

## A SYSTEMS-SCIENCE PROJECT AT AUSTRIA'S UNIVERSITY OF LINZ: ELECTRONIC BRAINS SAVE ENDANGERED SPECIES

STEPHEN SOKOLOFF



Photo Sokoloff:

Prof. Ernst Reichl  
retrieving information from „ZOODAT“

Mankind's inventive cleverness has rarely been a boon for Mother Nature. Technological advances have directly or indirectly led to the destruction of natural environments throughout the world and the extermination of countless species of plants and animals. Now however systems researchers in Linz are using highly complex electronic memory devices to assist conservationists.

The ZOODAT-project is the brainchild of Prof. Ernst Rudolf Reichl; he is currently being aided by Dr. Friedrich Valach and Dipl. Ing. Winfried Walter. Prof. Reichl was one of the first scientists to realize that enormous quantities of information are a prerequisite for effective conservation work. There are approximately 30.000 species of animals in Austria (about half of them are insects and snails). Ecologists strive to discover precisely in what areas each of them occurs and the manner in which the size of each population fluctuates in the course of time. Equipped with this knowledge, they can determine which species are threatened by extinction. It is estimated that the data from between four and ten million observations are now available, but they are not always easy to get at. Some of them have been published in various scientific journals, whereas others can only be obtained from the archives of public or private collections or from unpublished notes.

With the help of the computer it would be possible to gather these findings into one place and systematize them. Of course each of the individual items has to be programmed. Up until now the Austrian team has only managed to feed over a million pieces of information to the electronic

brain – nearly 700.000 of them have to do with butterflies and moths, almost 150.000 with beetles. The researchers however hope that their data bank will someday comprise all the animal species in Austria and the Italian province of Southern Tyrol as well as all the sites where they occur. To attain their goal, they will have to process about 185 million items.

The data bank has already proven itself invaluable. With its help, conservationists were able to rapidly formulate precise objections to a proposed new expressway between Augsburg (W.Germany) and Innsbruck (Austria). The computer immediately produced a list of biotopes which would have been adversely affected by the construction of the highway including details about the faunistic rarities which were to be found at each of the sites. A rerouting was recommended.

### DATA PROTECTION FOR ANIMALS

Unfortunately ZOODAT has to be kept under lock and key. Ecologists are afraid that unscrupulous animal traders could misuse information from the data bank to hunt out the nesting sites of rare birds of prey such as eagles, owls and hawks. Chicks of some species fetch horrendous prices nowadays. Similarly, insect collectors could link in to ZOODAT to localize rare butterflies. Therefore only authorized persons or institutions have access to the computer.

## ONE OF EUROPE'S LARGEST ANIMAL DATA BANKS

ZOODAT began as part of an international project. In 1972, when it was introduced at a scientific meeting, many researchers found it cute but rather insignificant. At that time it merely embraced 5.000 items. From such modest beginnings Prof. Reichl has brought the zoological data bank to its current size — today it is perhaps the largest one in Europe.

Prof. Reichl is not only a systems researcher — he is an amateur entomologist as well. Being intimately involved in both of these fields of study has enabled him to develop a link between them, in the form of a computer-assisted program of animal conservation. Building bridges between isolated disciplines is one of the most important goals of systems science.

## CAST — COMPUTER AIDED SYSTEMS THEORY

**A short report on a research activity at the Institute of Systems Science of the Johannes Kepler University Linz, Austria**

FRANZ PICHLER

Systems Theory is a field of applied mathematics which was developed to help engineers deal with models at different levels of abstraction. It is only about 40 years old and is still undergoing rapid transformations. It might be considered as having arisen out of control theory and signal theory. A large number of articles concerning systems theory appear in various scientific journals. Many monographs, textbooks, international conferences and university courses also deal with this field of science. It might therefore seem that systems theory has made amazing progress and that its devotees should be very satisfied. Unfortunately, however, the degree of acceptance of systems-theoretical methods in practical engineering is low; only a few of the most important of these techniques are now generally used as tools in the engineering workshop. The reasons for this are manifold. One of the main ones appears to be the lack of powerful and easy-to-handle computer assistance for the application of the systems theoretical framework and methods. Many of the most important results are only described in textbooks; for their study it is necessary to resort to „paper and pencil methods“. The software into which algorithms have been designed is usually not suited for use with the types of computers currently being employed by engineers. Therefore a new implementation would be necessary, but it is usually considered too costly; the consequence is the exclusion of systems theory from practical application. On the other hand we must also take into consideration the fact that the usage of mathematics and of systems theory requires that the engineer have some understanding of abstract models. Theoretical insight is also necessary if he is to be able to select the proper methods. Although he has certainly acquired such knowledge during his engineering studies, he is likely to have forgotten it very rapidly after graduation. Engineers remember primarily those mathematical concepts for which there are practical applications.

