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LOGIC AND PSYCHO-LOGIC: A LOGICAL-PSYCHOLOGICAL PERSPECTIVE OF COMPUTER SUPPORT

Introduction: some interfaces

This is the first step in a research subprogram, and it is cast in the form of a "reader".

A proper use of logic in computer and information science requires some knowledge about the place or function of such logic in the context of inquiry (Churchman, 1971, chap.2). Knowledge about details and requirements of logical professionalism, whatever "profession" might mean in the context of human inquiry, implies also an understanding of the present status and use of the discipline (Copi, 1979; Hamilton, 1978; Mendelson, 1987; Sterling, & Shapiro, 1986). It implies also a detailed knowledge of its history both as a discipline as such (Blanché, 1973; Guttenplan, 1986; Kneale, & Kneale, 1965, with a non-philosophical account; Makovelski, 1978; Scholz, 1983; Stjazkin, 1980), and in its philosophical context (Haack, 1978; Leibniz, 1973; Mugnai, 1973; Schaff, 1962; Vasa, 1983). Such kind of study should conveniently be prepared by means of a reading about logic in encyclopedias (see below).

The main purpose of such an inquiry is to understand: 1) what is *legitimate* to do with the help or support of logic, and 2) which are the relations ("interfaces") of logic with other established areas of knowledge such as language in order to profit of the insights that have been obtained in particular disciplines. Since linguistics, as a late Anglo-Saxon expression of earlier philology, often does not seem to be considered to be an obvious part of philosophy, it may be convenient to study in greater detail the points of contact between philosophy, logic and language.(Aarsleff, 1982; Bar-Hillel, 1973, as used by Langefors; Bausani, 1974; Johnson-Laird, 1983; Kühnert, 1913; Langefors, 1973; Morris, 1971; Rorty, 1967; Whorf, 1956). Encyclopedias could also be consulted (Bausani, 1974; International language, 1967; International language, 1973; Universal languages, 1911). The same kind of study should be dedicated to the contact between logic and psychology (Doyle, 1982, as an unconscious rebirth of psychologistic-logicistic issues in today's AI; Feldman, & Toulmin, 1976, especially considered as a critique of "cognitive science"; Macnamara, 1986; Norström, 1912; Nyman, 1917; Psychologism, 1967). We have also the contact between logic and the social and human sciences in general, and sociology in particular (Ackoff, & Emery, 1972, esp. pp.248-264, and chap.15; Elster, 1978; Freedle, 1975; Freedle, 1978; Mitroff, 1974; Mitroff, & Mason, 1982; Vasa, 1983), including more "dialectical" approaches (Datan, & Reese, 1977; Ilyenkov, 1977; Riegel, 1979; Rychlak, 1976a; Rychlak, 1977).

The historically most noted problematic aspects of the legitimate use of logic seem to be those which concern its relations to mathematics. Such relations are also expressed by the fact that electronic digital computers were from the beginning often

considered more as *mathematical* machines than as symbol manipulators or logical machines. The most straightforward way to approach these matters appears to be the consultation of encyclopedias which contain overviews of logic including the history of logic (Logic, 1911; Logic, 1967; Logic, 1974; Logic Machines, 1967; Systems, 1967). It will probably be soon experienced that the range and depth of problems which are met in the course of such an inquiry are overpowering and distressing taxing to its utmost our, often superficial, confidence in the nature of logical-mathematical rationality. It is, however, important that such problems be recognized in order: 1)To put in evidence the heavy responsibility of those who finance and, generally encourage the use of logical-mathematical machines or computers with the motivation that they not only are expected to increase profits but also represent some kind of higher rationality in the implementation of human affairs, and 2) To raise the question on whether our present research in computer and information science is really structured in a reasonable "economic" way to the extent that it requires such an effort in order to get rationally evaluated and directed.

In order to contribute to the second point above, the research that is proposed here will use logic and some of its particular modern problems as an entrance door into a realm which can be appropriately denominated as *psychology of science,* or of the scientist. Psychology of science, departing from historical attempts which are practically unknown in our contexts of computer-mediated fascination with positivism (Butler, 1926; Ducassé, 1939a, as examples of empirical studies besides the work of philosophers-psychologists like I. Kant; Ducassé, 1939b; Dumas, 1905) is well represented today in areas which are close to our own studies of software and organizational systems design (Mahoney, 1979, with a review; Mitroff, 1974). Such studies could be completed with special emphasis on logic considered as a tool-support for the individual's and the social group's search for knowledge. An overview of these problems in the theory and application of logic (Churchman, 1971; Haack, 1978; Ivanov, 1980; Ivanov, 1983a; Ivanov, 1983b; Mozes, 1989; Myhill, 1952; Peirce, (Hartshorne, & Weiss, 1932-1933; Schiller, 1912; Veatch, 1969; Veatch, 1952) would then be detailed with particular reference to mathematical logic and symbolisms which support the development and use of computer hardware and software (Nilsson, 1987, with comments on this in the context of a project on interactive information systems). Examples of detailed studies are, for instance, attempts to demarcate the field of application of logic (Kaufmann, 1940; Kneale, 1956,in a rather different research tradition), considerations on the problem of *time* in logic, reappearing today in the context of data base theory, (Prior, 1957, esp. "tenses and truth in the history of logic", pp. 104-122), the "if-then" concepts, which stand at the base of most computer programming and expert systems, (Geach, 1981, pp.194-198; Peirce, et al., 1932-1933, Vol. 3, pp.279ff.is a "classic" approach; Quine, 1982, pp.21-26; Sargent, Horwitz, Wallerstein, & Appelbaum, 1968, esp. pp.20ff and 36ff), or, more generally, the fundaments and presuppositions of data base approaches such as relational algebra (McKinsey, 1940). The proposed kinds of treatment of logic for problem solving should be contrasted with the modern more instrumental view of application of logic in computer science (Kowalski, 1979a; Kowalski, 1979b) and earlier views (Gorn, 1964; Korfhage, 1964).

