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## EPISTEMOLOGICAL AND METHODOLOGICAL DIFFERENCES BETWEEN OPERATIONS RESEARCH/MANAGEMENT SCIENCE AND GENERAL SYSTEM THEORY

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**What's wrong with OR/MS? John van Gigch believes that these fields would grow faster if their proponents devoted more effort to metamodeling. He maintains that these sciences, by being too closely wedded to a single methodology, are restricting their innovative and creative thrust. He proposes that OR/MS and GST should now move toward each other.**

### INTRODUCTION

When comparing OR/MS (Operations or Operational Research/Management Science) and GST (General Systems Theory), it is useful to take an epistemological perspective of both disciplines. This perspective requires that the following questions be answered:

1. What are the objects of study of each discipline?
2. What are the objectives of each discipline?
3. What methodology does each discipline use to meet its avowed objectives?

### COMPARISON OF THE OBJECTS OF STUDY OF THE DISCIPLINES

In order to provide a comparison of the objects of study of the two disciplines, we postulate the existence of three distinct categories of objects of study:

1. **Metamodeling**, where the object of study is the **methods which are used to design and formulate models**. Metamodeling provides the epistemological framework for modeling (see below).
2. **Modeling**, where the object of study is the **design and formulation of models**.
3. **Implementation of Models**, where the object of study consists of the **application and direct use of the models**, derived earlier, to the real world.

The use of these three objects of study can be associated with the three levels of the metasystem paradigm (see van Gigch, 1984 and 1987a), where **Modeling** takes place at the **object level**, **Metamodeling** at the **metalevel**, and **Implementation** at the **lower level** of the hierarchy of control levels. See Figure 1.

On the basis of a study of the papers published in the professional journals of each discipline, distribution depending on whether they deal with the topic of Metamodeling, Modeling, or Implementation can easily be obtained.

It is hypothesized that the proportions of papers devoted to Metamodeling, Modeling, and to Implementation are, respectively, 10 percent, 50 percent and 40 percent in the OR/MS journals such as **Management Science** and **Operations Research**. These proportions are reversed to 40 percent, 50 percent and 10 percent in the GST journals such as **Systems Research, Behavioral Science**, and **General Systems**. See Table 1. (Note that no study or compilation of actual figures was carried out for this short essay.)

### COMPARISON OF THE OBJECTIVES OF THE DISCIPLINES

Two statements gleaned from current publications exemplify distinct objectives:

1. "**The Institute of Management Sciences** is an international society which seeks to identify, extend and unify scientific knowledge pertaining to management."
2. "**The International Society for General Systems Research** is an international organization for the development of theoretical systems."

Operations Research and Management Science came into being as disciplines whose objectives were directly



related to the improvement of the decision-making ability of management and managers. On the other hand, General Systems Theory was born with a more grandiose objective: that of producing a paradigmatic revolution. It wanted to turn away from the traditional and classical Scientific Method and create a new science of living and open systems which would be devoted to integrating, synthesizing and finding isomorphism across other disciplines.

We will not discuss whether these two distinct goals have been met or whether the respective disciplines have been successful in achieving their stated purposes. On the whole, it can be said that the disciplines can still be clearly distinguished by those two statements of intent. Accordingly, and for all intents and purposes, **the disciplines stand almost at opposite ends of the Pure Science-Applied Science spectrum.**

## COMPARISON OF THE METHODOLOGIES USED BY EACH OF THE DISCIPLINES

OR/MS has always insisted on the necessity of following the traditional Scientific Method. It demands from its practitioners that they follow the traditional Science Paradigm which goes from observations to theory and from hypotheses to experimentation and measurement, to finally end in generalizations, laws and predictions.

GST has been less traditional and has not insisted that its disciplines follow any established paradigm or scientific method. As a matter of fact, it repudiated the analytical reductionistic approach and adopted the holistic all-embracing Systems Approach.

It is possible to draw a list of the possible methodologies available and hypothesize the proportion used by each discipline. The methods include:

Methodology 1:

Treatises of a Conceptual Nature such as discussions of philosophical, epistemological and theoretical questions.

