Reviews

Editor's note

To encourage the preparation of book reviews the following policy is instituted. The Editor will send the new books he receives to anyone willing to write a publishable review. The reviewer may keep the book in exchange for the review. We encourage readers to communicate to the Editor the names of recent titles which they are interested in acquiring and reviewing. For our part, the titles of new books received will be listed in these columns. The Editor reserves the right to modify this policy at any time.

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Book Reviews Editor

Heinz R. PAGELS (ed.)
Computer Culture
Annals of the New York Academy of Sciences (Vol. 426), New York, 1984, 288 pages.

This volume is the result of a symposium entitled Computer Culture: The Scientific, Intellectual, and Social Impact of the Computer, held in April 1983. As specified in the introduction, the computer revolution is not just new hardware and software but a new outlook about humanity's place in the universe. Watching the development of computer culture is like watching a child grow up, with all his/her associated precocity and unpredictable changes.

Are we embarking on a journey to the Eldorado of the human mind, or does something more mundane, even more sinister, wait at the end of the journey? This is the question presented by Pamela McCorduck. 'Frankly, nobody knows,' is her answer. Prophets must humbly remind themselves that a nonhuman mechanism with the capacity to reason is a singularity in human history. Since it is a singularity, nothing about it can be certain. We know, from looking backward, that mechanical amplifications of human memory, in the form of written word, made profound, unforeseeable changes in our fortunes. We assume that equally or even more profound changes will come about, as the consequence of our invention of a mechanical amplification of human reasoning power.

New computers are being planned to support innovations in the entire filed of information-processing technology, states Kazuhiro Fuchi, the head of the Japanese Institute for New Generation Computer Technology. But what will such innovative computers be like? In the search for the image of the fifth generation computer, he considers several approaches. 'When computers were invented, substantial contributions were made by basic and theoretical research.' Achievements, not only in electronics but also in mathematical logic and neurophysiology, were skillfully put to use. Turing's theories of logic contributed to the establishment of an image for universal computers (stored-program computers), and McCulloch-Pitts neurophysiological model was closely associated with the philosophy of logic elements. These were cleverly synthesized by von Neumann and others, to form the basis for today's computers. Since then, however, the development of computers has mainly been technological and autonomous. Automata theory, theory of formal languages, and other theories emerged, but they have not directly influenced the development of computer technology. Another facet of this progress is that computer technology is about to be crushed by the very wealth of the contents it has created. One example of this facet is the sense of crisis over the overgrown software. One of the causes seem to be the slow clarifying or theorizing of its contents. It is probably due to this aspect that information processing is being labeled an art but not a science. In information-processing research, the field of artificial intelligence has been trying to understand phenomena of intelligence and their application. Artificial intelligence research reached a turning point, in the early seventies, with its

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awareness of the issue of languages and knowledge. At that time, the philosophy of software engineering, data-base methodology and the like were not receptive of these ideas. Lately, however, these fields have tended to overlap to a great extent, and to become fused together. Fundamentally, knowledge representation has come to be associated with sophisticated data bases. Higher-level retrievals of data bases are precisely a form of inference. Future information processing must be able to handle natural languages. From this point of view, logical linguistics and computer technology will tend to merge.

A part of this book is devoted to a very interesting panel discuss on entitled 'Has Artificial Intelligence Research Illuminated Human Thinking?' In other words, can machines ever make us, intellectuals, obsolete? H.L. Dreyfus, a professor of philosophy from Berkeley states 'No, they can't because there are certain things that machines will never be.' J. Searle, another professor of philosophy from Berkeley, takes a slightly different position, stating that 'Whatever machines do, we won't call it thinking but we can't define what they'll do or won't do from outside. S. Papert, from the Artificial Intelligence Laboratory, MIT, states that it is socially dangerous for people to be lulled into a sense of security over the fact that no machine will ever threaten their positions. The fact is that the machines are changing the way people think, because machine thinking is often useful as a model for human thinking. The latter is sometimes a dangerous model.

Searle concedes that it is possible, in principle, to build a brainlike device out of silicon chips, or other hardware, that perfectly mimics the real time input–output behavior of a human brain. That is, you could throw a person's brain away, replace it with a suitable programmed computer, and that person's body would go on behaving exactly as it would have behaved had it kept its brain. In a paper entitled 'The Role of the Computer Metaphor in Understanding the Mind,' Daniel Dennett, a professor of philosophy at Tufts University states that the control powers of the brain are not the 'causal powers' Searle admires. Such a computer, being a purely formal system, would not produce real intentionality and, hence, there would not exist a glimmer of consciousness to associate with this animated body. Dennett points out that Searle's view has a curious implication in the area of evolutionary biology. If a mindless (purely formal) computer brain of this sort is possible, it presumably could have evolved by natural selection. Are we not lucky, then, that our ancestors did not have one of those mindless brains instead of the brains we have! Since such brains would be input–output equivalent to ours, from the outside, they would be indistinguishable; natural selection could find no leverage for selecting in favor of our conscious sort of brain, full of 'intentionality', instead of selecting in favor of the zombie-computer sort of brain. If it has been our misfortune to have had mindless ancestors of that sort, we would now all be zombies!