One issue of particular importance in the context of computer science is a detailed knowledge of the problems and debates concerning symbolisms, formal systems and axiomatics. Such knowledge may start from more general overviews of these special fields (Blanché, 1962, from which, however, the English translation has

symptomatically deleted the first two out of the five original chapters which deal with the axiomatic method in science and the philosophical import of axiomatics; Cajori, 1929, vol.1, p.431f, cf. vol. 2, pp. 281ff.; Systems, 1967).

Another particular issue leads the research attention in the direction of what, today, would be considered as an isolated problem of perception or cognitive psychology having importance for research on graphic computer representation: it is the relation between logic, "experimental logic" and geometry (Jager-Adams, 1984, concerning the irreconciliability of logic and thought, and compare with the fundamental empirical findings of Piaget's psychology; Nyman, 1928; Nyman, 1959). It is indeed tempting to regard such research as belonging to some subfield of psychology and such a policy may be welcomed by logicians who fear psychology and by psychologists who fear pure logic or hope to reap the rich financing available in the computer field. The issue, however, is much broader than that, and it is unclear whether such psychology can be differentiated from the discipline of logic as such or, for that matter, the disciplines of computer and information science. In logic, nowadays, this appears to be seldom acknowledged. As late as in 1934, however, it was still possible to find texts of modern logic which, at least in their introductory chapters, gave to students and other readers a chance of knowing that such demarcation problems exist or, at least, existed (Cohen, & Nagel, 1962,esp. chap.1 §5-6, and chap. 9 §3, pp. 16-23, 181-187).

Some roots of the logical AI-issue

It is not agreed today, especially in the context of discussions on *applied* logic which corresponds to the *application* of computers, that the above issues have been settled. They are certainly very much alive in the modern work of the heirs of American pragmatism and empirical idealism (Churchman, 1971) who, of course, continue the polemic in the original works of those schools of thought (Peirce, et al., 1932-1933, chap.1, §3; Schiller, 1912) and of other traditions (Frege, 1956). Some historical aspects of the oppositions to "psychologism" during this century (Braithwaite, Russell, & Waismann, 1938) may throw some light on why psychological aspects of applied logic are still banned today in the context of research on computer applications (Toulmin, 1977, presents some courageous discussions).

As a bridge to psycho-logical considerations it is possible to utilize here a quotation from C.S.Peirce in his polemic against the psychologism of his time (Peirce, et al., 1932-1933, vol.2, pp.27, 36, my emphasis. Cf. also pp.31-32 concerning issues related to what nowadays passes as artificial intelligence, as well as vol. 3, p.266-287):

> It is J.S.Mill [in his work *Examination of Hamilton,* chap.21] who insists that how we *ought* to think can be ascertained in no other way than by reflection upon those psychological laws which teach us how we *must needs* think. But here we have to distinguish the case in which *compulsion* attaches to that *subconscious* thought over which we have no control, and the case in which it attaches to *conscious* reasoning. In the former case, there is no room for logical criticism at all. But because there is nothing to be said against our thinking in a certain way, in subconscious thought, when we cannot do otherwise, it does not, at all, follow that we ought to think in that way when we have our choice between several ways of thinking. If, however, Mill refers to compulsion attaching to conscious thought, what he no doubt has in mind is, that a person ought to think in the way he would be compelled to think, if he duly reflected, and made his thoughts clear, and brought his whole knowledge to bear. But ...logic is not obliged even so much as to suppose that there is consciousness.... The essence of rationality lies in the fact that the rational being *will* act so as to attain certain ends. Prevent his doing so

> in one way, and he will act in some utterly different way which will produce the same result. Rationality is being governed by final causes. Consciousness, the feeling of the passing instant, has, as such, no room for rationality. The notion that logic is in any way concerned with it is a fallacy closely allied to hedonism in ethics.

Peirce goes on (vol.2, pp.31-32) developing the idea of truth as independent from the conscious subject. These thoughts, then, have a clear ressonance in the work of early logicists (Frege, 1956, pp.307-308) as in later debates (Jourdain, 1917; Rignano, 1913a; Rignano, 1913b; Rignano, 1913c; Rignano, 1915a; Rignano, 1915b; Rignano, 1915c), in philosophically more ambitious textbooks of logic (Cohen, et al., 1962, pp.16-23, 181-187), and in more superficial speculations about AI and so called cognitive science (Doyle, 1982; Haugeland, 1981; Hofstadter, & Dennett, 1981; Turing, 1963) especially in what concerns the idea of truth being independent of the who-subject represented by conscience, and therefore easily thought to be embodied in an objective computer. The basic idea seems to be that truth is independent of any subject, thought or conscience (consciousness), even if these are necessary in order to apprehend it. Ultimately the same basic issues stand at the core of the unending sterile debate in AI regarding the question of whether machines can think and may be regarded as having, in any sense, an own consciousness which would affect their status as "automatic" versus "supporting" tools (Peirce, et al., 1932-1933, pp.31-32 contains some surprisingly modern "AI" discussions). The matter has more than "academic" interest since it has implications for the controllability of the alleged truths which arrived at by means of computer supported thought processes. Peirce's approach has the merit of exposing the depth-psychological ("subconscious") and the ethical content of the misunderstanding about the legitimacy and applicability of a rational logic that has the advantage, compared to modern computer logic, of requiring a heavy teleological final element.

