COLLECTIVE ACTION, COMMUNICATION AND PERCEPTION
TOWARDS A UNIFIED DYNAMIC THEORY

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PREFACE

THIS BOOK BEGINS AT THE LEVEL OF THE INDIVIDUAL. IT BELONGS TO THE STREAM OF WORKS THAT DEAL WITH SOCIAL ACTION; HOWEVER, IT HAS NOTHING IN COMMON WITH SOCIOLOGICAL FUNCTIONALISM.

IT HAS ITS FOUNDATIONS IN PSYCHOLOGY AND RECENT PSYCHIATRIC RESEARCH WORKS. ITS SOCIOLOGICAL BASIS IS JAMES S. COLEMAN'S THEORY OF COLLECTIVE ACTION.

THE EXACT RESULTS ON THE STRUCTURE OF HUMAN ACTION, COMMUNICATION AND PERCEPTION ARE REPRESENTED IN TERMS OF MATHEMATICAL SYSTEM THEORY.

THROUGHOUT THIS WORK MAN IS NEITHER CONCEIVED AS A PRODUCT OF HIS ENVIRONMENT, NOR AS THE OMNIPOTENT ARCHITECT OF HIS FUTURE. HE IS CONCEIVED AS BOTH: A PRODUCT AND A CREATOR.

THE ELEMENTS OF THE THEORY ARE SIMPLE:
THERE ARE ACTORS, EVENTS AND MESSAGES.
THE ACTORS ARE INTERESTED IN THE EVENTS, AND THEY TRY TO GAIN CONTROL OVER THEM.
POWER TURNS OUT TO BE A PRODUCT OF BOTH.
COLLECTIVE CONTROL IS ARRANGED THROUGH 'WEAK MESSAGES'.
WHAT IS CURIOUS ABOUT THE 'WEAK MESSAGES' IS THAT THEY ARE BUILT UP BY INFORMATION AND INSTRUCTION. DURING A WEAK INTERACTION THE EFFORT OF AN ACTOR IS NEVER DIRECTED TOWARDS TRYING TO CONVINCE ANOTHER ACTOR. INSTEAD, COLLECTIVE ACTION WHICH IS BROUGHT ABOUT BY WEAK INTERACTION INVOLVES NEGOTIATIONS, I. E. THE EXCHANGE OF INFORMATION, INSTRUCTIONS AND AGREEMENTS.
THERE EXIST NEGOTIATIONS WHERE THE ACTORS DIRECT THEIR EFFORTS TOWARDS TRYING TO CONVINCE OTHER PLAYERS OF THE UTILITY OF CERTAIN ACTIONS. IN THIS CASE THE INTERACTION IS SAID TO BE MOTIVATING. COLLECTIVE ACTION WHICH IS BASED ON THE EXCHANGE OF MOTIVATING MESSAGES

INVOLVES TIME EVOLUTION OF THE INTERST MATRIX.
A THIRD CASE OF COLLECTIVE ACTION APPEARS WHEN THE EXCHANGE OF MESSAGES IS PARADOX. THEN THE ACTORS HAVE TO FACE AMBIGUITY AND DISCONFIRMATION. IT IS THE RESULT OF PSYCHIATRIC WORKS THAT THE EXCHANGE OF PARADOX MESSAGES LEADS TO THREATENING FORMS OF SOCIAL BINDING (DOUBLE BIND).
THROUGHOUT THIS EXPOSITION THIS MODE OF COMMUNICATION WILL BE CALLED 'STRONG INTERACTION'.
WHAT IS SO CURIOUS ABOUT THIS MODE OF INTERACTION ?
ACTORS WHO ARE ENTANGLED WITHIN DOUBLE BINDS CANNOT REALIZE THEIR INTERESTS SUFFICIENTLY. THUS, THEY HAVE TO LOSE CONTROL WITHIN THE EXCHANGE UNLESS THE DOUBLE BIND IS CANCELLED.
COLLECTIVE ACTION UNDER STRONG INTERACTION INVOLVES IRRATIONAL ACTION.
IN THE FIRST PART OF THE BOOK, THE CLASSICAL CONCEPTS OF INTEREST AND CONTROL ARE RECONSIDERED.
IN SYSTEM THEORY THERE EXIST CONCEPTS OF CONTROLLABILITY. THEREFORE ONE MUST ASK THE QUESTION, WHETHER COLEMAN'S CONCEPT OF CONTROL, AND THE CONTROL MATRIX RESPECTIVELY HAVE SOMETHING IN COMMON WITH THE CYBERNETIC CONTROLLABILITY MATRIX. IT TURNS OUT THAT THE RELATIONSHIP IS A QUITE NATURAL ONE.
ONE OF THE MAIN RESULTS WHICH IS INDUCED BY THE CONTROLLABILITY THEOREM CAN BE STATED AS FOLLOWS:
'MARKETS WHERE WE FIND MANY EVENTS WITH EQUALLY DISTRIBUTED INTERESTS RELATIVE TO THE ACTORS, AND WHERE MANY ACTORS POSSESS EQUALLY DISTRIBUTED CONTROLS RELATIVE TO THE EVENTS CAN HARDLY BE CONTROLLED UNLESS THE EQUIVALENCE OF THE EVENTS AND THE ACTORS IS SCREENED.
THE SECOND PART OF THE BOOK DEALS WITH THE COUPLING BETWEEN COLLECTIVE ACTION, COMMUNICATION AND PERCEPTION.

HERE, THE THREE MAIN MODES OF INTERACTION, I. E. WEAK INTERACTION, INTEREST CHANGING INTERACTION, AND STRONG INTERACTION ARE DESCRIBED.
POSSIBILITIES CONCERNING THE IDENTIFICATION OF COMMUNICATION SYSTEMS ARE CONSIDERED - AMONG OTHERS A QUANTUMFIELD THEORETIC MODEL.
COLLECTIVE ACTION IS DRIVEN BY A MATRIX OF INDIVIDUAL INTERESTS. EACH ACTOR'S INTEREST GIVES EXPRESSION TO HIS EXPECTATION CONCERNING THE OUTCOME OF AN EVENT. DISCREPANCIES BETWEEN ACTUAL OUTCOMES AND SUBJECTIVELY EXPECTED OUTCOMES CAUSE FRUSTRATION.
ONE CHAPTER IS DEDICATED TO THOSE DISCREPANCIES AND THEIR MEASURES.
WITHIN THE LAST CHAPTER WE DEAL WITH THE PSYCHOLOGICAL STATE OF NON-SEPARATIVE PERCEPTION AND INTEGRATED ACTION. THIS CHAPTER IS BASED ON THE WORKS OF RONALD LAING, DAVID COOPER ET AL., AND THE CONFERENCE OF SCIENTISTS WITH JIDDU KRISHNAMURTI AT BROCKWOOD PARK DURING THE WEAK FROM OCTOBER 12 TO 19, 1974. [1)]

THIS RESEARCH WORK STARTED WITH A FINANCIAL SUPPORT BY THE AUSTRIAN SOCIETY FOR CYBERNETIC STUDIES. IT WOULD HAVE BEEN COMPLETELY IMPOSSIBLE TO CONTINUE AND FINISH SUCCESSFULLY WITHOUT THE HELP OF THE MEMBERS OF THE INSTITUTE FOR ADVANCED STUDIES.
HERBERT MATSCHINGER, ERHARDT HEINRICH AND BERNHARD SCHWEEGER ADVISED ME IN THE MANAGEMENT OF THE UNIVAC COMPUTER SYSTEM 1106.
JAMES COLEMAN, PETER FLEISSNER AND PETER HAMPAPA KINDLY LET ME HAVE THEIR COMPUTER PROGRAMS ON EXCHANGE-ALGEBRA, SIMULATION, AND STOCHASTIC PROCESSES.
BETTINA FREY DID THE CONTENT ANALYSIS OF EUGENE IONESCO'S PLAY 'RHINOCEROS'.

1) Bulletin 24, Krishnamurti-Foundation
24 Southend Rd. Beckenham, Kent BR3 1SD, G.B.

THERE WERE MANY PROJECTS WHICH WERE OF GREATER IMPORTANCE THAN THIS ONE. NEVERTHELESS, GERHARD SCHWÖDIAUER, JÜRGEN PELIKAN, AND THE MEMEBERS OF THE ABTEILUNG FÜR SOZIOLOGIE CLEARED THE LINE.
JAMES COLEMAN AND ABDUR RAHMAN GAVE VALUABLE CORRECTIONS, COMMENTS, AND IDEAS.
JOHN BLACKBURN TRIED TO CORRECT THIS EXPOSITION WRITTEN IN 'GERMAN ENGLISH'.
ELFRIDE SCHROTT, MONIKA HERKNER AND EVA KÖLLESBERGER MANAGED THE FINAL REDACTION.
TO ALL THESE PEOPLE I AM GRATEFUL.

BERND SCHMEIKAL

INSTITUT FÜR HÖHERE STUDIEN
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PRELIMINARIES

"THE PROCESS OF INTERPRETATION ITSELF HAS A HYPOTHETICAL AND CIRCULAR CHARACTER, FROM THE PERSPECTIVES AVAILABLE TO HIM, THE INTERPRETER MAKES A PRELIMINARY PROJECTION (VORENTWURF) OF THE SENSE OF THE TEXT AS A WHOLE. WITH FURTHER PENETRATION INTO THE DETAIL OF HIS MATERIAL THE PRELIMINARY PROJECTION IS REVISED, ALTERNATIVE PROPOSALS ARE CONSIDERED, AND NEW PROJECTIONS ARE TESTED. THIS HYPOTHETICO-CIRCULAR PROCESS OF UNDERSTANDING THE PARTS IN TERMS OF A PROJECTED SENSE OF THE WHOLE, AND REVISING THE LATTER IN THE LIGHT OF A CLOSER INVESTIGATION OF THE PARTS, HAS AS ITS GOAL THE ACHIEVING OF A UNIT OF SENSE, THAT IS, AN INTERPRETATION OF THE WHOLE IN WHICH OUR DETAILED KNOWLEDGE OF THE PARTS CAN BE INTEGRATED WITHOUT VIOLENCE." (THOMAS MCCARTHY, 1973) HOWEVER, THE INTERPRETER IS INFLUENCED BY THE NORMATIVE STATEMENTS OF HIS CULTURE. THUS HE MAY INTEGRATE THE DETAILED KNOWLEDGE OF THE PARTS ACCORDING TO THESE NORMS. THE DEGREE OF VIOLENCE ACCOMPANYING THE PROCESS OF INTEGRATION DEPENDS ON THE NORMS AND THE INTERPRETER'S COMMITMENT. THIS HAS TO BE CONSIDERED, ALTHOUGH HUME'S SEPARATION THESIS HAS BEEN PROVED IN A DEONTIC FIRST-ORDER PREDICATE CALCULUS L :

"THERE IS NO THEOREM IN L OF THE FORM $P \rightarrow M$ WHERE P IS A CONSISTENT DESCRIPTIVE STATEMENT AND M IS A NORMATIVE STATEMENT." (DAVID HUME, 1969, ARNOLD A. JOHANSON, 1973)

EVEN IF NO NORMATIVE STATEMENT CAN BE LOGICALLY DEDUCED FROM DESCRIPTIVE PREMISSES IN L, THE RESTRICTION OF THE OPERATOR $\rightarrow$ TO PRODUCTS $P \times M$ MAY LEAD TO SUBJECTIVELY PROBABLE STATEMENTS IN A BELIEF SYSTEM B.
(A FUNCTIONAL MODEL OF BELIEF SYSTEMS HAS BEEN DESCRIBED BY BERNARD GROFMAN AND GERALD HYMAN, 1973)

OF COURSE, THE RESTRICTION OF THE OPERATOR $\rightarrow$ TO $P \times M$ MAY BE REGARDED AS BEING LOGICALLY MEANINGLESS IN L. HOWEVER, THE TERM $P \rightarrow M$ MAY BE SIGNIFICANT IN A NEURO-CYBERNETIC SENSE :

LET ANY STATEMENT OF THE FORM P BE SUBJECT TO HUMAN SENSUAL PERCEPTION, THUS P BELONGS TO A SET J OF INPUTS, SUBJECT TO SENSATION.

BY Ψ LET US DENOTE A SET OF PSYCHOLOGICAL STATES OF HUMAN ACTORS ('STATES OF CONSCIOUSNESS' - AFTER KARL R. POPPER, 1968).

LET C BE A SET OF COGNITIVE WORDS OVER A FINITE ALPHABET.

CONSIDER A COLLECTIVITY $\{i\}$ AND A FAMILY OF FUNCTIONS $F = \{f_i\}$ WHOSE DOMAINS ARE IN $J \times \Psi$ AND WHOSE CO-DOMAINS ARE IN C.

WHENEVER WE 'OBSERVE' f_i's AND STATES Ψ IN THE COLLECTIVITY, SUCH THAT THE DOMAINS $\mathcal{D}(f_i) \subset J \times \Psi$ CONTAIN DESCRIPTIVE STATEMENTS AND THE CO-DOMAINS $\mathcal{C}(f_i) \subset C$ INCLUDE NORMATIVE STATEMENTS, OPERATIONS $P \rightarrow M$ BECOME PROBABLE IN BELIEF SYSTEMS CORRESPONDING TO THIS COLLECTIVITY.

THEN, WITH EQUAL PROBABILITY WE MAY STATE $\overline{M} \rightarrow \overline{P}$, THAT IS THE NEGATION OF A NORMATIVE STATEMENT SUBJECTIVELY IMPLIES THE NEGATION OF A DESCRIPTIVE STATEMENT.

INDEED, THE RELATIONSHIP BETWEEN DESCRIPTIVE AND NORMATIVE STATEMENTS IS OF HUMAN INTEREST AND SOMETHING WHICH IS GOVERNED BY COLLECTIVE CONTROL PROCESSES.

MOST THREATENING NORMATIVE STATEMENTS MAY BE OF THE FORM 'YOU SHALL NOT DESCRIBE SITUATIONS OF THE FORM X'.

IN THIS CASE IT IS FOR BIDDEN TO COMMUNICATE X, EVEN IF IT IS SUBJECT TO HUMAN PERCEPTION.

USUALLY DESCRIPTIVE STATEMENTS WHICH CONCERN INTERPERSONAL PERCEPTION ARE RESTRICTED BY NORMATIVE STATEMENTS.

THE PHENOMENOLOGY OF INTERPERSONAL PERCEPTION AND THE DESIGN OF COLLECTIVE NORMATIVE CONTROL PROCESSES WHICH GOVERN THE COMMUNICATION OF DESCRIPTIVE STATEMENTS LEAD TO QUESTIONS CONCERNING THE WELL-BEING ACTORS, THE STABILITY OF HUMAN RELATIONSHIPS AND THE RATIONALITY OF COLLECTIVE ACTION.
AT THIS POINT THE DISCUSSION MAY BE LINKED TO WATZ-LAWICK'S, BEAVIN'S AND JACKSON'S PRAGMATICS OF HUMAN COMMUNICATION (54), TO RUDOLF CARNAP'S CONCEPT OF SEMIOTICS (8), TO THE THEORY OF INTERPERSONAL PERCEPTION BY LAING, LEE, AND PHILLIPSON (31), TO THE MODELS OF CHURCHMANIAN INQUIRING SYSTEMS, WORKED OUT BY MITROFF, BETZ, AND MASON (43), AND TO JAMES COLEMAN'S THEORY OF COLLECTIVE ACTION (15).

IN RECENT YEARS, A NUMBER OF STUDIES OF HUMAN COMMUNICATION HAVE APPEARED IN WHICH MOST SIGNIFICANT MODES OF INTERACTION HAVE BEEN DESCRIBED.
THE EFFECTS OF ACCEPTANCE, REJECTION, DISCONFIRMATION, VERBAL AMBIGUITY (54) AND MULTICHANNEL DISCREPANCY (5, 6, 39) HAVE BEEN EXPLORED BY SEVERAL WRITERS.
IT HAS BEEN POINTED OUT THAT THE OCCURRENCE OF THESE EVENTS IS OF COMMON PRACTICE.
IN THIS CASE HUMAN COMMUNICATION LEADS TO STRONG INTERDEPENDENCE AMONG THE ACTORS. THERE IS STRONG INTERDEPENDENCE OF INTERPERSONAL PERCEPTION, ENVIRONMENTAL PERCEPTION, AND COLLECTIVE ACTIONS.

MAN NEEDS TO CONTROL BASIC EVENTS WHICH DETERMINE HIS LIFE. CLEAR COMMUNICATION WHICH MAKES GOOD USE OF ACCEPTANCE AND REJECTION - OF YES AND NO - MAKES PEOPLE ABLE TO CONTROL SOCIO-ECONOMIC EVENTS IN A HUMAN AND RATIONAL WAY. HOWEVER, PARADOX COMMUNICATION MOST OFTEN PREVENTS RATIONAL CONTROL.

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SYSTEMS OF COLLECTIVE ACTION

PART ONE : SYSTEMS OF COLLECTIVE ACTION

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THE BASIC FORM OF THE THEORY

THROUGH THE SYNTHESIS OF SEVERAL DESCRIPTIVE STATEMENTS AND FORMAL MODELS IN THE FIELDS OF HUMAN PERCEPTION, HUMAN COMMUNICATION, AND COLLECTIVE ACTION, A FRAMEWORK FOR A UNIFIED THEORY OF MULTILEVEL-EXCHANGE SYSTEMS IS DEVELOPED. THE RESULTS SHALL BE APPLICABLE TO EMPIRICAL SITUATIONS, THUS CONTRIBUTING TO AN UNDERSTANDING OF HUMAN ACTION.
THE ESSENTIAL PHENOMENOLOGICAL ELEMENTS OF THE THEORY ARE

(1) HUMAN PERCEPTION

(2) HUMAN COMMUNICATION

(3) COLLECTIVE ACTION

THE EXCHANGE SYSTEM WILL CONTAIN TWO ACTIVE LEVELS. THE FIRST ONE IS REPRESENTED BY

A FINITE SET OF ACTORS, RESPECTIVELY
AN ALGEBRA OF SUBSETS OF ACTORS.

THE SECOND LEVEL IS REPRESENTED BY

A FINITE SET OF EVENTS, RESPECTIVELY
AN ALGEBRA OF SUBSETS OF EVENTS.

BY $\{j\}$ WE SHALL DENOTE A SET OF ACTORS; BY $\{i\}$ WE MEAN A SET OF EVENTS.
THE EVENTS i ARE SUBJECT TO ANY ACTOR'S SENSATIONS.

FOR ANY ACTOR j THE EXISTENCE OF EVENT i CORRESPONDS TO ACTUAL STIMULI 'FROM THE OUTSIDE'.
FURTHERMORE, FOR EACH ACTOR j THERE EXISTS A SET $\{\alpha\}$ OF FICTIVE EVENTS, SUBJECT TO j's PERCEPTION, SUCH, THAT THE EXISTENCE OF α CORRESPONDS TO ACTUAL STIMULI 'FROM THE INSIDE'. INFORMATION ABOUT α IS LINKED TO ANY OTHER ACTOR'S PERCEPTION ONLY, IF j COMMUNICATES WITH ACTOR k ($\neq j$).

EACH ACTOR IS INTERESTED IN AT LEAST ONE OF THE EVENTS $\{i\}$, WHICH ARE SUBJECT TO COLLECTIVE PERCEPTION.
ALL THE ACTORS TOGETHER HOLD CONTROL OVER THESE EVENTS.

THUS, IF THE ASSESSMENT OF MATRICES OF INTEREST AND CONTROL IS BASED ON MEASUREMENTS OF SUBJECTIVE UTILITIES AND BAYESIAN PROBABILITY THEORY, WE HAVE TO ASSUME THE EXISTENCE OF FUNCTIONS, REPRESENTING DECISIONS OR ACTIONS, WHOSE DOMAINS ARE IN AN ALGEBRA OF EVENTS AND WHOSE CO-DOMAINS ARE SETS OF OUTCOMES.
THE ACTIONS, WHICH ARE CONDITIONAL ON THE ALGEBRA OF EVENTS, IMPLICITLY DEFINE RELATIVE INTERESTS OF THE ACTORS.

THE EVENTS $\{\alpha\}$, WHICH MAY MOST ADEQUATELY BE STATED AS SUBJECTIVELY CONSTRUCTED EVENTS, RESULT FROM PAST INFORMATION PROCESSING AND PAST EXCHANGES. THEY ARE TAKEN TO BE FUNDAMENTAL IN THE FOLLOWING SENSE:
THEY CONTRIBUTE TO THE FORMATION OF STANDPOINTS, WORLD-VIEWS, BELIEF-SYSTEMS, THEORIES, AND INERT IMAGES OF REALITY.
EVENTS OF THE FORM α MAY ALSO BE GOVERNED BY COLLECTIVE CONTROL PROCESSES.

IN ANY CASE, COLLECTIVE ACTION IS STRONGLY EFFECTED BY COMMUNICATION:

"A MESSAGE IS CONCEIVED OF AS HAVING THREE POSSIBLE TYPES OF EFFECT AND, THEREFORE, CONTENT; IT DOES NOT EXCLUSIVELY INVOLVE THE TRANSMISSION OF INFORMATION. ANY ONE MESSAGE MAY INFORM, INSTRUCT, OR MOTIVATE, OR DO ANY COMBINATION OF THESE. INFORMATION REFERS TO WHAT AN INDIVIDUAL DOES, INSTRUCTION TO HOW HE DOES IT, AND MOTIVATION TO WHY HE DOES IT." (MARTIN W. MILES, PAGE 105, 1963)

THUS WE HAVE TO CONSIDER THREE ENTITIES OF COMMUNICATION WHICH RELATE TO COLLECTIVE ACTION:

INFORMATION
INSTRUCTION
MOTIVATION

ANY MESSAGE THAT EFFECTS THE PROBABILITIES OF CHOOSING GIVEN ACTIONS IS SAID TO INFORM.
ANY MESSAGE THAT EFFECTS THE PROBABILITIES THAT THE ACTORS REALIZE CERTAIN OUTCOMES, GIVEN A SEQUENCE OF ACTIONS, CONTAINS AN INSTRUCTION.
ANY MESSAGE THAT EFFECTS THE RELATIVE VALUE OF AN OUTCOME TO AN ACTOR IS SAID TO MOTIVATE.
(THESE ARE DEFINITIONS BY MARTIN MILES, WHICH HAVE ALSO BEEN USED BY IAN I. MITROFF ET AL. IN (42,43)

WE CONTINUE IN THE FOLLOWING MANNER:

ANY MESSAGE THAT IS INFORMATIVE MAY INCREASE AN ACTOR'S AMOUNT OF INFORMATION CONCERNING THE EXISTENCE AND STRUCTURE OF THE SET OF EVENTS $\{i\}$.