This book has an unforced inner elegance that makes it glow. Most importantly, it is a model of the happy coming together of imaginative thought, front-line science, and clean, stylish prose. It shows mastery of the facts and a refusal to be overwhelmed by them.

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O.G. SELFRIDGE, E.L. RISSLAND and M.A. ARBIB (eds.)
Adaptive Control of Ill-Defined Systems
Plenum Press, New York, 1984, 312 pages.

This is a pretty complete survey of significant opinions presented at a NATO Advance Research Institute held in England in 1981. Most of the papers of this contributed volume deal with the definition of an ill-defined system.

Neville Moray from the University of Toronto states, for instance, that an ill-defined system is one whose state–transition matrix cannot be known, either because some states are inaccessible, or because some of the transition probabilities are inaccessible, or because the matrix is not time-invariant. Although, in general, many industrial processes and man–machine systems can, to a good approximation, be regarded as well-defined, at least as far as the machine is concerned, the properties of the human operator can render the man–machine combination an effectively

ill-defined system. Nonetheless, what is surprising is that humans often control them rather effectively.

Richard Young from MRC Applied Psychology Unit, Cambridge, England, states that an essential property of an ill-defined system is that it does not lend itself to simple analysis which is both correct and also adequate to answer all relevant questions. Instead, we have to make use of a variety of different views, hoping to find, at last, one which is appropriate for a given purpose. If our intention is to create techniques for the understanding and control of complex and ill-defined systems, a useful viewpoint to consider is that of the operator (or user) of the system. In contrast to other approaches which focus more on the formal analysis and technical properties of the system itself, this orientation places its main emphasis on an essentially psychological question, that of the structure and content of the knowledge needed to utilise the system effectively.

Margaret Boden, from the University of Sussex, England, states that the concept of ill-defined system collapses into triviality if it is used to refer to any system that has not yet been well-defined or one that can never be understood in a well-defined way. This interpretation, however, invites troublesome disputes over what is to count as well-defined, and also prejudges the question of whether human knowledge will ever be adequate for the system concerned. For instance, Schrödinger's equations are mathematically well-defined, but they concern quantum phenomena which many would regard as a paradigm case of ill-definedness. Although the Copenhagen School believed this ill-definedness to be grounded at the ontological level, Einstein voiced his conviction that 'God does not play dice', in interpreting quantum indeterminacy as a merely epistemological matter. Therefore, an ill-defined system is one with respect to which certain prima-facie relevant types of theoretical description are inappropriate, because they treat the system as being more well-defined in a specific respect than it actually is. Minds (especially human minds) are ill-defined in a number of ways. That is, there are several sorts of theoretical description that one might expect to apply to mental phenomena but which are, in fact, inappropriate, because each wrongly assumes that minds are well-defined in some specific way in which they are not.

John Holland, from the University of Michigan, states that genetics provides us with a canonical example of a complex search through a space of ill-defined possibilities. The basic problem is one of manipulating representations – the chromosomes – so as to search out and generate useful organization – the functional properties of an organism.

Speaking now about our state of knowledge in respect to control, W.M. Wonham from the University of Toronto states that optimization of first-level linear multi-variable systems are fairly well understood. Nonlinear dynamics of lower level can usually also be dealt with, at least numerically, and structural results are available for specific classes of nonlinear systems, as for example the differential geometric theory of smooth systems, or (at the other extreme) the theory of sliding-mode regulators. Multi-level systems have been treated mainly from the viewpoint of optimization, using ideas of problem decomposition, originating in mathematical programming. By contrast, the logic or synchronization problem of supervisory control that underlies the software engineering of real time programs for concurrent control processes, have scarcely received any attention from a theoretical view-point. Higher-level adaptive techniques in a logico-linguistic framework (inspired perhaps by artificial intelligence) have not yet made much progress as a domain of system control. It seems likely that the present decade will witness systems control, as a discipline, borrowing from and contributing to the theoretical foundations of computer science (i.e., logic and language conceived procedurally), just as in the past, control science has been supported by Fourier Analysis (1948–57) differential equations and functional analysis (1958–69) or abstract algebra (1968–80). However, at this time (1981), the paradigms of control in logic and language have still to be formally articulated. A very wise conclusion, or premonition, confirmed by the so-called linguistic control.

It is surprising that this book does not touch upon the topic of fuzzy systems. It is surprising, because one of the editors, Michel Arbib, has written outstanding critical and polemical reviews about this topic. The reader interested to study how the linguistic approach can handle some of the complicated problems of representing ill-defined systems, may want to refer to my recent

book entitled *Expert Systems and Fuzzy Systems* [1]. [1] This book continue several examples which give a flavour of this new and fascinating approach.

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Reference

[1] Negoiţă, C., Expert systems and Fuzzy systems (Benjamin/Cummings, Menlo Park, CA, 1985).

Peter A. CORNING
The Synergism Hypothesis: A Theory of Progressive Evolution
McGraw Hill, New York, 1983, 493 pages.