Control of logical results

A proper research about confidence and controllability of results which are obtained in logical computer applications can then follow different paths. One path is a social intersubjective approach which extends logic into a social logic in the spirit of Hegelian and pragmatist approaches (Ackoff, et al., 1972, esp. the appendix; Churchman, 1971; Elster, 1978; Freedle, 1975; Freedle, 1978) which eventually may also suggest a passage from a psychology of science to a sociology of knowledge (Knowledge, 1977; Mannheim, 1952; Smith, 1984, adduces Mannheim).

Another path is according to the hermeneutical tradition (Bleicher, 1980; Fisher, 1987, and other contributors to the same thematic issue of the journal Argumentation, in close contact with disciplinary logic; Jonsson, 1982, and other contributors to the same book of proceedings from a symposium on hermeneutics; Palmer, 1969) This tradition has so far not been developed in the specific direction of computer logic (Langefors, 1980, is, however, an early attempt). Hermeneutics may indeed be seen as basic for user oriented systems development in its aspects of communication-cooperation, and interpretation of user needs which today tend to be drowned in the fashionable term "knowledge engineering". In general, computer and information science are close to hermeneutics to the extent that the latter was early recognized to belong to the same class of method-discliplines as statistics (Meitzen, 1891).

Work-oriented design of computer tools (Ehn, 1988), quality-oriented constructive computer applications (Forsgren, 1988; Forsgren, Ivanov, & Nordström, 1988; Ivanov, 1972; Ivanov, 1987a; Ivanov, 1987b), and cooperative design, esp. Scandinavian approaches that are by now well summarized and incorporated in available

literature (Sørgaard, 1988) can also be considered as more or less conscious attempts to launch alternative forms of social logic with more or (often) less capacity to bridge theoretically the gaps between the social world of the computer user and the logical aspects of software engineering. A problem met by some of the Scandinavian approaches (Sørgaard, 1988, summarizes them) is their reliance on eclectic material which evades common historical or philosophical understanding, like for instance the "transaction cost" school with possibly positivistic roots (Williamson, 1970; Williamson, 1975) running counter to unrecognized systems theoretical difficulties (Churchman, 1961, chap.13, suggests some of them).

One further path of evaluation of "logicality" is the expressely psychological one which takes into serious consideration what, as we saw (Peirce, et al., 1932-1933), was called *subconscious,* and *compulsion* (and "resistance" in modern psychoanalytic language) as related to consciousness and ethics. Besides works by some mathematicians on the psychology of mathematics (Hadamard, 1954, pp. 27n, 29, where the creative unconscious is taken in some consideration; Polya, 1957) the issue has been noted in works which, as mentioned earlier, would nowadays be characterized as belonging to the psychology of science, relatively apart from logic or mathematics as such (Butler, 1926; Dumas, 1905; Mahoney, 1979), to the psychology of learning mathematics (Skemp, 1986) or to the psychology of symbol manipulation or rather symbol games (Bergler, 1958; Fine, 1956; Fine, 1973; Halliday, & Fuller, 1974; Turkle, 1984), with some relation to the earlier ideas of cognitive "economy of thought" (Jourdain, 1917; Rignano, 1913a; Rignano, 1913b; Rignano, 1913c; Rignano, 1915a; Rignano, 1915b; Rignano, 1915c). It might also turn possible to enlarge the concept of "cognitive styles" which has lately been applied in research on computer use, in order to include the childlike playfulness of the child archetype "puer aeternus" (Hillman, 1971; Hillman, 1979; Jung, 1953-1979a, CW 9:1), the "compulsive-resistant" behavior and particular types of "computer personality" close to analog types which already have been defined in the field of psychology (Akhtar, & Thomson, 1982; Ivanov, 1983a, pp.23f.; Kernberg, 1975; Lifton, 1971; Shapiro, 1965, esp. the paranoid style, pp.78-79). Such types in part correspond to more loosely formulated descriptions in management literature, in essays of cultural criticism and fiction literature (Calvino, 1988, pp.117-123 on "multiplicity"; Hodges, 1983, pp.238, 485, 520-522, 540; Ivanov, 1986, p.135 on the "don Juán syndrome"; Musil, 1952, chap.17, 37, 61, 62, 89; Persson, 1976, pp.84f; Persson, 1987, pp.24, 90f, 105; Turkle, 1984, pp.196ff.; Weizenbaum, 1976, chap.4 about "the compulsive programmer"; Wilson, 1988, pp.222ff).

A psychological view of logic and mathematics.is obviously implicit in certain fiction literature. Interesting possibilities are offered by works which arrive to the point of attempting an integration of mathematical-logical thinking with socio-political, and even ethical-religious matters in the tradition of cultural criticism (Hesse, 1978; Musil, 1952; Musil, 1978, as noted by Zellini, 1980, 1985, 1988; Rényi, 1973).