Methodology 2:

Solutions Through the Analysis of Models.

Methodology 3:

Experimental Methods (including laboratory and field experiments).

Methodology 4:

Participant-Observer Methods (including clinical methods, surveys and case studies).

The hypothesized proportion used by each discipline is shown in Table 2. While one can argue about the exact proportions, the intent is to give the reader an idea of rough trends.

On the basis of a perusal of current publications, we can conclude that OR/MS definitely favors the Methodology 2 (Solution Through the Analysis of Models) and uses the other methodologies in only a sprinkling of cases. GST favors Methodology 1 (Treatises of a Conceptual Nature) and uses the Solution Through the Analysis of Models sometimes, but seldom uses the other two methodologies.

## CONCLUSIONS

Based on the comparison of the objects of study, the objectives and the methodologies employed by both disciplines, the following conclusions can be drawn.

1. By not devoting enough intellectual effort to the study of **Metamodeling**, OR/MS is limiting the scope and extent of its own growth. A discipline withers if it does not pursue the development of its own epistemological foundations. (van Gigch, 1987b)

2. Based on the diametrically opposite positions which OR/MS and GST hold on the Pure-Science-Applied Science spectrum, it would seem appropriate to encourage both disciplines to move toward each other, i. e., to encourage OR/MS scientists to renew their conceptual and theoretical foundations, while the GST scholars should seek to complement their theoretical cogitations with more applied science and practical work.

3. The discipline of OR/MS is much too closely wedded to the use of one single methodology which consists of the Solution Through the Analysis of Models, thus restricting its innovative and creative thrust. It should regain some of the boldness of the early years by encouraging departure from its hallowed and traditional approach. On the other hand, GST accepts more esoteric and untried methodologies but only concentrates upon theoretical and conceptual approaches. GST's originality demonstrates vigor and vitality, but often runs the risk of reduced acceptance from the conservative scientific community.

4. The divergence between OR/MS and GST is not widening by design. It is natural that each discipline attracts scientists whose intellectual bent is closer to the ideal definition of what constitutes the object of study, objectives and methodologies characteristic of each. It would appear that, as was spelled out 10, 20 and even 30 years ago, both disciplines would probably benefit from more cross-fertilization. Neither of them can claim to be closer to the truth and consequently the pursuit of knowledge must be carried out along both paths.

## REFERENCES

1. van Gigch, John, "The Metasystem Paradigm as a new Hierarchical Theory of Organizations", Proceedings of the 1984 Annual Meeting of the Society for General Systems Research, New York City, May 1984. Also presented at ORSA/TIMS 1984 Annual Meeting, San Francisco, May 1984 under the name of "Strategic Planning as a Form of Metadesign". Reprinted in **General Systems**, vol. XXIX, 1985 - 86.
2. **van Gigch, John, Decision Making About Decision Making, Metamodels and Metasystems**, Tunbridge Wells, Kent, England, Abacus Press, 1987a.
3. van Gigch, John, "The Potential Demise of OR/MS: Consequences of Neglecting Epistemology", Sacramento, California, California State University, 1987b. Submitted for publication.

FIGURE 1

### Metasystem hierarchy applied to the objects of study

Metalevel	METAMODELING	MCR
Object Level	MODELING	CR
Lower Level	IMPLEMENTATION	CS



TABLE 1

**Hypothesized comparison of the proportion of articles published at each level of the metasystem hierarchy by OR/MS and by GST**

	Proportion of Articles Published at Each Level of the Metasystem Hierarchy	
	OR/MS	GST
METAMODELING	10 %	40 %
MODELING	50 %	50 %
IMPLEMENTATION	40 %	10 %

TABLE 2

**Hypothesized percentage distribution showing the methodologies used by each discipline**

	Percentage Utilization by each discipline	
	OR/MS	GST
1. Treatises of a Conceptual Nature	10 %	70 %
2. Solution Through the Analysis of Models	60 %	20 %
3. Experimental Methods	10 %	5 %
4. Participant-Observer Methods	20 %	5 %

## NEW BOOKS AND PUBLICATIONS

### A NEW PERIODICAL:

## JOURNAL OF NEW GENERATION COMPUTER SYSTEMS

Akademie-Verlag Berlin

First issue is scheduled to appear at the beginning of 1988.