The author of this book has a very ambitious goal. He aims to make a contribution to three overlapping and ultimately connected domains of science: (1) evolutionary biology in general and sociobiology in particular; (2) social science as a corporate entity (especially cultural evolution theory); and (3) political science. To do so he first postulates the *synergism hypothesis* as follows:

It is the selective advantages arising from various synergistic effects that constitute the underlying cause of the apparently orthogenetic (or directional) aspect of evolutionary history, that is, the progressive emergence of complex, hierarchically organized systems.

Then, Corning claims to provide the basis for a theory of human evolution and finally to lay the foundations of a general theory of politics. His proposition is that 'there are fundamentally important commonalities that are shared by such seemingly disparate social entities as families, football teams, corporations, armies, and legislatures, and that it may be possible to reduce certain aspects of family life, team sports, commerce, war, and what is conventionally called politics to a unifying model and causal principle – the so-called cybernetic model and the principle of functional synergism.' What interest do these subjects offer to *HSM* readers?

This book covers a great deal of territory including sections relevant to the area of high technology. Corning claims that '*functional synergism* is the key to understanding our biological evolution as a species and the accelerating pace of progressive cultural evolution in recent millenia.' Our modern society is full of manifestations of the working of synergistic systems. Their capabilities emerge from the cooperation among its parts and their human controllers. Corning cites 'language' as an example of 'low-technology synergism' where phonemes, or letters, can be combined in precise ways to form words. An infinite variety of word combinations can be used to convey meanings which did not exist before. Language is dependent on the integrated functioning of the human mind (itself a complex synergistic system) and on our voice production and writing capabilities. Corning shows how synergism works in modern society from the telephone system, to management of large corporations, advertising, book publishing, and even attributes Japan's phenomenal success to the wonders of functional synergism.

The author remarks that one of Japan's strengths lies in appreciating that *both* efficiencies and inefficiencies can have multiplied effects. He cites the example of the dysergy (negative synergism) resulting from a train malfunction carrying 400 passengers to work. One hour of preventive maintenance could have avoided 100 hours loss in productivity. Corning cautions us not to confuse synergism with simplistic combinatorial effects such as division of labor, new technology, economies of scale, social cooperation, 'though it may involve all of these.' We can have non-linear combinatorial effects like Thom's combinatorial catastrophes.

The General Theory of Sociocultural Evolution brings together: (1) *The Interactional Paradigm*, (2) *The teleonomic selection of causation*, (3) *The cybernetic model of social organization*, (4) *The synergism hypothesis*, (5) *A bioeconomic (benefit–cost) approach*, and (6) *A revival of the Darwinian hypothesis*.

As the reader will appreciate from the very cursory survey of topics presented above, Corning set a very ambitious objective for himself. He

[1] This book will be reviewed in a forthcoming issue of *HSM*.

admits that this book can only be regarded as a 'progress report' of a complete description of 'the precise mechanisms' underlying his theory. His aim is to achieve 'an integration of paradigms, concepts, and data' across a number of disciplines. He claims that his theory asserts that 'there is an underlying patterning and societal continuity and change.' He sees 'in the present trends of events the hope of a reconciliation and synthesis between reductionist and holistic views of life, between scientific and humanistic ways of understanding "man" (used in the generic sense) and society, and between those who are rightly appalled by some contemporary manifestations of politics and those who would like to believe in the creative potential of politics.'

Corning has created here an encyclopaedic treatise which may capture the imagination of many of us who intuitively believe in this integration of the social/behavioral and biological. This book is not a text which can easily be used in the classroom. Rather, it can be read in small dosages. It covers a vast territory of subjects each of which would be used to develop many light years of research. It is admirably well documented and will be enjoyed by those who like the macro view of the world and will be rejected by others, as being too grandiose and, certainly, not operational. However, this book has enough food for thought for all serious readers of sociocybernetics.

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R.H. HAYES and S.C. WHEELWRIGHT
Restoring Our Competing Edge: Competing Through Manufacturing
John Wiley, New York, 1984, 427 pages.

E.S. BUFFA
Meeting the Competitive Challenge: Manufacturing Strategy for U.S. Companies
Dow-Jones-Irwin, Richard D. Irwin, Homewood, IL, 1984, 191 pages.

Ira C. MAGAZINER and Robert B. REICH
Minding America's Business: The Decline and Rise of the American Economy
Vintage Books, Random House, New York, 1983, 388 pages (paperback).

Lester C. THUROW
The Zero-Sum Society
Penguin Books, New York, 1984, 230 pages.

We continue to review books which chronicle the decline of the American economy which we started in previous issues of this journal (see for instance, Review, *HSM*, 5 (1985), No. 2, pp. 174–177). It is noteworthy that they all postulate the thesis that the remedy lies in a restructure of the U.S. manufacturing apparatus. The debate centers around the problem of whether the U.S. should protect its withering capital goods and so-called 'smoke-stack' industries, and stem the tide toward service industries which has plagued several post-WWII industrialized countries, such as Great Britain and our own. The debate has acquired several names. It is discussed in Congress when foreign imported goods hurt our domestic production. Shouts of dumping and of protectionism are heard. Some claim that the U.S. should only produce what 'it-knows-best.' However, this may be precious little, given that even our own Silicon Valley is hurting. From wine to shoes, from automobiles to textiles, it seems that the U.S. manufacturing machine does not know how to compete any longer. But, wait! Several authors and their books offer prescriptions for what ails us. As the titles of these various treatises attest, the remedy lies in revitalizing the manufacturing sector.