The phenomenological-existentialist tradition can also offer an entrance door to the question of psychologically compulsive behavior in relation to will and to the subconscious-unconscious. This is so to the extent that psychological inquiry was historically included in philosophy, and the phenomenological-existentialist tradition arised in the middle of the polemics about psychologism vs. logicism. (Barrett, 1978, in closer relation to technology; Heidegger, 1978; Husserl, 1970; Husserl, 1983; Smith, 1982; Smith, & Mulligan, 1982). There are phenomenological approaches more specifically oriented towards computer science today (Boland, 1979; Boland, & Hirschheim, 1987; Dreyfus, & Dreyfus, 1985; Winograd, 1987; Winograd, & Flores,

1986). In spite of some interest for phenomenological-existentialist thinking in Scandinavia today (prof. H.-E. Nissen in Lund, S.Carlsson in Karlstad; G. Goldkuhl in Linköping; P. Ehn in Stockholm] which has been partly documented (Ehn, 1988; Goldkuhl, & Lyytinen, 1982; Goldkuhl, & Röstlinger, 1988), such thinking seems to have lost its particularly psychological content. This loss is a curious feature that this approach shares with pragmatist systems-theoretical approaches (Forsgren, 1988). The reason for this may be searched in those aspects that are shared by these two approaches, such as a similar understading of "meaning" (Rosental, 1987). We will claim below that analytical psychology can be a fruitful approach to the problems of cognition vs. emotion in designing computer systems support and that, as an alternative to extreme positivist approaches (Simon, 1967) and it can also bridge the gaps between pragmatist and phenomenological-existentialist thinking (Rauhala, 1973). All this may also turn to be relevant for the cognitive-emotive organization of databases and for the computer support of "memory" (Bolzoni, 1987; Eco, 1987; Lurija, 1987; Yates, 1966)

One advantage of using C.S.Peirce's thinking for controlling logical results is that American pragmatism stays much closer than, for instance, phenomenology to the hard technological and scientific issues of our Anglo-Saxon culture and, consequently to the problems of computerization. It should not, therefore, be difficult to incorporate into the inquiry some regard for early information-theory psychology (Attneave, 1959) leading later to the so-called information-processing psychology (Ohlsson, & Almkvist, 1976, contains a summary) and to the presently fashionable cognitive science that was pioneered in the 1950's (Bruner, Goodnow, & Austin, 1956) and, as already noted, was lively criticized (Feldman, et al., 1976; Riegel, 1973; Riegel, 1975; Riegel, 1979; Rychlak, 1976a; Rychlak, 1976b; Rychlak, 1981; Toulmin, 1971). In this perspective the control of logical results and methods should be widened by picking up and developing the historical arguments of psychologism where, however, the associationistic empirical psychology of the time will be substituted by *analytical* psychology.

Sociopsychological logic

Analytical psychology is tentatively chosen as an avenue of research because of its explicit recognition of two (among several other) dimensions or "functions" in the psyche, thinking and feeling, roughly corresponding to logic and values, cognition and emotion, which can in turn be either conscious or unconscious. An introduction of the proposed psychological theory in terms of personality theory is by now readily available (Hall, & Lindzey, 1978, chap.3.; Hall, & Nordby, 1973; Rychlak, 1973, chap.3) One working hypothesis in what concerns the use of computer science and of computers might be that the felt need of formal "empty" formal systems and systems of symbolic notation, including the historical meaning of the formalist tradition in mathematics, fits the attempts of human consciousness to manipulate the psyche without being disturbed by interventions from the unconscious (Ivanov, 1983a, p.20). Conversely, it might be proposed that one fundamental problem in the successful use of computers in social settings such as administrative applications is the sociopsychological integration of unconscious contents into the collective conscious (Churchman, 1979, p.104).

Administrative of statistical information systems, including their support by means of so called knowledge-based learning expert systems can be interpreted as aiming at the build up of a collective conscious of plural ego (Churchman, 1979, pp.72, 101ff.) constituted by many experts, as represented by the administering state. In Anglo-Saxon or, rather, protestant and especially Lutheran countries the state possibly even takes

over the functions of the Church (Troeltsch, 1925, esp. pp. 156-191, 297-338). This touches upon the issues of collective rationality and collective logic which, in the computer age, are to a great extent represented by the problems of personal integrity, privacy, secrecy vs. openness or "right to know", and professional ethics, as related to democracy, liberalism, socialism, and the state (ibid.). Relevant literature that is not so easily available in Anglo-Saxon countries has been richly translated to other languages (Troeltsch, 1974; Troeltsch, 1977) but there are several authors that in one way or another have addressed the same issue (Ahlberg, 1974; Ahlberg, 1978; Gehlen, 1967; Riley, 1986). At a level of greater detail such line of thought should allow a treatment of the basic issues of computers and working life, by bridging the gaps the socialistic or marxistic Scandinavian approaches and the details of everyday working life considered in a Christian and classic philosophical perspective (Weil, 1970-1974; Weil, 1978; Weil, 1983). This bridging would possibly include also the intimate cultural nature of mathematics in its relation to science and technology embodied in the computer tool (Weil, 1966; Weil, 1970-1974).

At the level of the individual person in terms of citizen or worker, however, the capability of creating and using a computer tool or method can expressed as the capability of combining or integrating logical-mathematical thinking with perceptions, intuitions and feelings including individual and universal values. This is then the point where the previously mentioned concern with the subconscious and compulsions requires a complementation of one-sided cognition and perception, a process which within the frame of analytical psychology can be treated under the label of integration of conscious and unconscious in terms of functions (thinking, feeling, sensation, and intuition), and attitudes (introversion and extraversion). The proposed research intends to use theoretically planned empirical observations in order to capture the rationality of actors involved in the development and use of computer support in projects which are locally available (cf. the section on applied research).

