

Schmidt, Reinhart

Working Paper — Digitized Version

The design of interactive coordination games

Manuskripte aus den Instituten für Betriebswirtschaftslehre der Universität Kiel, No. 88

Provided in Cooperation with:

Christian-Albrechts-University of Kiel, Institute of Business Administration

Suggested Citation: Schmidt, Reinhart (1980) : The design of interactive coordination games, Manuskripte aus den Instituten für Betriebswirtschaftslehre der Universität Kiel, No. 88, Universität Kiel, Institut für Betriebswirtschaftslehre, Kiel

This Version is available at:

<https://hdl.handle.net/10419/190921>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Nr. 88

The Design
of Interactive Coordination Games

Reinhart Schmidt

November 1980

Paper presented to the 2nd French-German Round Table
on Empirical Decision Theory, Nov. 12-14, 1980 in
Aix-en-Provence

1. Introduction

Decentralization and interdependence of activities within organizations, especially within firms, leads to practical and theoretical interest in coordination. Following the coalition approach to organizations, the coordination of decisions has to take into account the existence of a system with several objectives. Thus, coordination is not only the adjusting of decisions to a single objective but also the adjustment to a value system. This adjustment can be the result of a centralized or decentralized procedure, the procedure being characterized by a formation of expectations or by feedback between the decision units [see Kirsch (1971)]. In the following we exclude the formation of expectations about the decisions of the other decision units from our definition of coordination. Coordination then means a centralized or decentralized procedure with a formal feedback to meet the requirements of the objective system.

Empirical research on coordination can be undertaken by

- field research
- role playing [see Klimoski (1978)]
- and
- gaming.

In the following we restrict ourselves to gaming, especially to computerized games in which the players interact by a man-machine-dialogue. The games are executed as laboratory experiments. As a result, we are interested in

- the efficiency of different coordination mechanisms
- the influence of personal behavior, and
- the interaction effects between coordination mechanisms and persons.

Interactive coordination games must be designed in the awareness of such a number of degrees of freedom, so that the main part of this paper is limited to the description and discussion of the design factors. As an example,

the structure of KOKOS - an interactive coordination game implemented at the University of Kiel ¹⁾ - will be demonstrated.

2. Aspects of Design

Following the definition of interactive coordination games given above, we look at economic, behavioral, and computer aspects of the game design. We also include aspects of documentation and analysis in research.

2.1. Economic aspects

The economic aspects are the main factors due to the fact that we are economic researchers. First, we have to look at the objective system. Results of empirical research on firm objectives show [see Hauschildt (1977)] that the structuring of the objective system is a complex task. One should allow several objectives for each decision unit within the firm, so that in general a multilevel multiobjective system must be constructed. Moreover we must be able to change the objective system over time [see Schmidt (1980)]. Thus, the traditional assumption of a profit maximizing firm with several divisions, acting as a team, is a very special case.

Secondly, the instruments of coordination must be regarded. These instruments are part of organizational policy so that all instruments of organizational design should be included. In the short-run one has to regard motivation, information, and control [see Albach (1974)]; in the long-run personnel management and reorganization must be added. Thus, we can construct the following catalogue for design.

1. Motivation

- a) pecuniary (see the problem of monetary incentives in the literature on laboratory experiments)
- b) other incentives (difficult to operationalize in laboratory games).

1) Financial support for the project was granted by the Deutsche Forschungsgemeinschaft.

2. Information

- a) structure of information [for different structures with respect to teams or coalitions see Albach (1967)]
- b) transfer mechanisms
 - transfer prices [see Drumm (1973)]
 - shadow prices
 - exogenous prices
 - cost-oriented prices
 - negotiated prices
 - assignment rules for volumes of resources, including auctions and bidding [see Olve (1977), Schmidt (1978), Güth (1979)]
 - combination of transfer prices and assignment rules [see Rabenstein (1979)].

3. Controlling

- ex post
- within the process of coordination
- ex ante
 - orientation at past deviations
 - demand for justification if some degree of deviation is planned by the decision unit
 - with respect to personality factors.

4. Personnel management

- exchanging employees
- changing the structure of salaries and wages
- management training,

5. Reorganization

- changing the number and/or functions of decision units [see Carzo (1974)]
- changing the structure of the decision process
- changing the composition of decision committees and their negotiation procedures.