We have already met R.B. Reich who, in his national best seller, *The Next American Frontier* (see *HSM* 5 (1982), No. 2), discussed the changes which we ought to make to retain our role of economic leadership. There, he argued for the adoption of high technologies devoted to precision products, customer products, and technology-driven products such as biotechnologies, fiber optics, lasers and ceramics, to name a few. These products lend themselves to precision-manufacture, customer-tailored, and technology-driven flexible systems. In the paperback, reviewed here, Reich teams with Magaziner to review the reasons

which have led to America's decline as an economic powerhouse. First, *Minding America's Business* describes (Part I) the problem, with common explanations of the U.S. productivity decline and the inadequacy of current economic policies. It then covers the role of business (Part II) and of government (Part III) in the decline of relative productivity. Magaziner and Reich recount the plight of the U.S. steel industry, color television, the electromechanical capital goods industries and ask 'Why don't U.S. business compete more successfully?' They describe how government subsidies, while well-intended, undermine the very fibre of our industrial strength. They propose (Part IV) a *rational industrial policy* to (a) 'integrate the full range of targeted government policies – procurement, R&D, trade, antitrust, tax credits, and subsidies – into a coherent strategy for encouraging the development of internationally competitive business, and (b) to facilitate the movement of capital and labor into business that permit higher value added per employee. This industrial policy should encourage four types of measures: (1) to assist firms and workers where industrial displacement takes place, (2) to correct and compensate market imperfections and lopsided returns on investment, (3) to encourage capital flow to high-risk, large-scale or long-projected payback industries, and (4) to encourage coordination between government and private industry to ensure continued economic growth.

Lester Thurow in *The Zero-Sum Society* makes the same plea as the two authors reviewed above. In this thesis, the U.S. economic stagnation takes the form of a zero-sum game which demands a drastic redistribution of income and restructuring of the economy. According to Thurow, we need radical changes such as the creation of federal work programs, the revamping of the tax structure, the repeal of antitrust laws, in order to solve the problems of energy shortage, environmental pollution, lagging production, endemic inflation, unemployment, government regulation, and the like. Whether we like it or not, we will have to learn to play a zero-sum economic game, where some of us will win and others lose. There is absolutely no way to ensure, in spite of what politicians want us to believe, that our problems can be solved without imposing economic losses to some of us. It is inevitable that to turn the economy around, some unpopular measures will have to be enacted. The question remains: What president would want to take this responsibility, when 'he has been elected on the basis of no losses for anyone, and he has no electorial mandate to impose the losses'? It would be political suicide.

In *Restoring Our Competitive Edge* and in *Meeting the Competitive Challenge*, Hayes, Wheelwright, and Buffa tackle the more operational problems of formulating a manufacturing strategy. In the former (Hayes and Wheelwright's), (a) *characteristics of a strategy* (time horizon, impact, concentration of effort, pattern of decisions, pervasiveness), and (b) *decision categories* (capacity, facilities, technology, vertical integration, workforce, quality control, production planning, materials control sourcing policies and organization structure) are defined and discussed. In the latter (Buffa's), the six basics of manufacturing strategy are covered:

(1) Positioning the production system.
(2) Capacity/location decisions.
(3) Product and process technology.
(4) Workforce and job design.
(5) Strategy implications of operating decisions.
(6) Supplies and vertical integration.

Both of these books can be used to advantage in the classroom or in management training seminars where the problem of how to restore American economic edge is at issue. Hayes and Wheelwright bring the impeccable credentials of Harvard's and Stanford's graduate schools of business to their credit. Their book is still presented in hardcover but will no doubt appear in softcover soon. Buffa (whose text is already in softcover) brings his long experience in production/operations management to bear on a subject with which he is, of course, thoroughly familiar. His text is more didactic and to the point than Hayes and Wheelwright's. However, any of these books or both can be used to train managers how a practical, but future-oriented manufacturing policy, can be forged, one that can reverse the economic decline which all the books reviewed have addressed.

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Milan ZELENY (ed.)
MCDM: Past Decades and Future Trends
JAI Press Inc., Greenwich, CT, 1984, 333 pages.

The book is the first in a series of monographs regarding decision research. It provides excellent state-of-the-art overviews of several important fields. It is well edited, and it is thought-provoking. And therefore, though I am rather critical as to much of its specific contents, I recommend that it finds its place on the working-desk of all those interested in the field.

My first major criticism is that it does not live up to its impressive title or to the introduction's pronouncement that 'It is time to recapitulate the achievements, assess the state of the arts, and trace out future directions in MCDM'. With few exceptions, there is little historical content regarding the past decades and similarly there are only isolated analyses of future trends.