Theoretical background

The theoretical background concerning the "hard" logical-physical parts of the research will be based mainly on one particular systems theory developed out of American pragmatism (Ackoff, et al., 1972; Churchman, 1961; Churchman, 1971; Churchman, 1979; Churchman, Auerbach, & Sadan, 1975). Regarding the psychological aspects to be integrated into systems theory the theoretical background will be extracted mainly from C.G.Jung (Jung, 1953-1979a, Collected Works, in the following abbreviated as CW), and, in particular, from those volumes where special reference is made to one-sided types of thinking (CW 6), "directed thinking" seen as archetypally influenced logical rational thinking, compulsion towards symbolic thinking, ego-inflation, etc. (e.g. CW 2, CW 5, pp.14ff, 226; CW 8, p.26; CW 10, pp.211ff, 380ff., etc.). Since these psychological approaches are not so well academically established in our country, their use will be supplemented by a criticism of some of their main features. Such is the concept of "type" (Hammen, 1981, presents a thorough review), akin to the concept of style as in "cognitive styles" and in Wittgensteinian "family resemblances", with obvious importance for database theory, and with its roots in continental thought , including types and type theory in the general setting of logical taxonomy.

These discussions seem to be scantily represented in the philosophy of science and history of ideas in Scandinavia and in the Anglo-Saxon world in general with few exceptions (D'Aquili, 1975; Dicks-Mireaux, 1964; Hildebrand, 1958; Mervis, & Rosch, 1981; Nyman, 1951, concerning functional logic, Jung's types, etc.; Ribbing, 1861; Stephenson, 1939). They appear, however, to be more vital in continental biological

sciences (Hammen, 1981; Ulrich, 1981), and, in a much more restricted sense, in semantic echoes in informatics or European computer and information science where the purpose is to make scientific classifications by means of topological analysis algorithms (Chandon, & Pinson, 1981). Curiously enough, however, the most advanced thinking in this last mentioned area is developed in the proposed pragmatically oriented systems theory (Churchman, 1971, chap.3), in terms of morphological structural classes, functional classes, and teleological classes. It is a development which albeit apparently far from the typological thinking of analytical psychology, appears to be historically close to it in that it is based on the concept of morphology (Biological homologies and analogies, 1973; Morphology, 1911; Morphology, 1967; Morphology, 1974; Owen - Sir Richard , 1911; Zoological nomenclature, 1911).

This kind of taxonomical research, compared with much historically rootless ongoing AI-ESS (artificially intelligent expert-support systems) database research appears to be promisingly related both to interesting efforts in the combined field of mathematics and biology (Rosen, 1985a; Rosen, 1985b), and in "pure" biology (Portmann, 1954; Portmann, 1969; Sperry, 1935) with their obvious import for the issue of "artificial" intelligence versus cognition. It is also related to influential currents of continental thought which stand at the roots of analytical psychology and to the earlier mentioned issue of integration between, among others, between cognition, emotive feelings, and consequently the body. This continental thought, which may be seen as an alternative or a complement to the Anglo-Saxon approaches (Izard, Kagan, & Zajonc, 1984; Klein, 1958, including other contributions to the same volume; Zajonc, 1980) and conceptualizations of "personal knowledge" (Polanyi, 1970) with its applications to work-oriented design of computer support (Ehn, 1988; Göranzon, & Josefson, 1988, presents a summary). Such continental thought seems to be a vital inheritor of the pre-romantic and romantic ideals of integrative systems-oriented natural science as noted, for instance in the famous debate about Geisteswissenschaften versus Naturvissenschaften.

This heritage is sometimes vitally present in the creative impulses of eminent scientists (Böhler, 1973; Dobbs, 1975, about Newton; Goethe, 1970; Knoll, 1957; Pauli, 1955) and it is evidenced in particular in studies that relate to Goethe's work (Born, 1963; Bortoft, 1986; Heimendahl, 1961; Knoll, 1957; von Franz, 1974) including advanced engineering (Jahn, 1981; Jahn, 1982), and certain integrative efforts of "Kulturkritik" in essays and literary works or implicit in classical holy books (Calvino, 1988; Hesse, 1978; I Ching, 1968, as commented by e.g. Kuo, 1976; Musil, 1952; Pirsig, 1974; Zellini, 1985a; Zellini, 1985b) as well as in the class of "the new physics" (Capra, 1975; Jones, 1982; Zukav, 1980).

The accusation of being rather speculative thinking is sometimes bestowed upon works which in this century have directly or indirectly built upon features of the continental romantic philosophy (Steiner, 1926/1988; Steiner, 1937/1982). Such basis, however, may have been the main rational philosophical anchoring ground of particular efforts in computer and systems science which attempt to deal with new and vague phenomena associated with the use of computers (Mitroff, 1983; Mitroff, 1984, on graphic interaction). This qualifies the issue of research methodology to be followed in our proposed research program, an issue which is obviously aggravated by the ambition to escape triviality by bridging the gaps between apparently so disparate fields as logic-mathematics, and analytical psychology.

