the continuous development and redevelopment (maintenance, upgrading) of a particular system intended for certain clients, etc. Instead of leaving the build up of the hyper-network to a purely associationistic (Guthrie, 1942) or connectivistic (Hillis, 1986) learning (Rychlak, 1977; 1981, offers a critical view of the debates on learning theory), the structure or skeleton of the network itself is modeled according to the concept of structure and function, or morphological-functional-teleological classes. The measure of performance in terms of the metaphorical concept of quality of information can be formally structured in terms of particular data structures (Ivanov, 1972, chaps. 4-5; Ivanov, 1987) or mathematical matrixes (Ivanov, 1975, pp.46-49), while a "co-constructor" (Forsgren, 1989) can provide computer support to the above mentioned structure or skeleton of the system. The co-constructor is an embryonic computer application with abilities to encourage critical co-constructive interactions about its future design. It also supports its own redesign using meta-design techniques, at the same time encouraging users (clients, decision makers, and other primitives such as actors, system activists, etc.) to participate in the process of improving such techniques. Critical coconstructive interactions take place where people with different interests are invited to critically examine the existing way of acting, and also to suggest and push for new ways of acting that better fits their interests or, rather, their ethical values.

Opportunities

One main opportunity of the ongoing research is the opportunity to test the social systems theory (Churchman, 1968; 1971; 1979) in a sense that is analog to its testing

by means of "soft systems methodology", SSM, but with the advantage of integrating both computer technology, group communication, and critical social theory in this SSM. A second opportunity is to obtain a marketable product that can be useful for use in business systems design, implementation, and maintenance of computer systems. A third opportunity is the use of the process of research itself as a vehicle for rising by means of computer technology the interest of young graduate students and instructors for social systems science. One might say that in the research project the computer is utilized as a "motorcycle" as a pretext for discussing methodological and philosophical questions with people who would spontaneously eschew such questions (Pirsig, 1974).

Expected problems

Among the practical problems that we foresee in our applied research concerning group communication there are in first place those that can be derived from the theoretical criticism of the thinking of J.Habermas (Ivanov, 1989a, to be integrated in a special work on the subject of "design and creativity", identifies some relevant literature; Thompson, & Held, 1982, esp. H. Ottmann's "Cognitive interests and self-reflection") who is considered by many to be the main modern theoretician of dialogue and communication. Such problems concern mainly the issue of power and ethics in cooperative learning communication, which has not yet been satisfactorily developed. Experiences and theories of learning (Ackoff, 1988; Argyris, Putnam, & McLain-Smith, 1985; Docherty, et al., 1988; Gustavsen, 1985; Löfberg, 1989; Oesterreich, & Volpert, 1986; Revans, 1982; Rychlak, 1977; 1981; Volpert, 1988) have not yet been incorporated in the work. The risks are that, in the worst case, this applied research leads to expensive activity with results that are not evaluable or that can be foreseen already now with the help of common sense or of available theory. If the social systems aspect is lost out of sight during the research, as it easily can in a context where young researchers become fascinated with the "erotic" glamorous aspect of "boy's toys" equipment, the consequences can be disastrous. Such a vision is already suggested in some programs for research that embody high technology and high capital investments with scenarios that would be considered by many as very challenging, offering rewarding creative opportunities (Lee, Cosh, & Migliarese, 1988, includes some relevant examples; Schwartz, 1986, represents an instructive extreme).

A problem that is related to loosing out of sight the systems dimension is the uncritical belief that applied research can start out using as building blocks available software packages as if they were neutral "atoms", and assuming that the consequences of their assemblage depends only upon the way they are interrelated. The antithesis of this position is, of course, that the "tools" themselves in such oversimplified mean-ends chains bear within themselves the presuppositions of what is bound to happen whenever they are used. If this were not so is would not have been necessary that engaged scientists and philosophers down through the last decades envisaged the need and possibility of creating new concepts of logic, mathematics or information (Churchman, 1971; Ivanov, 1972; Rosen, 1985; Rota, 1986). Also from the political left we get the concept of "dead labor" that is crystallized in capital equipment (Solomonides, & Levidow, 1985) and bears within itself the presuppositions of its use. The whole issue is also related to the dream of specialization of knowledge, and of "separability" in systems design (Churchman, 1971).