THUS, IT EFFECTS THE PROBABILITIES OF CHOOSING ACTIONS ON EVENTS WHICH MAY HAVE BEEN OF SMALL INTEREST BEFORE THE MESSAGE WAS RECEIVED.
ANY MESSAGE THAT IS INSTRUCTIVE EFFECTS THE CONDITIONAL PROBABILITIES THAT GIVEN ACTIONS YIELD GIVEN OUTCOMES, FOR AT LEAST ONE ACTOR.
THUS, IT DOES NOT CHANGE UTILITIES OF OUTCOMES; AN INSTRUCTION IS SAID TO LEAVE PERSONAL INTERESTS INVARIANT, UNLESS THE INSTRUCTION IS SHOWN TO CHANGE UTILITIES.
FINALLY, ANY MESSAGE THAT IS MOTIVATING CHANGES UTILITIES. MESSAGES OF THIS FORM HAVE TO BE REGARDED AS BEING STRONG DRIVERS FOR CHANGES OF INTERESTS.
THEREFORE, WE SET UP THE FOLLOWING DESCRIPTIVE STATEMENT WHICH MAY ALSO BE STATED AS A FORMAL THEOREM:

COMMUNICATION PROCESSES THAT CONTAIN MOTIVATIONS CHANGE PERSONAL INTERESTS. PROCESSES WHICH CONTAIN INFORMATIVE MESSAGES CHANGE PERSONAL INTERESTS ONLY, IF CHANGES IN PROBABILITIES $P_j(A_i)$ EFFECT CHANGES IN UTILITIES.

HERE $P_j(A_i)$ STANDS FOR THE PROBABILITY THAT ACTOR j CHOOSES AN ACTION A ON EVENT i.

THE ABOVE STATEMENT MAY EASILY BE UNDERSTOOD THROUGH THE DEFINITION OF INTEREST BY JAMES COLEMAN AND THE FORMAL DESIGN OF INFORMING, INSTRUCTING, AND MOTIVATING MESSAGES BY IAN MITROFF.

MATRICES OF INTEREST AND CONTROL HAVE BEEN SUCCESSFULLY SET UP FOR EXCHANGE SYSTEMS OF COLLECTIVE ACTION BY JAMES COLEMAN (15). THE ALGEBRAIC LAWS WHICH GOVERN SUCH SYSTEMS AND SOME PROBLEMS CONCERNING TIME-EVOLUTION OF COLLECTIVE VALUES OF EVENTS ARE BEING DISCUSSED IN (15).

HOWEVER, NO ATTEMPT HAS BEEN MADE TO COUPLE CYBERNETIC MODELS OF COLLECTIVE ACTION TO BEHAVIOURAL THEORIES OF HUMAN COMMUNICATION. MEASURES OF RELATIVE INTEREST AND PARTIAL CONTROL HAVE NOT YET BEEN APPLIED TO SYSTEMS OF COMMUNICATION.
ACCORDINGLY, THE RELATIONSHIP BETWEEN COMMUNICATION, COLLECTIVE ACTION, AND PERCEPTION HAS NOT BEEN EXPLORED SUFFICIENTLY, ALTHOUGH IT SEEMS CLEAR THAT HUMAN INTERESTS INTERACT STRONGLY WITH ENVIRONMENT-PERCEPTION AND INTERPERSONAL PERCEPTION.

THE FORMAL THEORY OF 'THE DIALECTICAL INQUIRER' WHICH IS BASED ON RUSSELL ACKOFF'S BEHAVIORAL THEORY OF COMMUNICATION (1) MAY BE REGARDED AS A MOST PURPOSEFUL ATTEMPT TO GET CLOSER TO THE VITAL POINTS OF HUMAN DECISION AND POLICY FORMATION THROUGH C. WEST CHURCHMAN'S APPROACH (10, 11 , 12 , 13 , 14) AND THE USE OF COMMUNICATION THEORY, AND BAYESIAN PROBABILITY THEORY.
THUS, INQUIRING SYSTEMS MAY BE USEFUL FROM A 'RATIONAL POLICY FORMATION'-POINT OF VIEW; SYSTEMS OF VOTE-TRADING AND COLLECTIVE ACTION, AS SUGGESTED BY JAMES COLEMAN (16, 17, 18) MAY BE REGARDED AS BEING HIGHLY EFFECTIVE, RELATIVE TO THIS SAME POINT OF VIEW. HOWEVER, THERE ARE STILL BEHAVIORAL ELEMENTS, WHICH HAVE BEEN EXPLORED IN THE COURSE OF THE DEVELOPMENT OF 'THE PRAGMATICS OF HUMAN COMMUNICATION', THAT ARE CONCERNED WITH HUMAN WELLBEING, AND THE STABILITY OF HUMAN RELATIONS.
AS SOON AS WE TAKE INTO CONSIDERATION THE EXACT RESULTS ON THE STRUCTURE OF INTERACTION PATTERNS, MODES OF COMMUNICATION AND INTERPERSONAL PERCEPTION, HUMAN DECISION AND POLICY FORMATION IS ANALYTICALLY CONTINUED INTO EXCHANGE SYSTEMS WHICH ALLOW FOR BOTH, RATIONAL AND IRRATIONAL ACTION.
USING THE LANGUAGE OF 'COLLECTIVE ACTION' WE MAY STATE A MAIN PRINCIPLE OF IRRATIONAL ACTION IN THE FOLLOWING WAY:

PARADOX COMMUNICATION ALLOWS FOR CONTRADICTIONS, AMBIGUITY, DISCONFIRMATION, MYSTIFICATION, AND CONFLICT. MYSTIFICATION MAY EITHER BE REGARDED AS AN ACTIVE MODE OF COMMUNICATION: MYSTIFYING MESSAGES SCREEN INFORMATION ; OR IT MAY BE CONSIDERED AS A PSYCHIC STATE OF ACTORS: ACTORS WHO ARE EXPOSED TO MYSTIFYING MESSAGES MAY ENTER THIS STATE. PARADOX COMMUNICATION CAUSES IRRATIONAL ACTIONS SUCH THAT THE ACTORS SEEM INCAPABLE OF REALIZING THEIR INTERESTS ACCORDING TO THEIR RESOURCES.

FOR A BETTER UNDERSTANDING OF THE TERMS 'AMBIGUITY', AND 'DISCONFIRMATION' WE REFER TO THE WRITINGS OF PAUL WATZLAWICK, BEAVIN, JACKSON (54), GREGORY BATESON, DON JACKSON, JAY HALEY ET AL. (2), BERND SCHMEIKAL AND BETTINA FREY (51); DESCRIPTIONS AND DEFINITIONS OF THE STATES OF 'MYSTIFICATION' AND 'CONFLICT' MAY BE FOUND IN THE WRITINGS OF LAING, LEE, PHILLIPSON (31, 32), AND JOAD (27); THE PROCESS OF 'REALIZATION OF AN ACTOR'S INTEREST THROUGH HIS RESOURCES' MAY BE COMPREHENDED BY THE AID OF COLEMAN'S 'MATHEMATICS OF COLLECTIVE ACTION' (15, 18).

OF COURSE, IN THIS FIELD THERE EXIST MANY MORE WRITINGS. THERE IS THE WORK OF EGON BRUNSWIK (4), IAN MITROFF (42), AND THERE ARE THE ESSENTIAL SOCIO-PSYCHIATRIC WRITINGS OF LYMAN WYNNE, IRVING RYCKOFF, JULIANA DAY, STANLEY HIRSCH (58) WHO INTRODUCED THE SCIENTIFIC TERM OF 'PSEUDO MUTUALITY', AND SOME WORKS ON THE 'DEFENSE OF STEREOTYPIC ROLES' (SEE FOR EXAMPLE 57).

THE FORMAL CONCEPT OF DECISION REVISITED

LET $\mathcal{J}$ BE A SET OF EVENTS. $\mathcal{E}$ AN ALGEBRA OF SUBSETS OF $\mathcal{J}$. $\mathcal{E}$ CONTAINS THE SET OF NULL-EVENTS $\mathcal{N}$.
LET $\mathcal{C}$ DENOTE THE SET OF POSSIBLE OUTCOMES OF DECISIONS.

$\mathcal{D}$ IS A FAMILY OF FUNCTIONS

$$\mathfrak{f}: \mathcal{E}\text{-}\mathcal{N} \to \mathcal{C}$$

THAT IS, $\mathcal{D}$ REPRESENTS A SET OF CONDITIONAL DECISIONS; $\mathcal{E}\text{-}\mathcal{N}$ THE ALGEBRA OF EVENTS ON WHICH DECISIONS ARE CONDITIONAL.
CLEARLY, THE CONCEPT OF HUMAN DECISION HAS TO BE GIVEN BY SOMETHING LIKE SETS OF FUNCTIONS WHOSE DOMAINS ARE SETS OF EVENTS AND WHOSE CO-DOMAINS ARE OUTCOMES.
IN THE ABOVE FORM THE CONCEPT OF DECISION HAS BEEN SET UP AS A STARTING POINT FOR A FORMAL DERIVATION OF CONDITIONAL EXPECTED, EXTENSIVE UTILITIES, THUS ADDITIVE OVER CONCATENATION OF DECISIONS, BY R. DUNCAN LUCE, 1972 (37).

THE CONCEPT OF INTEREST RECONSIDERED

IN THIS APPROACH, MOST OF THE ALGEBRAIC PROPERTIES OF EXCHANGE SYSTEMS WHICH INCLUDE COMMUNICATION AND PERCEPTION SHALL NOT EXPLICITLY BE BASED ON UTILITY BUT ON MEASURES OF RELATIVE INTEREST.
CONSIDER THE CASE OF 'TWO OUTCOME EVENTS' (SEE 15):

BY $U_{i,j}$ WE DENOTE THE UTILITY OF THE OUTCOME REPRESENTING ACTION ON EVENT i FOR ACTOR j.

$U_{i_2 j}$ IS THE UTILITY OF THE OUTCOME REPRESENTING NO ACTION. THE UTILITY OF THE ACTION RELATIVE TO THE STATUS QUO IS $U_{i_1 j} - U_{i_2 j}$.
THE SCALING OF QUANTITIES $U_{i_1 j} - U_{i_2 j}$ IS UNDETERMINED, BECAUSE THERE IS NO BASIS FOR AN INTERPERSONAL COMPARISON OF UTILITY. THUS, THESE QUANTITIES ARE SCALED FOR EACH ACTOR IN THE FOLLOWING WAY:

$$Y_{ji} = \frac{U_{i_1 j} - U_{i_2 j}}{\sum_i |U_{i_1 j} - U_{i_2 j}|}$$

"THESE QUANTITIES Y_{ji}, WHICH WILL BE TERMED RELATIVE UTILITY DIFFERENCES, ARE POSITIVE IF ACTOR j FAVOURS THE COLLECTIVE ACTION ON EVENT i, NEGATIVE IF HE OPPOSES IT. THEIR ABSOLUTE VALUES SUM UP TO 1.0 OVER THE EVENTS IN THE SYSTEM; AND THE GREATER THE ABSOLUTE VALUE, THE GREATER THE DIFFERENCE THIS COLLECTIVE ACTION MAKES FOR HIM.
THE SCALING OF UTILITY DIFFERENCES Y_{ji} SO THAT $\sum_i |Y_{ji}| = 1$ ALLOWS FOR A SIMPLE INTERPRETATION OF THE RESULTING NUMBERS. IF $|Y_{ji}|$ IS LABELED X_{ji}, THEN X_{ji} MAY BE DESCRIBED AS HIS INTEREST IN THE EVENT, USING THE TERM INTEREST IN A WAY CONSISTENT WITH ITS COMMON MEANING.

THE INTEREST OF AN ACTOR IN AN EVENT IS THE DIFFERENCE THAT ITS OUTCOME WILL MAKE FOR HIM, OR THE IMPORTANCE OF THE OUTCOME FOR HIM. THE SCALING THAT MAKES X_{ji} SUM TO 1 OVER ALL EVENTS i IS A SCALING SUCH THAT X_{ji} IS A MEASURE OF THE PROPORTION OF j's TOTAL INTEREST IN THIS SYSTEM THAT IS IN EVENT i. THUS EACH ACTOR'S TOTAL INTEREST IN THE SYSTEM OF EVENTS IS SCALED TO 1, AND X_{ji} IS HIS RELATIVE INTEREST IN EVENT i."

THE CASE OF MULTIPLE-ACTION ON EVENT i :

CONSIDER r POSSIBLE ACTIONS ON EVENT i AND NULL-ACTION ϕ OF ACTOR j.
IF ALL THE ACTIONS A_ν INCLUDING ϕ ARE OF EQUAL UTILITY THE EVENT i IS SAID TO BE OF NO INTEREST TO ACTOR j. THEN, WHATEVER THE ACTIONS OF j MAY BE, THEY WILL ALL YIELD EQUALLY USEFUL OUTCOMES, THUS THEY ARE ALL ONE.

THIS SUGGESTS THAT 'IN THE WORST CASE' WE HAVE TO CONSIDER SOMETHING LIKE 'OVERALL DIVERSITIES' OF THE UTILITIES $U_{ij}(A_\nu)$ OF THE ACTIONS A_ν OF ACTOR j ON EVENT i, IN ORDER TO OBTAIN RELATIVE MEASURES OF INTEREST.

USUALLY ONE PRESUPPOSES THE EXISTENCE OF 'MOST RATIONAL ACTIONS' WHICH ALLOW THE SINGLE ACTOR TO MAXIMIZE THE AMOUNT OF CONTROL HE HOLDS OVER EVENT i. WHAT ACTOR j ESSENTIALLY HAS TO DO IS, TO CHOOSE BETWEEN 'BEING ACTIVE

ON EVENT i OR BEING INACTIVE', RESPECTIVELY 'GIVING A VOTE, OR GIVING NONE'.
THUS, IN MANY CASES OF RATIONAL ACTION THE ESTIMATION OF MEASURES OF RELATIVE INTEREST, BASED ON TWO OUTCOME EVENTS, HAS BEEN VERY INFORMATIVE.
ON PAGE 65 IN (15) WE FIND THE FOLLOWING STATEMENT:
"IF THERE IS TOTAL CONTROL OF THE EVENT i BY INDIVIDUAL j THERE ARE TWO ACTIONS k AND h SUCH THAT

$$P_{ij_k} = 1 \text{ AND } P_{ij_h} = 0, \text{ OR } P_{ij_k} - P_{ij_h} = 1$$

AT THE OTHER EXTREME OF NO CONTROL, FOR EVERY PAIR OF ACTIONS k AND h

$$P_{ij_k} - P_{ij_h} = 0$$

THIS SUGGESTS THAT A REASONABLE MEASURE OF THE DEGREE OF CONTROL OF ACTOR j OVER AN EVENT IS GIVEN BY THE MAXIMUM DIFFERENCE IN THE PROBABILITY OF OUTCOME 1 THAT HE CAN INDUCE THROUGH CARRYING OUT ONE ACTION RATHER THAN ANOTHER. THUS IF WE LABEL THE CONTROL OF ACTOR j OVER AN EVENT i AS C_{ij}, THEN ACCORDING TO THIS DEFINITION

$$C_{ij} = \underset{k}{\text{MAX}}\, P_{ij_k} - \underset{k}{\text{MIN}}\, P_{ij_k}$$

SINCE IT IS NOT RATIONAL FOR THE INDIVIDUAL TO EXERCISE LESS THAN HIS MAXIMUM POTENTIAL CONTROL OVER EVENT i, ALL ACTIONS OTHER THAN THE TWO WHICH MAXIMIZE AND MINIMIZE P_{ij} MAY BE NEGLECTED. WE MAY THUS THINK OF THE DEGREE OF CONTROL C_{ij} AS THE INCREMENT IN PROBABILITY OF OUTCOME 1, ΔP_{ij}, THAT ACTOR j CAN ACHIEVE OR PREVENT FOR EVENT i.
IT IS TEMPTING TO INTERPRET THESE TWO ACTIONS IN A COLLECTIVE DECISION AS A POSITIVE AND NEGATIVE VOTE; HOWEVER THERE ARE COMPLICATIONS TO THIS INTERPRETATION, AS WE SHALL SEE SHORTLY..."

THE ABOVE STATEMENT MAY BE REGARDED AS THE DESCRIPTION OF A PRINCIPLE OF RATIONAL ACTION.
WHAT, IF SELECTION RULES OF THIS FORM ARE :
MISSING, STOCHASTIC, OR UNDETERMINED IN ANY OTHER MANNER ?
THERE ARE EXCHANGES WHICH INCLUDE MORE THAN TWO MODES OF ACTION, AND THERE ARE SUCH WHERE THE ACTOR DOES NOT MAXIMIZE P_{ij}.
THEN WE ARE OBVIOUSLY CONFRONTED WITH A DIFFICULT BUT STILL VERY REALISTIC SYSTEM OF ACTION.

INTEREST, AND MIXEDNESS OF UTILITIES THROUGH A PRE-ORDER RELATION

IN THIS SECTION WE SHALL DERIVE A PRE-ORDER FORMULATION OF THE CONCEPT OF INTEREST, STRICTLY SPEAKING THE CONCEPT OF MIXEDNESS, WHICH MAY EVEN BE APPLIED TO CASES OF HILBERT SPACE REPRESENTATION. BUT FIRST WE WANT TO EXTEND COLEMAN'S PROCEDURE OF 'INTEREST MATRIX CONSTRUCTION' TO THE CASE OF MULTIPLE-ACTION ON EVENT i , FOR THE SAKE OF CONVENTIONAL REPRESENTATION.
CONSIDER THE ACTIONS

$$A_1,\ A_2,\ \ldots,\ A_{r-1} \text{ AND } A_r = \phi$$

ON EVENT i (ϕ REPRESENTING >NO ACTION<)
AND THE UTILITIES OF THESE ACTIONS RELATIVE TO ACTOR i

$$U_{ij}(A_1),\ U_{ij}(A_2),\ \ldots,\ U_{ij}(A_r)$$

BY $\mathcal{M}_{ij}=\{\Delta_{ij}\}$ WE DESIGN THE SET OF ALL REAL VALUED CONCAVE SYMMETRIC FUNCTIONS ON THE SPACE OF UTILITY-VECTORS

$$u^{\lambda}_{ij} = U_{ij}(A_\lambda)/\sum_{\nu} U_{ij}(A_\nu)$$

SUCH THAT $\Delta_{ij}(U_{ij}^{1}, \ldots, U_{ij}^{r})$ HAS A UNIQUE MAXIMUM ON THE r-SIMPLEX, AND BY SYMMETRY

$$\Delta_{ij}(1/r, \ldots, 1/r) \geq \Delta_{ij}(U_{ij}^{1}, \ldots, U_{ij}^{r})$$

THE EQUALITY HOLDS IFF FOR ALL λ, $U_{ij}^{\lambda} = 1/r$.
THEN $\Delta_{ij}(\vec{U}_{ij})$ IS SAID TO REPRESENT A DEGREE OF MIXEDNESS OF THE ACTIONS A_{ν} WITH RESPECT TO THE UTILITIES U_{ij}, AND THE QUANTITY

$$1 - \frac{\Delta_{ij}(\vec{U}_{ij})}{\Delta_{ij,max}}$$

IS A REASONABLE MEASURE OF ACTOR j's INTEREST IN EVENT i. IF WE CHOOSE A UNIQUE Δ_{ij}, AND THE ACTIONS A_{ν} ARE SUITABLE ACTIONS ON ALL EVENTS i, THE MAXIMUM $\Delta_{j,max} \equiv \Delta_{ij}(1/r, \ldots, 1/r)$ HAS TO BE THE SAME FOR ALL EVENTS.
THUS NORMALIZATION YIELDS:

$$X_{ji} = \frac{\Delta_{j,max} - \Delta_{ij}(\vec{U}_{ij})}{m\Delta_{j,max} - \sum_{i}\Delta_{ij}(\vec{U}_{ij})}$$

WHERE m IS THE NUMBER OF EVENTS SUBJECT TO ACTOR j's INTEREST.
EXAMPLES FOR Δ_{ij}'s ARE ENTROPY-MEASURES (SHANNON, 1948) OR DEGROOT'S MEASURES $1 - \max_{\lambda} U_{ij}^{\lambda}$ (50, 25).

DURING THE LAST YEARS, IN MANY PAPERS THERE HAVE BEEN DISCUSSIONS ABOUT WHAT SHOULD BE CONSIDERED AS THE RIGHT REPRESENTATION OR EXPRESSION FOR THE ENTROPY OF A PROBABILITY VECTOR.

"INFORMATION TRANSMITTED IS DEFINED AS THE AMOUNT BY WHICH ADDED EVIDENCE DIMINISHES 'UNCERTAINTY'. THE LATTER IS CHARACTERIZED BY SOME PROPERTIES INTUITIVELY SUGGESTED BY THIS WORD AND POSSESSED BY CONDITIONAL ENTROPY, A PARAMETER OF THE POSTERIOR PROBABILITY DISTRIBUTION. HOWEVER, CONDITIONAL ENTROPY SHARES THESE PROPERTIES WITH SOME OTHER CONCAVE SYMMETRIC FUNCTIONS ON THE PROBABILITY SPACE" (JACOB MARSCHAK, 1974). SIMILAR STATEMENTS CAN BE FOUND IN THEORETICAL PHYSICS: "WHEREAS IN EQUILIBRIUM STATISTICAL QUANTUM MECHANICS THERE IS NO DOUBT THAT THE ENTROPY OF A DENSITY MATRIX, SAY A, IS GIVEN BY $S(A) = -\mathrm{TR}\, A \ln A$, IN THE NON-EQUILIBRIUM CASE THE SITUATION SEEMS TO BE SOMEWHAT UNCLEAR. (CF., FOR INSTANCE, PRIGOGINE (48)) THUS THERE MIGHT BE SOME INTEREST IN THEOREMS THAT DO NOT DEPEND ON EXPLICIT EXPRESSIONS FOR THE ENTROPY BUT REFER ONLY TO THE FACT THAT THE ENTROPY IS A MEASURE FOR THE DEGREE OF 'MIXEDNESS', OR 'PURITY', OF A DENSITY MATRIX." (WEHRL, 1974)

POSSIBLY, MANY THEOREMS OF THE STATISTICS OF EXCHANGE SYSTEMS CAN BE DERIVED BY THE AID OF A PRE-ORDER RELATION, WITHOUT REFERENCE TO ANY SPECIAL EXPRESSION FOR THE ENTROPY; DEPENDING ON THE EXPLICIT EQUATIONS OF MOTION THAT GOVERN SUCH SYSTEMS :

LET THE A_λ BE ACTIONS OF ACTOR j ON EVENT i.
THE U_{ij}^{λ} ARE THE ABOVE MENTIONED UTILITIES OF ACTIONS λ ON EVENT i TO ACTOR j.

DEFINITION:

THE EVENT i IS SAID TO BE PRE-ORDERED TO EVENT i' IFF THE UTILITY VECTOR $\vec{U}_{ij}$ IS STRONGER MIXED THAN THE UTILITY VECTOR $\vec{U}_{i'j}$.