When constructing games for experimental research, one must look at the possibility of controlling the interacting factors. Therefore one should select a proper set of factors, the others being excluded from the actual design. A flexible gaming system should be able to construct different games by composition of distinct factor combinations.

2.2. Behavioral Aspects

There are many behavioral aspects that could be considered for the construction of a business game [see for instance Carlson/Misshauk (1972)]. We concentrate on categories that can be operationalized for experimental research.

1. Negotiation behavior [see Huppertsberg (1972), Lamm (1975), Müller/Crott (1979)].
2. Group decision behavior [Edström (1974), Hart/Sung (1976)].
3. Coalition formation [Levinsohn/Rapoport (1978)].
4. Structure of personality and behavior [see different personality inventories].
5. Behavior and context.

For the conduction of games, the differences between categories of people must be considered with respect to the validity of results [see Babb (1977)]. Additionally the special influence of gaming as opposed to deciding in reality [see Schlenker/Bonoma (1978)] and of computer usage [see Johnson/Baker (1973)] must be taken into account.

2.3. Computer Game Aspects

Arranging experimental games by computer enables quicker playing and better documentation for subsequent analysis. There are many examples of computerized games [see for instance Barton (1970), Hoggatt (1972), and Greenblatt/Duke (1975).]

The first question - of special importance for research - is the complexity of the game. Though computer application allows for a high complexity, this complexity reduces the possibilities of testing hypotheses. Thus, the design procedure should be to install some problem elements of the real world [see Walaszek (1975)], but to keep the game simple. This outline will lead to so-called matrix games [see Křivohlavý (1974) and Dornette/Pulkowski (1974)]. Table 1 shows an example of a decision matrix with nine decision fields.

Table 1: Example of Decision Alternatives in a Matrix Game

Resource 2 Resource 1	Demand 2.1	Demand 2.2	Demand 2.3
Demand 1.1	Goal Score 1.1/2.1	Goal Score 1.1/2.2	Goal Score 1.1/2.3
Demand 1.2
Demand 1.3

The simplification of the problem structure by matrix games does not imply that gaming is an inflexible approach to experimental research. By using techniques of flexible planning software [see Schmidt/Janowski (1979)] it is easily possible to reorganize the mathematical problem structure, which may have resulted in the matrix of the special game. Thus, the approach of constructing gaming systems is recommended here: A special game is established by combining game modules. The same approach is to be found in industrial computerized modeling [see Schmidt/Janowski (1979)].

The interaction of players on a dialogue basis creates special computer problems. Figure 1 shows the process of interaction over the rounds of a multiperiod game. In KOKOS each of the three players interacts with the machine by terminal. When all players have finished their decisions, headquarters - represented by a program - evaluates the decisions of the decision units.