There have been a number of projects at different universities to realize a computer-assistance of systems theory for various purposes. As an important basic example we shall mention the „general systems problem solver“ (GSPS) implemented by Professor George Klir and his research group at the State University of New York at Binghamton, USA. GSPS is a rather complex software-package for general use. It realizes some of the most important parts of the general systems methodology as described in numerous articles and books on this subject. Another example of the more general part of systems theory is given by the work of Professor Bernard Zeigler of the

University of Arizona, Tucson, USA, which realizes a multi-level systems design and simulation methodology. It can be used for the engineering task of any systems design which requires a multifaceted approach.

There are many other examples for the implementation of systems theory methods in software. Most of them are constructed for special tasks, such as controller-design, electrical network synthesis or digital filter design. It is the goal of our group to help promote a general approach for the construction of systems theoretical tools for design and simulation. We propose that modern computer languages such as LISP or PROLOG be used for functional programming and we especially emphasize RAPID-PROTOTYPING. In this way we also encourage the user to implement his personal routines for problem solving as parts of the program-package.

In our programming task we want to make use of not only the „artificial intelligence“ languages LISP and PROLOG but also of the mechanisms which are provided by expert systems. Therefore we are interested in being able to employ an expert system shell, such as for example LOOPS or KEE, to offer the user enough comfort for data- and method manipulation. In our case we use the LISP-dialect INTERLISP-D which provides additional support for interactive work and display graphics together with LOOPS. All our CAST-systems are implemented on SIEMENS/XEROX Dandelion work stations which are interconnected by means of the ETHERNET.

We are still in an early phase of systems development. We are using a basic framework called STIPS (= **S**ystems **T**heory **I**nstrumented **P**roblem **S**olving) which is similar to the framework used in GSPS by Professor Klir and to the framework of Professor Zeigler's „Multifaceted Modelling and Simulation Methodology“. By specializing the STIPS framework to subclasses of systems specifications and related design and analysis methods we obtain method-banks which can serve as tools in engineering workstations. One project in which we are involved is designated as CAST:FSM.

That stands for „Computer Aided Systems Theory with emphasis on the case of Finite State Machines“. It is intended to provide the user (usually thought to be a Logic Designer involved in computer systems design) with the „world“ of automata theory which is relevant for hardware problems. Our goal is to devise a system of programs (implemented in INTERLISP/LOOPS) to enhance current computerized tools of logic design workstations. Another project in which we are currently involved concerns „Design for Testability“ problems in VLSI-circuitry design. In addition to the special parts of CAST:FSM which can be used for that type of problem (e. g. for structuring finite state machines to become more easily testable) we try to develop new methods for functional testing (= testing from a user-information point of view) and for fault-simulation

(rule-based simulation procedures based on the language PURLOG, a PROLOG extension). Furthermore, within this project we are developing the tool LISAS for systolic array testing (LISAS = Linz Systolic Array Simulator). Finally, we want to adapt the CAST philosophy so that it will apply to other problem areas such as cryptography (design of hardware for data encryption) and digital image processing: both of these fields could very well be aided by systems theory.

## CONCLUSION

Developing CAST tools for the synthesis and analysis of systems is one of the most important goals of the systems

scientist. Pioneering studies in this field have already been published by Prof. George Klir (SUNY Binghamton) and his colleagues and by Prof. Bernard Zeigler (University of Arizona, Tucson). CAST research and development is going to be the subject of a special symposium chaired by Franz Pichler and Wayne Wymore. We hope that it will include lectures on CAST-software engineering, applications of CAST and theoretical questions relevant to both of these topics. The symposium, to which all "CAST-enthusiasts" are invited to contribute, will be held at the University of Vienna within the framework of the "Ninth European Meeting on Cybernetics and Systems Research" (EMCSR 88) from April 5 until April 8, 1988.