Editor-in-Chief: Volker Kempe (Berlin)

Chairman of Editorial Board: B. N. Naumow (Moscow).

This journal will bring articles about all major activities leading to the development of computer systems with new properties and novel application areas. It will report on advances in realizing national and international research and development programs and projects, and in particular on the co-operation projects of the socialist countries.

#### Areas of interest:

Very large scale integration.

New design and manufacture technologies for computer systems.

Innovative architectures for various applications (computer vision, speech recognition etc.).

Artificial intelligence-based software engineering

Knowledge processing

Man-machine communication

Theory and artificial intelligence research

The journal will also include conference reports, book reviews, a calendar of events, etc.

### CONTRIBUTIONS

Papers presenting original research results or reporting technological progress will be considered for publication. We also welcome comprehensive surveys, state-of-the-art reports and short communications. Articles written in English or Russian can be submitted to:

W. Kolbe

Executing Editor of JNGCS

ZKI/AdW

Kurstraße 33, P. O. Box 1298

DDR Berlin 1086

German Democratic Republic

Subscription Information (the price was not available to us at time of Newsletter publication):

Akademie-Verlag Berlin

Leipziger Straße 3 - 4

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German Democratic Republic

## MEETINGS - DETAILED INFORMATION

### INITIAL ANNOUNCEMENT OF A CONFERENCE ON

## "Support, Society and Culture: mutual uses of Cybernetics and Science"

to be held in Amsterdam, Monday 27 March to Friday 1 April 1989

We chose this theme because of our strong conviction that a growing and yet resolvable problem exists concerning many notions and uses of science, especially in relation to cybernetics (more particularly, 2nd-order cyber-

netics), as experienced in the study of how they support society and culture. This relationship has rarely been explicitly examined as to its character and the benefits and difficulties deriving from it. It is maintained that, while both science and cybernetics continue to make valuable contributions, these are not always as mutually beneficial and supportive as they might be - the use they make of each other is often, unfortunately, better characterised as abuse - and that there is much lacking in their synergy: there is degradation as well as celebration.

Participants will be invited to consider this theme, both in the light of their personal experiences concerning social and cultural support systems and by analyzing the consequences of differences between cybernetics and science at aspirational, philosophical, methodological,



technical and tool-application levels. Thus, we will be, in a manner of speaking, writing the history of the future.

Although we will, in the Conference, permit the conventional presentation and publication of papers, this is not our primary intention. Rather, we hope to create an occasion for participants to celebrate by learning and teaching, creating, designing, describing – and just coming together. To help catalyse this, we want to invite several scholars to present short, provocative position papers some time in advance. These are meant to act as both primers and focussers around which events and contributions can develop.

Since we will be using up-to-the minute computing facilities, transcripts will become available during the progress of the conference, enabling participants to amend and/or clarify the texts. This material will then form the basis of a co-operative book.

The conference is being supported by:

1. the University of Amsterdam, Institute of Andragology

(from where it is being directed and where it will be held),

2. the Dutch System Group,
3. the American Society for Cybernetics and
4. the Cybernetics Society, London.

The chairpersons are Dr. Ranulph Glanville (University of Amsterdam and Portsmouth Polytechnic) and Prof. Dr. Gerhard de Zeeuw (University of Amsterdam). They will initially direct the conference.

A Preliminary Announcement will be published early in 1988 and mailed through contact lists and other conventional sources. All those who might be interested are invited to contact the conference co-ordinator, to make sure their names appear on the mailing list.

**Ms. Joop Muller**, Co-ordinator, Programma Ondersteuning, Overleving en Cultuur, IWA, Grote Bickersstraat 72, Amsterdam 1013 KS, The Netherlands, tel Amsterdam (20) 525-1250.