What is practice and application?

A semantic analysis

Webster's Third New International Dictionary (unabridged) informs us that *empiric* is one who follows an empirical method: one who relies on practical experience. An

(unfortunately) archaic meaning of *empirical* is relying on experience or observation alone, without proper regard for consideration of system, science, and theory; or "being or befitting a quack or charlatan" {sic!}. Empirical means also experiential, observational, factual; capable of being confirmed, verified, or disproved by observation or experiment. *Empiricism* is the practice of emphasizing experience especially of the senses or the practice or method of relying upon observation or induction rather than upon intuition, speculation, deduction, dialectic, or other rationalistic means in the pursuit of knowledge. Empiricism is also the theory {sic!} associated especially with the British philosophers John Locke, George Berkeley, and David Hume that all knowledge originates in experience. Cf. phenomenology, positivism, pragmatism, sensationalism.

Experience is the direct observation of, or participation in events: encountering, undergoing, or living through things in general as they take place in the course of time. It is also the state, extent, duration, or result of being engaged in a particular activity (as a profession) or in affairs generally. It is the sum total of the conscious events that make up the individual life. It may also mean something personally encountered, undergone, or lived through as: a) an event observed or participated in, b) a state of mind that forms a significant part of one's inner religious life and that is sometimes accompanied by intense emotion. Furthermore it can mean something by which one is stimulated or moved. Philosophically, experience means the act or process of perceiving or apprehending, as well as the discriminative reaction or the unconscious response of an organism to events or happenings within its environment. As a verb, experience stands for: to have experience of, meet with, suffer, undergo. It also means to learn by experience, find out, discover. Other meanings are to respond or react discriminatively to (a set of events within the environment): used of an organism. Synonyms are: undergo, sustain, suffer. Experience indicates an actual living through something and coming to know it first hand, rather than through hearsay or report. {In this sense it comes into conceptual conflict with the idea of "cooperative" mutual learning.}

To the extent that *praxis* is not obscurely founded on a non summarizable massive body of ideologically loaded literature it is defined by the dictionary as originating from medieval Latin, further from Sanskrit, something meaning doing, action, from the stem of *prasein*, to pass through, experience, practice, + *sis*; more at *practical*. Cf. action, practice. Praxis means then a) exercise or practice of an art, science, or skill; b) usual or conventional conduct: habit, custom.

Speculation, that was mentioned above as a kind of opposite to empiricism, means the faculty, act or process of intellectual examination of investigation as 1) Reasoning taking the form of prolonged and systematic analysis; 2) Reasoning or theorizing about a matter that transcends experience and does not admit of demonstration; 3) - In Hegelianism - reasoning that apprehends the unity of opposing categories, synthesizes them in a broader comprehension, and constitutes the thinking which explains objects of *experience* by their relation to the absolute personal reason. An (again: unfortunately) archaic meaning of the word is capacity for or exercise of the power of seeing: a) comprehending or mental vision; b) physical vision, the act of viewing, observation {sic!}.

Closely related to speculation, *theory* is defined as originating from words that stand for: to look at, behold, contemplate, consider. It means a belief, policy, or procedure proposed as the basis of action: principle of plan of action {sic!}. It also means the body of generalizations and principles developed in association with practice in a field of activity.

Pragmatism means an emphasis in philosophical thought on the application of ideas or the practical bearings of conceptions and beliefs. More specifically the word refers to an American movement in philosophy founded by C.S. Peirce and W. James and marked by the doctrines that the meaning of conceptions is to be sought in their practical bearings, that the function of thought is as guide to action, and that the truth is preeminently to be tested by the practical consequences of belief.