Nor do the majority of the contributions live up to the editor's assessment: 'They are written in a clear and engaging style, stressing concepts rather than mathematical technicalities, and emphasizing usefulness and relevancy rather than ivory-tower purity'. Several of the contributions presume a rather high degree of mathematical sophistication on the part of the reader, and only a very few of them emphasize usefulness and relevancy. It is this reviewer's strong belief that the MCDM field is not lacking in mathematical virtuosity or in algorithmic production; new (more-or-less ad hoc) approaches are being produced at a rapid rate. What is lacking is the didactical development of these approaches so that they are rooted in, are relevant for and have an impact on the practice of human judgement and decision making!

The introduction of the book also includes some rather bold, and very debatable evaluations. For example: 'Some MCDM areas have proven to be of limited usefulness and low survivability: Cost–benefit ratios, outranking procedures à la ELECTRE, preemptive goal programming, ...'. There are certainly many very active European theoreticians and practitioners in the field of MCDM who would not accept this characterization of outranking procedures and much evidence exists that preemptive goal programming, particularly when combined with interactive procedures, is of considerable usefulness and probably represents the most used MCDM approach of all, as also is stated in the excellent contribution regarding goal programming by A.L. Hannan. In addition, it is stated that 'some approaches, although promising and potentially very useful, are not yet sufficiently developed and theoretically grounded to warrant the serious review (for example, interactive programming approaches)'. This is a surprising statement when one of the major purposes of the volume purportedly is to discuss and analyze future trends in the field; no area of MCDM appears to have greater promise than interactive approaches.

I fear that newcommers to the field, attracted by the enticing title, will be disappointed as the book presumes a familiarity with fundamental ideas and terminology. However the editor's well written and to-the-point prefaces to each section mitigates this deficiency. As to omissions: No mention is made of approaches which consider what might be called qualitative rather than quantitative criteria. Included here would certainly be criteria which cannot be measured on a cardinal scale, but perhaps are measurable on an ordinal scale, or perhaps criteria which require verbal expression, for example as regards esthetic or emotional responses. Furthermore, I miss a treatment of multiperson/multicriteria decision making (and therefore of intra- and interpersonal conflicts) which is a vital subject matter for future development.

The book consists of a series of ten contributions and a comprehensive bibliography. The following is a brief characterization of each of these contributions.

The first contribution is by Nicholas Georgescu-Roegen: 'Analytical representation of economic decisions under multiple criteria'. This is a fascinating and demanding analysis, but its major attention is given to utility-theory and uncertainty within the context of economics and with only minor and indirect statements regarding MCDM.

The second contribution is by Po-Lung Yu: 'Introduction to decision dynamics, second-order games, and habitual domains'. Although providing an excellent overview of the concepts of decision dynamics, habitual judgemental domains, and so-called second-order games which are not restricted by the assumptions imposed by the traditional game-models, professor Yu's errand is far more inclusive then considering MCDM. The multi-

criteria aspects are briefly mentioned at the commencement, and then dropped; they are not the central theme in the paper.

Wolfram Stadler discusses: 'Applications of multicriterion optimization in engineering and the sciences'. The survey employs three criteria to select those papers reviewed: (1) The paper should consider the solution of an MCDM problem rather than focusing on algorithms, (2) it should employ a generally accepted mathematical model which may lend itself to experimental justification, and (3) the choice of criteria should be based on physical rather than on economic considerations. The author argues that only approximately forty papers satisfy these three criteria, and they are all reviewed. While thus providing an interesting historical perspective the paper gives little reason for optimism as to 'future trends'.

The fourth contribution is by William B. Gearhart:'Analysis of compromise programming'. It is devoted to a mathematical and computational development of compromise programming, and as such is not in line with the book's stated goals; it provides neither a historical overview nor contemplates future trends and appears to be better suited as a journal article than as a contribution to a publication referred to as a 'sourcebook'.

The contribution by Mustafa Yilmaz: 'A theory of the displaced ideal with decisions under uncertainty', relates compromise programming, the concept of the displaced ideal and the effects of risk and uncertainty on decision making under multiple criteria. It is a very well-written, precise and clear disposition which treats a complex subject matter in an admirably simple language. However, it is not sufficiently critical as to the limitations of the concept of the displaced ideal; for example regarding the assumption that 'the preference order for a given factor does not depend on the particular states of the other factors'. What justification is there for the statement that 'this assumption is plausible in many situations'? Certainly in problem situations where 'significant' decisions are to be made, i.e., decisions which can result in a significant change in the state of the system, this assumption may not be plausible. If this is the case, employing a model based upon this assumption can conceivably lead a decision maker to make decisions which will be far less in accord with his/her actual preferences than might otherwise be the case.

The paper by Edward L. Hannan: 'Goal programming: Methodological advances in 1973–1982 and prospects for the future', is one of the contributions which lives up to the title of the book: *MCDM: Past decades and future trends*. It is to be commended for its critical assessment of existing goal programming procedures and for its discussion of interactive goal programming which the author (and his reviewer) consider to be a more satisfying and certainly a more operational approach than either non-interactive preemptive goal programming or goal programming with established inter-goal weights. The concluding remarks by Hannan deserve citation:

> 'It is also becoming obvious that significant analyst–DM interaction is essential for complicated real-world problems, whether the analyst is using GP or other multiple objective methods. Furthermore, after the generation of a solution, a formalized interactive procedure seems to be preferable to ad hoc quizzing of the DM. Many formalized GP interactive methods exist, and surely more will be proposed. The notion of using a goal-based interactive procedure has an intuitively sound foundation, and most criticism of the standard GP methodology is not applicable to the interactive methods.
>
> In my opinion, the future of GP, at least in the next decade, lies in the continued development of GP interactive techniques, in methods of comparing the effectiveness of these techniques with each other and with other multiple objective methods, and in the continued development of non-linear methods to be incorporated into interactive techniques'.