## CAST WORKSHOP 1988

**Johannes Kepler University Linz  
Institute of Systems Science**

**April 11 – 13, 1988**

(following EMCSR 88, University of Vienna, April 5 – 8, 1988 and GAMM 88, Technical University of Vienna, April 5 – 9, 1988)

### Announcement and “Call for Participation”

An important aim of Systems Research is to provide interactive method banks for the application of systems-theoretical methods. As a contribution toward the realization of this goal the CAST Workshop 1988 will consider the following topics:

1. Collection of knowledge on existing CAST method banks – Reports on such installations and their applications.
2. Investigation of research topics necessary for CAST – Reports on current CAST research
3. Investigation of fields in which CAST applications seem to be promising
4. Planning of EUROCAST'89, an international CAST Conference which we have tentatively scheduled to take place at the Johannes Kepler University Linz, March 28 – 30, 1989.

### Workshop Participants:

Researchers from Universities and Industry, who are interested in CAST research

### Place:

Johannes Kepler University Linz and Haus “Waldheimat”, Gallneukirchen (11 km from the University)

### Accommodation:

Gästehaus “Waldheimat”, A-4210 Gallneukirchen

### Costs:

The costs for room and board are modest:

full board/day AS 265/person (if sharing a room)

AS 295/person (single)

For a limited number of participants we will be able to completely refund the costs (application required). There is no registration fee.

The workshop will be organized by the

**Division of Systems Theory and Information Engineering  
Institute of Systems Science**

**Johannes Kepler University Linz**

**A-4040 Linz/Austria**

Phone (0043) (732) 2468-896

Researchers interested in participating in the CAST workshop 1988 are kindly requested to submit the registration form no later than March 28, 1988.

Since we have to limit the number of participants to 20, please apply as soon as possible.

## LIST OF MEMBERS OF IFSR – UPDATED JANUARY, 1988

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American Society for Cybernetics  
Dr. Laurence D. Richards  
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George Mason University  
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\*Address seems incorrect!

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Libertad 742

1640 Martinez  
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Austria

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Design Methodology Unit  
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Polish Academy of Sciences  
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John v. Neumann Society For  
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(Telex: + 22-5369)

## MEETINGS and COURSES

Title	Date 1988	Place	Deadlines	Further Information
Ninth European Meeting on Cybernetics and Systems Research	5 – 8 April	Vienna Austria	15 Oct. 1987	Prof. Robert Trappl Dept. of Medical Cybernetics & AI Freyung 6 A 1010 Vienna, Austria
Workshop on CAST Computer aided Systems Theory	11 – 13 April	Linz Austria		Prof. Franz Pichler Johannes Kepler Universität Linz A 4040 Linz, Austria Tel. (0043) (732) 2468-896
4th International Software Process Workshop	11 – 13 May	Devon England	16 Oct. 1987	Colin Tully STC Technology Limited London Road Harlow Essex CM 17 9NA, U. K.
1988 National Meeting International Society for General Systems Research (IGSR)	23 – 27 May	Omni Hotel St. Louis Missouri USA	–	Jamshid Gharajedaghi Program Chairman Interact 3440 Market St. Suite 320 Philadelphia, PA 19104, USA
International Conference Culture, Language and Artificial Intelligence	30 May – 3 June	Stockholm Sweden	–	Maritta Nilsson Box 5606 S 11486 Stockholm, Sweden Tel. (8)-7909500 (Birger Viklund)
cyberNET '88 The Silver Anniversary Conference of the American Society of Cybernetics	15 – 19 June	University of Victoria, Victoria, B. C. Canada	Abstracts 31 Jan 1988	Programme Committee CYBERNET'88 c/o University Extension Conference Office P. O. Box 1700 Victoria, B. C. V8W 2Y2 Tel. (604) 721-8465
Ninth European Workshop on Application and Theory of Petri Nets	22 – 24 June	Venice Italy	15 Jan. Abstracts 15 May Papers	Giorgio De Michelis Dipartimento de Scienze dell' Informazione Università de Milano Via M. da Brescia 9 I 20133 Milano, Italy
4th International Conference on System Science in Health Care	4 – 8 July	Lyon France	Sept. 1987 Abstracts Dec. 1987 typed papers	G. Duru, director G. S. Sante Lyon 1, Bat. 101 43 BD DU 11 novembre 1918 F 69622 Villeurbanne France