THUS,

$$i \underset{j}{>} i'$$

FURTHERMORE,

j's INTEREST IN EVENT i' IS 'GREATER' THAN HIS INTEREST IN EVENT i IFF $i \underset{j}{>} i'$

THUS,

$$i \underset{j}{\chi} i' \triangleq i > i'$$

THE BINARY RELATION $\underset{j}{\chi}$ CAN NOW BE DEFINED IN AN EXPLICIT MANNER, BY THE AID OF A. UHLMANN'S CONCEPT OF MIXEDNESS (53) :

$$i \underset{j}{\chi} i' \triangleq U^1_{ij} \leq U^1_{i'j},\ U^1_{ij} + U^2_{ij} \leq U^1_{i'j} + U^2_{i'j},$$
$$U^1_{ij} + U^2_{ij} + U^3_{ij} \leq U^1_{i'j} + U^2_{i'j} + U^3_{i'j},\ \ldots$$
$$U^1_{ij} + U^2_{ij} + \ldots + U^r_{ij} = U^1_{i'j} + U^2_{i'j} + \ldots + U^r_{i'j} = 1$$

THIS DEFINITION OF MIXEDNESS MAY BE VERY USEFUL WHEN DETERMINISTIC PROCEDURES FOR THE DERIVATION OF INTEREST- AND CONTROL MATRICES ARE MISSING, WHICH IS THE CASE IF RATIONALITY RULES ARE VIOLATED, PROVIDED THAT THERE ARE ANY EXPLICIT STOCHASTIC LAWS WHICH GOVERN THE DYNAMICS OF MULTIPLE ACTION.

EXAMPLE

A NATIONAL PLANNING BOARD HAS TO RANK TWO PLANNING ALTERNATIVES RELATIVE TO THE MIXEDNESS OF UTILITIES. TWO EVENTS ARE SUBJECT TO COLLECTIVE ACTION:

1. PROMOTION OF THE EDUCATION OF ADULTS IN AN URBAN REGION
2. PROMOTION OF THE EDUCATION OF ADULTS IN A RURAL REGION

THE NATIONAL EDUCATIONAL SYSTEM CONSISTS OF FIVE ELEMENTARY PROGRAMS CORRESPONDING TO THESE EVENTS. THESE ARE REPRESENTABLE BY INVESTMENTS IN:

A_1 WORKSHOPS AT THE PLACE OF EMPLOYMENT ...WE
A_2 UNIVERSITY EXTENSION ... UE
A_3 TRAINING CENTRES UNDER PARTY LEADERSHIP ...PTC
A_4 MEDIA-TRAINING COURSE ... MTC
A_5 BONUS SYSTEM ... BS
A_6 REPRESENTS >NO ACTION< ON BOTH EVENTS $\triangleq \phi$

THE FOLLOWING INPUT-OUTPUT TABLE HAS BEEN ESTIMATED. HERE THE ELEMENTS OF THE ODD COLUMNS OF THE TABLE REPRESENT THE 'NUMBER OF PEOPLE ENTERING WE, ..., BS AT THE BEGINNING OF 1968, RESPECTIVELY 1973'; THE ELEMENTS IN THE EVEN COLUMNS ARE 'NUMBERS OF PEOPLE HAVING SUCCESSFULLY FINISHED A PROGRAM AT THE END OF 1969, AND 1974 RESPECTIVELY'.

THE DISTRIBUTION OF NUMBERS PLACED WITHIN THE ODDNUMBERED COLUMNS REPRESENTS A CAPACITY-DISTRIBUTION RELATIVE TO THE EDUCATIONAL PROGRAMS; SUCCESS IS DEFINED A 'DECREASE IN THE LITERACY-RATE'.

	URBAN REGION				RURAL REGION			
	1968 IN	1969 OUT	1973 IN	1974 OUT	1968 IN	1969 OUT	1973 IN	1974 OUT
WE	25000	1750	21000	2200	3000	280	2600	270
UE	2000	1800	1950	1800	360	310	350	300
PTC	300	270	320	290	110	60	100	60
MTC	5300	180	4300	130	1700	90	2100	110
BS	3200	1600	4700	2100	1500	800	1600	820

BY THE AID OF THIS TABLE, EFFICIENCY-RATES OF WE, ..., BS ε, AND EFFICIENCY-GAINS $\Delta\varepsilon$ ARE COMPUTED :

	URBAN REGION			RURAL REGION		
	EFF. 1969	EFF. 1974	$\Delta\varepsilon$	EFF. 1969	EFF. 1974	$\Delta\varepsilon$
WE	0,07	0,11	0,04	0,09	0,10	0,01
UE	0,90	0,93	0,03	0,86	0,86	0,00
PTC	0,90	0,91	0,01	0,55	0,60	0,05
MTC	0,03	0,03	0,00	0,05	0,05	0,00
BS	0,50	0,45	-0,05	0,53	0,51	-0,02

LIMITED RESOURCES GENERATE PLANNING BOUNDARIES SUCH THAT THE ACTIVITIES ON URBAN AND REGIONAL PLANNING HAVE TO BE COMPATIBLE WITH THE FOLLOWING CAPACITY-DISTRIBUTIONS OF THE EDUCATIONAL ESTABLISHMENTS IN THE URBAN REGION

$c_1(WE) = 0{,}4$; $c_1(UE) = 0{,}1$; $c_1(PTC) = 0{,}3$;
$c_1(MTC) = 0{,}1$; AND $c_1(BS) = 0{,}1$

AND IN THE RURAL REGION :

$c_2(WE) = 0{,}2$; $c_2(UE) = 0{,}1$; $c_2(PTC) = 0{,}4$;
$c_2(MTC) = 0{,}1$; AND $c_2(BS) = 0{,}2$.

FROM THIS, A FIRST VECTOR OF UTILITIES IS DETERMINED UP TO A LINEAR TRANSFORMATION, BY COMPUTING PRODUCTS OF CAPACITY AND EFFICIENCY GAIN

$$c_i(A_\lambda).\Delta\varepsilon_i(A_\lambda)$$

E.G.: $U_{2,NAT.PL.BOARD}(A_3) = c_2(PTC).\Delta\varepsilon_2(PTC) = 0{,}4.0{,}05 = 0{,}02$

	U_{1j}	x100	+5	U_{2j}	x100	+4
WE	,016	16	21	,002	2	6
UE	,003	3	8	,000	0	4
PTC	,003	3	8	,020	20	24
MTC	,000	0	5	,000	0	4
BS	-,005	-5	0	-,004	-4	0
ϕ	,000	0	5	,000	0	4

BEING INACTIVE ON THE EVENTS WAS CONSIDERED AS BEING OF UTILITY ZERO. THUS, LINEAR TRANSFORMATION

$U_{ij}(A_\lambda) \times 100 + 5$ (RESPECTIVELY + 4)

YIELDS NON-ZERO UTILITIES FOR ϕ SINCE ACTIVITY A_5 IS OF NEGATIVE USE IN BOTH, THE URBAN AND THE RURAL REGION.
NORMALIZATION OF THE UTILITIES TO UNITY, GIVES :

		EVENT 1	EVENT 2
		U_{1j}^{λ}	U_{2j}^{λ}
WE	$\lambda = 1$	0,450	0,143
UE	$\lambda = 2$	0,170	0,095
PTC	$\lambda = 3$	0,170	0,572
MTC	$\lambda = 4$	0,105	0,095
BS	$\lambda = 5$	0,000	0,000
ϕ	$\lambda = 6$	0,105	0,095
		URBAN REGION	RURAL REGION

BY ARRANGING THE U_{ij}^{λ} IN DECREASING ORDER

0,450	0,170	0,170	0,105	0,105	0,000
0,572	0,143	0,095	0,095	0,095	0,000

WE CAN EASILY VERIFY OUR PRE-ORDER RELATION :
WE HAVE $0,450 < 0,572;\ 0,450 + 0,170 = 0,620 <$
$< 0,572 + 0,143 = 0,715;$

0,450 + 0,170 + 0,170 = 0,790   0,572 + 0,143 + + 0,095 = 0,81, ..., FINALLY 1,000 = 1,000.

THUS, THE MIXEDNESS OF 'ACTIONS ON EVENT 1 RELATIVE TO UTILITY' IS GREATER THAN THE MIXEDNESS OF ACTIONS ON EVENT 2.

IT IS VERY IMPORTANT THAT THE TWO CONCEPTS 'UTILITY' AND 'INTEREST' ARE NOT CONFUSED.
'UTILITY' REFERS TO THE USE OF AN ACTION, OR THE EFFICIENCY OF ITS OUTCOME, WHEREAS 'INTEREST' IS DEFINED THROUGH THE INEQUALITY OF UTILITIES.
IN OUR EXAMPLE, THE RELATIONSHIP

$$1 \underset{j}{x} 2$$

HAS BEEN VERIFIED. THIS MEANS THAT 'ACTIVITY ON EVENT 1', (URBAN PLANNING), IS LESS INTERESTING THAN 'BEING ACTIVE ON EVENT 2', (RURAL PLANNING).

THE CONCEPT OF CONTROL RECONSIDERED

THERE EXIST MANY SCIENTIFIC DEFINITIONS OF THE TERM 'CONTROL':

"THE PURPOSE OF CONTROL IS TO ALTER THE DYNAMIC BEHAVIOR OF A PHYSICAL SYSTEM IN ACCORDANCE WITH MAN'S WISHES. THE PROBLEM SPLITS QUITE NATURALLY INTO TWO VERY DISTINCT PARTS:

1. WE MUST GET A MATHEMATICAL DESCRIPTION OF THE DYNAMICAL PROPERTIES OF THE PHYSICAL OBJECT (THE PLANT) TO BE CONTROLLED
2. WE MUST FIND A 'SCHEME' FOR ACCOMPLISHING THE DESIRED CONTROLLED BEHAVIOR" ...

"THE CRITICAL CONCEPT, THAT OF 'FEEDBACK' IS FORMALIZED AS FOLLOWS:
(5.1) DEFINITION. CONSIDER AN ARBITRARY DYNAMICAL SYSTEM Σ. A CONTROL LAW IS A MAP $K: T \times X \to U$ WHICH ASSIGNS TO THE STATE $x(t)$ AT TIME t THE VALUE $u(t)= K(t,x(t))$ OF THE INPUT AT THAT TIME; THAT IS, THE VALUE OF THE INPUT AT ANY MOMENT DEPENDS ONLY ON THE STATE $x(t)$ AT THAT MOMENT AS WELL AS, POSSIBLY, ON t. OTHER PARAMETERS OF Σ MAY, HOWEVER, AFFECT THE SPECIFIC DEFINITION OF THE FUNCTION K."
(RUDOLF E. KALMAN, PETER L. FALB, MICHAEL A. ARBIB, 1969, PAGE 46)
CONSIDER A STOCHASTIC PROCESS DESCRIBED BY SOME LINEAR DIFFERENCE EQUATION:
"A PROCESS IS CALLED CONTROLLABLE IF IT IS POSSIBLE TO FIND AN (UNCONSTRAINED) CONTROL VECTOR WHICH BRINGS THE SYSTEM FROM ANY INITIAL STATE TO ANY SPECIFIED FINAL STATE IN FINITE TIME." (PIETER EYKHOFF, 1974)
CONSEQUENTLY, 'CONTROL' MAY BE REGARDED AS AN ACTIVITY WHICH BRINGS ABOUT SOME DESIRED STATE IN A FINITE INTERVALL OF TIME.

COLEMAN'S DEGREE OF PARTIAL CONTROL

$$C_{ij} = \max_k p_{ij_k} - \min_k p_{ij_k}$$

REPRESENTS AN EXPLICIT EXPRESSION FOR THE 'PARTIAL SUBJECTIVE CONTROLLABILITY OF EVENT i, THAT IS, A POSITIVE OUTCOME ON EVENT i, BY ACTOR j'.

HOWEVER, IT IS A SOMEWHAT DIFFICULT TASK TO DETERMINE THE RELATIONSHIP BETWEEN THIS EXPLICIT EXPRESSION FOR EVENT-CONTROL, AND THE CONCEPT OF CONTROL AS DEFINED IN CONTROL THEORY.

EVEN IF THIS PROBLEM CAUSES PROBLEMS IT IS STILL WORTHWHILE TO CONSIDER IT.
THUS CONSIDER N REPRESENTATIVES j OF LOCAL COMMUNITIES J SUCH THAT THE LOCAL DISTRIBUTION OF VOTES 'FAVORING' OR 'OPPOSING' COLLECTIVE ACTION ON EVENTS i LOCKS UP THE DISTRIBUTION OF INTERESTS X_{ji} RELATIVE TO EACH REPRESENTATIVE j.
THE ACTORS HAVE TO WORK OUT A COLLECTIVE DECISION ON EACH OF THE ISSUES i. THUS THEY SHALL TRY TO SELL VOTES, IN OTHER WORDS SELL CONTROL OVER EVENTS WHICH ARE OF LOW INTEREST WITHIN COMMUNITY J TO COMMUNITIES OTHER THAN J, AND BUY VOTES FROM THESE COMMUNITIES ON ISSUES WHICH ARE OF HIGH INTEREST FOR J.
THEY SHALL BUY CONTROL SUCH THAT COLLECTIVE ACTION ON EVENTS i FOR WHICH A POSITIVE OUTCOME IS UNCERTAIN AT THE BEGINNING OF THE BARGAINING (RELATIVE TO THE VOTING RULE), IS HIGHLY SECURED AT THE END OF THE BARGAINING.
THIS IS A DECISIONPROCESS SUCH THAT AN ALLOCATION OF RESOURCES PROPORTIONAL TO INTEREST INDUCES AN OPTIMAL REALIZATION OF EACH SOCIETIES INTEREST.
THE EVENTS THAT MATTER MOST TO REPRESENTATIVE j APPEAR THROUGH THE DISTRIBUTION OF VOTES WITHIN THE LOCAL COMMUNITIES J. THUS, ACTOR j SHALL GAIN AS MUCH CONTROL AS POSSIBLE OVER THOSE EVENTS THAT MATTER MOST TO COMMUNITY J.

COLEMAN'S MATHEMATICS OF COLLECTIVE ACTION CONSISTS OF AT LEAST TWO LAWS WHICH GOVERN SUCH A PROCESS OF DECISION MAKING.
THE FIRST ONE REPRESENTS AN ALGEBRAIC LAW OVER MATRICES OF INTEREST AND CONTROL WHICH ALLOWS FOR THE CONSTRUCTION OF DEPENDENCY MATRICES, VECTORS OF 'POWER', AND VECTORS OF 'COLLECTIVE VALUE'.

THIS LAW MAKES IT POSSIBLE TO COMPUTE THE MATRIX OF 'EQUILIBRIUM CONTROL C^{*}' AND THE PROBABILITY-VECTOR OF POSITIVE OUTCOMES.
THE SECOND LAW IS CONCERNED WITH THE DYNAMICS OF THE VALUES OF EVENTS i.

INDEED, THE EXCHANGE OF VOTES HAS TO BE REGARDED AS A STOCHASTIC PROCESS, WHICH MAY POSSIBLY BE APPROXIMATED BY STOCHASTIC DIFFERENTIAL EQUATIONS OF THE FORM AS SUGGESTED IN (15).
THE MAIN IDEA WHICH LEADS TO AN EQUILIBRIUM CONTROL MATRIX CONCERNS THE ALLOCATION OF THE ACTORS' RESOURCES. THIS 'ALLOCATION-RULE' BRINGS FORTH THE RESULT THAT THE EQUILIBRIUM VALUE OF THE VECTOR OF COLLECTIVE VALUES HAS TO BE AN EIGENVECTOR OF THE PRODUCT MATRIX $\sum_j C_{ij}X_{ji}$. THIS PROPERTY MAY BE REGARDED AS THE ESSENTIAL STATEMENT OF THE ALGEBRAIC LAW.
COLEMAN HIMSELF WROTE "EQUATION 3.6 IS THE FUNDAMENTAL EQUATION OF THE STATIC SYSTEM, AND IT IS USEFUL TO CONSIDER IT AT SOME LENGTH", (JAMES COLEMAN, 1973).
AT THE SAME TIME THE EQUILIBRIUM MATRIX C^{*}_{ij} CAN BE DERIVED FROM A DYNAMIC SYSTEM IN WHICH THE MOVEMENT OF THE VALUE OF EACH EVENT IS REGULATED BY AN EXCESS OR MARKET DEMAND FOR CONTROL OVER EVENT i.
YET THERE EXIST SOME QUESTIONS CONCERNING THE RELATIONSHIP BETWEEN THE 'STATIC' AND THE 'DYNAMIC' EQUATIONS, CONSTANTS OF MOTION, AND THE INVARIANCE OF LAWS.

THEREFORE, LET US BEGIN WITH A MINIMUM INPUT OF FORMAL REQUIREMENTS :

BY

X_{ji} WE DENOTE A MATRIX ELEMENT OF THE $n \times m$ ROW STOCHASTIC INTEREST MATRIX

C_{ij} REPRESENTS A MATRIX ELEMENT OF THE $m \times n$ ROW STOCHASTIC CONTROL MATRIX

LET I DENOTE A FINITE SET OF EVENTS, J A FINITE SET OF ACTORS.
LET $\mathfrak{I}$ BE THE SET ALGEBRA OF SUBSETS OF I, $\mathfrak{J}$ THE SET ALGEBRA OF SUBSETS OF J.
THE SMALLEST NON-EMPTY SETS OF $\mathfrak{I}$ CONTAIN A SINGLE EVENT i , THE SMALLEST NON-EMPTY SETS OF $\mathfrak{J}$ CONTAIN A SINGLE ACTOR j .

DEF.: THE 'COLLECTIVE VALUE V' IS A REAL VALUED MEASURE FUNCTION

$$V : \mathfrak{I} \longrightarrow [0,1] \quad \text{SUCH THAT}$$

+1+

$V(\phi) = 0$ 'THE VALUE OF THE EMPTY EVENT IS ZERO'

+2+

$V(E) \geqq 0$ FOR ANY SET OF EVENTS

+3+

IF $E \subset \mathfrak{I}$, $F \subset \mathfrak{I}$ ARE MUTUALLY EXCLUSIVE,
I.E. $E \cap F = \phi$ THEN $V(E \cup F) \equiv V(E) + V(F)$

+4+

$$V(I) \equiv V(\{1\}) + V(\{2\}) + \dots + V(\{m\}) = V_1 + V_2 + \dots + V_m = 1$$

THUS, FROM AN AXIOMATIC POINT OF VIEW 'V' REPRESENTS A PROBABILITY MEASURE (SEE, FOR EXAMPLE 49).
ACCORDINGLY, THE FIRST THEOREM THAT MAY BE DERIVED IS: FOR ANY SETS $E, F \subset \mathfrak{I}$, $V(E \cup F) = V(E) + V(F) - V(E \cap F)$.
THE VALUE OF THE UNION OF TWO SETS OF EVENTS EQUALS THE SUM OF THE VALUES OF THESE SETS MINUS THE VALUE OF THE SET OF COMMON EVENTS.

DEF.: THE 'RESOURCES R' ARE REPRESENTED BY A REAL VALUED MEASURE FUNCTION

$$R : \mathfrak{J} \longrightarrow [0,1] \quad \text{SUCH THAT}$$

+5+

$R(\phi) = 0$ 'THE RESOURCES OF >NO ACTOR< ARE NULL'

+6+

$R(S) \geqq 0$ FOR ANY SET S OF ACTORS

+7+

IF $S \subset \mathfrak{J}$, $T \subset \mathfrak{J}$ ARE DISJOINT, I.E. $S \cap T = \phi$
THEN $R(S \cup T) \equiv R(S) + R(T)$

+8+

$$R(J) \equiv R(\{1\}) + R(\{2\}) + \ldots + R(\{n\}) = R_1 + R_2 + \ldots + R_n = 1$$

THUS, FROM AN AXIOMATIC POINT OF VIEW, 'R' ALSO REPRESENTS A PROBABILITY MEASURE.

THE QUANTITIES $V_1, V_2, \ldots, V_m$, AND $R_1, R_2, \ldots, R_n$ WILL BE REGARDED AS STOCHASTIC ROW VECTORS.
THUS V IS THE VECTOR OF COLLECTIVE VALUES OF THE POINT-EVENTS i ; R REPRESENTS THE VECTOR OF RESOURCES OF THE ACTORS.

IN THE SEQUENCE, MATRICES OF INTEREST, AND CONTROL AS WELL AS VECTORS OF VALUE, AND POWER WILL BE LABELED X, C, V, R.
GENERALLY WE ASSUME THAT THESE QUANTITIES EVOLVE THROUGH TIME.
FOR THE PRESENT,

DEF.: AT ANY TIME t THE VECTOR $V(t)$ IS SAID TO DEFINE A STATE OVER THE ALGEBRA $\mathfrak{T}$ OF SUBSETS OF EVENTS.

DEF.: AT ANY TIME t THE VECTOR $R(t)$ IS SAID TO DEFINE A STATE OVER THE ALGEBRA $\mathfrak{F}$ OF SUBSETS OF ACTORS.

LET $X(0)$, $C(0)$ BE INTEREST-, AND CONTROL MATRICES WHICH PROVIDE THE ESSENTIAL DATA INPUT FOR A BARGAINING BETWEEN THE n REPRESENTATIVES j, COLEMAN'S 'ALGEBRAIC LAW' ALLOWS FOR A MAP

$$(X(0), C(0)) \longrightarrow \hat{R}, V^*$$

WHERE $\hat{R}$ DENOTES A SPECIAL VECTOR OF RESOURCES, AND V^* IS THE EQUILIBRIUM VECTOR OF VALUES.

THIS LAW IS DERIVED BY THE AID OF THE FOLLOWING STATEMENT :

SUPPLY OF CONTROL $\mathscr{S}_i$ OVER EVENT i CONSISTS OF THE VALUE OF ALL CONTROL THAT EXISTS IN THE SYSTEM FOR THAT EVENT, THAT IS,

$$\mathscr{S}_i = \sum_j V_i(t)\ C_{ij}(t)$$

WHEN THE SYSTEM IS CLOSED RELATIVE TO COLLECTIVE CONTROL, THAT IS,

$$\sum_j C_{ij}(t) = 1$$

THEN

$$\mathscr{S}_i(t) = V_i(t)$$

THE VALUE OF THE TOTAL SUPPLY OF CONTROL OVER i IS EQUAL TO THE COLLECTIVE VALUE OF i, $V_i(t)$ AT THAT TIME t.

LET V^* BE THE EQUILIBRIUM VECTOR OF VALUE.

THEN THE CONSTANT VECTOR

$$\hat{R} = V^* C(0) \quad \left(\text{IN DETAIL} \quad \hat{R}_j = \sum_i V_i^* C_{ij}(0) \right)$$

REPRESENTS ACTOR j's TOTAL RESOURCES, THAT IS, "HIS PROPORTION OF CONSTITUTIONAL CONTROL OVER EVENTS, WITH EACH EVENT WEIGHTED BY ITS EQUILIBRIUM PRICE OR VALUE." (COLEMAN, 1973)

THE ALLOCATION RULE

IT IS ASSUMED THAT EACH ACTOR ALLOCATES HIS RESOURCES $\hat{R}_j$ OVER EVENTS i PROPORTIONAL TO THE RATIO

$$X_{ji}(0)/V_i^*$$

THUS HIS FINAL CONTROL OVER EVENT i, C_{ij}^* WILL BE

$$C_{ij}^* = \frac{X_{ji}(0)}{V_i^*} \sum_k V_k^* C_{kj}(0)$$

THE TOTAL DEMAND FOR CONTROL OVER EVENT i, $\mathscr{D}_i$ IS

$$\mathscr{D}_i = \sum_j X_{ji}(0) \sum_k V_k^* C_{kj}(0)$$

EQUILIBRIUM OCCURS WHEN $\mathscr{D}_i = \mathscr{S}_i$ FOR ALL EVENTS i
THUS, IFF

$$\mathscr{S}_i = V_i^* = \sum_j X_{ji}(0) \sum_k V_k^* C_{kj}(0) = \mathscr{D}_i$$

THE EQUILIBRIUM VECTOR V^* TURNES OUT TO BE AN EIGENVECTOR OF THE DEPENDENCY MATRIX $C(0)X(0)$ SINCE

$$V_i^* = \sum_k V_k^* \sum_j C_{kj}(0) \, X_{ji}(0) = \sum_k V_k^* CX_{ki}(0)$$

FROM THIS WE OBTAIN AN EXPLICIT EXPRESSION FOR THE VECTOR OF RESOURCES R, IN TERMS OF $X(0)$, AND $C(0)$.

$$R_j = \sum_i \underbrace{\sum_k V_k^* \sum_h C_{kh}(0)\, X_{hi}(0)}_{V_i^*}\, C_{ij}(0) =$$

$$= \sum_i \sum_h \underbrace{\sum_k V_k^*\, C_{kh}(0)}_{\hat{R}_h}\, X_{hi}(0)\, C_{ij}(0) =$$

$$= \sum_h \hat{R}_h \sum_i X_{hi}(0)\, C_{ij}(0) = \sum_h \hat{R}_h\, XC_{hj}(0)$$

THUS, $\hat{R}$ TURNS OUT TO BE AN EIGENVECTOR OF THE SOCIOMATRIX $XC(0)$.