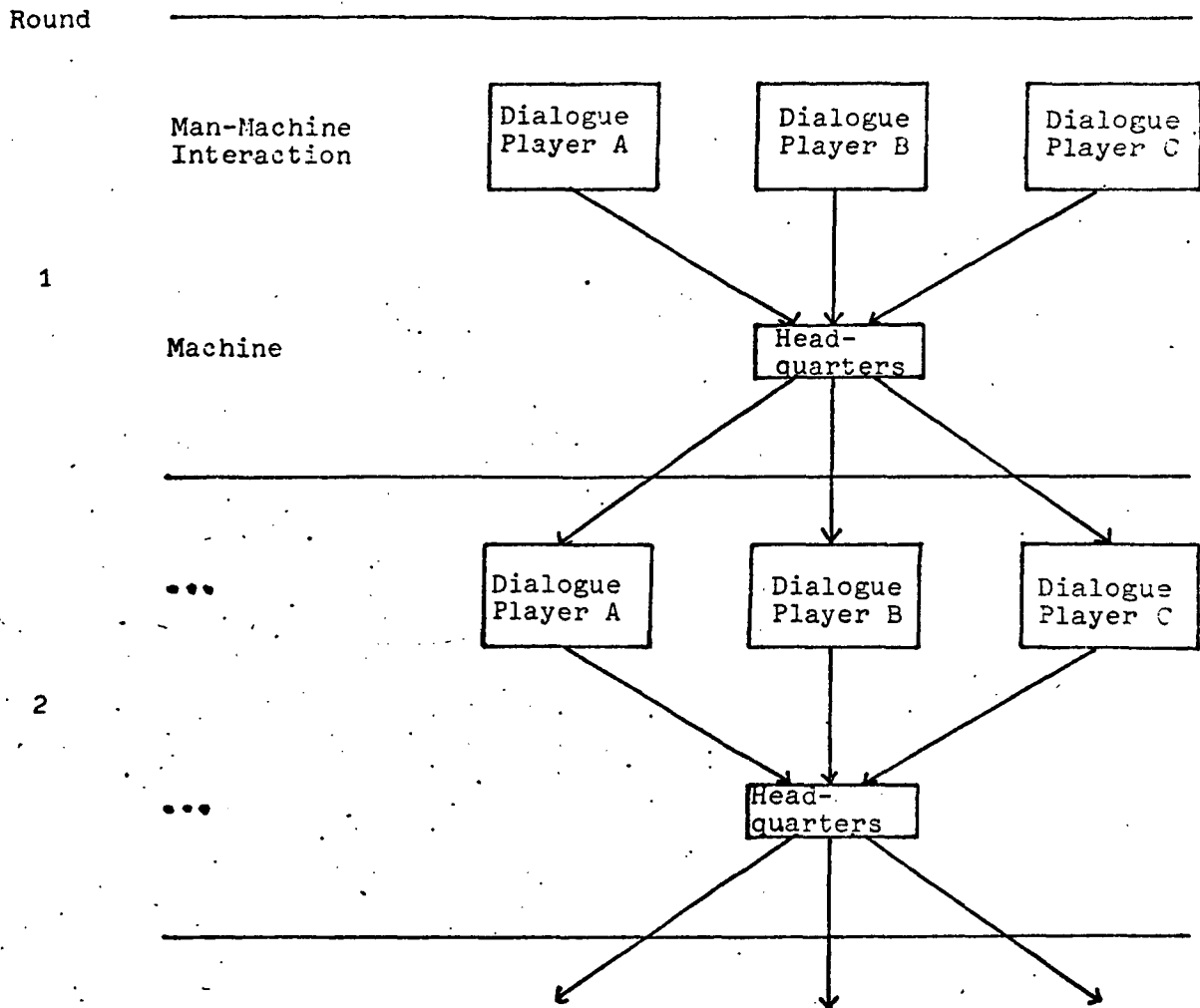


Figure 1: Dialogue Structure of a Coordination Game

While Figure 1 assumes three separated dialogues between players and the machine, a further development would be the application of computer conferencing.

Once established, interactive games can be used for other purposes than experimental research, too. Firstly, the game may be part of a management training program.

Secondly, playing alternative games within a gaming system may be a device for academic teaching. Thirdly, and that may be the most interesting point, research can be done by assuming fictitious players [see Emshoff (1970)]. The players can be "designed" by following predetermined strategies [see Schmidt (1978)]. Thus, one can do research in applied game theory or compare the results of fictitious players with those of persons in laboratory experiments.

2.4. Aspects of Documentation and Analysis in Research

Computerized gaming by laboratory experiments allows for a clear experimental design [see Figure 2]. The inquiries of the players can be accomplished by manual or automated questionnaires. In the future it will be possible to perform interviews by man-machine-dialogue.