## ABOUT OUR NEWSLETTER:

Our Austrian group doesn't want to dominate the newsletter. Until the rest of you overcome your inertia and start sending us contributions, we have no choice! We're especially looking for **critical** commentary. You can submit items in English, German, French, Spanish, Italian or Russian (always accompanied by an English translation of technical terms).

## SUBSCRIPTIONS:

Ask your national organization (see membership list). If there is no member organization in your country, write to the editor: Dr. Stephen Sokoloff, Breitwiesergutstraße 40/7, A-4020 Linz, Austria.

## BOOK REVIEWS

Have you published a new book about Systems Science recently? We would like to bring a review of it in this newsletter. Please have your publisher send us a copy.

## BOOKS, JOURNALS, ORGANIZATIONS

**A new, quarterly systems science journal!**

### REVUE INTERNATIONALE DE SYSTEMIQUE

(Most papers in French, occasionally other languages)

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The journal is edited by the French Association for Economical and Technical Cybernetics (AFCET). It will provide a permanent forum for an interdisciplinary approach to the scientific, philosophical and technical problems raised by systems science.

Papers will appear under the following headings:

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Submit papers to:

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## APPLIED ARTIFICIAL INTELLIGENCE JOURNAL

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## A NEW BOOK:

### MODELLING AND SIMULATION METHODOLOGY IN THE ARTIFICIAL INTELLIGENCE ERA

Editors: Maurice S. Elzas, Tuncer I. Ören, Bernard B. Zeigler

A selection of the most important papers presented at the 1984 conference in the Netherlands (near the Wageningen Agricultural University) Published 1986 by Elsevier Science Publishers, 423 pp.

Major categories of articles: Applicability of artificial intelligence to modelling and simulation; bases, model/knowledge; experimentation with models; machine learning; machine interfaces; methodological aspects; model manipulation; software tools; systems research concepts.

Price not available. Order from:

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## A NEW BOOK:

### DECISION MAKING ABOUT DECISION MAKING

Metamodels and Metasystems  
John P. van Gigch (Author/Editor)

This book (304 pp.) discusses the application of the metamodel paradigm to a diversity of issues in the realm of systems theory and systems science.

With contributions by: John R. Battista, Norman A. Coulter, Jr., Nora Femenia, C. O. Francois, Ann F. van Gigch, John P. van Gigch, Ranulph Glanville, Albert J. Johnson, Vladimir A. Lefebvre, Magoroh Maruyama, Richard O. Mason, Ian I. Mitroff, Maria Nowakowska, Rammohan K. Ragade, Mildred L. G. Shaw, Werner Ulrich, B. H. Voorhees.

Price: \$ 38.00/£ 27.00

Published April 1986 by: Abacus Press, PBS P. O. Box 643, Cambridge, Ma 02139, USA. Telephone: (617) 4916562, Telex: 650 2403359 MCI

— Address in U. K.: Abacus House, Speldhurst Road, Tunbridge Wells, Kent TN4 0HU, United Kingdom. Telephone: Tunbridge Wells (0892) 29783/27237. Telex: 877440 PBURNS G

## NEW BOOKS

The following books may be of interest to system scientists in general:

Sirgy, M. Joseph (1984), **Marketing as Social Behavior: A General Systems Theory**. New York: Praeger Publishers.

Sirgy, M. Joseph (1986), **Self-Congruity: Toward a Theory of Personality and Cybernetics**. New York: Praeger Publishers.

## ARE YOU INTERESTED IN QUALITY OF LIFE ISSUES?

We are trying to establish a network of systems scientists who are interested in quality of life issues. If you would like to become part of this network, please drop a note to **Dr. M. Joseph Sirgy, Associate Professor, Department of Marketing, Virginia Tech, Blacksburg, VA 24061, USA**, (703) 961-5110 (office), (703) 961-6949 (department), (703) 951-9418 (home). Also, write for reprints (copies) of recent articles on systems science/quality-of-life:

Sirgy, M. Joseph (1986), "A Quality of Life Theory Derived From Maslow's Development Perspective", *THE AMERICAN JOURNAL OF ECONOMICS AND SOCIOLOGY*, 45 (July), 329 – 342.