BEFORE WE CONTINUE IN OUR INVESTIGATION OF THE TERMS 'CONTROL' AND 'CONTROLLABILITY', LET US GIVE AN EXAMPLE WHICH DEMONSTRATES THE ALGEBRAIC PROPERTIES OF THE EXCHANGE SYSTEM.

EXAMPLE 1:

CONSIDER THE (RATHER ARTIFICIAL) SITUATION OF TWO ACTORS REPRESENTING THE SUBSYSTEMS :

1 ... THE US GOVERNMENT

2 ... THE US MILITARY HIGH COMMAND

THE EVENTS THAT ARE OF COLLECTIVE INTEREST ARE REPRESENTED BY THE SLOGANS

1 ... CHECKING THE COMMUNIST EXPANSION IN SOUTH EAST ASIA

2 ... DEFENDING DEMOCRACY IN SOUTH VIETNAM

3 ... WEAKENING COMMUNISM IN NORTH VIETNAM
4 ... DEFENDING THE LIVES OF THE DEMOCRATIC SOUTH VIETNAMESE
5 ... KEEPING AMERICAN INFLUENCE IN SOUTH VIETNAM
6 ... SAVING THE PRESTIGE OF THE US IN THE WORLD

SUPPOSE THAT EACH SLOGAN DEFINES A DEFINITE PROGRAM, AND THAT THESE PROGRAMS ARE SUBJECT TO COLLECTIVE ACTION.
WE MADE USE OF MARIO BUNGE'S CONSIDERATIONS (AND "GUESSTIMATIONS", MARIO BUNGE, 1973), AND COMPUTED THE FOLLOWING MATRICES OF INTEREST, AND CONTROL:

$$X(0) = \begin{pmatrix} 0,50 & 0,13 & 0,11 & 0,10 & 0,09 & 0,07 \\ 0,70 & 0,10 & 0,20 & 0,00 & 0,00 & 0,00 \end{pmatrix}$$

$$C(0) = \begin{pmatrix} 1/4 & 3/4 \\ 2/3 & 1/3 \\ 1/2 & 1/2 \\ 1 & 0 \\ 3/4 & 1/4 \\ 1 & 0 \end{pmatrix}$$

FROM THIS WE OBTAIN THE SOCIOMATRIX

$$XC(0) = \begin{pmatrix} 0,50 & 0,50 \\ 0,35 & 0,65 \end{pmatrix}$$

THUS THE GREATER RESOURCES ARE AT THE GOVERNMENT'S DISPOSAL, SINCE THE EIGENVECTOR OF $XC(0)$ IS

$$\hat{R} = (\,0{,}60 \quad 0{,}40\,)$$

EXAMPLE 2 :

THERE ARE 10 REPRESENTATIVES OF GERMAN HOSPITALS. THESE REPRESENT COMMUNITIES :

1 ... HOSPITAL HEADS
2 ... HEAD PHYSICIANS
3 ... HOUSE PHYSICIANS
4 ... PRACTITIONERS
5 ... MATRONS
6 ... SISTERS
7 ... NURSES
8 ... THERAPISTS
9 ... ORDERLIES
10 .. MUNICIPAL COUNCIL

THEY HAVE TO DECIDE ON THE FOLLOWING EVENTS, REPRESENTED BY PROGRAMS ON :

1 ... CHILD CARE
2 ... THE RECRUITMENT OF PERSONAL
3 ... MEDICAL INVENTORY
4 ... MEDICAL THERAPY
5 ... NON-MEDICAL THERAPY
6 ... SCIENTIFIC RESEARCH
7 ... SCIENTIFIC EQUIPMENT
8 ... GENERAL EQUIPMENT
9 ... PLANNING

THE FOLLOWING NUMBERS ARE TAKEN FROM AN INTERVIEW THAT HAS BEEN DESCRIBED IN DETAIL BY BETTINA FREY (51).

X(0)

INTEREST OF ACTOR j IN EVENT i

	CHILD CARE	PERSONNEL RECRUITMENT	MEDICAL INVENTORY	MEDICAL THERAPY	NONMEDICAL THERAPY	SCIENTIFIC RESEARCH	SCIENTIFIC EQUIPMENT	GENERAL EQUIPMENT	PLANNING
HEADS	.1	-.2	.0	.1	.1	.3	.2	.0	.0
HEAD PHYS.	.2	-.2	.0	.5	.1	.0	.0	.0	.0
HOUSE PHYS.	.0	.0	.0	.4	.0	.2	.2	.0	.2
PRACTITION.	.2	.0	.0	.5	.0	.1	.1	.0	.1
MATRONS,	.1	-.5	.4	.0	.0	.0	.0	.0	.0
SISTERS,	.1	-.6	.3	.0	.0	.0	.0	.0	.0
NURSES	.2	-.15	.0	.0	.0	.0	.0	.0	.65
THERAPISTS	1.	.0	.0	.0	.0	.0	.0	.0	.0
ORDERLIES,	.0	.3	.0	.0	.0	.0	.0	.7	.0
MUN. COUNC.	.0	.4	.0	.0	.0	.0	.3	.3	.0

$C(0)^T$ ... CONSTITUTIONAL CONTROL OF EVENT i BY ACTOR j

HEADS	.0	.3	.0	.2	.0	1.	1.	.0	.5
HEAD PHYS.	.1	.	.	.	.	.	.	.	.
HOUSE PHYS.	.05	.	.	.2	.	.	.	.	.
PRACTITION.	.1	.	.	.	.	.	.	.	.
MATRONS	.	.	.5	.6	.	.	.	.	.1
SISTERS	.1	.	.5	.	.	.	.	.	.1
NURSES	.15	.	.	.	.	.	.	.	.
THERAPISTS	.5	.	.	.	1.	.	.	.	.
ORDERLIES	.	.	.	.	.	.	.	.7	.3
MUN. COUNC.	.	.7	.	.	.	.	.	.3	.

THE SOLUTION OF THE EIGENVALUEPROBLEMS ESTABLISHES THE FOLLOWING HIERARCHY , ACCORDING TO THE ACTOR'S RESOURCES:

		RESOURCES $\hat{R}_j$
1)	HEADS	0,36
2)	MUNICIPAL COUNCIL	0,22
3)	THERAPISTS	0,13
4)	ORDERLIES	0,10
5)	MATRONS	0,06
6)	SISTERS	0,04
7)	NURSES	0,03
8)	HOUSES PHYSICIANS	0,02
9)	HEAD PHYSICIANS	0,02
10)	PRACTITIONERS	0,02

THE ORDERING OF EVENTS DUE TO THEIR VALUE GIVES:

		VALUE V_i
1)	RECRUITMENT OF PERSONELL	0,25
2)	CHILD CARE	0,19
3)	SCIENTIFIC EQUIPMENT	0,14
4)	GENERAL EQUIPMENT	0,14
5)	SCIENTIFIC RESEARCH	0,11
6)	MEDICAL THERAPY	0,06
7)	NON-MEDICAL THERAPY	0,04
8)	MEDICAL INVENTORY	0,04
9)	PLANNING	0,03

THE BEHAVIOR OF THE STATIC SYSTEM HAS BEEN DERIVED BY MEANS OF A SOMEWHAT HEURISTIC PROCEDURE. THERE ARE TWO ESSENTIAL ARGUMENTS WHICH PRODUCED THE RESULTS:

1) THE VECTOR OF 'TOTAL RESOURCES' $\hat{R} = V^{*}C(0)$ APPEARS AS A 'HIDDEN CONSTANT OF MOTION'. THE USE OF $\hat{R}$ IS STRAIGHTFORWARD BUT PROBLEMATIC FROM A DYNAMIC POINT OF VIEW.

2) THERE EXISTS AN ALLOCATION RULE OF THE FORM

$$C^{*}_{ij} = \frac{X_{ji}(0)}{V^{*}_{i}} \sum_{k} V^{*}_{k} C_{kj}(0) = \hat{R}_{j} X_{ji}(0) / V^{*}_{i}$$

THIS RULE TOGETHER WITH THE DEFINITION OF $\hat{R}$ BRINGS ABOUT SOME TROUBLES, DEPENDING ON THE CONTEXT IN WHICH DYNAMIC AND STATIC OPERATIONS ARE EMPLOYED.

THE DYNAMIC SYSTEM

$$dV(t)/dt = \hat{R}\, X(0) - V(t)$$

(IN DETAIL $dV_{i}(t)/dt = K\,(\mathscr{D}_{i} - \mathscr{S}_{i}) = \sum_{j} \hat{R}_{j} X_{ji}(0) - V_{i}(t)$

EXPLAINS TIME EVOLUTION OF THE VECTOR OF VALUES IN TERMS OF THE MARKET DEMAND FOR CONTROL OVER EVENTS, THAT IS, THE DIFFERENCE BETWEEN DEMAND FOR CONTROL $\mathscr{D}_{i}$ AND SUPPLY OF CONTROL $\mathscr{S}_{i}$.
AGAIN, EQUILIBRIUM OCCURS WHEN

$$V^{*} = R\, X(0) = V^{*}\, CX(0)$$

NOW, CONSIDER A DYNAMIC VECTOR V, AND THE FOLLOWING MODIFICATIONS OF THE ALLOCATION RULE:

(A) THE ALLOCATION RULE IS GIVEN IN THE FORM

$$C^*_{ij} = \frac{X_{ji}(0)}{V^*_i} \;{}_{k}\; V^*_k \, C_{kj}(0)$$

THUS AT EQUILIBRIUM TIME t^* IT TURNS OUT THAT ACTOR j's RESOURCES ARE NOW ALLOCATED PROPORTIONAL TO $X_{ji}(0)/V^*$.

(B) THE ALLOCATION RULE REPRESENTS A TIME INVARIANT LAW, THAT IS, FOR ALL TIMES t WE HAVE

$$C_{ij}(t) = \frac{X_{ji}(0)}{V_i(t)} \hat{R}_j$$

IN THIS CASE WE MAY BE CONVINCED THAT, AT ANY TIME t , ACTOR j WILL ALLOCATE HIS RESOURCES $\hat{R}_j$ PROPORTIONAL TO THE RATIO $X_{ji}(0)/ V_i(t)$ DETERMINED BY THE PRICE OF i AT THAT TIME t . THUS ACTOR j ALLOCATES HIS RESOURCES $\hat{R}_j$ IN PROPORTION TO HIS INTEREST $X_{ji}(0)$ AND INVERSELY PROPORTIONAL TO THE VALUE OF EVENT i. IN THIS CASE THE ALLOCATION RULE HOLDS FOR ALL t WITHIN THE BARGAINING (THAT IS, AT ANY PHASE OF NEGOTIATION).

CLEARLY CASE (B) LEADS TO A CONTRADICTION.

CONSIDER THE EQUATION

$$C_{ij}(t)\, V_i(t) = X_{ji}(0)\, \hat{R}_j$$

PASSING OVER TO DIFFERENTIALS, WE OBTAIN

$$C_{ij}(t)\, dV_i(t) + V_i(t)\, dC_{ij}(t) = 0$$

INTEGRATION FROM $t = 0$ TO t^* AND FROM $t = 0$ TO t YIELDS

$$V_i(t)\ C_{ij}(t) = V_i(0)\ C_{ij}(0)$$

AND

$$V_i(t^*)\ C_{ij}(t^*) = V_i(0)\ C_{ij}(0)$$

SUMMATION OVER j RESULTS IN

$$V_i(t^*) = V_i(0) = V_i(t) \quad \text{FOR ALL TIMES } t .$$

THUS THE ASSUMPTION OF A TIME-INVARIANT ALLOCATION RULE OF THE FORM (B) LEADS TO THE CONTRADICTORY STATEMENT THAT THE DYNAMIC SYSTEM DOES NOT ALLOW FOR A TIME EVOLUTION OF PRICES, OR COLLECTIVE VALUES.

THE CONCLUSION, THAT IF THERE WERE A CONSTANT VECTOR OF TOTAL RESOURCES $\hat{R}$, A TIME INVARIANT INTEREST MATRIX X, AND A TIME INVARIANT ALLOCATION RULE (B), THEN THE VECTOR OF VALUES WOULD BE A CONSTANT OF MOTION CAN BE DRAWN.

IN ORDER TO OVERCOME THIS PROBLEM WHICH IS THE RESULT OF SOME HEURISTIC PROCEDURE, EITHER TURN DOWN TIME INVARIANCE' OF THE ALLOCATION RULE, OR FIND SOME MORE REALISTIC REPRESENTATION THAT ALLOWS FOR DYNAMIC RESOURCES $R(t)$ (INSTEAD OF CONSTANT TOTAL RESOURCES $\hat{R}$).

IN ANY CASE, IT IS A SOMEWHAT ARTIFICIAL THING TO UPHOLD THE ASSUMPTION OF CONSTANT RESOURCES TOGETHER WITH A LAW WHICH CANNOT BE REGARDED AS BEING INVARIANT WITH RESPECT TO TIME TRANSLATIONS. THUS TWO THINGS ARE POSSIBLE:

ALLOW FOR DYNAMIC $R(t)$; AND CONSIDER EXTENDED DYNAMIC EQUATIONS OF THE FOLLOWING FORM:

SUBSYSTEM I 'PRICE-DYNAMICS' ... $dV/dt = \alpha(RX - V)$

SUBSYSTEM II 'RESOURCES' ... $dR/dt = \beta(VC - R)$

MORE PRECISELY:

AT EACH TIME t THE STATE OF SUBSYSTEM I IS DESCRIBED BY A VECTOR OF COLLECTIVE VALUES. FURTHERMORE, AT EACH TIME t THE STATE OF SUBSYSTEM II IS DESCRIBED BY A VECTOR OF RESOURCES, OR 'POWER

SUBSYSTEM I REPRESENTS A TIME-INVARIANT SYSTEM WITH STATE VECTOR V, n SCALAR INPUTS $R_j(t)$, AND INVARIANT PARAMETERS X_{ji}.
SUBSYSTEM II IS A TIME VARYING SYSTEM WITH STATE VECTOR $R(t)$, m SCALAR INPUTS $V_i(t)$ AND TIME VARYING PARAMETER MATRIX $C(t)$.

IN SYSTEM I THE DYNAMICS OF PRICES IS CONTROLLED BY RESOURCES VIA THE INTEREST-MATRIX X, WHEREAS IN SYSTEM II RESOURCES ARE BEING CONTROLLED BY PRICES VIA THE T I M E V A R Y I N G CONTROL MATRIX $C(t)$.

EQUILIBRIUM PROPERTIES AND CONTROLLABILITY OF EXCHANGES

IT IS NOW EASY TO SHOW THAT THE EXTENDED DYNAMIC SYSTEM ACTUALLY GENERATES COLEMAN'S ALGEBRAIC LAW FOR THE STATIC CASE.
THE CONSTANT VECTOR $\hat{R} = \sum_i V_i^* C_{ij}(0)$ SATISFIES THE EIGENVALUE EQUATION

$$\hat{R} = \hat{R}\, X(0)\, C(0)$$

THE EQUILIBRIUM MATRIX ELEMENT C_{ij}^* GIVEN BY THE EXPRESSION

$$\frac{\hat{R}_j}{V_i^*} X_{ji}(0)$$

$R^* = \hat{R}$ SATISFIES THE EQUATION

$R^* \triangleq R^*\, X(0)\, C(0)$ IFF $R^* = R^*\, X(0)\, C^*$, BECAUSE

LET $R_j^* \neq \sum_k R_k^* \sum_i X_{ki}(0)\ C_{ij}^*$

THEN

$$R_j^* \neq \sum_k R_k^* \sum_i (R_j^*/V_i)\ X_{ki}(0)\ X_{ji}(0)$$

DIVIDING THROUGH BY R_j^* GIVES

$$1 \neq \sum_k \sum_i (R_k^*/V_i)\ X_{ki}(0)\ X_{ji}(0) = \sum_i \sum_k C_{ik}^*\ X_{ji}(0) =$$

$$= \sum X_{ji}(0) \quad \text{SINCE} \quad \sum_k C_{ik}^* = 1$$

HOWEVER THE EQUATION $\Sigma_i X_{ji}(0) \neq 1$ CONTRADICTS THE FACT THAT X IS ROW STOCHASTIC.
ON THE OTHER HAND, WE CAN DERIVE $R^* = R^*\ X(0)\ C(0)$ FROM $R^* = R^*\ X(0)\ C^*$ THROUGH THE DEFINITION OF C^*.
ACTUALLY, THE VECTOR OF 'TOTAL RESOURCES' R SATISFIES THE 'EQUILIBRIUM-EQUATION' $R^* = R^*\ X(0)\ C^*$.
ANALOGOUSLY V^* HAS TO BE AN EIGENVECTOR OF THE MATRIX $C^*X(0)$ WITH THE m-FOLD DEGENERATE EIGENVALUE 1.

NOW, MULTIPLYING EQUATION 'SUBSYSTEM I' BY $C(t)$ FROM THE RIGHT HAND SIDE, AND SUBSTITUTING

$$VC = (1/\beta)\ \dot{R} + R \quad \text{YIELDS} \quad \dot{V} + (\alpha/\beta)\dot{R} + \alpha R = \alpha RXC$$

IN CASE OF EQUILIBRIUM WE HAVE $\dot{V} = \dot{R} = 0$, AND THEREFORE

$$R^* = R^*\ x(0)\ C^*$$

SIMILARLY, MULTIPLYING 'SUBSYSTEM II' BY $X(0)$ FROM THE RIGHT HAND SIDE, WE OBTAIN THE EQUILIBRIUM EQUATION

$$V^* = V^*\ C^*\ X(0)$$

ACTUALLY, IT SEEMS APPROPRIATE TO CONSIDER STATES V AS BEING CONTROLLED BY RESOURCES R THROUGH THE INTEREST MATRIX. WHEREAS, THE VECTOR OF POWER R IS CONTROLLED BY CURRENT PRICES V THROUGH A TIME VARYING CONTROL MATRIX $C(t)$.

THIS STATEMENT HAS TO BE PINNED DOWN IN A CLEAR WAY. OTHERWISE THE RELATIONSHIP BETWEEN 'CONTROL' WITHIN EXCHANGES AND CONTROLLABILITY OF THE DYNAMIC EQUATIONS CANNOT BE UNDERSTOOD.

LET US DESIGN SYST. I IN THE FOLLOWING WAY:

$$(d/dt)\begin{pmatrix} V_1 \\ V_2 \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ V_m \end{pmatrix} = -\alpha \begin{pmatrix} V_1 \\ V_2 \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ V_m \end{pmatrix} + \alpha \begin{pmatrix} X_{11} \\ X_{12} \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ X_{1m} \end{pmatrix} R_1 + \alpha \begin{pmatrix} X_{21} \\ X_{22} \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ X_{2m} \end{pmatrix} R_2 + \ldots + \alpha \begin{pmatrix} X_{n1} \\ X_{n2} \\ \cdot \\ \cdot \\ \cdot \\ X_{nm} \end{pmatrix} R_n$$

THIS IS A TIME INVARIANT LINEAR SYSTEM WITH n SEPERATE SCALAR INPUTS, AND CONTROLS: $R_1, R_2, \ldots, R_n$

CONSIDER THE FOLLOWING CONTROLLABILITY THEOREM:

THE TIME INVARIANT SYSTEM I IS TOTALLY CONTROLLABLE BY RESOURCES, IF AND ONLY IF THE INTEREST MATRIX $X(0)$ IS OF RANK m.

ANY LINEAR SYSTEM

$dV/dt = A\,V + B\,U$ WITH m-VECTOR V, AND n SCALAR INPUTS

IS TOTALLY CONTROLLABLE IFF THE $m \times mn$ MATRIX

$Q = (B|AB|\ldots|A^{n-1}B)$

HAS RANK m. (SEE DONALD M. WIBERG, 1971)

IN THE PRESENT CASE THE CONTROLLABILITY MATRIX Q EQUALS

$(\alpha X \mid -\alpha^2 X \mid \alpha^3 X \mid \ldots \mid (-1)^{m-1}\alpha^m X)$

THIS MATRIX IS OF RANK m IFF THE INTEREST MATRIX IS OF RANK m.
THUS, THE COLLECTIVE VALUES OF THE EVENTS ARE TOTALLY CONTROLLABLE BY RESOURCES, IFF THERE ARE NO TWO EVENTS SUCH THAT THE DISTRIBUTION OF INTERESTS IS THE SAME FOR BOTH

THE SAME STATEMENT CANNOT HOLD FOR SYSTEM II, SINCE RESOURCES ARE CONTROLLED THROUGH A DYNAMIC CONTROL MATRIX.
THE TIME VARYING SYSTEM

$$(d/dt)\begin{pmatrix} R_1 \\ R_2 \\ \vdots \\ R_n \end{pmatrix} = -\beta \begin{pmatrix} R_1 \\ R_2 \\ \vdots \\ R_n \end{pmatrix} + \beta \begin{pmatrix} C_{11} \\ C_{12} \\ \vdots \\ C_{1n} \end{pmatrix} V_1 + \ldots + \beta \begin{pmatrix} C_{m1} \\ C_{m2} \\ \vdots \\ C_{mn} \end{pmatrix} V_m$$

IS TOTALLY CONTROLLABLE IF AND ONLY IF THE MATRIX

$Q(t) = (Q_1|Q_2|\ldots|Q_n)$ HAS RANK n FOR ALMOST EVERY t,

THAT IS, THE CONTROLLABILITY MATRIX SHOULD BE OF RANK n FOR A SUBSET OF TIMES LYING DENSE IN THE CONTROL INTERVAL. THERE SHOULD EXIST ONLY ISOLATED POINTS FOR WHICH Q IS NOT OF 'FULL' RANK n.
THE MATRICES Q_K ARE DEFINED IN THE FOLLOWING WAY

$$Q_1 = C(t); \quad Q_2 = \beta\, C\,(t) + (d/dt)\, C(t);$$

$$Q_3 = \beta^2 C(t) + 2\beta (d/dt)\, C(t) + (d^2/dt^2)\, C(t); \ \ldots$$

$$Q_{k+1} = \beta Q_k + (d/dt)\, Q_k$$

THUS IT IS NECESSARY, BUT NOT SUFFICIENT, THAT THE CONTROL MATRIX IS OF RANK n.
(RECALL THAT THE CYBERNETIC DESIGN OF THE CONTROL MATRIX HAS BEEN REARRANGED BY USING C^T, THAT IS, THE TRANSPOSED CONTROL MATRIX)
NOW, WHAT IS THE RELATIONSHIP BETWEEN THE 'MATRIX OF COLLECTIVE CONTROL C' AND THE CONTROLLABILITY MATRIX Q? IF WE COLLECT THE RESULTS WHICH ARE AVAILABLE UNTIL NOW, WE MAY FORMULATE THE FOLLOWING STATEMENT:

THE TIME EVOLUTION OF THE POWER OF THE ACTORS WITHIN A SYSTEM OF COLLECTIVE ACTION IS TOTALLY CONTROLLABLE BY THE COLLECTIVE VALUES OF THE EVENTS, IF AND ONLY IF THE CONTROL MATRIX OF THE COLLECTIVITY, AND ITS FIRST $n-1$ DERIVATIVES ARE MATRICES WITH RANK n.