Practice as transitive verb means to exercise oneself for instruction or improvement or for the acquisition of discipline, proficiency, or dexterity. It also means to do or to perform often, customarily, or habitually: make a practice of, engage regularly. Practice further means to scheme to bring about: plan, plot; to make an effort (as to cause something: try). As an intransitive verb it means to act, to perform an act often or customarily in order to acquire proficiency or skill, to do something habitually.

Synonyms: exercise, drill.

Consequences

In face of the expected problems in applied research it is justified to dwell a while, with the help of the above semantic overview, on the concept of practice and application. A paradoxical but justified question is to ask ourselves what is applied research and how do we know that we are doing really applied research and not just "doing". A preliminary analysis of the above meanings indicates that theory and practice are intimately intertwined and that a good practice must be theoretical as much as a good theory must be practical. Most, if not all of the research proposed in our program should then be termed as practical unless one takes a particular philosophical position and subscribes to the Anglo-Saxon empiricism of Locke, Berkeley and Hume. A particular emphasis on this school of philosophical thought, besides of paradoxically implying an excessive reliance on "philosophical" assumptions, also indicates an emphasis on repetitive, habitual action at the expense of the creative one. Experience means much more than doing or sheer trial and error activism, or, for that matter, political action. Participation or engagement that also mean experience may be stronger in an attitude of theorizing or speculation. Instead of just "observing" this experience implies a willingness to learn to see, learn to observe, and a readiness to test whether one really sees what is to be seen. It is one of the main purposes of our proposed research.

The positivistic and formal views of this matter (Macmurray, Ewing, & Franks, 1938, is just an example), as it may subsumed under other keywords such as action, concreteness, praxis, manual, experimental, done-manufactured, lived, etc., is not very helpful here. The marxistic concept of praxis as well as the phenomenological concept of Lebenswelt paradoxically do not display the necessary concreteness that is expected in a discussion about concreteness itself. The idea of praxis as it was supposed to get implemented in the Chinese culture revolution, with periodic exchange between manual and intellectual work, has since then fallen in disreputation.

Obviously there is something that is not in order with this concept, as it is not so easy to understand except in trivial political terms why, in spite of all modern talk against separation of planning and performance of work, both the Bible (Syrak 38:24ff.) and the Chinese I Ching (in the first hexagram - The Creative) take the trouble to emphasize the legitimacy and value of deepening oneself in only one term of the dyad thought-action, wise man versus worker, wise saint versus hero. It is easy, however, to see that the word "application" itself presupposes that there is something that is going to be applied, and therefore it is what it says, *a thing* in isolation in the sense that its

nature until further motive is not to be discussed and still less be used as a subject in a conversation.

The philosophical doctrine of pragmatism may be helpful here as a background for our starting point in dialectical social systems theory, since it opposes the absolute separation of thought from action, pure from applied science, intuition or revelation from experience or experimental verification, and, finally, private interests from public concerns (Dictionary of the history of ideas: Studies of selected pivotal ideas, 1973, pp.551-553). Common features of components of various pragmatist directions have also been a pluralistic empiricism, a temporalistic view of reality and knowledge, a relativistic or rather contextualistic conception of reality and values, a probabilistic view of physical and social hypotheses (versus a mechanistic view or versus dialectical materialism), and finally a secular democratic individualism. Pragmatism also favors procedural rules for explicating meaning of philosophical and scientific concepts; it also sees thought and knowledge as evolutionary, where reality is transitional, oriented towards the future; finally *it takes a broad philosophical attitude towards the conceptualization of experience.*