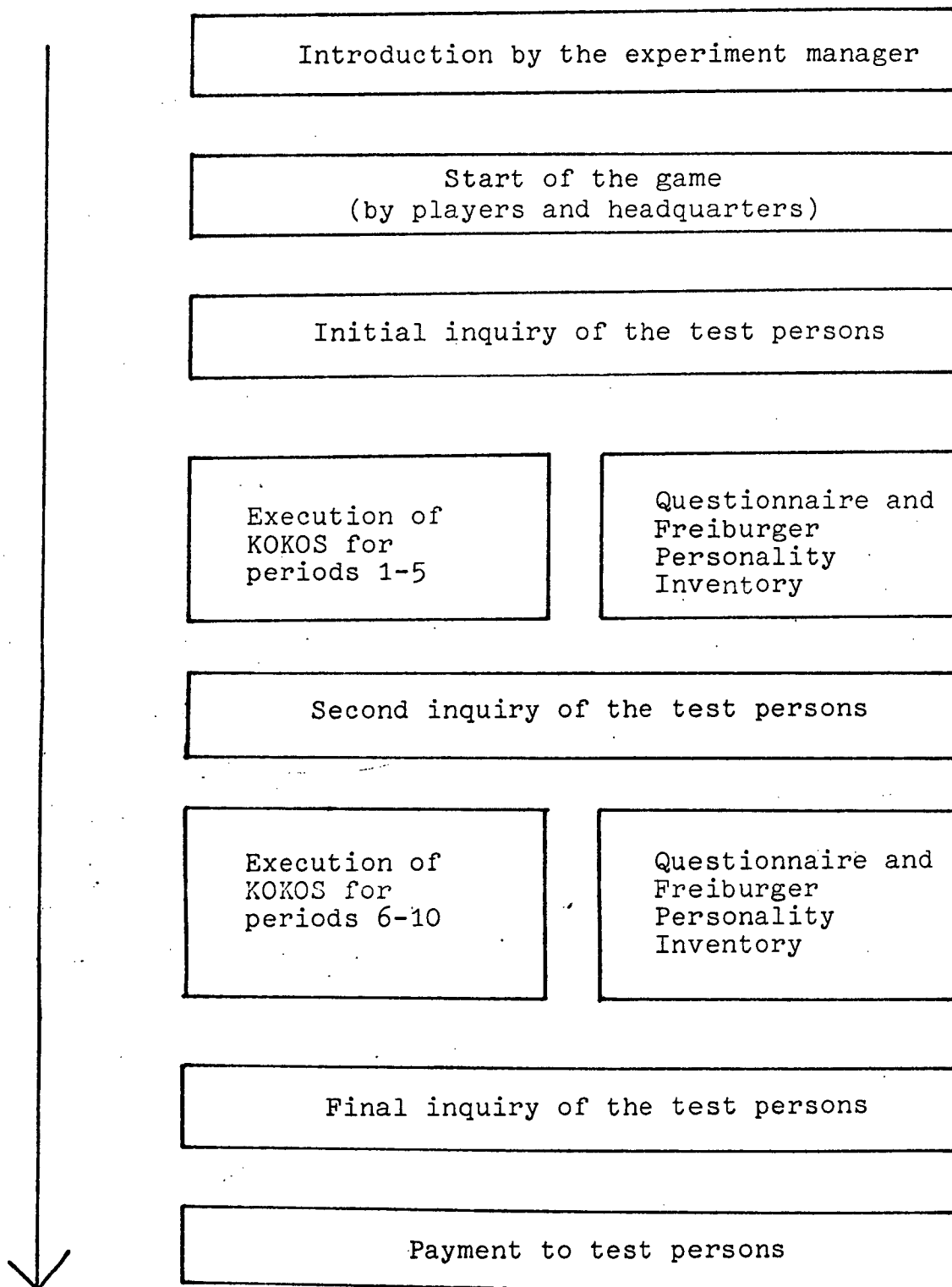


Figure 2: Process of an Experiment

As Figure 3 shows, there are several possibilities to analyse the documented experiments. Especially it is possible to perform computer-based analyses. This guarantees more reliable, safer, and quicker research.