THE TIME EVOLUTION OF THE COLLECTIVE VALUE OF EVENTS WITHIN AN EXCHANGE SYSTEM IS TOTALLY CONTROLLABLE BY RESOURCES, IF AND ONLY IF THE INTEREST MATRIX IS OF RANK m.

(AGAIN, RECALL THAT WE USED X^T AND C^T RELATIVE TO THE CONVENTIONAL NOTATION OF THE MATRICES)

BACK TO THE DISCRETE CASE - CONTROLLABILITY, AND THE INVARIANCE OF LAWS

IN THE PREVIOUS CHAPTER USE WAS MADE OF SOME EXTENDED DYNAMIC SYSTEM (I, II). STATES OVER THE ALGEBRAS II , I HAVE BEEN EVOLVED THROUGH TIME BY LINEAR DIFFERENTIAL OPERATORS.
WE PROVED THAT THE MARKET PRICES WERE TOTALLY CONTROLLABLE BY RESOURCES IFF THERE WERE NO TWO EVENTS WITH EQUAL DISTRIBUTIONS OF INTERESTS. FURTHERMORE, POWER TURNED OUT TO BE TOTALLY CONTROLLABLE BY COLLECTIVE VALUES OF EVENTS IFF THERE WERE NO TWO ACTORS WITH EQUAL CONTROLS, AND IFF THE CONTROL MATRIX EVOLVED IN TIME SUCH THAT ITS FIRST $n-1$ DERIVATIVES HAD RANK n .
THIS HAS BEEN SHOWN FOR THE CONTINUOUS CASE, THAT IS, SMOOTH TIME EVOLUTION - WHAT FOR ?

ACTUALLY, THE EXCHANGE PROCESS CONSISTS OF DISCRETE PHASES OF NEGOTIATION. THUS CONTROL MATRICES CAN ONLY BE OBSERVED AT DISCRETE TIME-POINTS.
THIS SUGGESTS, THAT IT IS MORE REALISTIC TO CONSIDER A PROCESS DESCRIBED BY LINEAR DIFFERENCE EQUATIONS OF THE FORM:

$$\nabla V(T) = \alpha \left\{ R(T-1)\, X - V(T-1) \right\}$$

$$\nabla R(T) = \beta \left\{ V(T-1)\, C(T-1) - R(T-1) \right\}$$

WHERE ∇ IS THE BACKWARD DIFFERENCE OPERATOR.

THESE EQUATIONS MAY ALSO BE WRITTEN IN THE FORM:

$$V(T) = (1-\alpha)\, V(T-1) + \alpha R(T)\, X \qquad \text{SYS I.}$$

$$R(T) = (1-\beta)\, R(T-1) + \beta V(T-1)\, C(T-1) \qquad \text{SYS II.}$$

THE QUESTION OF CONTROLLABILITY OF THIS DISCRETE SYSTEM BECOMES CLEARER BY THE AID OF THE EQUIVALENT RECURSIVE EQUATIONS

$$V(T) = (1-\alpha)^T V(0) + \sum_{\tau=1}^{T} \alpha(1-\alpha)^{T-\tau} R(\tau-1) X \quad \ldots \text{I}$$

$$R(T) = (1-\beta)^T R(0) + \sum_{\tau=1}^{T} \beta(1-\beta)^{T-\tau} V(\tau-1) C(\tau-1) \ldots \text{II}$$

$$T > 1$$

AGAIN, SYSTEM I IS A TIME INVARIANT (STATIONARY) LINEAR DIFFERENCE EQUATION; SYSTEM II REPRESENTS A TIME VARYING LINEAR PROCESS SINCE THE CONTROL MATRIX C DEPENDS ON TIME; (CF. KREINDLER AND SARACHIK, 1964).
WE MAKE USE OF THE FOLLOWING NOTATION

$$X = \begin{pmatrix} X_{11}, & X_{21}, & \ldots, & X_{n1} \\ X_{12}, & X_{22}, & \ldots, & X_{n2} \\ \vdots & \vdots & & \vdots \\ X_{1m} & X_{2m} & & X_{nm} \end{pmatrix} \qquad C = \begin{pmatrix} C_{11}, & C_{21}, & \ldots, & C_{m1} \\ C_{12}, & C_{22}, & \ldots, & C_{m2} \\ \vdots & \vdots & & \vdots \\ C_{1n} & C_{2n} & & C_{mn} \end{pmatrix}$$

$$R = \begin{pmatrix} R_1 \\ R_2 \\ \vdots \\ R_n \end{pmatrix} \qquad V = \begin{pmatrix} V_1 \\ V_2 \\ \vdots \\ V_m \end{pmatrix}$$

AND REARRANGE THE RECURSIVE SYSTEM :

$$V(m)-(1-\alpha)^m V(0) = \left[\alpha(1-\alpha)^{m-1}X \,\middle|\, \alpha(1-\alpha)^{m-2}X \,\middle|\, \ldots \,\middle|\, \alpha X\right] \begin{pmatrix} R(0) \\ R(1) \\ \vdots \\ R(m-1) \end{pmatrix}$$

THIS DESIGN OF THE PROCESS I IS MOST USEFUL, WHEN A BETTER UNDERSTANDING OF THE FORMAL MEANING OF CONTROLLABILITY IS CONCERNED:

"A PROCESS IS CALLED CONTROLLABLE IF IT IS POSSIBLE TO FIND A CONTROL VECTOR WHICH BRINGS THE SYSTEM FROM ANY INITIAL STATE TO ANY SPECIFIED FINAL STATE IN FINITE TIME". (PIETER EYCKHOFF, 1974)

WHEN α, $V(0)$, AND $V(m)$ ARE KNOWN THE LEFT HAND SIDE OF THE EQUATION IS DETERMINED. A UNIQUE SOLUTION OF THE "OVER-TIME R-VECTOR $R(0), R(1), \ldots, R(1-m)$" WHICH IS A VECTOR OF VECTORS CAN BE FOUND IF THE MATRIX

$$\left(\alpha(1-\alpha)^{m-1} X \;\middle|\; \alpha(1-\alpha)^{m-2} X \;\middle|\; \ldots \;\middle|\; \alpha X \right) \quad \text{HAS RANK } m,$$

THAT IS, IFF THE INTEREST MATRIX

$$\begin{pmatrix} X_{11}, & \ldots, & X_{n1} \\ \vdots & & \vdots \\ X_{1m}, & \ldots, & X_{nm} \end{pmatrix}$$

HAS RANK m.

SIMILARLY, WE MAY REARRANGE THE SYSTEM OF RESOURCES II:

$$R(n)-(1-\beta)^n R(0) = \left(\beta(1-\beta)^{n-1} C(0) \;\middle|\; \ldots \;\middle|\; \beta C(n-1) \right) \begin{pmatrix} V(0) \\ \vdots \\ V(n-1) \end{pmatrix}$$

THUS, WHEN β, $R(0)$ AND $R(n)$ ARE KNOWN THE LEFT HAND SIDE OF THE EQUATION IS DETERMINED. A UNIQUE SOLUTION OF THE "OVER-TIME V-VECTOR OF COLLECTIVE VALUES" EXISTS IFF THE

CONTROLLABILITY MATRIX

$$\left[\; \beta(1-\beta)^{n-1}\, C(0) \;\middle|\; \beta(1-\beta)^{n-2}\, C(1) \;\middle|\; \ldots \;\middle|\; \beta C(n-1) \;\right]$$

HAS RANK n . THIS REQUIRES THAT EACH OF THE CONTROL MATRICES

$$\begin{bmatrix} C_{11}(0) & ,\ldots, & C_{m1}(0) \\ & & \\ C_{1n}(0) & ,\ldots, & C_{mn}(0) \end{bmatrix} , \begin{bmatrix} C_{11}(1) & ,\ldots, & C_{m1}(1) \\ & & \\ C_{1n}(1) & ,\ldots, & C_{mn}(1) \end{bmatrix}$$

$$\ldots \qquad \begin{bmatrix} C_{11}(n-1) & ,\ldots, & C_{m1}(n-1) \\ & & \\ C\ \ (n-1) & ,\ldots, & C\ \ (n-1) \end{bmatrix}$$

HAS RANK n .

THUS WE OBTAIN THE FOLLOWING CONTROLLABILITY THEOREM FOR DISCRETE SYSTEMS:

IN A SYSTEM OF COLLECTIVE ACTION INVOLVING n ACTORS, THE VECTOR OF POWER IS CONTROLLABLE BY PRICES IF AND ONLY IF THE n CONTROL MATRICES WHICH SPAN THE TIME INTERVALL $[0, n-1]$ HAVE RANK n , THAT IS, AT NO TIME T: $0 \leqq T \leqq n-1$ THERE EXIST TWO ACTORS j, k WITH EQUAL CONTROL VECTORS $C_{1j}, C_{2j}, \ldots, C_{mj}$, AND $C_{1k}, C_{2k}, \ldots, C_{mk}$.

THE VECTOR OF COLLECTIVE VALUES IS CONTROLLABLE BY RESOURCES IF AND ONLY IF THE INTEREST MATRIX IS OF RANK m .

CONSIDER THE FOLLOWING STATEMENTS

THE VALUE OF EVENT 5 EQUALS

({THE POWER OF ACTOR 1 TIMES HIS CURRENT INTEREST IN EVENT 5}

PLUS

{THE POWER OF ACTOR 2 TIMES HIS CURRENT INTEREST IN EVENT 5}

PLUS

.
.
.

PLUS

{THE POWER OF ACTOR n TIMES HIS CURRENT INTEREST IN EVENT 5})

ADDITIONALLY,

THE POWER OF ACTOR 2 EQUALS

({THE VALUE OF EVENT 1 TIMES HIS CURRENT CONTROL OVER EVENT 1}

PLUS

{THE VALUE OF EVENT 2 TIMES HIS CURRENT CONTROL OVER EVENT 2}

PLUS

.
.
.

PLUS

{THE VALUE OF EVENT m TIMES ACTOR 2'S CONTROL OVER EVENT m })

THESE STATEMENTS REPRESENT THE ALGEBRAIC LAWS $V = R\,X$ AND $R = V\,C$ WHICH LEAD TO $V = V\,CX$, $R = R\,XC$. THE RELATIONSHIPS SEEM QUITE UNDERSTANDABLE.

BUT ARE THEY REPRESENTATIVE FOR A TIME INVARIANT LAW, THAT IS, A LAW WHICH KEEPS ITS ALGEBRAIC WELL-FORMEDNESS STATIONARY.

HOWEVER, ONE MAY EASILY VERIFY THAT THE EIGENVALUE EQUATIONS MAY NOT REMAIN STATIONARY.

WE SHALL GIVE A PROOF OF THIS STATEMENT BY SETTING $\alpha = \beta = 1$ WHICH CAN BE DONE WITHOUT LOSS OF GENERALITY BECAUSE THE PROOF SHALL BE GIVEN INDIRECTLY

MAKING USE OF THE DIFFERENCE EQUATION THAT DEFINES SYSTEM II, WE MAY FIND THE FOLLOWING RELATIONSHIPS:

$$
\begin{aligned}
R(1) &= R(0) \times C(0) &&= R(0) \\
R(2) &= R(0) \times C(1) &&= R(1) \times C(1) = R(1) \\
R(3) &= R(0) \times C(0) \times C(2) &&= R(2) \times C(2) = R(2) \\
R(4) &= R(0) \times C(1) \times C(3) &&= R(3) \times C(3) = R(3) \\
R(5) &= R(0) \times C(0) \times C(2) \times C(4) &&= R(4) \\
R(6) &= R(0) \times C(1) \times C(3) \times C(5) &&= R(5) \\
&\vdots && \vdots
\end{aligned}
$$

WE OBTAIN THE IDENTITIES $R(0) = R(1) = \ldots = R(T)$. THUS, POWER HAS TO BE A CONSTANT OF MOTION AS LONG AS THE EQUATION $R = R \times C$ IS CONSIDERED AS BEING TIME INVARIANT, THAT IS, FOR ALL T
$R(T) = R(T) \times C(T)$.
QUITE SIMILARLY IT CAN BE SHOWN THAT THE VECTOR OF VALUES WOULD BE A CONSTANT OF MOTION TOO.
THUS, IT SHOULD BE CLEAR THAT THE ALGEBRAIC LAW CAN BE APPLIED ONLY WHEN THE SYSTEM IS IN EQUILIBRIUM, IF SUCH AN EQUILIBRIUM EXISTS.

PART TWO

THE COUPLING BETWEEN SYSTEMS OF COLLECTIVE ACTION, HUMAN COMMUNICATION AND PERCEPTION

WEAK INTERACTION AMONGST THE ACTORS

IN THIS PART WE SHALL ELABORATE A FRAMEWORK FOR A SYNTHESIS OF COLLECTIVE ACTION AND COMMUNICATION. FOR THE PRESENT, LET US CONSIDER THREE MODES OF INTERACTION WHICH ARE BEING ORDERED ACCORDING TO THEIR PSYCHOLOGICAL INTENSITY:

(1) WEAK INTERACTION
(2) INTEREST CHANGING INTERACTION
(3) STRONG INTERACTION

IT IS THE DIRECTED INTEREST OF HUMAN ACTORS THAT HAS TO BE REGARDED AS THE MOST ESSENTIAL DRIVER OF COLLECTIVE ACTION.
THE REALIZATION OF THE INTERESTS OF THE ACTORS THROUGH THEIR POWER, AND THE EXTENT OF THEIR RESOURCES IS ACHIEVED BY THE AID OF COMMUNICATION, VOTE TRADING, AND PROCESSES OF COLLECTIVE ACTION.
A WEAK INTERACTION IS A COMMUNICATION PROCESS SUCH THAT THE EXCHANGE OF MESSAGES DOES NOT AFFECT INDIVIDUAL UTILITY DIFFERENCES. THUS, WEAK INTERACTION LEAVES PERSONAL INTERESTS INVARIANT. IT IS CONSISTENT WITH THE EXCHANGE OF INFORMATIVE AND INSTRUCTIVE MESSAGES, HOWEVER, IT MUST NOT CONTAIN MOTIVATIONS.

"INFORMATION REFERS TO WHAT A MAN DOES, INSTRUCTION TO HOW HE DOES IT, AND MOTIVATION TO WHY HE DOES IT."

WEAK INTERACTION AFFECTS WHAT THE ACTORS DO, AND HOW THEY DO IT. HOWEVER, THE ACTORS DO NOT COMMUNICATE IN SUCH A MANNER THAT AN INDIVIDUAL IS TOLD ABOUT 'A REASON FOR BEING ACTIVE' IN THIS OR THAT WAY, THAT IS, THE COMMUNICATION DOES NOT CONTAIN MOTIVATING MESSAGES.
WEAK INTERACTION DOES NOT AFFECT SUBJECTIVE UTILITIES.

HOWEVER, IT MAY AFFECT THE PROBABILITIES $P_{ji}(A_\nu)$ THAT ACTOR j ACTS ON EVENT i BY CHOOSING ACTION A_ν. IT MAY ALSO CHANGE THE SUBJECTIVE CONDITIONAL PROBABILITIES THAT ACTIONS A_ν YIELD GIVEN OUTCOMES.
IF WE MAKE EXPLICIT USE OF SUBJECTIVE PROBABILITIES $P_{i_\gamma j_\nu}$ (THAT ACTION A_ν OF ACTOR j ON EVENT i YIELDS OUTCOME γ)
AND THE DEFINITION OF MAXIMUM SUBJECTIVE POTENTIAL CONTROL OVER EVENT i OF ACTOR j, WE MAY GIVE THE FOLLOWING DESCRIPTION

THE EXCHANGE OF MESSAGES DURING COMMUNICATION PROCESSES OF WEAK INTERACTION MODIFIES, CHANGES, ARRANGES, AND REARRANGES THE DISTRIBUTION OF CONTROL, THAT IS, IT AFFECTS THE CONTROL MATRIX.
WEAK INTERACTION MAY ALSO AFFECT PROBABILITIES OF ACTIONS A_ν OF ACTOR j ON EVENT i .

IT IS QUITE NATURAL TO CALL COMMUNICATION PROCESSES, WHICH AT MOST REARRANGE THE CONTROL MATRIX, WEAK INTERACTIONS.
THERE IS A RELATIONSHIP BETWEEN COLLECTIVE EXCHANGE SYSTEMS AND THE PSYCHOLOGICAL STATES OF THE ACTORS, THAT IS, A RELATIONSHIP BETWEEN CONTROL, INTEREST, AND THE WEBER-FECHNER LAW. (SEE COLEMAN, 1972)
ANY INTERACTION WHICH AFFECTS THE WEBER-FECHNERIAN

$\frac{\Delta S_{ij}}{\Delta C_{ij}} = K_{ji}\frac{1}{C_{ij}}$ THROUGH THE PSYCHOLOGICAL 'CONSTANT' K_{ji} MAY, WITH GOOD REASONS, BE CALLED STRONGER THAN A PROCESS THAT CHANGES C_{ij} .
PUT IT THIS WAY:

AN INTERACTION WHICH AFFECTS THE INTENSITIES C_{ij} OF STIMULI IS LESS STRONG THAN AN INTERACTION WHICH CHANGES WEBER-FECHNER-CONSTANTS.

ACTUALLY, TO CHANGE SOME WEBER-FECHNER CONSTANT FROM THE OUTSIDE MEANS THAT NEURO-PSYCHOLOGICAL MANIPULATIONS TAKE PLACE.

WHAT CAN BE SAID ABOUT THE DEGREE OF INSTRUCTIVENESS OF A WEAK INTERACTION ?
SUPPOSE THAT AT TIME $T = 0$ ACTOR j's CONTROL OVER EVENT i EQUALS $C_{ij}(0)$
AFTER SOME WEAK INTERACTION WITH ACTOR k j's CONTROL IS CHANGED TO $C_{ij}(T)$

THIS SUGGESTS TAKING $C_{ij}(T) - C_{ij}(0)$ AS A MEASURE FOR THE DEGREE OF THE 'INSTRUCTIVE LOAD OF j's INTERACTION WITH k '. THUS, MOST REASONABLE MEASURES FOR THE INTENSITY OF A WEAK INTERACTION ARE PRODUCED BY THE SHIFT OF CONTROL ∇C_{ij} .
IT IS A VERY ARDUOUS TASK TO DESCRIBE FORMALLY THE EFFECT OF INSTRUCTIVE MESSAGES ON THE MOVEMENT OF THE CONTROL MATRIX.
FIRSTLY, THE DESIGN OF THIS EFFECT DEPENDS ON THE DEFINITION OF 'QUALITY AND QUANTITY' OF AN INSTRUCTION WHICH CAN ONLY BE ESTABLISHED BY MEANS OF A HIGH DEGREE OF ARBITRARINESS; FURTHERMORE, INSTRUCTIONS WHICH ARE WIDELY DISTRIBUTED OVER TIME AFFECT THE CONTROL MATRIX ACCORDING TO THE DENSITY OF THEIR APPEARANCE IN TIME. FINALLY, THE EFFECTABILITY OF SUBJECTIVE PROBABILITIES IS HIGHLY DEPENDENT ON THE PSYCHO-PHYSIOLOGICAL STATE OF AN ACTOR.
ANYWAY, MODELS THAT DESCRIBE SUCH AN EFFECT HAVE TO LINK THE SHIFT OF CONTROL ∇C_{ij} TO SOMETHING LIKE "PROBABILITIES OF THE OCCURRENCE OF INFORMATIVE ELEMENTS OF A MESSAGE WITHIN SOME FINITE INTERVALL OF TIME".
YET IT MAY BE POSSIBLE RATHER TO DESCRIBE THE AVERAGE CONTROLS THAT HAVE BEEN ACQUIRED BY A WHOLE SUBGROUP OF SOCIETY AS BEING GENERATED BY A CERTAIN WELL KNOWN PROCESS OF INSTRUCTION OR EDUCATION (SOCIALIZATION).

EXAMPLE:

THERE ARE TWO PRINTERS WHICH CONTROL 30% AND 70% RESPECTIVELY OF THE OUTPUT OF A DAILY PAPER. THE 70%-PRINTER IS OVERLOADED, WEAK INTERACTION BETWEEN THE MEMBERS OF THESE PRINTER LEADS TO SOME MORE SUITABLE APPLICATION OF THE PLANT WIHTIN THE FIRST PRINTER. THUS, CONTROL IS RAISED FROM 30% TO 38%; PRINTER 2 IS UNBURDENED.
THE NUMBER 0,08 IS A MEASURE OF THE AMOUNT OF INSTRUCTION WHICH WAS DIRECTED TO PRINTER 1.

EXAMPLE:

THIS IS AN INFORMATIVE MESSAGE

INTEREST CHANGING INTERACTION

INTEREST CHANGING INTERACTIONS ARE BOUND TO PROCESSES OF COMMUNICATION THAT CHANGE SUBJECTIVE UTILITIES. THEY CONTAIN MESSAGES WHICH MOTIVATE THE ACTORS.

THOSE VERBAL BARGAININGS WHICH INDICATE TO A PERSON WHY ACTION A_ν SHOULD BE CARRIED OUT IN PREFERENCE TO A_μ CONTAIN MESSAGES WHICH MOTIVATE AN ACTOR.
THEY ARE ACCOMPANIED BY THE EXERCISE OF VERBAL POWER; THUS, THEY MAY EVEN AFFECT THE PSYCHOLOGICAL STATE OF THE ACTOR.
THE EFFECTIVENESS OF MOTIVATING MESSAGES IS CLOSELY LINKED TO REFLECTION.
AN ACTOR IS ABLE TO REFLECT ON AN ACTION AND ITS OUTCOME. THUS, HE CAN BE MADE TO PRESUPPOSE THE UTILITY OF AN ACTION WHICH HAS NOT YET BEEN CARRIED OUT.
IF HE COULD NOT DO THIS HE COULD NEITHER BE INFORMED NOR CONVINCED OF THE UTILITY OF AN ACTION.