Consequently one of the most concrete insights of industrial science in the new technological era has been the understanding that all manufacturing is a manufacturing *up to specification* (Churchman, 1948; Ivanov, 1972; Shewhart, 1939). A submarine that is manufactured and stands up concretely in the dockyard but sinks when navigating in troubled water is not a submarine or is not yet manufactured. Some concrete screws that cannot be sold to a customer or cannot stand a certain mechanical load are rather abstract and "theoretical" screws, while some estranged mathematicians that pass months or centuries developing abstract mathematical theories become very "practical" and applied as soon as they turn out to have supported the development of an atomic bomb. Similarly, if a psychoanalyst or a systems analyst "talks" with his client or customer, it is *just talk*, even if it may affect the customer's fundamental life-decisions the next hour. But if in the meantime their conversation is channeled through a capital intensive computer communication network, and it is sound and video recorded for creating a video "product", then the equipment operators have really been *doing* something. May it be so because of the fact that as it has been remarked in the context of computer aided instruction "Five million dollars per hour is regarded as a modest budget for production of quality film"? (Schwartz, 1986, p. 227.)

To this it should be added that many past and ongoing applications of available computer software are of a rather doubtful concreteness. Replicability is the hallmark of experimental concreteness, but computer runs, even disregarding the ultimate consequences of the use of the results of such runs, cannot be replicated because of obsolescent and ever changing hardware and associated software.

It seems that the ultimate accepted criterium of application understood as successful application is ("international") consensus about profitability in the wide sense of the word. We are thus reminded of the lamentable fact that "verification of the theory depends as much on the cost of trying to apply it as it does on other empirical evidence" (Churchman, 1961, p.331). Those who cannot afford to set up journals and frequent recurring conferences in various corners of the world about narrow interests that appear to be politically neutral and are judged promising by big business or big state will not have the chance of publishing and getting international recognition in the English-speaking universe of consensus. The ultimate criteria of science thus have been established as being political and economical, notwithstanding the contrasting claims of

different schools of political science and economics. Does it matter what one means by democracy or profitability?

Against the background of this sceptical image of applied research it may very well happen that the best applied research is the "philosophical" one, granted that it is the expression of an engaged and good philosophy. A promising vision of future applied research in information technology for administrative data processing will then be the critical review of software packages in use, and promising work that already has been done on this subject (Heim, 1987) certainly deserves to be used as an inspiration in the planning and implementation of future applied research.

Relations to other international research

These applications have a clear connection to applied research going on in other research centers (McWhinney, Greening, & Mitroff, 1988) but there are no known reports of so called concrete work that has advanced further than a primitive prototypical realization of some of the above ideas, unless we relate them to the keywords of group decision making, computer mediated communications, computer supported cooperative work, and conflict resolution - conflict management - crisis management.

Implications for university organization

Today it is taken for granted that the university can function as a research department belonging to a business company. Research is supposed to foster the competitiveness of the industry, the growth of export, and it is supposed to be applied research or at least "directed basic research". Few would claim, however, that it is convenient to equate science and business as little as it is convenient to equate science with politics. It is not justified to believe that a successful career in business is an indication of scientific proficiency as little as it is justified to conclude that a failure in business is an indication of lack of aptitude for scientific work. Whoever happens to insist in equating science and politics would certainly get something to think about if he knew about certain studies of the relation between the two (Boffey, 1975; Hahn, 1971; Ivanov, 1985, see the bibliography at the end; Nisbet, 1971; Rouse, 1987; Schick, 1969; Schlesinger, 1968; Schmidt, 1986), or, in general, if he knew about the history of scientific institutions (Weiss, 1982).

An unnoticed way today towards confusing science as politics is the increase consultative role attributed by the state to universities (Ivanov, 1984; Ivanov, 1985). Lately this seems to have been emphasized in order to avoid the costs of the promises of democratic availability of university education for "everyone", especially those belonging to the working class. Especially in the fashionable field of information technology this may be paradoxically be leading further to the problem of what has been called "the higher capitalism, new men of power, and the academic bourgeoisie" (Nisbet, 1971, chs. 5-7; Scott, 1984).