Sirgy, M. Joseph, Michael Morris, and A. C. Samli (1985), "The Question of Value in Social Marketing", *THE AMERICAN JOURNAL OF ECONOMICS AND SOCIOLOGY*, 44 (April), 215 – 228.

## WOULD YOU LIKE TO JOIN THE STAFFORD BEER FOUNDATION?

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Address: The Stafford Beer Foundation, P. O. Box 87, Commerce Court Postal Station, Toronto, Ontario, Canada M5L1C6

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## LIST OF MEMBERS OF IFSR updated January 9, 1987

We would like to extend a special greeting to our three new member groups: **The Asociacion Mexicana de Sistemas y Cibernetica, the United Kingdoms Systems Society and the Polish Cybernetical Society.**

American Society for Cybernetics  
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Department of Decision Sciences:  
George Mason University  
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Dr. Nimal Jayaratna  
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Broomgrove Hall  
9 Broomgrove Road  
Sheffield S10 2LW  
England

## MEETINGS – DETAILED INFORMATION

31st Annual Meeting of the

### INTERNATIONAL SOCIETY FOR GENERAL SYSTEMS RESEARCH

Budapest, Hungary, 1 – 5 June, 1987

(This organization is meeting in Europe for the first time!)

Co-Chairmen: Prof. Peter Checkland and Dr. István Kiss

Theme: Problems of Constancy and Change; the complementarity of systems approaches to complexity.

Structure of the meeting: three days of plenary sessions in the morning and parallel sessions in the afternoon.

Day 1: Systems ideas

Day 2: The use of systems ideas, systems methodology

Day 3: The applications of systems thinking, its results.

The fourth and fifth days will be devoted to symposia.

Contributors are invited to suggest topics. Currently the following themes are being considered: perspectives of mathematical systems theory, hierarchy-duality theory, soft systems methodology, complexity and manageability, systems design, systems analysis and decision making (including DSS), design vs. planning, growth vs. development, peace studies, role of experts in applied systems

analysis, systems education.

Fees: Members \$ 100, Non-members \$ 130 (there is a deduction for fees paid prior to 1. March).

Where to obtain information: see list of meetings.

### EUROPEAN SOCIETY FOR THE STUDY OF COGNITIVE SYSTEMS

Fifth workshop, Bern, Switzerland, 25 – 27 June 1987. Papers are invited on all multidisciplinary topics of cognition. They may be either on specific topics within single disciplines, but of interest across the boundaries of those disciplines, or they may be on topics of general character. The following disciplines belong explicitly to the scope of the workshop:

- psychology (cognitive, developmental), perception
- artificial intelligence (general aspects)
- associative memory and neural networks, neuroscience
- linguistics, origin of language
- education and instruction
- philosophy, history of concepts.

The number of participants is limited to 40! The fee is Sfr. 40,00.

Where to get additional information: see meetings list.