ACCORDINGLY, IT SEEMS REASONABLE TO MEASURE THE INTENSITY OF MOTIVATING INTERACTIONS IN TERMS OF THE MOVEMENT OF INDIVIDUAL INTERESTS, OR THE SHIFT ∇X_{ji}.

EXAMPLE:

THE INTERACTION BETWEEN THE FURNITURE INDUSTRY AND THE GENERAL PUBLIC VIA ADVERTISING IS AN INTEREST CHANGING INTERACTION.

STRONG INTERACTION AMONGST THE ACTORS

"MOST OF OUR DIALOGS ARE DRIVEN BY THE DESIRE TO MOTIVATE OUR OWN IMPORTANCE. THEY ARE GUIDED BY THE AMBITION TO REPRESENT OUR STANDPOINTS.
WY TRY TO DEFEND ROLES AND VIEWS WHICH HAVE BEEN ACQUIRED DURING THE PAST.
WE HAVE EXPECTATIONS CONCERNING OTHER PERSONS SIGHTS WE ARE OBJECTS OF.
TALKING TO OUR PARTNERS WE TRY TO TRANSPORT OUR OWN VIEWS, OPINIONS, ATTITUDES AND EXPECTATIONS 'INTO' THEIR PERCEPTION SPACE.
THUS, VERY OFTEN CONFLICT COMES UP. THE CONFLICT IS ACCOMPANIED BY FRUSTRATION AND SEVERAL KINDS OF CONFUSION. IT IS ALSO A CONSTANT GENERATOR OF THE SEARCH FOR THE REASONS OF CONFLICT.
THEN A NEW PARADOX ARISES:
EITHER WE FAIL TO FIND ENOUGH CAUSES, OR WE FIND SOME WHICH ARE EASILY REFUTABLE BY OUR PARTNER, OR IF MIND IS ADAPTABLE ENOUGH WE DISCOVER CAUSES OF WIDE EXTENT WHICH CONVINCE OUR PARTNER. BUT THESE SO CALLED CAUSES BEING PRODUCTS OF A CONFLICT SITUATION, AGAIN MOTIVATE OUR OWN IMPORTANCE, AND THEY ARE GUIDED BY THE AMBITION TO REPRESENT STANDPOINTS. THUS, THEY MAKE UP NEW CONFLICT.
THE PARADOX OF THE PROCESS OF 'REASONING CONFLICT WITHIN A CONFLICT' IS THAT IT IS SUBJECT TO THE RULES OF PARADOX COMMUNICATION AS ALL THE OTHER STATEMENTS OF THE DIALOG ARE SUBJECT TO THESE RULES.
... ACTUALLY, THE SEPARATION BETWEEN SUBJECTIVE OBSERVER AND OBSERVED OBJECT IS A SUFFICIENT CONDITION FOR 'KNOTTING', VERBAL FORCE, AND VIOLENCE WITHIN A SOCIAL SYSTEM."
(BERND SCHMEIKAL & BETTINA FREY, 1975)

STRONG INTERACTION ALLOWS FOR PARADOX COMMUNICATION.
IT IS BUILT UP BY AMBIGUOUS MESSAGES, DISCONFIRMATION, MYSTIFICATION, AND DOUBLE BINDS.
STRONG INTERACTION GENERATES A THREATENING FORM OF SOCIAL BINDING WHICH WILL BE CALLED 'KNOTTING'.

"SINCE I HAVE MET HARDLY ANY OF YOU WHO MAY HEAR OR READ THIS, I MUST LEAVE YOU TO TAKE OR LEAVE WHAT YOU MAY FIND IN WHAT I'VE SAID THAT MAY SEEM INTERESTING OR RELEVANT TO YOU. HERE IS ONE LAST EXAMPLE, WHICH I OFFER TO SUGGEST THAT THE GAP BETWEEN WHAT SEEMS TO BE ABNORMAL OR DEVIANT OR PATHOLOGICAL, AND WHAT DOES NOT, MAY BE MORE SUPERFICIAL THAN IT APPEARS AT FIRST ENCOUNTER. THIS IS A CONVERSATION BETWEEN A MOTHER AND HER FOURTEEN-YEAR-OLD DAUGHTER:

M: YOU ARE EVIL
D: NO I'M NOT
M: YES, YOU ARE
D: UNCLE JACK DOESN'T THINK SO
M: HE DOESN'T LOVE YOU AS I DO
ONLY A MOTHER REALLY KNOWS THE TRUTH ABOUT HER DAUGHTER, AND ONLY ONE WHO LOVES YOU AS I DO WILL EVER TELL YOU THE TRUTH ABOUT YOURSELF NO MATTER WHAT IT IS.
IF YOU DON'T BELIEVE ME, JUST LOOK AT YOURSELF IN THE MIRROR CAREFULLY AND YOU WILL SEE THAT I'M TELLING THE TRUTH.

THE DAUGHTER DID, AND SAW THAT HER MOTHER WAS RIGHT AFTER ALL, AND REALIZED HOW WRONG SHE HAD BEEN NOT TO BE GRATEFUL FOR HAVING A MOTHER WHO SO LOVED HER THAT SHE WOULD TELL HER THE TRUTH ABOUT HERSELF. WHATEVER IT MIGHT BE.

THIS EXAMPLE MAY APPEAR SOMEWHAT DISTURBING, EVEN SINISTER. SUPPOSE WE CHANGED ONE WORD IN IT:
REPLACE 'EVIL' BY 'PRETTY'...
THE TECHNIQUE IS THE SAME. WHETHER THE ATTRIBUTION IS PRETTY, GOOD, BEAUTIFUL, UGLY, OR EVIL, THE STRUCTURE IS IDENTICAL. THE STRUCTURE IS SO COMMON THAT WE HARDLY NOTICE IT UNLESS THE ATTRIBUTION JARS.
WE ALL EMPLOY SOME RECOGNIZABLY SIMILAR VERSION OF THIS TECHNIQUE AND MAY BE PREPARED TO JUSTIFY IT. I SUGGEST THAT WE REFLECT UPON THE STRUCTURE OF THE INDUCTION NOT ONLY THE CONTENT THEREOF.
WHAT, I THINK, WE FIND MOST IMMEDIATELY DISTURBING ABOUT THIS CAN BE EXPRESSED IN GENERAL TERMS AS FOLLOWS:
THE OTHER PERSON INDUCES SELF TO MAP INTO SELF'S OWN IMAGE OF SELF A VALUE WHICH, WE FEEL, SHOULD NOT BE MAPPED ONTO SELF; THE SELF SYSTEM IS A RANGE THAT SHOULD NOT, WE MAY FEEL, BE MAPPED IN THAT WAY, IN ANY CIRCUMSTANCES.
NEVERTHELESS, IF IT WAS ANOTHER VALUE WE FELT TO BE MORE 'APPROPRIATE', WE MIGHT NOT FEEL DISTURBED. FURTHER, IF A CHILD WERE TAUGHT TO MAP THE SAME VALUE, 'EVIL', ONTO A REGION REGARDED AS THE PROPER RANGE FOR SUCH A VALUE, THAT ALSO WOULD NOT, I THINK, DISTURB US.
HITLER WAS AN EVIL MAN, FOR EXAMPLE. WE TEACH OUR CHILDREN THIS, AND MANY SIMILAR THINGS, BEFORE THEY CAN POSSIBLY MAKE UP THEIR OWN MINDS FROM THE 'EVIDENCE'. WE MAY FEEL THAT SOMEONE IS POSITIVELY EVIL IF HE DOES NOT FEEL THAT HITLER WAS AN EVIL MAN. TAKE RACISM: SEMITISM: ANTI-SEMITISM; ANTI-ANTI-SEMITISM. BLACKS AND WHITES. BLACK ANTI-WHITES. WHITE ANTI-BLACKS. WHITE TRASH AND NIGGERS. 'ANYONE WHO THINKS IN THAT WAY IS WORSE THAN THEY ARE.' BLACK ANTI-ANTI-WHITES. WHITE ANTI-ANTI-BLACKS. EVEN THOSE OF US WHO THINK WE DO NOT EMPLOY SUCH VALUES TEND STILL TO USE THEM, BUT THEY ARE NOW RESERVED FOR THOSE WHO EMPLOY THEM.

'I DON'T THINK THE WHITES ARE ANY MORE DEGENERATE, ESSENTIALLY, THAN US BLACKS. BUT ANYONE WHO TALKS ABOUT NIGGERS IS REALLY WHITE TRASH.'
'I DON'T THINK THE WHITES ARE SUPERIOR TO THE BLACKS, ESSENTIALLY, BUT THOSE BLACKS WHO INCITE VIOLENCE AND TALK ABOUT 'WHITE MONKEYS', ARE NO BETTER THAN MONKEYS THEMSELVES.
AS LONG AS WE CANNOT UPLEVEL OUR THINKING BEYOND US AND THEM, THE GOODIES AND THE BADDIES, IT WILL GO ON AND ON. THE ONLY POSSIBLE END WILL BE WHEN ALL THE GOODIES HAVE KILLED ALL THE BADDIES, AND ALL THE BADDIES ALL THE GOODIES, WHILE TO THEM, WE ARE THE BADDIES AND THEY ARE THE GOODIES.
MILLIONS OF PEOPLE HAVE DIED THIS CENTURY AND MILLIONS MORE ARE GOING TO, INCLUDING, WE HAVE EVERY REASON TO EXPECT, MANY OF US AND OUR CHILDREN, THROTTLED BY THIS KNOT WE SEEM UNABLE TO UNTIE.
IT SEEMS A COMPARATIVELY SIMPLE KNOT, BUT IT IS TIED VERY, VERY TIGHT - ROUND THE THROAT, AS IT WERE, OF THE WHOLE HUMAN SPECIES.
BUT DON'T BELIEVE ME BECAUSE I SAY SO, LOOK IN THE MIRROR AND SEE FOR YOURSELF."
(RONALD D. LAING, 1972)

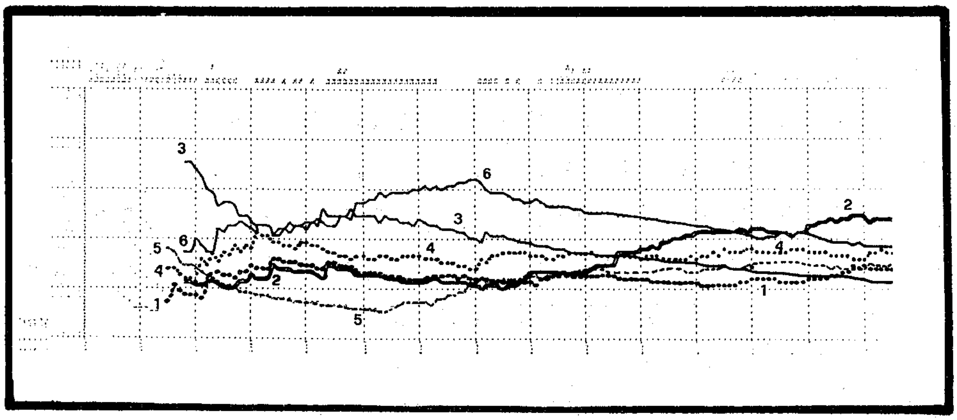
OBVIOUSLY, WITHOUT AWARENESS THE MEANING OF THESE SENTENCES CANNOT BE UNDERSTOOD.
VIOLENCE IS BASED ON INTERPERSONAL COMPARISON.
THIS LEADS TO A CONTINUOUS MAP-PROCESSING OF VALUES - REGARDELESS WHETHER GOOD ONES OR BAD ONES - ONTO HUMAN BEINGS.

OUR NEXT EXAMPLE WILL BE BASED ON THE PLAY "RHINOCÉROS" BY EUGÈNE IONESCO.
THEREBY WE WANT TO EXPLAIN SOME OF THE EFFECTS OF 'KNOTTING' WHICH MAY BE RECOGNIZED 'MOST IMMEDIATELY'.

THE FOLLOWING ANALYSIS REFERS TO THE LAST SCENE OF THE PLAY, THAT IS, THE FINAL DIALOG BETWEEN THE ACTORS DAISY AND BEHRENGER.
LET US DISCOVER HOW THE 'TOPIC' OF THIS DIALOG CHANGES BY DEFINING SIX VERY SIMPLE ELEMENTARY EVENTS:

(1) DAISY MAKES A STATEMENT CONCERNING HERSELF
(2) DAISY MAKES A STATEMENT CONCERNING BEHRENGER
(3) DAISY MAKES A STATEMENT NOT DEALING WITH THE ACTORS
(4) BEHRENGER MAKES A STATEMENT CONCERNING HIMSELF
(5) BEHRENGER MAKES A STATEMENT CONCERNING DAISY
(6) BEHRENGER MAKES A STATEMENT NOT DEALING WITH THE ACTORS

THESE EVENTS HAVE BEEN COUNTED, AND THEIR CUMULATED RELATIVE FREQUENCIES PLOTTED. THUS, THE DIAGRAM REPRESENTS THE RELATIVE OCCURRENCE OF THESE EVENTS UNTIL TIME T, WHICH MOVES FROM 1 TO 260.



ONE MAY REALIZE THAT THE TOPIC GETS CENTERED UPON STATEMENTS WHICH ARE CONCERNED WITH BOTH ACTORS, DAISY AND BEHRENGER. AFTER THE FIRST QUARTER OF THE DIALOG THE OCCURRENCE OF OUTSIDE-STATEMENTS SLOWS DOWN. THE STATEMENTS WHICH COME UP DURING THE CONVERSATION EXPRESS MAIN INTERPERSONAL INTERESTS OF DAISY AND BEHRENGER. THEY CONCERN THE CONTINUANCE OF THE ALLIANCE, THUS GENERATE STRONG **INTERACTION.**

AS SEPARATION AND DISCONFIRMATION PROGRESS, THE OUTSIDE-STATEMENTS BECOME LESS FREQUENT. 'SPACE' FOR INTERPERSONAL ENTANGLEMENT HAS TO BE DELIVERED. THERE IS A FORCE AFFECTING DAISY TOWARDS 'MAKING STATEMENTS DEVOTED TO BEHRENGER'.
AT TIME T=130 CURVE 2 HAS A MAXIMUM (AT THE RIGHT END OF OUR PLOT).
AT ABOUT TIME 50 THE DYADIC PATTERN IS DISTURBED BY A MAN NAMED 'DUDARD' WHO IS FACED BY BOTH ACTORS IN AN AMBIGUOUS MANNER:

DAISY, À DUDARD: ALORS TROIS COUVERTS, N'EST-CE PAS, VOUS RESTEZ AVEC NOUS ?
BEHRENGER, À DUDARD: RESTEZ, VOYONS, RESTEZ.

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DUDARD, RÉFLÉCHISSANT: JE ME DEMANDE SI CE N'EST PAS UNE EXPÉRIENCE À TENTER.
DAISY: POUR LE MOMENT, DÉJEUNONS.

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DUDARD: JE NE VEUX PAS VOUS GÉNER, VRAIMENT.
BEHRENGER: PUISQU'ON VOUS DIT QUE...
DUDARD, INTERROMPANT BEHRENGER: C'EST SANS FACON.
DAISY,À DUDARD: SI VOUS VOULEZ NOUS QUITTER ABSOLUMENT, ÉCOUTEZ, ON NE PEUT VOUS OBLIGER DE...
DUDARD: CE N'EST PAS POUR VOUS VEXER.
BEHRENGER: NE LE LAISSEZ PAS PARTIR, NE LE LAISSEZ PAS PARTIR.
DAISY: JE VOUDRAIS BIEN QU'IL RESTE... CEPENDANT, CHACUN EST LIBRE.

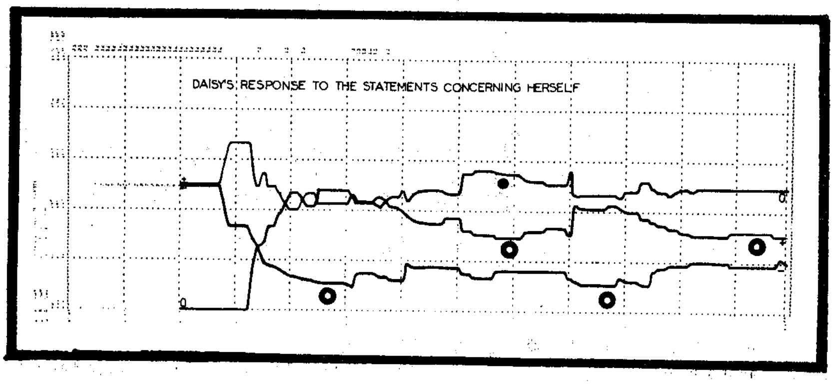
"VERY ESSENTIAL ARE THE CONVEX SHAPES OF CURVES 2 AND 6; THEY ARE REPRESENTATIVE FOR INTERPERSONAL FORCES BY MEANS OF WHICH A STRONG HIERARCHY OF THE ELEMENTARY EVENTS 1 TO 6 IS ESTABLISHED." (51)

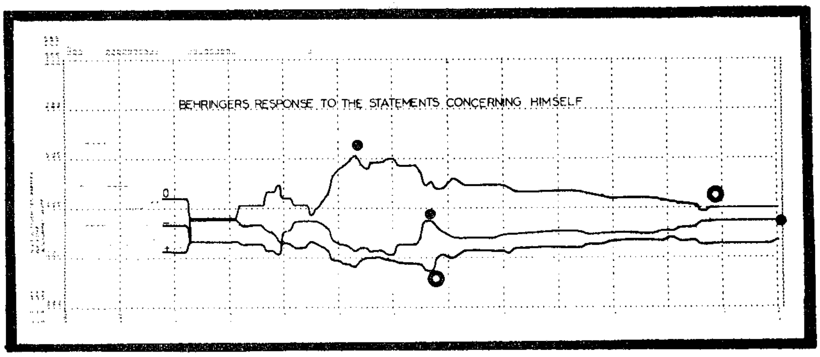
THE ESSENTIAL EFFECT OF HUMAN VERBAL COMMUNICATION IS THAT IT GIVES IMPLICIT DEFINITIONS OF 'EGO' AND 'ALTER'.
THERE IS A PICTURE WHICH EGO HAS OF ITSELF.
THERE IS A PICTURE WHICH EGO HAS OF ALTER.
EGO CONSISTS OF BUNDLES OF IMAGES.ONE OF THESE IMAGES IS THE PICTURE OF ALTER'S PICTURE OF EGO.
ALL OF THESE IMAGES ARE ACQUIRED THROUGH INTERPERSONAL COMPARISON BY MAPPING VALUES ONTO THE SELF-SYSTEM OF ALTER, AND ONTO THE SELF-SYSTEM OF EGO,AND
BY BEING EXPOSED TO THE PROJECTIONS OF ALTER WHICH IS BEING PROJECTED BY EGO.

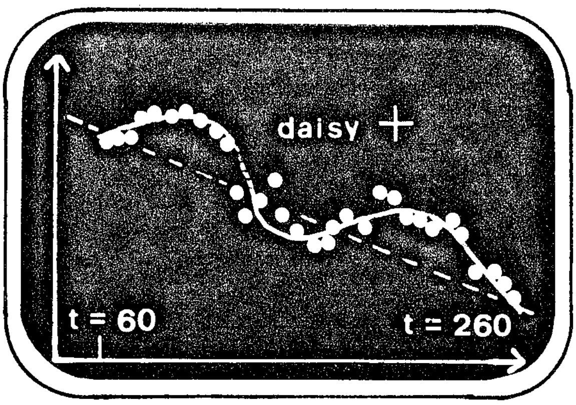
THE GENERATION OF THE IMPLICIT DEFINITIONS OF EGO AND ALTER IS SUBJECT TO A CONTROL PROCESS.
EACH SINGLE STATEMENT OF A HUMAN ACTOR IS EXPOSED TO A VALUATION, OR A JUDGEMENT OF ALTER.
EACH ACTOR MAY ACCEPT, REJECT, OR DISCONFIRM A STATEMENT OF ANY OTHER ACTOR.
THUS, HE MAY E. G. DISCONFIRM A STATEMENT WHICH CONCERNS HIMSELF. JUST AS WELL HE MAY ACCEPT OR REJECT THIS STATEMENT. IN THE FOLLOWING PLOTS WE USED THE NOTATION

+ ... ACCEPTANCE
- ... REJECTION
Ø ... DISCONFIRMATION

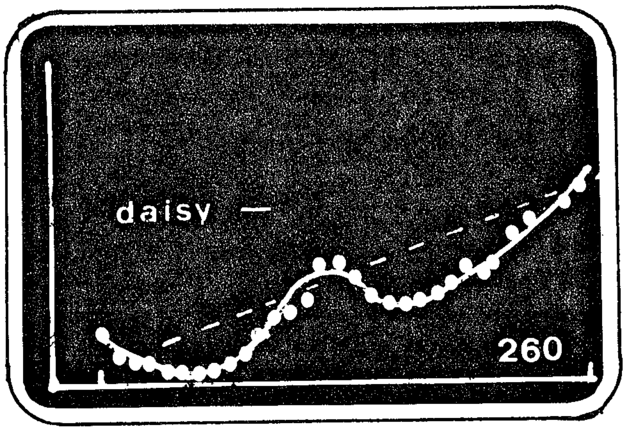
THE CUMULATED RELATIVE FREQUENCIES OF THESE JUDGEMENTS (RESPONSES) TO 'STATEMENTS CONCERNING ONESELF' HAVE BEEN ELABORATED FOR 'DAISY' AND 'BEHRENGER':







THIS IS THE RELATIVE FREQUENCY OF STATEMENTS BY DAISY WHICH ACCEPT A PREVIOUS STATEMENT OF BEHRENGER - SAMPLED WITHIN THE INTERVALS [T, T+60] DAISY'S ACCEPTANCE TURNS DOWN UNTIL IT GETS ALMOST SWITCHED OFF. THE MOVEMENT OF THIS MEASURE WHICH HAS BEEN BASED ON FOURIER ANALYSIS MAY BE COMPARED WITH A SINUSOIDAL CREEP-PROCESS. ITS MAXIMUM VALUE EQUALS 0,55. THE FINAL VALUE IS 0,1.



ACCORDINGLY, REJECTION CREEPS UPWARDS.
THE FIRST-ORDER MOVEMENT OF REJECTION IS VERY SIMILAR TO THE ACCORDING MOVEMENT OF ACCEPTANCE, JUST THAT THE SIGN OF THE SLOPE IS BEING REVERSED.