Research methodology

It has been already stated that the historical aspect is an important aspect of our proposed approach, taken will full consciousness about its possibilities and limitations (Nietzsche, 1988; Toulmin, 1977). We are, however, well aware of the common requirements that research should be also logical and empirical, and, according to the latest requirements, even profitable. At least the two former requirements are to be satisfied by our committment subscribing, without rescinding proper criticism, in matters of methodological principle to pragmatism, experimental idealism, and social systems theory (Ackoff, et al., 1972; Churchman, 1948; Churchman, 1961; Churchman, 1968a; Churchman, 1968b; Churchman, 1971; Churchman, 1979) being consistent with the traditional "harder" aspects of science (Ackoff, 1962), in its general methodological views, consistent with traditional views of scientific methodology (Kaplan, 1964), and having succeeded to demonstrate its practical fruitfulness (Checkland, 1981).

Integration among different psychological functions and cognitive styles in light of analytical psychology indicates that the problems of the place of empiricism and empirical validation (Shapere, 1988), will be similar to those which have been already investigated for the field of psychoanalysis, with due consideration of the differences between these two main orientations of depth psychology (Jung, 1953-1979b), CW 4, §§670ff and 768ff, or pp. 290ff. and 333ff; Friedman, 1964; Rychlak, 1981,Freud].

In this context it will be noted that criticism against depth psychology has to a great extent been based on a particular understanding of what is to be meant by (scientific) experience, i.e. public, in such a way as to "exclude from consideration any uniqueness of our own private experience. What other observers cannot verify is not knowledge." (Stevens, 1935, unidentified reference, p.522] Such developments of P.W. Bridgman's doctrine of operationism stand still today at the core of what is to be considered as knowledge in the field of computer based expert systems. These developments explain some of the difficulties of taking into account the "ragbag" class of knowledge which was lately named personal or tacit knowldge, and which is hoped to be bypassed by renaming expertise and automation with the words support and interactivity. In spite of the claims that operationistic aaproaches are essentially empirical or, in a rigorous sense, concrete-practical, it is well established that they make very particular philosophical assumptions, e.g. about the relation between sensations and perceptions (say, of colors), attributes of sensation, existence, experience, etc., "in an effort to cut them to the operational pattern and thereby rid them of all metaphysical excess (Stevens, ibid., p.527).

Similar expressions of simple objectifying tendencies, against which repeated warning were issued by, among others, even professional physicists (Oppenheimer, 1956), have been found later on in the context of "research problems in psychology which were mostly framed in terms of technical statistical problems. It was remarked, for instance, that the difficulty of determining the effects of "the experimenter variable" which was considered as "a neglected stimulus object" might be surmounted by attempting to "eliminate the experimenter from the experiment" and replacing him by a completely automated device [sic!] (McGuigan, 1963). Nowadays it is clear that there are alternative views of which are important research problems in psychology, including phenomenological approaches that are so to say diametrically, utterly opposed to operationistic empiricism (Ashworth, Giorgi, & de Koning, 1986; Giorgi, 1970).

In any case it is apparent that research about development and use of computer support at the individual and group level suffers of lack of understanding of the nature of knowledge, reality, experiment, validation, etc. Disregarding for the moment that

which could be learnt from the case of depth psyhcology it seems clear that computer supported administrative or industrial work can be framed in terms of particular human beings and social groups who are active subjects or "experimenters" in an ongoing continuous experiment at the work place (Apel, 1980; Churchman, 1979, pp. 56, 59-60, 122, 146-147, about planning versus experimentation; Forsgren, 1988, about constructive computer applications; Habermas, 1979, about communicative ethics; Ivanov, 1972, about the conceptualization of quality).

It is symptomatic that these issues of empiricism in terms of perception and of the role of the body, subjectivity versus objectivity, etc. stood at the center of the romantic and German continental concern for science. It was, for instance, noted that modern mathematics developed historically during several hundred years out from the programmatic and problematic Cartesian split of mind from body. It is, therefore, rather late for trying to repair this split by launching the concept of personal knowledge while keeping the mathematical computer tool as it evolved from that split. The price payed for the extreme achievements by modern science is an ideal of "knowledge representation", such as found in computer science, which is intrinsically incompatible with the personal individual participation of the body in space and time, as well as in spirit and soul which belong to a required more complex conception than mind or brain (Steiner, 1937/1982).

It should be emphasized that such considerations include the all important "method" as relation between concepts and perception, knowledge and experience or action (Steiner, 1926/1988, pp. 107-119), where action obviously includes human work such as it is intended in some contemporary research on computer supported working life (Ehn, 1988; Sørgaard, 1988). While, as already noted, some of these issues are nowadays treated by means of such concepts as personal or tacit knowledge, the pragmatist and phenomenological traditions reconnect them to philosophical, ethical and religious aspects which require taking stand on such things as the continental criticism of I.Kant's conception of knowledge, including the nature and functions if mathematics versus experience, etc. (Hamann, 1967; Steiner, 1926/1988, pp. 100ff, 155ff).

In the present cultural climate, where pragmatism is often understood as simplistic matter-of-factness rather than as pointing to the function of thought as a guide to action, the considerations above may appear, in some vague sense unpractical, abstract, speculative or superfluous. They are, however empirical and concrete enough in that they have, during the last decades, raised a series of debates in the context of applications of the "queen of empiricism", statistic , to that field where statistics or probabilistic logic meet the human mind in all its complexity: psychology.