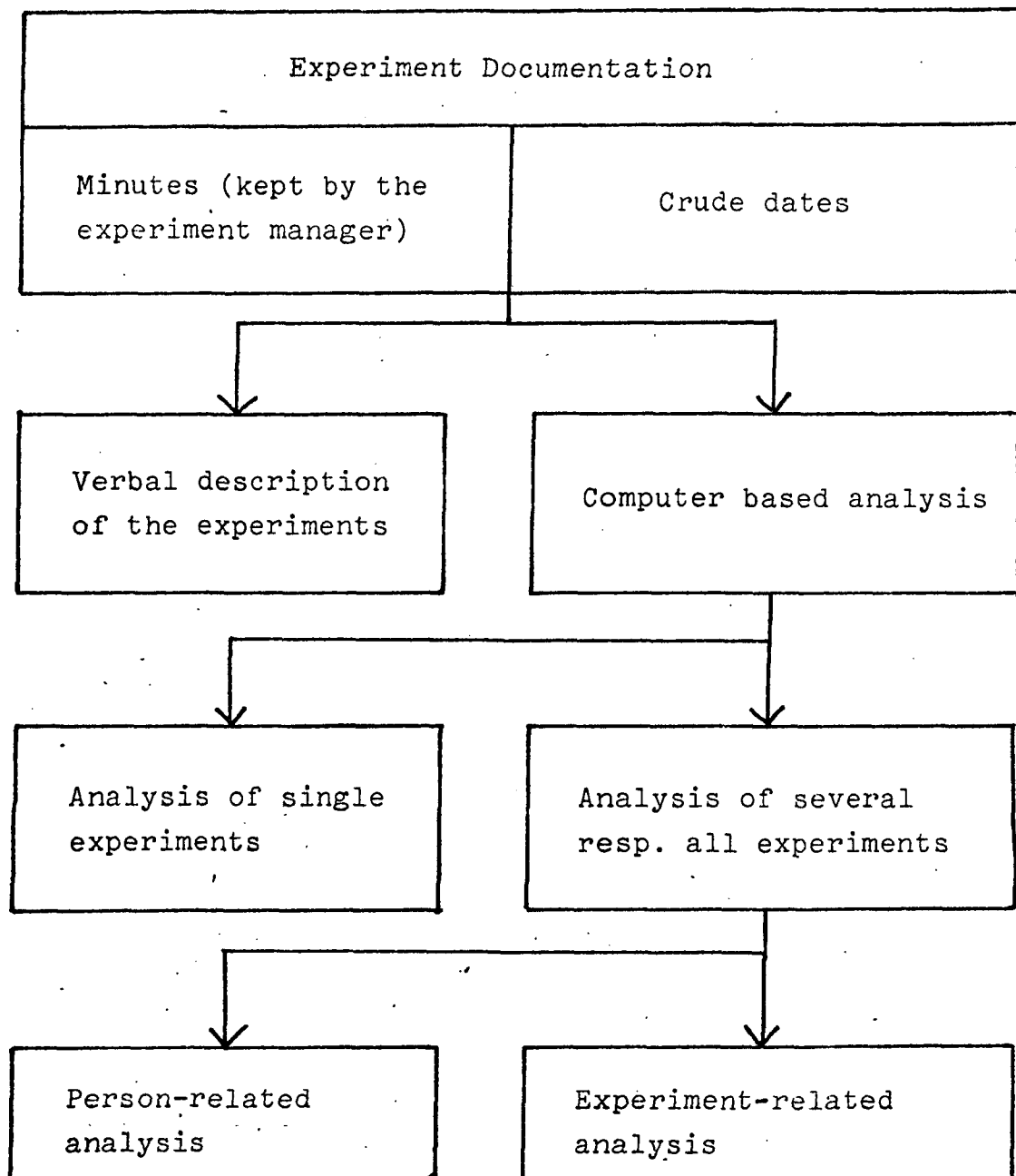


Figure 3: Possibilities for Analysis of Experiments

The documentation of all decisions enables the researcher to replay the games, and perhaps to change strategies up from a certain round. Table 2 shows an output which is presented as a result to the players at the terminal (translated into English).

Table 2: KOKOS - Firm Results per Period over Time

PERIOD	1	2	3	4	5
DEMAND MIN (T)	3300.00	2900.00	1800.00	3000.00	1300.00
DEMAND MAX (T)	4500.00	3100.00	2000.00	3000.00	3500.00
ASSIGNED	3000.00	2900.00	2000.00	3000.00	3000.00
=====					
INVESTMENT	2000.00	2000.00	500.00	1500.00	1500.00
DEPRECIATION (T)	1480.00	1880.00	1980.00	2280.00	2580.00

FIXED ASSETS (T)	5920.00	6040.00	4560.00	3780.00	2700.00
=====					
DECAY OF RAW MATERIALS	0.00	0.00	0.00	44.01	97.99
INCOMING STOCKS	1000.00	900.00	1500.00	1500.00	1500.00
CONSUMPTION	1000.00	900.00	1411.99	1348.00	1243.99