In the contribution: 'Fractional programming in MCDM', Jonathan S.H. Kornbluth reviews the essentials of multiple objective linear fractional programming with particular emphasis upon its application to those goal programming problems where precise fractional goals, or ratios, are to be attained. The presentation is algorithmic and excludes any discussion whatsoever as to the reasonableness of a decision maker desiring to precisely attain a fractional goal. However, it must be commended for its clarity, conciseness, and discussion of future directions.

Milan Zeleny has, as is usual for this 'enfant terrible' of operational research/systems science, presented a thought-provoking and highly debatable contribution: 'Multi-criterion design of high-productivity systems'. It transcends here-and-now-optimization of a given system and focuses our attention on the design of an optimal system. Within a linear programming framework, this leads to the simultaneous determination of optimal values of decision variables *and* optimal right-hand

sides as well as to considerable computational efficiency.

When the de novo approach is extended to problems with multiple criteria it appears to lose some of its significance. Assuming that prices can be used to reduce all restrictions to a single budgetary restriction essentially reduces the multiple criteria content of the problem to a single criterion problem, not withstanding the fact that several objective functions, each in their own units of measure, are employed. Implicitly assuming this ability to reduce all restrictions to a single monetary measure, is tantamount to reducing multi-criteria problems to problems of economics.

Relevant to discussions of de novo programming within either a single or multiple criteria context, is the reasonableness of the assumption that 'No system can be considered optimal (at least not in the long run) if it leads to not fully utilized, idle resources'. Almost all systems, be they technical, economic or social in nature, require various levels of (intelligently designed) redundancy and 'inefficient utilization of resources' in order for them to be successful, to be creative and dynamic (see, for example, the discussions in the field of cybernetics regarding variety and redundancy).

These comments should not detract from the conceptual significance of Zeleny's contribution. He raises a poignant point when he concludes that 'The problem of designing optimal systems and choosing among them, rather than optimizing a given system, stands now posed as one of the most important concerns for the MCDM-research'. His contribution constitutes a creative, thought-provoking, and hopefully trend-provoking step forward.

The book concludes with two 'applications'-oriented papers and a comprehensive bibliography.

Ibrahim Kavrakoglu discusses: 'Multiple criteria decision in power systems planning'. The author commences with a methodological discussion wherein he rejects the a priori articulation of preferences, the a posteriori approach characterized by generating all non-dominated solutions and choosing from among them, and an interactive approach.

It should be noted that his criticisms of interactive approaches applies equally well to any approach to modelling a human decision problem: Problems of identifying decision makers exist in any approach, and arguing that 'the value system of the expert will influence the outcome without being stated explicitly' is a criticism which applies to almost any form for model approach; the values of the designer of the model will in all cases influence the outcome as the choice of terminology, the modelling of relationships, the choice of criteria (there are no criteria for the choice of criteria) all influence the outcome. This clearly applies to the case at hand.

The author proceeds to utilize one of the approaches he originally rejects, that is to generate all non-dominated solutions. To achieve this, and to avoid the possibility of a huge number of such solutions, he proceeds to define what to me appears to be an ultra-simplistic model, both in its choice of criteria and in its choice of restrictions. I will only here focus on the criteria. The first is one of economic cost. The second and third criteria are entitled 'environmental impact' and 'risk'. In contrast to the economic criteria, they are not operationally defined other than by the author's quite subjective, and extremely questionable, assessments. His model design appears to be quite in discord with his concern about how 'the value system of the expert will influence the outcome without being stated explicitly'.

Lester B. Lave discusses: 'Suboptimal regulations when addressing multiple attributes'. Although providing convincing arguments as to the multi-criterion nature of governmental and public decision making, and that governmental and regulatory agency decision behavior does not account for interactions among attributes, the paper may be criticized for employing rather simplistic arguments. For example, when discussing automobile regulation it falls back on the often used approach of assigning monetary value to human life, thereby removing the multi-criteria aspect by reducing the problem to simplistic economic evaluation of what in fact are non-commensurable measures; the problem is removed from the sphere of MCDM and placed within a simplistic MAUT (Multiattribute Utility Theory) frame of reference. Or, when he consideres the problem of making sleepware fire resistant and concludes that 'The failure ... to consider all the relevant attributes simultaneously leads to the situation where it seems likely that more harm was posed to children after regulation than before'. Is it reasonable/operational to presume that governments and regu-

latory bodies should examine all possible attributes and every possible behavior by producers? An alternative approach could be to require that producers demonstrate convincingly that their behavior (for example, adding chemicals to reduce flammability, adding chemicals to foods so as to make them more appetizing, etc.) is *not* dangerous.