Probabilistic logic and statistics meet psychology

Statistics, which since about the turn of the century has come to mean applied formal probabilistic logic including its extreme questionable expression in the so called theory of fuzzy sets (Klir, & Folger, 1988, with a problematic attempt to relate it to information; Negoita, 1988; Zadeh, 1965), should, in its older form, rightly be considered as a mother-discipline of computer and information science applied to administrative activities (Ivanov, 1984; Ivanov, 1986). Up to this century it has been apparently well known that probability may be properly considered as a branch of logic, and so it was considered by e.g. Leibniz (Keynes, 1952). The psychological aspects have often been implicit in the role accorded to language. It was, for instance, remarked that

> Confusion of thought is not always best avoided by technical and unaccostumed expressions, to which the mind has no immediate reaction of understanding; it is

> possible, under cover of a careful formalism, to make statements which, if expressed in plain language, the mind would immediately repudiate. There is much to be said, therefore, in favour of understanding the substance of what you are saying *all the time* and of never reducing the substantives of your argument to the mental status of an *x* or*y.* (Keynes, 1952, p. 19n).

It will be therefore be important for both content and form (method) of the proposed research to study how the meeting between statistics and psychology has been treated in the scientific literature, since psychology by its very nature of human complexity, taxes to the utmost the capabilities of statistics.

An important aspect of the issue has been often labeled as "clinical vs. statistical prediction (Holt, 1958; Meehl, 1954; Meehl, 1957), and as the question of "the unique" or of the "case study" or of "the subjective vs. the objective" (Bacan, 1955; Bacan, 1965; Baldwin, 1942; Dukes, 1965; Horst, 1941; Janis, 1958; Kilpatrick, & Cantril, 1960; Shapiro, 1961) including the context of computer and information science (Benbasat, Goldstein, & Mead, 1987). The discussions lead eventually also to the specific relation of statistics to logic (Bacan, 1956) and to decision science (Cowan, 1963), which should be of particular interest for computer science. They lead also to the classical empirical-mathematical validation matters of parameter estimation and hypothesis testing (Cohen, et al., 1962; Peatman, 1937, working in the more traditional spirit of Cohen & Nagel), and to other works on statistical fallacies and misunderstandings of technicalities (Bacan, 1970; Binder, 1963; Lykken, 1968; McNemar, 1940; McNemar, 1960; Rozeboom, 1960; Wilson, & Miller, 1964). Such discussions, deeply understood, do not deal with some bad use and misunderstanding of dogmatically safe technicalities, but they rather unveil questions of principle about the place and nature of statistical method with respect to proper legitimate application (Nunnally, 1960). In particular, they put in evidence the relation of statistics, beyond its unfortunate conception in terms of purely mathematical expression of probabilistic logic, to a philosophically more pragmatist view of experience and reality (Ciampi, & Till, 1980; Tukey, 1960). In particular, the central question of the unique case study, and of the subjective vs. the objective, has focused the attention in the debates on issues which lie well beyond the mere statistical ones (Allport, 1968a; Bennett, 1940; Klein, 1932; Lewin, 1931; Rogers, 1955) and relating sometimes to the formation of veritable alternative schools of psychological science.

Meeting economics

Something analog to the interface between logic and psychological statistics may be found at the interface between logic and economic statistics including econometrics with their great opportunities for applied computer and information science. Hints about this can be found in a wide range of debates and contributions (Menges, 1973; Rasmussen, 1957; Wold, 1957a; Wold, 1957b).

Econometrical debates have a certain have a certain importance in computer and information science because they also deal at least with measurement or with the methodolology to be followed when evaluating the result or impact of the computer application, e.g. on work result and work environment. It is then interesting to note that such debates introduce considerations on statistical technicalities which ultimately actualize philosophical assumptions about causality vs. finality as they appear in the pragmatist development of statistics into statistical operation analysis, and further into social systems theory (Churchman, 1948 1961, Churchman, 1971, Churchman, 1979). It may be fruitful to see the contrast with other approaches (Shafer, 1976, is an example).

One basic issue of history, as implied by econometric models with time series, is, again, the problem of the unique and unrepeatable event. It was the object of the nineteenth century's debate in continental science about the nomothetic method of Naturwissenschaften vs. the idiographic method of Geisteswissenschaften. To these two methodological poles corresponded conflicting conceptions of statistics and its relation to ethics, as represented on the one hand by H.T. Buckle, combining positivistic influences from A. Comte and L.A.J. Quételet, and on the other by J.G. Droysen in the romantic and Hegelian tradition, who gave primary statistical research importance to the unique (Liedman, 1983, pp.54-59).

Concerning non-probabilistic logic and mathematics we should remark the following. In the same way as the surveyed problematic application of (probabilistic) logic or statistics to psychology may be seen as indicative for problems in the application of statistics to economics and to computer support of economic-administrative activities, corresponding insights could probably be derived from the application of (non probabilistic) logic and mathematics to the very same psychology and economics. In order to foresee and to appreciate this correspondence and its implications concerning the applicability of the computer conisidered as an embodyment of logic and mathematics, it would be necessary to understand the relation between logic and statistics in their quality of formal methodological sciences (Meitzen, 1891; Sigwart, 1895, for insights into such a relation which, surprisingly, is so difficult to find discussed in modern methodological literature). The methodological relevance of mathematics in our research is, in any case, covered in the special section of the proposal which is dedicated to mathematics.