Implications for university education

One particular problem appearing in the university milieu is related to the motivation and expectations of the students who happen to have been attracted to this institution in view of preparing for a lucrative professional career. The social psychological climate in the computer field is in certain respects characterized by what has been called the "Don Juan syndrome" (Ivanov, 1986). The disregard of theoretical and ethical aspects of the work frees a great amount of psychic energy that is thus invested in empirical and profitable activities. Objections raised by theoreticians are easily countered by paradoxically requesting that they, without comparable financial support, show "empirically" what their theories are good for.

Smart operators in the form of analytically gifted Young Urban Professionals oversell glamorous high tech equipment and related consultancy. Stories that are published about successful Silicon-valley tychoons, the heirs of pioneering whiz kids, (Jobs, 1989; Lammers, 1988; Rheingold, 1985) stimulate the belief in fortunate breakthroughs without the labors of mathematical and engineering education, an analogy to rapid fortunes by means of smart speculations on the stock exchange. It is only natural that this attitude of mind will color the relation between the universities' senior research staff and graduate students, reflecting and supporting, in the context of research education, the enactment of a drama that is analog to that of modern family relations between parents and their children: responsibility without authority, rights without obligations (Collange, 1985). This recalls the need of some kind of cultural criticism to be developed elsewhere.

The fact that certain scientific discoveries like radioactivity were obtained "by chance", however, does not mean that the discoverers were uneducated smart operators. Be as it may be, under present circumstances it is probably necessary to design applied university research with due consideration for this environment if students are going to be attracted to certain important matters in spite of their potential unprofitability (Churchman, 1982, chap. 3, mentions certain aspects of the "success of failure"). Disregarding the unfortunate (or fortunate) difficulties to evaluate results of applied research it is necessary that researchers and grant givers be clear about the legitimate impossibility to guarantee in advance the results of research that by definition is searching for unknown results. The incapacity to clarify this issue may lie at the bottom of the paradox constituted by ethically committed university or "center" researchers that are encouraged to sell part time or integral time their services as consultants only to discover that the university does not offer a genuine research environment, and conclude that they must leave the university in order to set up their own research center or consultancy bureau. A similar paradox arises for researchers employed by well funded consultant firms or agencies of the government who were supposed to be allowed to make research but find out with distress that they are not allowed to do that type of free research that the universities themselves are unable to find funding for.

The struggle for funding versus the integrity of research should certainly prompt further inquiries beyond the optimistic views presented by the few studies of the matter

References

- Ackoff, R. L. (1988). A theory of practice in the social systems sciences. *Systems Research*, 5(3), 241-246.
- Argyris, C., Putnam, R., & McLain-Smith, D. (1985). *Action science*. San Francisco: Jossey-Bass.
- Boffey, P. M. (1975). *The brain bank of America: An inquiry into the politics of science*. New York: McGraw-Hill.
- Checkland, P. B. (1981). *Systems thinking, systems practice*. New York: Wiley.
- Churchman, C. W. (1948). *Theory of experimental inference*. New York: Macmillan.
- Churchman, C. W. (1961). *Prediction and optimal decision: Philosophical issues of a science of values*. Englewood Cliffs: Prentice-Hall.
- Churchman, C. W. (1968). *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.