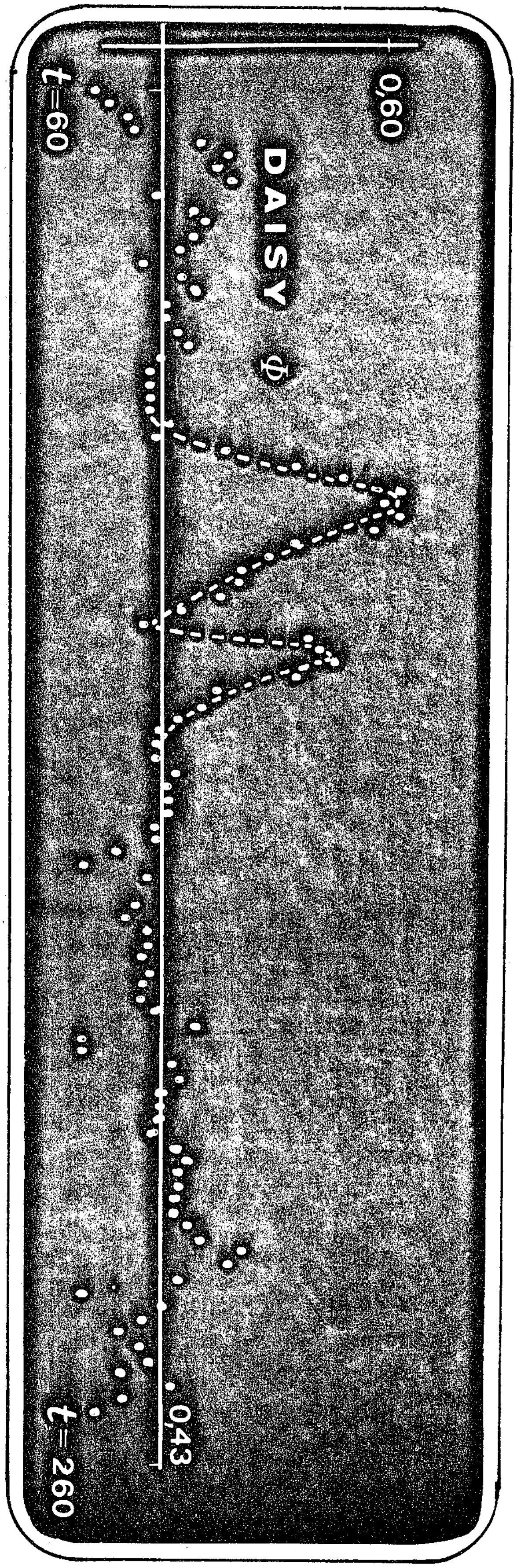
THIS FACT SEEMS TO BE VERY ESSENTIAL. ACCEPTANCE AND REJECTION SEEM TO BE COUPLED IN SUCH A WAY THAT THE DECREASE IN ACCEPTANCE CORRESPONDS TO AN ACCORDING INCREASE IN REJECTION.
THE SHAPE OF THE DISCONFIRMATION-CURVE LOOKS QUITE DIFFERENT. IT RATHER CORRESPONDS TO THE ACTION OF DELTA-LIKE IMPULSES THAT MAY BE DAMPED VERY QUICKLY.

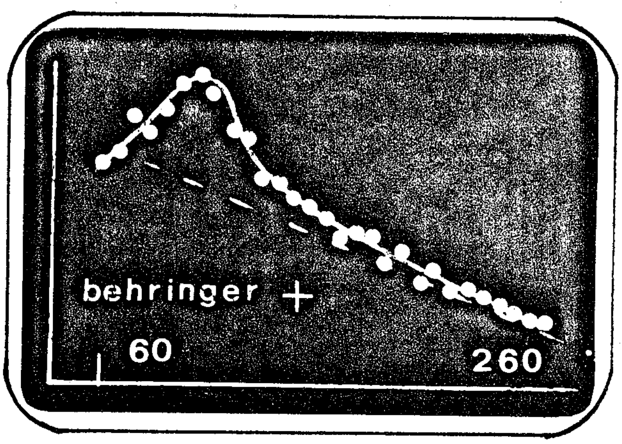
IT SEEMS NOT TO BE SURPRISING THAT THE FIRST-ORDER MOVEMENT OF BEHRENGERS 'ACCEPTANCE-CURVE' IS ESSENTIALLY EQUAL TO DAISY'S.

HERE FORMAL CONSIDERATIONS BRING UPON SOME PARADOX WHICH IS WELL KNOWN TO FEW PEOPLE:

WHEREAS THE ACTORS TRY TO DENY THE EXISTENCE OF THEIR RELATION, THE CORRESPONDENCE BETWEEN THEIR VERBAL EXERCISES PROVES THAT, IN REALITY THEY ARE HIGHLY DEPENDENT.

THE SHAPE OF THE CURVE MAY BE COMPARED WITH A DAMPED OSCILLATORY MOVEMENT.





THE ELEMENTS "ACCEPTANCE, REJECTION, DISCONFIRMATION" REPRESENT THE HIDDEN PAYOFFS WITHIN ECONOMICAL EXCHANGES THAT HAVE BEEN DESCRIBED IN THE FIRST PART OF THE PAPER. EXCHANGE PROCESSES WHICH ARE LARGELY DEPENDING ON DIALOGS, CONVERSATIONS, DISCUSSIONS, AND VOTE TRADING MAKE EXTENDED USE OF DISCONFIRMATION. HOWEVER, MOST OF THE TIME THE ACTORS CANNOT REALIZE THIS.
DISCONFIRMATION, AMBIGUITY, AND DOUBLE BIND PRODUCE STRONG SOCIAL BINDINGS, AND PROVIDE THE MOST ESSENTIAL SUPPORT FOR THE GENESIS OF NEUROTIC BEHAVIOR.
SINCE THE VALUE OF A RELATION WHICH IS BOUND BY A DOUBLE MEANING CANNOT BE DECIDED BY ITS MEMBERS, THE ACTORS WHO ARE ENTANGLED WITHIN DOUBLE BINDS HAVE TO WAIT UNTIL SOME DEFINITE VALUATION OF THE RELATION COMES UP.
DOUBLE BIND IMPLIES THAT THE ACTORS ARE ABLE TO PUT AN END TO ENTANGLEMENT ONLY IF ALTER CAN BE SHOWN TO BE 'GUILTY'. ADDITIONALLY, ALTER WILL PROVE THAT 'EGO' WHICH MAPS GUILT ONTO ALTER IS GUILTY TOO.
ACCEPTANCE, REJECTION, AND DISCONFIRMATION ARE NOT ONLY THE PSYCHOLOGICAL OUTCOMES OF EXCHANGES; THEY ARE THEMSELVES SUBJECT TO CONTROL PROCESSES, THAT IS

THE PRACTISE OF ACCEPTANCE BY ACTOR j MAY BE CONTROLLED BY ACTOR k's ACCEPTANCE, REJECTION, AND DISCONFIRMATION. THE SAME HOLDS FOR j's REJECTION, RESPECTIVELY HIS PRACTISE OF DISCONFIRMATION.

ANALOGOUSLY, THE PRACTISE OF ACCEPTANCE, REJECTION, AND DISCONFIRMATION BY ACTOR k MAY BE CONTROLLED BY ACTOR j's PRACTISE OF ACCEPTANCE, REJECTION, RESPECTIVELY DISCONFIRMATION.

IN (51) WE COMPUTED THE FOLLOWING TABLES OF CONDITIONAL PROBABILITIES WHICH REPRESENT THE MUTUAL VERBAL CONDITIONING OF THE ACTORS DAISY AND BEHRENGER:

DAISY'S PRACTISE AT TIME T

BEHRENGER'S PRACTISE AT TIME T+1

	NONE	+	-	Φ
NONE	0.00	0.27	0.19	0.25
+	0.55	0.46	0.13	0.25
-	0.10	0.13	0.39	0.18
Φ	0.31	0.17	0.30	0.32

BEHRENGER'S PRACTISE AT TIME T

DAISY'S PRACTISE AT TIME T+1

	NONE	+	-	Φ
NONE	0.00	0.36	0.25	0.17
+	0.39	0.29	0.04	0.26
-	0.15	0.13	0.38	0.11
Φ	0.42	0.22	0.33	0.46

THESE TABLES LEAD TO A CONTROL MATRIX C WHICH HAS BEEN BASED ON THE AMOUNTS OF TRANSINFORMATION (22,44) CORRESPONDING TO THEM.

THE MATRIX ELEMENTS C_{jk} REPRESENT ACTOR j's VERBAL CONTROL OVER ACTOR k's EMISSION OF STATEMENTS THAT CARRY "ACCEPTANCE, REJECTION, OR DISCONFIRMATION".

$$C = \begin{bmatrix} 0.90 & 0.10 \\ 0.10 & 0.90 \end{bmatrix}$$

THE NUMBER 0.1 REPRESENTS THE AMOUNT OF TRANSINFORMATION RELATIVE TO THE VARIETIES 'ACCEPTANCE,...,DISCONFIRMATION' EMITTED BY ACTOR BEHRENGER (DAISY) INDUCED BY ACTOR DAISY (BEHRENGER).
IN (51) IT IS EXPLAINED HOW ACTOR j's INTEREST IN ACTOR k's SAYINGS MAY BE MEASURED BY MAKING USE OF THE AMOUNTS OF DISCONFIRMATION THAT ACTOR j DIRECTS ONTO ACTOR k. IT HAS BEEN SUGGESTED TO TAKE AS A "ROUGH BUT REASONABLE MEASURE OF ACTOR j's INTEREST IN k's STATEMENTS" THE QUANTITY $1 - 2p_j(\Phi)$ WHERE $p_j(\Phi)$ IS THE PROBABILITY OF THE EMISSION OF DISCONFIRMATION BY ACTOR j ONTO ACTOR k.

IT IS ASSUMED THAT THE ACTIVE PRACTISE OF DISCONFIRMATION BY ACTOR j DETERMINES HIS PSYCHOLOGICAL UTILITIES AND MOREOVER, HIS INTEREST. THIS ASSUMPTION MAY BE EASILY UNDERSTOOD THROUGH THE INSIGHT INTO THE PHENOMENOLOGY OF HUMAN PERCEPTION (34), RESPECTIVELY THE PRAGMATICS OF HUMAN COMMUNICATION (54). (WHETHER THE READER IS READY TO ACCEPT THIS ASSUMPTION IS UP TO HIS IDEOLOGY, AND HIS 'PRIVATE' PHENOMENOLOGY OF PERCEPTION.)

SINCE THE CONTROL MATRIX, WHEN DERIVED BY MEASURES OF TRANSINFORMATION, HAS TO BE SYMMETRIC,
A CONCLUSION CAN BE DRAWN:

DURING A STRONG INTERACTION THE APPEARANCE OF VERBAL POWER IS SOLELY DETERMINED BY THE ACTOR'S PRACTISE OF DISCONFIRMATION, AND THE EXCHANGE OF AMBIGUOUS MESSAGES. VERBAL POWER TURNS OUT TO BE A RESULT OF PARADOX COMMUNICATION.

IN THE CASE OF DAISY AND BEHRENGER WE OBTAINED:

$$XC=\begin{bmatrix} 0.64 & 0.46 \\ 0.30 & 0.70 \end{bmatrix} \begin{bmatrix} 0.90 & 0.10 \\ 0.10 & 0.90 \end{bmatrix} = \begin{bmatrix} 0.62 & 0.38 \\ 0.34 & 0.66 \end{bmatrix}$$

FROM THIS A MEASURE FOR DAISY'S VERBAL POWER IS DERIVED $R = 0.53$ AND BEHRENGER'S $R = 0.47$.
THE VALUE OF BEHRENGER'S STATEMENTS IS $V = 0.36$, THAT OF DAISY'S IS $V = 0.64$.

INDEED THE LEVEL OF DAISY'S PRACTISE OF DISCONFIRMATION IS VERY HIGH AND IS BUILT UP BY IMPULSES OF HIGH FREQUENCY. FINALLY, DAISY EXPRESSES HER 'NEGATIVE VOTE' CONCERNING THE CONTINUANCE OF THE RELATION TO BEHRENGER. SHE DENIES THE PSYCHOLOGICAL DEPENDENCY AND QUITS.

DURING THIS RESEARCH WORK QUANTUM FIELD THEORETIC MODELS HAVE BEEN APPLIED BECAUSE IT WAS FELT THAT, PITIABLE ENOUGH, VERBAL COMMUNICATION HAS SOMETHING IN COMMON WITH THE THEORY OF PARTICLE RADIATION, THAT IS,
THE INTERACTION PATTERNS DURING VERBAL COMMUNICATION PRODUCE AN OSCILLATING FIELD WHICH CAN BE EXCITED TO CERTAIN QUANTUM STATES.

LET IT BE MENTIONED THAT QUANTUM THEORETICAL APPROACHES ALREADY EXIST IN THE SOCIAL SCIENCES; SEE FOR EXAMPLE (23)).
THUS, WE ASSUMED THAT THERE EXIST OPERATORS WHICH CORRESPOND TO THE CREATION, AND TO THE ABSORPTION OF A STATEMENT CARRYING CERTAIN JUDGES, I.E. ACCEPTANCE AND DISCONFIRMATION.
THE MAIN ALGEBRAIC PRINCIPLES OF THIS SYSTEM CAN BE FOUND IN THE APPENDIX.

A QUANTUM FIELD THEORETIC MODEL OF VERBAL COMMUNICATION

IF WE BEGIN WITH THE POTENTIAL

$$\Omega_{ji} = \alpha(\rho_j/\upsilon_i)^{1/2} \, x_{ji}$$

AND A PERTURBED HARMONIC OSCILLATORY MOVEMENT

$$i(\partial/\partial t)\psi_{ji} = \frac{1}{2}\left\{-\partial^2/\partial X_{ji}^2 + (X_{ji}-x_{ji})^2 - \alpha\sqrt{\rho_j/\upsilon_i}\; x_{ji}(X_{ji}-x_{ji})\right\}\psi_{ji}$$

X_{ji} ... ACTOR j's INTEREST IN STATEMENT VARIETY i

x_{ji} THE CENTER OF THE OSCILLATING INTEREST

ρ_j ... THE VERBAL POWER OF ACTOR j

υ_i ... THE VALUE OF STATEMENT VARIETY i WITHIN THE DIALOG

ψ_{ji} ... THE FIELD AMPLITUDE

THE QUANTIZATION PROCEDURE AND SUDDEN APPROXIMATION ALLOW FOR AN ESTIMATION OF TRANSITIONAL PROBABILITIES $w_{\mu_i \nu_i}$ THAT ACTOR j EMITS ν_i STATEMENTS OF VARIETY i AT TIME $T+1$ AFTER HAVING EMITTED μ_i STATEMENTS OF THE SAME TYPE AT TIME T.

$$w_{o_i \nu_i} = \frac{\{(\alpha^2/2)(\rho_j/\upsilon_i)x_{ji}^2\}^{\nu_i}}{2^{\nu_i}\;\nu_i!}\, e^{-(\alpha^2/2)(\rho_j/\upsilon_i)x_{ji}^2}$$

THIS QUANTITY BEING A FUNCTION OF ν_i IS A POISSON DISTRIBUTION WITH MEAN

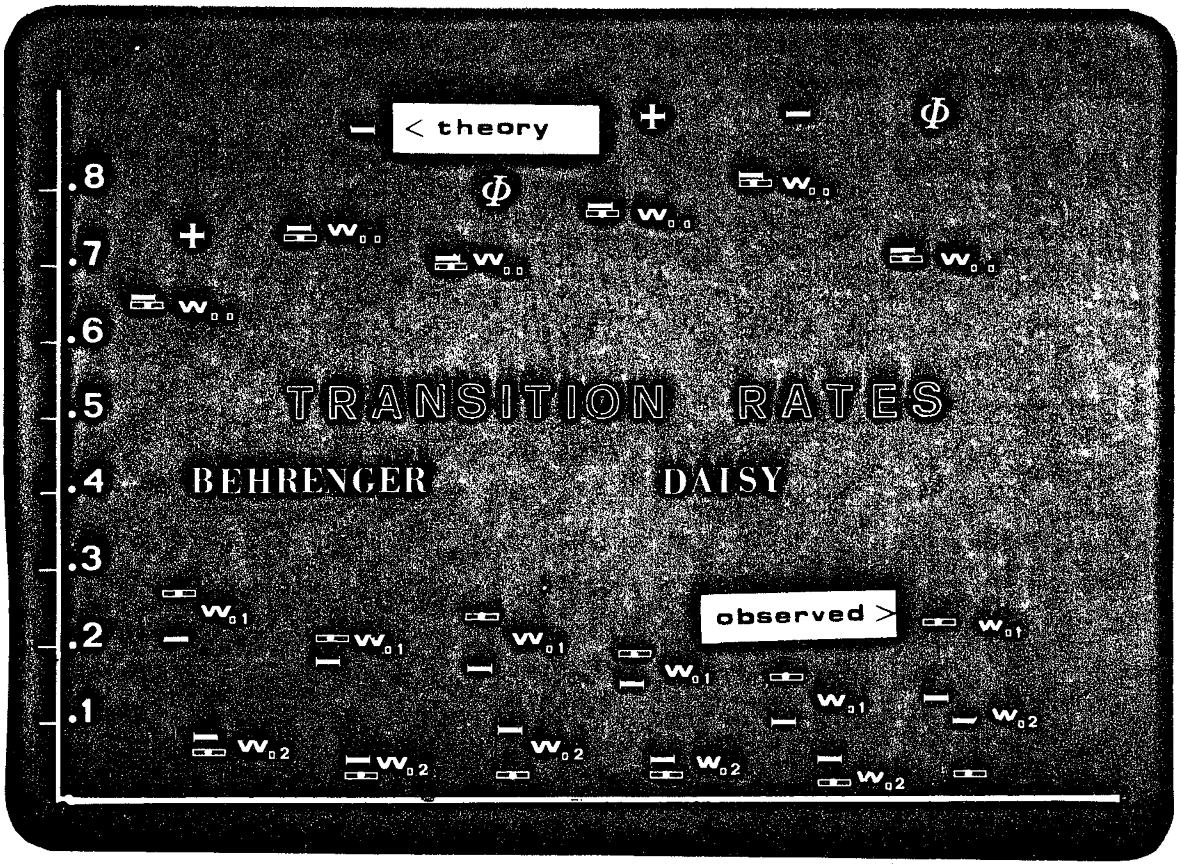
$$\bar{\nu}_i = (\alpha^2/2)(\rho_j/\upsilon_i)x_{ji}^2$$

THIS LEADS TO THE VERY SIMPLE RESULT THAT THE EXPECTED LEVEL OF EXCITATION OF ACTOR j ON THE EMISSION OF STATEMENTS WHICH BELONG TO VARIETY i IS PROPORTIONAL TO THE CONTROLLED INTEREST OF ACTOR j IN STATEMENTS OF THE TYPE i, AS MAY BE EXPECTED BY CONSIDERING THE REALIZATION OF HIS INTEREST THROUGH HIS VERBAL POWER.

"THE MORE ACTOR j EXPECTS FROM STATEMENTS OF THE TYPE i THE MORE EXCITED BECOMES HIS EMISSION OF THOSE STATEMENTS WHICH BELONG TO i.

THIS CONSIDERATION HAS BEEN APPLIED TO THE PLAY RHINOCEROS.

WE OBTAINED THE FOLLOWING TRANSITIONAL PROBABILITIES WHICH HAVE BEEN COMPARED WITH THE OBSERVED ONES:



THE COMPUTATION OF THE TRANSITION PROBABILITIES $w_{\mu_i \nu_i}$ IS BASED ON THE INTEGRATION OF SCHRÖDINGER'S EQUATION (52, 40)

$$i(\partial/\partial t)\psi_{ji} = \frac{1}{2}\{-\partial^2/\partial X_{ji}^2 + U_{ji}(X_{ji}, t)\}\psi_{ji} = H(t)\psi_{ji}$$

WITH THE OSCILLATOR POTENTIAL

$$U_{ji} = \frac{1}{2}\{(X_{ji} - x_{ji})^2 - \alpha\sqrt{\rho_j/\upsilon_i}\, x_{ji}(X_{ji} - x_{ji})\}$$

THUS WE CONSIDER A FIELD ψ_{ji} CENTERED AT THE LEVEL x_{ji} OF ACTOR j's INTEREST IN STATEMENTS OF THE TYPE i. THE TERM $(X_{ji} - x_{ji})^2$ TOGETHER WITH THE LAPLACE-OPERATOR ∂^2/X_{ji}^2 MODEL THE UNPERTURBED HAMILTONIAN OPERATOR H_o, THAT IS, THE UNPERTURBED PRODUCT OF CREATION AND ANNIHILATION OPERATORS A^+, A:

$$H_o = \frac{1}{2}\{-\partial^2/\partial X_{ji}^2 + (X_{ji} - x_{ji})^2\} =$$

$$= \frac{1}{\sqrt{2}}(X_{ji} - x_{ji} - \partial/\partial X_{ji})\frac{1}{\sqrt{2}}(X_{ji} - x_{ji} + \partial/\partial X_{ji}) =$$

$$= A_{ji}^+ A_{ji}$$

THESE OPERATORS GENERATE THE STATIONARY STATES OF ACTOR j's n_i-QUANTA-EMISSION ON VARIETY i.
THUS THE UNPERTURBED SCHRÖDINGER EQUATION REPRESENTS THE HARMONIC OSCILLATOR PLACED AT THE LEVEL x_{ji}.

THE SYSTEM DEVELOPS THROUGH SUDDENLY ACTING POTENTIALS

$$\Omega_{ji} = \alpha\sqrt{\rho_j\ \upsilon_i}\, x_{ji}$$

CORRESPONDING TO THE EXCITING ENERGY

$$\Pi_{ji} = \alpha\sqrt{\rho_j/\upsilon_i}\, x_{ji}(X_{ji} - x_{ji})$$

THE POTENTIAL Ω_{ji} GENERATES THE EXCITATION OF THE STATEMENT EMISSION OF ACTOR j, THAT IS, THE EXCITATION DRIVES THE ACTOR'S INTEREST OFF ITS CENTER x_{ji}. SINCE Ω_{ji} IS A POTENTIAL TO ALL INTENTS AND PURPOSES ITS CONTRIBUTIONS TO THE ENERGY, THAT IS, THE TOTAL NUMBER OF STATEMENTS ON VARIETY n_i, IS EQUAL TO Ω_{ji} MULTIPLIED BY THE 'OFF DRIFT' $X_{ji} - x_{ji}$ OF ACTOR j's INTEREST.
Ω_{ji} IS PROPORTIONAL TO THE LEVEL x_{ji} MULTIPLIED BY THE SQUARE ROOT OF THE RATIO OF j's VERBAL POWER ρ_j AND THE PRICE OF STATEMENTS OF THE TYPE i.
THE INTEGRATION OF THE EQUATION OF MOTION UNDER THE ASSUMPTION OF SUDDEN EXCITATION LEADS TO A PERTURBATION INTEGRAL (51) WHOSE SOLUTION MAY ALSO BE FOUND IN (36) ON PAGE 150; THE GENERAL DERIVATION OF THE INTEGRAL ON PAGES 147-150.

THERE ARE RESTRICTIONS TO THE INTERPRETATION OF QUANTIZED WAVE FIELDS. THERE ARE DIFFICULTIES WHICH HAVE ALREADY APPEARED IN QUANTUM MECHANICS. IN CLASSICAL PHYSICS, SPACE VARIABLES X HAVE BEEN DETERMINISTIC. HOWEVER, IN QUANTUM MECHANICS X WAS SUPPOSED TO BE STOCHASTIC.
USUALLY PHYSICISTS INTERPRETED THE QUANTITY $\psi^*(X,t)\psi(X,t)$ AS A PROBABILITY DENSITY OVER X.
NOW, LET ψ_n BE AN EIGENFUNCTION OF H_o:
THEN THE INTEGRAL

$$\int \psi \, \psi_n^* \, dX = a_n$$

OUGHT TO BE THE PROBABILITY AMPLITUDE OF STATE ψ_n, AND THE NORM $|a_n|^2$ THE PROBABILITY OF THIS STATE.