The final and by far most voluminous contribution is by W. Stadler: 'A comprehensive bibliography on multicriteria decision making'. It includes over 1700 references on MCDM and more than 300 Russian citations with English title translations. It would help the reader if a cut-off date was provided; although the book is published in 1984, almost all references are prior to the present decade. The bibliography will be of great value to all workers in the MCDM-field.

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I.R. GOODMAN and H.T. NGUYEN
Uncertainty Models for Knowledge-Based Systems
North Holland, Amsterdam, 1985, 644 pages, $74.00.

M. GUPTA, A. KANDEL, W. BRANDLER and J. KISZKA (eds.)
Approximate Reasoning in Expert Systems
North-Holland, Amsterdam, 1985, 840 pages, $92.50.

M. SUGENO (ed.)
Industrial Applications of Fuzzy Control
North-Holland, Amsterdam, 1985, 270 pages, $55.50.

Without any doubt, North-Holland is nowadays the most prolific publishing house in the field of fuzzy sets and systems. These new books prove it again.

The first is a treatise that deals systematically with a single subject./ The second is a contributed volume presenting working models. The third is focused on practical applications. The combination of mathematics, computer science, and industrial engineering prove that the fuzzy set technology is becoming excitingly useful.

The main idea presented in these books is that given a model that mirrors a system, it is possible to derive information about the system's behavior by just studying the model's behavior. Depending on how the computation is performed, we speak about simulation programs or knowledge-based programs.

In simulation, the analyst transforms the system from structures of the objective world, into structures of the subjective consciousness. The analyst writes the program, while internalizing the model.

In knowledge-based system, the model is internalized inside the computer. The analyst transforms the system from the structures of the subjective world, into new structures of the objective computer. Having the model in its knowledge base, the computer proceeds to write the program.

For almost thirty years, system analysis was oriented towards looking at the controlled system. Recently this orientation has changed. System analysis is now looking at the controller.

Looking at the *controlled system* is the old paradigm of physical sciences. Looking at *the controller* is the new paradigm of Artificial Intelligence. Looking at *the controlled system* meant the building of mathematical models embedded in hard-coded programs. Looking at *the controller* means the building of knowledge bases.

These three books are dealing with the second topic. These are momentous books of brilliant editorial achievements, drawing together an astonishing range of ideas. They represent a welcome addition to the bookshelf of anyone contemplating the use of the process of reasoning in intelligent machines.

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J. WAGENSBERG
Ideas About World's Complexity
Barcelona, TUSQUETS Editors, 1985, 154 pages (in Spanish).

Ilya PRIGOGINE
Is It Only an Illusion? An Exploration From Chaos to Order
Barcelona, Spain, TUSQUETS Editors, 1983, 332 pages (in Spanish).

In spite that these books are written in Spanish, we thought it would be important and worthwhile to bring these books to the attention of our readers because they show the rebirth of the Spanish academic community and because the series edited by Wagensberg, places them at the forefront of the literature published on these topics in the world.

Wagensberg is the general editor of this series entitled *Metatemas* (Metathemes) which includes not only Prigogine's work listed above, but other translations such as works by Schrödinger, Monod, and Wiener. Wagensberg does not limit himself to being editor. He writes on his own as evidenced by his *Ideas About World's Complexity* where some interesting ideas are presented.

In the first part of this book he brings the reader up to date about the modern ideas concerning Thermodynamics and Systems Science. Wagensberg discusses the meaning and implication of systems far from equilibrium, irreversible processes, order through fluctuations, dissipative structures, and bifurcations. He explains Prigogine's concept of entropy balance which takes into account the entropy produced by the system and the entropy exchanged with its environment. In an essay on *Auto-organization and the Progress of Fluctuations*, Wagensberg describes the relationships among quantitative measures of a system's complexity, its predictive capacity, the environment's uncertainty, and its sensitivity.

In entropy and information theory-related terms, it is shown how the system's complexity less its predictive capacity is equal to the information which the environment provides about a system's environment; and, in the opposite direction: the environment's uncertainty less its sensitivity is equal to the information which a system's behavior provides about the environment's behavior. According to M. Conrad [1], both messages contain identical quantities of information. Apparently, this equation guides a change in the world with respect to any of its components. If, for instance, the uncertainty of the environment increases, then the system must increase its complexity, elaborate its predictive capacity, or inhibit its effect on the environment.

'The equation contains four terms to play with, but one law to respect.' When the dialectic struggle between system and environment is settled and when the law is not violated, then *adaptation* obtains: The system readjusts its internal structure to remain compatible with its environment. The system adapts. When this is not possible, when a perturbation (fluctuation) in one of the terms can not be absorbed by a response from the other three, adaptation fails and the system is in crisis. Then, either the system dies or abruptly changes over to another (new, unpredictable) structure. It auto-organizes and 'rebels' against its environment. A catastrophy (bifurcation) occurs. If the system can find a way to be compatible with the newly established entity, it will prevail. And the system goes on to survive other changes in time.

Indeed, the whole of humanity is a system which interchanges matter, energy, and information with the rest of the world.