### MEETINGS AND COURSES-LIST

Title	Date	Place	Deadlines	Further Information
Congress of Cybernetics and Systems	1987 March (Exact Date not available)	New Delhi India	30 Nov. 1986	The Society of Management Science and Applied Cybernetics C/-, CSIR Complex NPL Campus Pusa, New Delhi 110012 INDIA
Special European Conference of the American Society for Cybernetics Theme: Design for Development of Social Systems	15 – 19 March	St. Gallen Switzerland	31 Jan 1986 Abstract	Dr. Laurence D. Richards Dept. of Engineering Management Old Dominion University Norfolk VA 23508 USA Phone: (804) 4403758 OR: Dr. Gilbert J. B. Probst University of St. Gallen Institut für Betriebswirtschaft Dufourstraße 48 St. Gallen, Switzerland 9000 Phone: 41 (071) 233572
Intl. Symposium: Self-Steering and Cognition in Complex Systems: Toward a New Cybernetics	23 May	Brussels Belgium	15 Dec. 1986 Abstract	Frank DeMeyer Center for Empirical Epistemology Free University of Brussels Pleinlaan, 2 B-1050 Brussels, Belgium
Annual Meeting, International Society for General Systems Research	1 – 5 June	Budapest Hungary	1 April 1987 finished papers	Dr. István Kiss Bureau for Systems Analysis POB 565, Budapest, Hungary H-1374
Fourth Euro Summer Institute Theme: Systems Science	5 – 21 June	Turku Finland	1 March 1987 Applications	Limited to 20 young European scientists Prof. P. Pruzan, DASY, Copenhagen School of Economics and Business Administration Julius Thomsens Plads 10, DK-1925 Frederikaberg C, Denmark
European Society for the Study of Cognitive Systems Fifth Workshop	25 – 27 June	Bern Switzerland	None	Dr. G. J. Dalenoort (ESSCS) Inst. for Exper. Psychology Univ. of Groningen P. O. Box 14, 9750 AA HAREN, The Netherlands Tel. Netherlands (0)50-636472

Title	Date	Place	Deadlines	Further Information
X. IFAC World Congress	27 – 31 July	Munich F. R. Germany	—	Eng. H. Wiefels VDI/VDE Gesellschaft Meß- und Regelungstechnik GMR Postfach 1139 D-4000 Düsseldorf 1 F. R. Germany
World Organization of General Systems and Cybernetics 7th International Congress of Cybernetics and Systems	31 August – 4 Sept.	Budapest Hungary	—	Prof. J. Rose, WOGSC Office 5 Margate Rd., St. Annes-on-Sea FY83EG Lancs, England, U. K. Tel. 532-727 or 530-214
2nd IFIP Conference on Human-Computer Interaction	1 – 4 Sept.	Stuttgart F. R. Germany	15 March 1987 Final text must be there!	Interact '87, Secretary c/o IAO/IPA Nobelstraße 12 D-7000 Stuttgart 80 F. R. Germany
Xlth International Congress of Mathematical Biology	7 – 9 Sept.	Paris France	1 May 1987 Summary of paper	Secretariat de la Société Internationale de Biologie Mathématique 11 Bis avenue de la Providence 92160 Antony, France
World Organisation of General Systems and Cybernetics Seventh International Congress	9 – 13 Sept.	London U. K.	30 Nov. 1986 Abstracts	Professor J. Rose 5 Margate Road Lytham St. Annes, FY83EG Lancs, England (Tel. 0253725114)
12. Symposium on Operations Research	9 – 11 Sept.	Passau F. R. Germany	15 Febr. 1987	Prof. Dr. Dr. F. J. Radermacher Lehrstuhl für Informatik und Operations Research Universität Passau Innstraße 27 D-8390 Passau F. R. Germany-
Österreichische Artificial Intelligence Tagung 1987	22 – 25 Sept.	Vienna Austria	—	Österreichische Gesellschaft für Artificial Intelligence "ÖGAI-Tagung 1987" Postfach 177 A-1014 Vienna, Austria
Ninth European Meeting on Cybernetics and Systems Research	<u>1988</u> 5 – 8 April	Vienna Austria	—	Prof. Robert Trappl Inst. of Medical Cybernetics Freyung 6 A-1010 Vienna, Austria
4th IFAC Symposium Computer aided Design in Control and Engineering Systems	23 – 25 August	Beijing (Peking) People's Republic of China	15. April 1987	Prof. Chen Zhen-Yu Cadcs '88 Secretariat Application Committee of the Chinese Association of Automation P. O. Box 919 Beijing, PRC
IFAC/IFORS Symposium Identification and System Parameter Estimation	27–31 August	Beijing (Peking) People's Republic of China	15. April 1987	Prof. Chen Han-Fu Institute of Systems Sciences Academia Sinica Beijing, 10080, P.R. China

#### Offenlegung:

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Präsident der IFSR ist für 1986/88 Prof. Dr. Robert Trappl (Österreich), Vizepräsident Dr. Bela H. Banathy (USA), Sekretär-Schatzmeister Prof. Dr. Gerard de Zeeuw (Niederlande). Alle Funktionen werden ehrenamtlich ausgeübt.

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