- Churchman, C. W. (1979). *The systems approach and its enemies*. New York: Basic Books.
- Churchman, C. W. (1982). *Thought and wisdom*. Seaside, CA.: Intersystems.
- Collange, C. (1985). *Moi, ta mère*. Paris: Fayard. (Trans. to Swedish.)
- Davis, P. J., & Hersh, R. (1986). *Descartes' dream: The world according to mathematics*. New York and London: Harcourt Brace Jovanovich, and Penguin Books.
- Dictionary of the history of ideas: Studies of selected pivotal ideas. (1973). . New York: Scribner's. (Wiener, P.P., Editor.)
- Docherty, P., Leymann, H., Berg, A., Caroli, B., Dilschmann, A., Elling, M., Friedrich, P., Hård, L., Ljungström, L., & Löfberg, A. (1988). *Erfarenhetsbildning, kunskapsteknik och arbetets kvalifikationsutveckling i förvaltningen [Experience build-up, knowledge techniques and skill development in public administration]*. Stockholm: Statskontoret – The Swedish Agency for Administrative Development. (Report Dnr 363/88-9. Includes an appendix in English, PLUTO – Development of a KBS support system for handling social assistance, also published as report 1988:54.)
- Forsgren, O. (1988). *Samskapande datortillämpningar [Constructive computer applications]* (Doctoral diss., Report UMADP-RRIPCS-3.88). University of Umeå, Inst. of Information Processing. (In Swedish. Summary in English.)
- Forsgren, O. (1989). The first "co": A prototype of a learning co-constructor. *Proc. of the ISSS Int. Society for the Systems Sciences, 33rd Annual Conference, Edinburgh, Scotland, 2-7 July 1989. Vol. 1* (pp. 92-97).
- Gustavsen, B. (1985). Workplace reform and democratic dialogue. *Economic and Industrial Democracy*, 6(4),
- Guthrie, E. R. (1942). The principle of associative learning. In F. P. Clarke, & M. C. Nahm (Ed.), *Philosophical essays in honor of Edgar Arthur Singer, Jr.* (pp. 100-114). Philadelphia and London: University of Pennsylvania Press and Humphrey Milford Oxford University Press.
- Hahn, R. (1971). *The anatomy of a scientific institution: The Paris Academy of Science 1666-1803*. Berkeley: Univ. of California Press.
- Heim, M. (1987). *Electric language: A philosophical study of word processing*. New Haven and London: Yale University Press.
- Hillis, W. D. (1986). *The connection machine*. Cambridge: The MIT Press.
- 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. (1975). *Projekt, system och effektivitet: Några kalkylproblem och förslag till bättre realisering*. Stockholm: Statskontoret – The Swedish Agency for Administrative Development.
- Ivanov, K. (1984). *Mot ett ingenjörsvetenskapligt universitet: Några tankeställare inför universitetets samarbete med intressenter på data-området* (Report LiU-IDA-R-84-2). University of Linköping, Dept of Computer and Information Science. (Revised excerpt by same author in "Universitetets bidrag till näringslivets och förvaltningens samhällsnytta". In C. Knuthammar, & E. Pålsson (Ed.), *Vetenskap och vett: Till frågan om universitetets roll* (pp. 52-62). Linköping: University of Linköping. (ISBN 91-7372-925-6. With a bibliography of 95 entries - pp. 124-127.)