Wagensberg's original contribution is his *Ideas About the Complexity of the World* consists of an interesting comparison between the world of art and the world of science which parallel this reviewer's effort in the same field (see, van Gigch [2,3], and Hatchuel et al. [4]). Art like science is a form of knowledge. To analyze complexity and obtain knowledge of the natural world, science invented the so-called scientific method. If is a logical system of laws, models, theories, and methods.

Science – physical and natural science – is based on the *principle of intelligibility* where objectivity can be obtained through the so-called object/subject split. The scientists decomposes the world to transmit a finite image (model) of a finite portion of reality.

On the other hand, art does not convey its meaning in parts.

In art, there can be no subject/object split, where the object 'pulls back' to remove himself/herself from the subject: How can I leave part of myself somewhere else? How can I separate myself from my 'other being'?

We must comprehend the 'infinite' complexity of a work of art in its totality (Gestalt = global comprehension). Wagensberg invokes his *principle of communicability* through which 'creator' (or

artist) and 'contemplator' (or person for whom it is created) relate. This relationship is compared favorably to the wordless communication between two lovers.

It is akin to 'auto-communication,' a 'real symbolism where the particular represents the universal not like a dream or a shadow (with reference to Plato) but as living and momentary revelation of the inscrutable.'

A work of art is in act which takes place between a pair of minds, a communication between creator and contemplator, where the same infinite complexity is sent (exhibited) by the source but different complexities (interpretations) are received by different receivers. To know and understand art means to known and understand what is the complexity that moved the artist (creator) but not necessarily to 'understand it.'

The world of science justifies the object/subject split and the limited representation of portions of reality. Once created, the scientist's work (scientific knowledge) is separated (liberated) from its creator. It can be transmitted and taught innumerable times, not so in art. Knowledge in art occurs when the act of creation is consumed and its needs to occur only once. Whereas in science, we can have an almost infinite number of occurrences of an event, in art we only have one masterpiece, one 'big complexity,' one artist, one strategy, one subject, but an infinite number of admirers (contemplators).

Wagensberg also deals with the science/art dialectic in terms of the contraposition of the deterministic, application-oriented, and objectivistic assumptions of science vs the indeterministic, creative, and auto-organizational attitude of art. The former is intelligible and articulable knowledge, the latter reflects unintelligible complexity and knowledge, but in merging mind with creation, 'creates an act of suggestive magic which contains at the same time the object and the subject, the world exterior to the artist and the artist himself' (quote from Baudelaire in his *Art Philosophique*).

Wagensberg's comparison of the differences between the complexity of art and that of science is convincing. However, he is less successful in his attempt to justify that 'progress' in art (as in science) exists. It is not pertinent to delve here with his arguments.

Is it Only An Illusion is a compilation and translation of several of Prigogine's lectures presented throughout the world in India, France, Belgium, USA, Israel, etc.

The content of his lectures cover the familiar theme of his theories which are presented elsewhere. In order not to be repetitious we refer the reader to our review of *La Nouvelle Alliance* [5], which is representative of the material in the book reviewed here. However, some new pieces were included here, such as *Einstein: His Triumphs and Conflicts*, a presentation which Prigogine made during the Albert Einstein Memorial Lecture presented to the Belgium Royal Academy in 1981 on the occasion of the celebration of Einstein's centenary of his birth. In an appendix appears an apocryphal letter between Rabindranath Tagore and Professor Albert Einstein which is dated July 14, 1930.

In it, the philosopher and the physicist engage in a fictitious conversation on the measuring of truth, beauty, and the place of humankind in the universe.

'Is It Only an Illusion?' refers to a passage of a letter written by Einstein where they asked him: 'What is Time,' 'What is Irreversibility?' These questions give Prigogine the opportunity to argue his thesis that determinism and reversibility are only illusions. Whereas the artificial (man-made) world may be deterministic and reversible, nature contains essential elements of chance and of irreversibility. As Prigogine has stated in his other publications, this calls for the new vision of the world for which he is so justly famous.

We must congratulate and wish the editor and publishers well for their effort to bring to light a very impressive series of well-presented books which will bring the Spanish speaking world up-to-date on the modern ideas in System Science. We look forward to more books in the metathemes series which is published with the symbol of Aleph, Cantor's symbol for transfinite numbers.

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References

[1] Conrad, M., Adaptability (Plenum Press, New York, 1983).
[2] Gigch, J.P. van, The art of metacreation and the metacreation of art, Presented to Ecole Nationale Supérieure d'Electricité, Paris, Alumni Committee (June 1985).
[3] Gigch, J.P. van, Explaining creativity through metacreation and paradigm displacement, Proceedings of the 1986 Annual Meeting of the Society for General Systems Research, Philadelphia, PA (May 1986).
[4] Hatchuel, A., P. Agrell and J.P. van Gigch, Innovation as organizational intervention, Centre de Gestion Scientifique, Ecole Nationale Supérieure des Mines de Paris, and School of Business and Public Administration, California State University, Sacramento, CA (1986).
[5] Prigogine, Ilya and I. Stengers, La nouvelle alliance: Métamorphoses de la science (Gallimard, Paris, 1979). Published in the U.S. as Order out of chaos (Bantam, New York, 1984). Reviewed in HSM 4 (1983) 58–59.