STOCK OF RAW MATERIALS (T)	0.00	0.00	88.01	196.00	354.01
=====					
CONTRIBUTION MARGIN (T)	2233.00	2700.00	2974.01	2846.00	2638.00
DEPRECIATION (T)	1480.00	1880.00	1980.00	2280.00	2580.00
SALARIES (T)	30.00	30.00	30.00	30.00	30.00

GROSS(T)	723.34	790.00	964.01	536.00	28.01
PREMIUM (T)	223.33	270.00	288.60	265.00	228.40

EBIT (T)	500.01	520.00	675.41	271.00	-200.39
INTEREST	236.80	241.60	182.40	151.20	108.00
TAXES	105.28	111.36	197.20	47.92	0.00
EAT (T)	157.93	167.04	295.81	71.88	-308.39
EAT ACCUMULATED	157.93	324.97	620.78	692.66	384.27
RETAINED EARNINGS	157.92	324.96	620.77	692.65	76.85
=====					
POSSIBLE PREMIUM (T)	126.34	259.97	496.61	554.12	307.41

SCORE	253.33	553.34	871.94	1166.94	1732.76

3. Conclusion

The design of interactive coordination games has been described and discussed. The approach of a gaming system, which allows for a combination of gaming modules, is a necessary reply to the multiplicity of design factors. This approach enables the researcher to study human decision behavior and the efficiency of organizational instruments under controllable conditions. The introduction of man-machine-interaction in the study of group behavior will lead to more efficient research on interaction between human beings.

oOo

Literature:

- Albach, H., "Die Koordination der Planung im Großunternehmen," in: Schneider, E. (ed.), Rationale Wirtschaftspolitik und Planung in der Wirtschaft von heute, Berlin 1967, pp. 332-438.
- Albach, H., "Innerbetriebliche Lenkpreise als Instrument dezentraler Unternehmensforschung," Zeitschrift für betriebliche Forschung, Vol. 26 (1974), pp. 216-242.
- Anzai, Yuichiro, "Recognition of Coalition by Computer in a Three-Person Game," Behavioral Science, Vol. 22 (1977), pp. 403-422.
- Babb, E.M., M.A. Leslie, and M.D. van Slyke, "The Potential of Business-Gaming Methods in Research," Journal of Business, Vol. 39 (1966), pp. 465-472.
- Banker, R.D., "A game theoretic approach to measuring efficiency," European Journal of Operational Research, Vol. 5 (1980), pp. 262-268.
- Barton, R.F., A Primer on Simulation and Gaming, Englewood Cliffs, New Jersey: Prentice-Hall 1970.
- Brown, G.W., "Iterative Solution of Games by Fictitious Play," in: Koopmans, T.G. (ed.), Activity Analysis of Production and Allocation, New York: Wiley and Sons 1951, pp. 374-376.
- Carlson, J.G.H., and M.J. Misshauk, Introduction to Gaming: Management Decision Simulations, New York: Wiley and Sons 1972.
- Carzo, R., and J.N. Yanouzas, "Auswirkungen flacher und tiefer Organisationsstrukturen," in: Eisenführ, F. et al. (eds.), Unternehmensspiele in Ausbildung und Forschung, Wiesbaden: Gabler 1974, pp. 179-205.
- Dornette, W., and H.B. Pulkowski, Konfliktspele, München: Ernst Reinhardt 1974.
- Drumm, H.J., "Zu Stand und Problematik der Verrechnungspreisbildung in deutschen Industrieunternehmen," Zeitschrift für betriebswirtschaftliche Forschung, special issue 2 (1973), pp. 91-107.
- Edström, A., "Untersuchung des Gruppenentscheidungsverhaltens in einem Unternehmungsspiel," in: Eisenführ, F. et al. (eds.), Unternehmensspiele in Ausbildung und Forschung, Wiesbaden: Gabler 1974, pp. 239-255.
- Eisenführ, F., and G. Puck, "Das System XPER.D - ein neuer Ansatz für Unternehmungsspiele," Zeitschrift für betriebswirtschaftliche Forschung, Vol. 26 (1974), pp. 591-612.
- Emshoff, J.R., "A Computer Simulation Model of the Prisoner's Dilemma," Behavioral Science, Vol. 15 (1970), pp. 304-317.