Title	Date 1988	Place	Deadlines	Further Information
Systems Prospects: The next ten years of systems Research (Conference)	12 – 15 July	Hull U. K.	Abstracts 31. March	M. C. Jackson Dept. of Management Systems and Sciences University of Hull HU 6 7 RX, United Kingdom
International Conference on System Science and Engineering (ICSSE '88)	25 – 28 July	Beijing (Peking) People's Republic of China	Abstracts 15 Sept 1987 Papers: 15 Febr. 1988	Prof. Wei-Min Cheng, Chairman International Programme Committee of ICSSE '88 Department of Automation Tsinghua University Beijing 100084, China
European Conference on Artificial Intelligence	1 – 5 August	Munich F. R. Germany	15 Febr.	Prof. Dr. Bernd Radig Technische Universität München ECAI-88 Institut für Informatik Postfach 20 24 20 D 8000 München 2, F. R. Germany
Working Conference on Office Information Systems The Design Process	15 – 17 August	Linz Austria	15 Febr.	Roland Wagner Johannes Kepler University A 4040 Linz, Austria Papers: Dr. Barbara Pernici Dipartimento di Elettronica Politecnico di Milano Piazza Leonardo da Vinci, 32 I 20133 Milano, Italy
4th IFAC Symposium Computer Aided Design in Control and Engineering Systems	23 – 25 August	Beijing (Peking) People's Republic 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	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
13th Symposium on Operations Research	7 – 9 Sept.	Paderborn F. R. Germany	15 Febr.	SOR-PB Universität – GH Paderborn D 4790 Paderborn, F. R. Germany
3rd International Symposium on System Analysis and Simulation	12 – 16 Sept.	Berlin DDR (East Germany)	Abstracts: 1. Dec. 1987 Papers: 1 May 1988	Mrs. Böttcher Zentralinstitut für Kybernetik und Informationsprozesse Kurzstraße 33 1086 Berlin, DDR
33rd Institute for Medical Informatics Conference Topic: Expert Systems and Decision Support in Medicine	26 – 29 Sept	Hannover F. R. Germany		Ms. U. Piccolo Medical School Hannover Institute for Medical Informatics P. O. B. 61 01 80 D 3000 Hannover 61, F. R. Germany Tel. (0511)-532-2540
3rd International Workshop on Spectral Techniques	4 – 6 Oct.	Dortmund F. R. Germany	2 April	Claudio Moraga Dept. Computer Science University of Dortmund P. O. Box 500500 D 4600 Dortmund 50, F. R. Germany
Conference on Support, Society and Culture— mutual uses of Cybernetics and Science	<b>Date 1989</b> 27 March to 1 April	Amsterdam, Netherlands		Ms. Joop Muller Co-ordinator, Programma Ondersteuning, Overleving en Cultuur IWA Grote Bickerstraat 72 Amsterdam 10013 KS, The Netherlands Tel. Amsterdam (20) 525-1250
Beijing International Conference on System Simulation and Scientific Computing	15 – 18 August	Beijing (Peking) People's Republic of China	Abstract or Paper 15 March 1988	Chinese System Simulation Council Beijing Institute of Aeronautics and Astronautics Beijing, China

#### Offenlegung:

Der "IFSR Newsletter" erscheint in unregelmäßigen Abständen in englischer Sprache unter der Redaktion von Dr. Stephen Sokoloff. Die Zeitschrift dient der Information über die Aktivitäten der IFSR. Sie wird kostenlos an Mitglieder ihrer insgesamt 17 Mitgliedsorganisationen in 14 Länder versandt. Die Kosten werden von der IFSR aus den Beiträgen der derzeit 17 Mitgliedsorganisationen getragen.

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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