Towards analytical and empirical psychology

Having indicated in the above sections the methodological import for our research of logic and statistics in its relations to psychology in general, and psychoanalysis in particular, the time has now come to complete the picture with some indications on how the touched issues can be connected to the analytic-psychological literature. The statistical issue appears there in its traditional form in the pioneering studies on word association which resultet in the discovery of so called psychic *complexes*. In its more refined and problematical form, the issue appears in the planning and analysis of the empirical material which generated the concept of *synchronicity* or "meaningful coincidences" of non-causally related simultaneous events (Bash, 1976, for a summary; Frey-Wehrlin, 1976; Jung, 1953-1979a, CW 18, §§ 1174ff, pp.494ff., and CW 8, pp.233-234, 414).

Concerning the more traditional use of statistics there are example of empirical experimental work in the same tradition of analytical psychological research which may generate ideas for possibilities and fallacies in alternative experimental set ups or empirical studies in the proposed research program (Bash, 1972, concerning Rorschach testing ideas which were proposed by Turkle; Bellak, & Smith, 1956,in the psychoanalytic tradition; Dashiell, 1962; Domino, 1976; Groesbeck, 1978; Hillman, 1975; Kadinsky, 1970; Kirsch, 1968; Mattoon, 1977; Mindess, 1955; Spiegelman, 1955; Turkle, 1980; Turkle, 1984, pp.320ff as relevant for interpreting use of computer support).

It is, however, probable that empirical as well as theoretical approaches of analytical psychology will be criticized not only because of statistical shortages related to difficulties of operationalization of variables, but also because they are not sufficiently social in their outlook (Moreno, 1976) or because they do not incorporate sociology and political science in a sufficient degree. There are, however, exceptions in

this respect (Odajnyk, 1976, to a still higher degree; Progoff, 1973). On the contrary it seems that analytical psychology sometimes questions the possibilities of an independent social psychology (Allport, 1968b, presents a historical overview of social psychology).

The answer to such criticism reaches beyond the earlier problematization of statistics and empiricism, and it would probably follow either a pragmatic-phenomenological line of argument (phenomenological in a Kantian sense) not far from William James' thought, or a philosophical line which according to Jung's own collected works seems to be close to the German post-romantic philosophy. In any case it is probable that the basic tenets of analytical psychology as a theoretical and methodological base for our studies will be justified at a cultural level of discourse (Bär, 1976; Homan, 1969; Karier, 1976; Kelsey, 1971; Rauhala, 1973; Rosenblatt, & Thickstun, 1970; Sanford, 1971; Tourney, 1956; Willeford, 1975). Alternatively one may follow the lines of defense of psychoanalysis which has a somewhat longer history and a greater volume of published material aimed at evaluating its scientific status of valid knowledge, and its relation to empirical data (Benjamin, 1950; Farrell, 1961; Gill, 1976; Hilgard, 1952; Hilgard, 1962; Hook, 1959; Klauber, 1968; Kubie, 1952; Lesche, & Stjernholm-Madsen, 1976; Loewenberg, 1977; Rychlak, 1976b; Sargent, et al., 1968; Schmidl, 1955; Sjöbäck, 1978; Thomä, & Kächele, 1973; Waelder, 1962). There have been also attempts at what can be characterized as a psychoanalytic systems approach (Kubie, 1970) which seems to stay close to similar directions of research and practice at the Tavistock Institute of Human Relations in England. The systems attempts remind us that the more we specialize and fail to pragmatically enlarge the scope of science in order to include in it the use or application of laws and facts, the more will increase the gap between theoreticians and practitioners. Theoreticians will despise a trivial albeit (hopefully) in the short run profitable, exploiting practice, and practitioners will despise an "abstract-academic-speculative-scientific" theory and will try to rely on "other types of knowledge" like "personal-tacit-intuitive-practical-clinical" knowledge. So called science and its institutional representative, the university, will be abandoned to its own premises, and so called reality will continue on its own, out there. Symptoms of such a tendency have been visible quite a while by now (Skaggs, 1934).

A way to creative systems development

Psycho-logic can finally, from what has been written above, be seen as a way to creative systems development.

Creativity and design are sometimes considered as dependent upon a combination of analytic/logical and intuitive thinking, as a balance between quantity and quality, as a question of restructuring, etc. Many of the mentioned concepts have quite a long stand in the history of logic and of psychology. This section started from a part of a proposed program for research on information technology regarding mainly the historical interface between logic and psychology. It was molded in the form of a "reader" and a guide for studies through a great amount of potentially relevant literature. We would like now to indicate in which way such studies relate to design and creativity, and how they can contribute to better creativity in systems development. This was done after having touched upon some pragmatist roots of AI thinking, dwelled on the controllability of logical results, expanded the study towards sociopsychological logic, touched upon the interface with statistics and economics, and finally considered the potentialities of analytical psychology which opens the door for a framing of the creativity-design issue. It will be developed in a special section dedicated to creativity and design.

Concluding remarks

The proposed research program considers computers as logical-mathematical machines or "tools", and will therefore also study their application from the point of view of logic and mathematics. This section of the research program is focused on logic as a point of departure, and deals with the applicative problem of the relations between the supposedly psychological "is", and the logical "ought-must" aspects of computer supported thought. These relations are considered mainly from the point of view of the interface between logic and psychology wich, for the purpose, is enlarged beyond the scope of cognitive science into the realm of analytical psychology. Some expected methodological difficulties of research and how they could be met are illustrated, and connections are established with the field of statistics seen as probabilistic logic, and with economics seen as a field of administrative application. An analogy may be also seen between computer information systems analysis or consultancy for application of computer support, and socio-psychological clinical counseling. Empirical material for the research is expected to be furnished by the local administrative and industrial environment in the course of research oriented consultancy according to the section on applied research

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