- Greenblatt, C.S., and R.D. Duke, Gaming-Simulation: Rationale, Design and Applications, New York - London - Sidney - Toronto: Wiley and Sons 1975.
- Güth, W., "Kriterium für die Konstruktion fairer Aufteilungs-
spiele," in: Albers, W. et al. (eds.), Entscheidungen in
kleinen Gruppen, Königstein/Ts.: Hain 1979.
- Hart, E.W., and Y.H. Sung, "Systems Simulation - Computer
and Experimental Simulation of Triad Decision Making,"
Behavioral Science, Vol. 21 (1976), pp. 532-547.
- Hauschildt, J., Entscheidungsziele, Tübingen: Mohr 1977.
- Hoggatt, A., "On Economic Experiments in Economics," in:
Sauermann, H. (ed.), Beiträge zur experimentellen Wirt-
schaftsforschung, Vol. 3, Tübingen: Mohr 1972, pp. 6-28.
- Huppertsberg, B., Verhandlungsspiele als Instrument explo-
ratorischer Forschung, Aus dem Sonderforschungsbereich 24,
Universität Mannheim 1972.
- Johnson, E.S., and R.F. Baker, "Computers in Behavioral Science
- The Computer as Experimenter: New Results," Behavioral
Science, Vol. 18 (1973), pp. 377-385.
- Kirsch, H., "Die Koordination von Entscheidungen in Organi-
sationen," in: Zeitschrift für betriebswirtschaftliche
Forschung, Vol. 23 (1971), pp. 61-82.
- Klimoski, R.J., "Simulation Methodologies in Experimental
Research on Negotiations by Representatives," Journal of
Conflict Resolution, Vol. 22 (1978), pp. 61-77.
- Křivohlavý, J., Zwischenmenschliche Konflikte und experimen-
telle Spiele, Bern - Stuttgart - Wien: Huber 1974.
- Lamm, H., Analyse des Verhandelns, Ergebnisse der Sozial-
psychologischen Forschung, Stuttgart: Enke 1975.
- Levinsohn, J.R., and A. Rapoport, "Coalition Formation in
Multistage Three-Person Cooperative Games," in: Sauermann,
H. (ed.), Coalition Forming Behavior, Tübingen: Mohr 1978,
pp. 107-144.
- Müller, G.F., and H.W. Crott, "Der Einfluß der Verhandlungs-
praxis in gemischt erfahrenen Gruppen," in: Albers, W. et al.
(eds.), Entscheidungen in kleinen Gruppen, Königstein/Ts.:
Hain 1979.
- Olve, N.-G., Multiobjective Budgetary Planning, Models for
Interactive Planning in Decentralized Organizations,
Stockholm: EFI 1977.
- Rabenstein, H.-U., Dezentrale Planung, Königstein/Ts.:
Hain 1979.

Schelling, T.C., "The Strategy of Conflict. Prospectus for a reorientation of game theory," *Journal of Conflict Resolution*, Vol. 2 (1958), pp. 203-264.

Schlenker, B.R., and T.V. Bonoma, "Fun and Games - The Validity of Games for Study of Conflict," *Journal of Conflict Resolution*, Vol. 22 (1978), pp. 7-39.

Schmidt, R., "Flexibility of Corporate Planning Models in Case of Changing Objectives," in: *Nijenrode Studies in Business*, Vol. 5: Capital Budgeting under Conditions of Uncertainty, Boston: Martinus Nijhoff 1980.

Schmidt, R., "Zur Dekomposition von Unternehmensmodellen," *Zeitschrift für Betriebswirtschaft*, Vol. 48 (1948), pp. 949-966.

Schmidt, R., and W. Janowski, "PLASMA II - An Interactive Modeling System for Mathematical Programming," *Manuskripte aus dem Institut für Betriebswirtschaftslehre der Universität Kiel*, September 1979.

Shubik, M., *Games for Society, Business and War*, New York: Elsevier 1975.

Shubik, M., G. Brewer, and E. Savage, *The Literature of Gaming, Simulation, and Model-Building: Index and Critical Abstracts*, Santa Monica: Rand Corporation 1972.

Shubik, M., *The Uses and Methods of Gaming*, New York: Elsevier 1975.

Walaszek, Z., "On Methodology of Gaming: Testing Theories in the Absence of Field Research," *The Polish Sociological Bulletin*, No. 1-2 (1975), pp. 49-58.