- Ivanov, K. (1985). Universitetets bidrag till näringslivets och förvaltningens samhällsnytta. In C. Knuthammar, & E. Pålsson (Ed.), *Vetenskap och vett: Till frågan om universitetets roll* (pp. 52-62). Linköping: University of Linköping. (ISBN 91-7372-925-6. With a bibliography of 95 entries - pp. 124-127.)
- 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. (1987). 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. (1989a). Creativity and systems design. In S. Bødker (Ed.), *Proc. of the 12th IRIS Conference - Information Systems Research in Scandinavia, 13-16 August 1989, Skagen, Denmark* (pp. 293-312). Aalborg: Aalborg University, Inst. of Electronic Systems.
- Ivanov, K. (1989b). *HyperChurchman: From hypermedia to hyperdescriptions of social systems* (Lecture and research seminar on March 14, 1989). Umeå University, Inst. of Information Processing.
- Jobs, S. (1989). *Vandringen är målet* . Stockholm: Columna. (Orig. *The journey is the reward*, 1988.)
- Lammers, S. (1988). *De stora programmerarna* . Stockholm: Columna. (Orig. *Programmers at work*. Redmond, Wash.: Microsoft Press, 1986.)
- Lee, R. M., Cosh, A. M., & Migliarese, P., (Eds.). (1988). *Organizational decision support systems* . Amsterdam: North Holland.
- Löfberg, A. (1989). *Kunskapsproduktion och lärande i arbetet* (Research report). University of Stockholm, Pedagogiska Inst.
- Macmurray, J., Ewing, A. C., & Franks, O. S. (1938). Symposium: What is action? *Action, perception and measurement* (pp. 69-120). London: Harrison and Sons.
- McWhinney, W., Greening, T., & Mitroff, I. (1988). *Four levels of nuclear reality* (Unpublished manuscript). University of Southern California, Graduate School of Business.
- Nilsson, K. (1987). *Project description: Design of interactive information systems* (Report UMADP-RRIPCS-5.87, ISSN 0282-0579). Inst. for Information Processing, University of Umeå, Inst. of Information Processing.
- Nisbet, R. (1971). *The degradation of the academic dogma. The university in America, 1945-1970* . London: Heineman.
- Oesterreich, R., & Volpert, W. (1986). Task analysis for work design on the basis of action regulation theory. *Economic and Industrial Democracy*, 7, 503-527.
- Pirsig, R. (1974). *Zen and the art of motorcycle maintenance* . New York: Bantam Books.
- Revens, R. W. (1982). *The origins and growth of action learning* . Lund: Studentlitteratur.
- Rheingold, H. (1985). *Tools for thought: The people and the ideas behind the next computer revolution* . New York: Simon & Schuster.
- Rosen, R. (1985). Organisms as causal systems which are not mechanisms: An essay into the nature of complexity. In R. Rosen (Ed.), *Theoretical biology and complexity* . New York: Academic Press.

- Rota, G. C. (1986). Husserl and the reform of logic. In M. Kac, G. C. Rota, & J. Schwartz T. (Ed.), *Discrete thoughts: Essays on mathematics, science, and philosophy* (pp. 167-173). Boston: Birkhäuser. (Orig. published 1975.)
- Rouse, J. (1987). *Knowledge and power: Towards a political philosophy of science*. Ithaca & London: Cornell University Press.
- Rychlak, J. F. (1977). *The psychology of rigorous humanism*. New York: Wiley.
- Rychlak, J. F. (1981). Logical learning theory: Propositions, corollaries, and research evidence. *J. of Personality and Social Psychology*, 40(4), 731-749.
- Schick, A. (1969). Systems politics and systems budgeting. *Public Administration Review*, (March-April), 137-151.
- Schlesinger, J. (1968). Systems analysis and the political process. *J. of Law and Economics*, 2(2, October), 281-298.
- Schmidt, L. H. (1986). *Vetandets politik*. Gothenburgh: Symposion.
- Schwartz, J. T. (1986). Computer-aided instruction. In M. Kac, G. C. Rota, & J. Schwartz T. (Ed.), *Discrete thoughts: Essays on mathematics, science, and philosophy* (pp. 207-230). Boston: Birkhäuser. (Originally published 1983.)
- Scott, P. (1984). *The crisis of the university*. London: Croom Helm.
- Shewhart, W. A. (1939). *Statistical method from the viewpoint of quality control*. Washington, D.C.: The Graduate School, Dept of Agriculture.
- Solomonides, T., & Levidow, L. (Ed.) (1985). *Compulsive technology: Computers as culture*. London: Free Association Books:
- Thompson, J. B., & Held, D., (Eds.). (1982). *Habermas: Critical debates*. London: Macmillan.
- Ulrich, W. (1988). Systems thinking, systems practice, and practical philosophy: A program of research. *Systems Practice*, 1(2), 137-163.
- Volpert, W. (1988). *What working and learning conditions are conducive to human development?* (Research report presented at the Swedish-German workshop on the humanization of working life, Stockholm, December 1988). Institut für Humanwissenschaft, TU Berlin, Ernst-Reuter Platz 7, D-1000 Berlin 10.
- Weiss, J. H. (1982). *The making of technological man: The social origins of French engineering education*. Cambridge: MIT Press.