HOWEVER, IF X IS STOCHASTIC, INTEGRALS OF THE FORM

$$\int \psi \, \psi^* \, dX$$

MAKE NO SENSE.

MODERN QUANTUM PHYSICS DID NOT REALLY PROCEED FROM A SPACE $\mathcal{M}(\mathcal{H})$ OF PROBABILITY MEASURES OR DISTRIBUTIONS ON A HILBERT SPACE $\mathcal{H}$.

ACCORDINGLY, IF X WERE STOCHASTIC, THIS WOULD BE A SUFFICIENT CAUSE TO CALL THE SYSTEM 'BADLY IDENTIFIED'.

THE IDENTIFICATION OF A COMMUNICATION SYSTEM UNDER STRONG INTERACTION

IT IS BY NO MEANS EASY TO IDENTIFY A SYSTEM OF VERBAL COMMUNICATION.
THE TIME SERIES OF STATEMENT NUMBERS REPRESENTS A NON SMOOTH POINT PROCESS, THAT IS, THERE EXIST REMARKABLE PEAKS.
THE AUTOCORRELATION FUNCTIONS OF DIALOG-TIME-SERIES REPRESENT MORE OR LESS REGULARLY OSCILLATING FUNCTION.

A CONCRETE DESIGN FOR A LINEAR FILTER WHICH IS IN SIGHT MAY BE OBTAINED IN THE FOLLOWING MANNER:

LET $N_j(T)$ BE THE VECTOR OF STATEMENT NUMBERS $(N_{ji}(T))$ MADE BY ACTOR j AT TIME T.
TAKE ONE SUCH NUMBER $N_{ji}(T)$; DEFINE THE BACKWARD SHIFT OPERATOR

$$B\, N_{ji}(T) = N_{ji}(T) - N_{ji}(T-1)$$

AND THE BACKWARD DIFFERENCE OPERATOR

$$\nabla N_{ji}(T) = N_{ji}(T) - N_{ji}(T-1) = (1-B)\, N_{ji}(T)$$

ITS INVERSE IS REPRESENTED BY THE SUM

$$\nabla^{-1} N_{ji}(T) = \sum_{\tau=1}^{\infty} N_{ji}(T-\tau) = N_{ji}(T) + N_{ji}(T-1) + \ldots$$
$$= (1+B+B+\ldots) N_{ji}(T) = (1-B)^{-1} N_{ji}(T)$$

JUST FOR ONE MOMENT CONSIDER SOME LINEAR DYNAMIC SYSTEM WITH A CONTINUOUS INPUT ϕ AND A CONTINUOUS OUTPUT ψ

$$b_o(t)\psi + b_1(t)\frac{d\psi}{dt} + b_2(t)\frac{d^2\psi}{dt} = a_o(t)\phi + a_1(t)\frac{d\phi}{dt} + a_2(t)\frac{d^2\phi}{dt}$$

WITH CONTINUOUS b's AND a's ,

(WITHOUT LOSS OF GENERALITY $b_2(t) = 1$)
IF WE HAD A CONSTANT $b_1(t) = 2\beta =$ CONST., AND CONSTANT $b_o=\Omega^2$, THEN ψ COULD BE INTERPRETED AS THE AMPLITUDE OF A DAMPED OSCILLATOR WITH FREQUENCY Ω AND FRICTION CONSTANT β UNDER THE EFFECT OF THE EXTERNAL FORCE

$$K(t) = a_o(t)\phi + a_1(t)\frac{d\phi}{dt} + a_2(t)\frac{d^2\phi}{dt}$$

WHICH IS A LINEARLY FILTERED NONSTATIONARY INPUT SIGNAL.
SUCH A SYSTEM INCORPORATES THE POSSIBILITY FOR OSCILLATIONS IN A MOST NATURAL MANNER:

$\Omega^2 + 2\beta\, d/dt + d^2/dt^2$ IS THE DIFFERENTIAL OPERATOR

OF THE DAMPED LINEAR HARMONIC OSCILLATOR. THE DERIVATION OF ITS KERNEL CAN BE FOUND IN THE APPENDIX.
IF THIS OPERATOR IS NONSTATIONARY IT MAY BE INTERPRETED AS THE OPERATOR OF SOME NONSTATIONARY OSCILLATION WITH TIME VARYING FREQUENCY AND FRICTION CONSTANT, DEPENDING ON THE BEHAVIOR OF $b_o(t)$ AND $b_2(t)$.

IN A SIMILAR WAY, FOR THE DISCRETE PROCESS WE MAY REPRESENT THE TRANSFER BETWEEN INPUT AND OUTPUT BY THE DIFFERENCE EQUATION

$$\{1 + b_1(T)\nabla + b_2(T)\nabla^2\}N_{ji}(T) = \{a_o(T) + a_1(T)\nabla + a_2(T)\nabla^2\}N_{ki}(T-\tau)$$

WHERE τ IS THE DEAD TIME OR PURE DELAY BETWEEN INPUT ϕ AND OUTPUT ψ.
SUBSTITUTING $B = 1 - \nabla$ WE OBTAIN

$$(1 - \beta_1 B - \beta_2 B^2) N_{ji}(T) = (\alpha_o B^{\tau} - \alpha_1 B^{\tau+1} - \alpha_2 B^{\tau+2})\ N_{kh}(T)$$

WITH SOME NEW PARAMETERS α, β.
WE MAY AS WELL WRITE

$$\beta(B) N_{ji}(T) = \alpha(B) B^{\tau} N_{kh}(T) = \theta(B) N_{kh}(T)$$

USING THE NOTATION $\beta(B) = 1 - \beta_1 B - \beta_2 B^2$.

LET F BE THE RATIO OF THE POLYNOMIALS θ, β

$$F(B) = \beta^{-1}(B)\theta(B)$$

THEN j's EMISSION OF STATEMENTS (OUTPUT) AND k's EMISSION (INPUT) ARE LINKED BY A LINEAR FILTER

$$N_{ji}(T) = F_o N_{kh}(T) + F_1 N_{kh}(T-1) + F_2 N_{kh}(T-2) + \ldots$$

HOWEVER, THIS EQUATION IS NOT YET THE ONE NEEDED, SINCE MOST OF THE MOVEMENT OF $N_{ji}(T)$ IS RATHER INDUCED BY ACTOR j HIMSELF, THAN BY ACTOR k.
THUS THE TERM
$\beta^{-1}(B)\Theta(B)$ WILL BE SMALL COMPARED TO ACTOR j's SUPERIMPOSED NOISE E_{ji}.
THE MODEL HAS AT LEAST TO BE OF THE FORM:

$$N_{ji}(T) = F(B) N_{kh}(T) + E_{ji}(T)$$

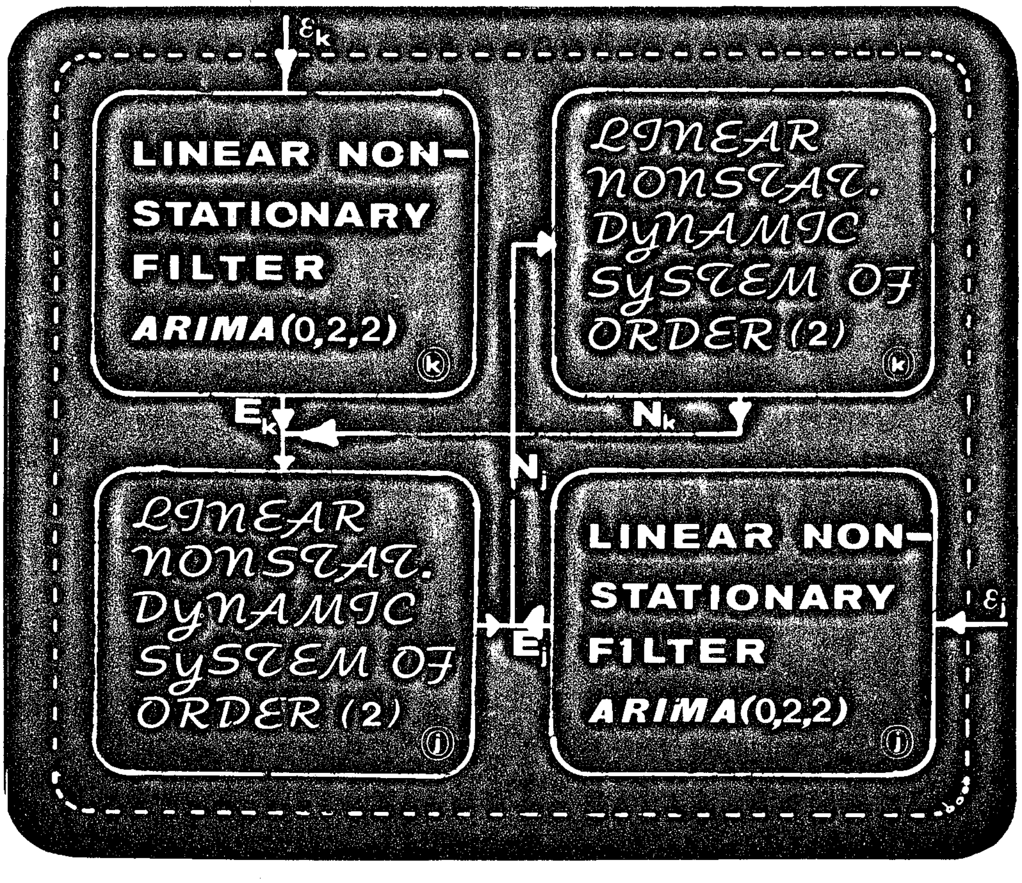
WHERE $N_{ji}(T)$ AND $E_{ji}(T)$ ARE INDEPENDENT.
FURTHERMORE, $E_{ji}(T)$ OUGHT TO BE REPRESENTED BY A NONSTATIONARY AUTOREGRESSIVE INTEGRATED PROCESS WITH

MOVING AVERAGE (0, 2, 2) (SEE 3).

THEN THE WHOLE COMMUNICATION SYSTEM REPRESENTING A DIALOG UNDER STRONG INTERACTION WOULD BE IDENTIFIED AS FOLLOWS:

ε_j ... RANDOM SHOCK CORRESPONDING TO ACTOR j
ε_k ... RANDOM SHOCK CORRESPONDING TO ACTOR k
N_j ... THE VECTOR OF STATEMENT NUMBERS BY ACTOR j
N_k ... THE VECTOR OF STATEMENT NUMBERS BY ACTOR k
E_j ... j's 'NOISE' GENERATED BY THE NONSTATIONARY SECOND-ORDER AUTOREGRESSIVE PROCESS ARIMA(0, 2, 2)
E_k ... k's 'NOISE' GENERATED BY AN ANALOGOUS PROCESS

NOTE: THIS IS A VERY ROUGH WAY TO DESIGN THE COMMUNICATION PROCESS, AND I LEAVE YOU TO TAKE WHAT YOU MAY FIND WORTH TO BE TAKEN. OBVIOUSLY, WE ARE LEAD TO FORMAL PROBLEMS WHAT THE REPRESENTATION OF THE SIGNALS AND CORRESPONDING QUANTIZATION PROCEDURES IS CONCERNED.



DISCREPANCIES BETWEEN REALITY AND EXPECTATION

THE FORMAL SOCIOLOGICAL THEORIES HAVE NOT SUFFICIENTLY ACCOUNTED FOR THE CONSEQUENCES OF SOCIAL CONTROL PROCESSES. THERE ARE BEARINGS ON MAN'S ABILITY TO REALIZE HIS OWN AND OTHER ACTORS INTERESTS; SOCIAL EXCHANGES MAY EVEN AFFECT THE ACTORS ABILITY TO COMMUNICATE.
OFTEN MAN L OSES CONTROL OVER BASIC ECONOMICAL EVENTS: THIS CONTRIBUTES TO THE GENERATION OF PARADOX COMMUNICATION, THUS, TO STRONG INTERACTION.
ACTORSWHO ARE EXPOSED TO FRUSTRATION USUALLY TRY TO MOTIVATE OTHER ACTORS TO A LARGER DEGREE THAN THOSE WHO ARE NOT. THUS, THEY SUPPORT INTEREST-CHANGING INTERACTION.
USUALLY THE ACTORS EXPECT CERTAIN OUTCOMES. THUS, THEIR INTEREST IS A DIRECTED ONE. EITHER AN ACTOR FAVORS, OR HE OPPOSES A POSITIVE DECISION ON AN EVENT. ACCORDINGLY, HIS INTEREST MAY BE POSITIVE OR NEGATIVE.
HOWEVER, THE EXPECTATION OF A DEFINITE OUTCOME BY AN ACTOR CORRESPONDS TO A PERCEPTIONAL ANTICIPATION OF REALITY. IT CHARACTERIZES THE 'RATIONALIST'S PARADIGM' THAT HE HAS TO EXPECT THINGS WHICH ARE DETERMINED IN THE FUTURE. THEREFORE, IT MAY HAPPEN THAT A FUTURE-OUTCOME CONTRADICTS THE EXPECTATION OF AN ACTOR. IT CAN BE STATED THAT THE CONTRADICTION BETWEEN AN OUTCOME ON ANY EVENT AND THE ACTOR'S EXPECTATION IS SUBJECT TO HIS PERCEPTION. THE MORE HE IDENTIFIES HIMSELF WITH A COLLECTIVE ACTION ON EVENT i THE MORE HE IS STRESSED IF THE COLLECTIVE DECISION WILL CONTRADICT HIS INTEREST.

SUPPOSE, ACTOR j IS EXPECTING A NEGATIVE DECISION ON EVENT i (POSSIBLY HE IS CONVINCED THAT THE DECISION WILL BE NEGATIVE). SUPPOSE, THAT HE EXPECTS SOME DEFINITE SEQUENCE OF NEGOTIATIONS WHICH WILL MAKE THATSURE.

HIS EXPECTATION MAY BE CONSIDERED AS A 'SUBJECTIVELY CONSTRUCTED' OR FICTIVE EVENT α .
SUPPOSE, THAT THE EXCHANGE ENDS WITH A POSITIVE DECISION ON EVENT i , THEN ACTOR j CANNOT IDENTIFY HIMSELF WITH THE COLLECTIVE DECISION; HE EXPERIENCES DISCREPANCY, OR 'FRUSTRATION ON EVENT i '.
'DISCREPANCY' IS A RELATIONSHIP BETWEEN A 'FICTIVE EVENT α AND A DEFINITE OR REAL EVENT. i .
THERE IS A REAL OUTCOME PERCEIVED BY ACTOR j AS INFORMATION COMING FROM THE OUTSIDE. AND THERE IS A SUBJECTIVELY CONSTRUCTED OUTCOME REPRESENTING INFORMATION FROM THE INSIDE OF ACTOR j .
THE EXPECTED OR FICTIVE EVENTS, AND OUTCOMES RESPECTIVELY HAVE TO BE CONSIDERED AS STRUCTURES MAPPED FROM THE SELF-SYSTEM OF ACTOR j ONTO THE OUTSIDE.
THE REAL EVENTS AND OUTCOMES HAVE TO BE CONSIDERED AS INFORMATION MAPPED FROM THE OUTSIDE OF ACTOR j ONTO THE SELF SYSTEM OF ACTOR j .
EACH REAL OUTCOME THAT CONTRADICTS ACTOR j's EXPECTATION CONTRIBUTES TO HIS TOTAL AMOUNT OF PERCEPTIONAL DISCREPANCY, THAT IS, THE TOTAL AMOUNT OF FRUSTRATION ACQUIRED BY HIM DURING THE EXCHANGE PROCESS.

CONSIDER THE QUANTITY

$$Q_i = 0{,}5 + 0{,}5 \sum_j C^*_{ij} \, \sigma_{ji}$$

WHICH REPRESENTS THE PROBABILITY OF A POSITIVE OUTCOME ON EVENT i . (C^*_{ij} ... THE EQUILIBRIUM CONTROL OF ACTOR j OVER EVENT i , σ_{ji} ... THE SIGNUM OF THE DIRECTED INTEREST OF ACTOR j IN EVENT i)(SEE 15)
SUPPOSE, THERE EXISTS A DECISION RULE SUCH THAT

$$\delta_i = \begin{cases} 1 \ldots \text{ IF } Q_i \geqq Q^*_i \\ 0 \ldots \text{ IF } Q_i < Q^*_i \end{cases}$$

δ_i EQUALS 1 IF THE DECISION ON EVENT i IS POSITIVE AND 0 IF IT IS NEGATIVE.
THEN THE QUANTITY

$$\delta_i(1-\sigma_{ji}) + \sigma_{ji}(1-\delta_i) \text{ WHERE WE PUT } \sigma_{ji} = \begin{cases} 1 \; \ldots\ldots X_{ji} > 0 \\ 0 \; \ldots\ldots X_{ji} \leq 0 \end{cases}$$

EQUALS 1 IF THE OUTCOME ON EVENT i CORRESPONDS WITH ACTOR j's EXPECTATION; IT IS 0 IF THE OUTCOME CONTRADICTS HIS EXPECTATION.
A REASONABLE MEASURE OF THE 'PSYCHOLOGICAL OUTCOME' OF A DISCREPANCY IS REPRESENTED BY THE QUANTITY

$$D_{ji} = [\,\delta_i(1-\sigma_{ji}) + (1-\delta_i)\sigma_{ji}\,]\, X_{ji}$$

THUS WE HAVE WEIGHTED THE BINARY DISCREPANCY-MEASURE BY ACTOR j's INTEREST IN EVENT i, WHICH MAY BE CONSIDERED AS THE SOURCE OF HIS ENGAGEMENT AND HIS IDENTIFICATION RELATIVE TO EVENT i.
THE QUANTITY

$$F_j = \sum_i D_{ji}$$

IS HIS TOTAL AMOUNT OF FRUSTRATION WHICH HE HAS GAINED DURING THE EXCHANGE.
IF THE VOTING RULE DOES NOT EXIST THE CALCULATION HAS TO BE BASED ON THE VECTOR OF 'PROBABILITIES OF POSITIVE OUTCOME ON EVENT i'. THEN THE DISCREPANCY MEASURES ARE OF PROBABILISTIC NATURE.

EXAMPLE:

AGAIN, CONSIDER OUR TEN EVENTS

(1) CHILD CARE, (2) RECRUITMENT OF PERSONNEL,
(3) MEDICAL INVENTORY, (4) MEDICAL THERAPY,
(5) NON-MEDICAL THERAPY, (6) SCIENTIFIC RESEARCH,

(7) SCIENTIFIC EQUIPMENT, (8) GENERAL EQUIPMENT,
(9) SCHEDULE, (10) PLANNING, AND TEN ACTORS.

ALL THE IMPORTANT QUANTITIES WHICH CHARACTERIZE THIS 'ECONOMICAL EXCHANGE' CAN BE FOUND ON THE FOLLOWING PAGES. OBSERVE THAT NEGATIVE INTERESTS ARE FREQUENT. THIS GIVES REASON TO CONFLICT.

COMPUTE THE DISCREPANCIY-MEASURES IN THE FOLLOWING WAY:

THE VECTOR OF PROBABILITIES OF POSITIVE OUTCOMES IS:

	Q_i
CHILD CARE	0.95
RECRUITMENT OF PERSONNEL	0.09
MED. INVENTORY	0.36
MED. THERAPY	0.89
NON-MED. THERAPY	0.00
SCIENTIFIC RESEARCH	0.00
SCIENTIFIC EQUIPMENT	0.63
GENERAL EQUIPMENT	1.00
SCHEDULE	0.92
PLANNING	0.79

CONSIDER A MAJORITY RULE $Q_i^* = 0.5$ FOR ALL EVENTS i .
THEN:

$$\delta_i = (1, 1, 0, 1, 0, 0, 1, 1, 1, 1)$$

IF WE PUT $\sigma_{ji} = 0$ IF $X_{ji} = 0$ WE OBTAIN FOR ACTOR 6

$F_6 = 0,8$, WE HAVE $\sigma_{6i} = (0, 0, 1, 1, 0, 0, 0, 0, 0, 0)$

THUS, THERE ARE DISCREPANCIES ON EVENTS 1, 2, 3, 4

$D_{6i} = (0.2, 0.2, 0.2, 0.2, 0, 0, 0, 0, 0, 0)$

PROBLEM 1

```
*****************************************************************
********* 10 ACTORS******* 10 EVENTS***** 0
```

CONSTITUTIONAL CONTROL BY ACTOR I OF EVENT J

0	0	0	.05
.1	0	.2	.3
.1	.05		
0	.1	.1	.45
.1	0	.15	0
.2	0		
.05	.2	.1	0
.1	0	.05	0
.3	.05		
.1	.15	.1	0
.1	0	.05	0
.4	0		
.05	0	.1	0
.1	.5	0	.3
0	.1		
.1	.1	.1	0
.1	0	.2	0
0	0		
.15	.2	.1	0
.1	0	.05	.3
0	.1		
.15	0	0	.15
.1	.5	.15	.1
0	.3		
.2	.15	0	0
.1	0	.15	0
0	.1		
.2	.1	.4	.35
.1	0	0	0
0	.3		

DIRECTED INTEREST OF ACTOR I IN EVENT J

.1	.1	-.1	-.1
-.1	-.1	.1	.1
.1	.1		
0	-.1	-.1	.1
-.1	-.1	.1	.1
.1	.1		
0	0	0	1
0	0	0	0
0	0		
.2	-.2	-.1	0
0	-.1	0	.1
-.1	.2		
.4	0	0	0
-.3	0	0	0
.3	0		
-.2	-.2	.2	.2
-.2	0	0	0
0	0		
0	0	0	.7
0	0	-.2	0
0	.1		
.3	0	0	0
-.3	0	0	0
.3	.1		
0	0	.1	-.2
-.1	-.2	.1	.2
.1	0		
.6	0	0	0
0	0	0	0
.3	-.1		

CONTROL OF EVENT I BY EVENT J

.225	.04	.0[illegible]	.21[illegible]
.1	.05	.0[illegible]	.05
.15	.07		
.11	.07	.0[illegible]	.4
.045	.055	.0[illegible]5	.055
.07	.07		
.32	.06	.0[illegible]	.2
.06	.02	.0[illegible]	.02
.17	.08		
.26	.095	.0[illegible]	.05
.095	.05	.0[illegible]	.05
.2	.1		
.16	.07	.0[illegible]	.23
.11	.05	.0[illegible]	.05
.15	.07		
.35	0	0	0
.3	0	0	0
.3	.05		
.115	.1	.095	.19
.135	.07	.0[illegible]	.07
.1	.085		
.18	.05	.0[illegible]	.24
.15	.05	.0[illegible]	.03
.15	.07		
.09	.13	.07	.33
.05	.07	.03	.07
.07	.11		
.015	.005	.015	.145
.135	.025	.035	.025
.225	.075		

CONTROL OF ACTOR I BY ACTOR J

.08	.11	.0[illegible]5	.09
.115	.08	.1	.145
.07	.145		
.08	.12	.1	.095
.11	.08	.1[illegible]5	.13
.065	.135		
.05	.45	0	0
0	0	0	.15
0	.35		
.05	.05	.1	.1
.12	.05	.13	.15
.09	.18		
.06	.09	.14	.19
.05	.07	.04	.09
.11	.11		
.03	.15	.04	.09
.05	.08	.11	.08
.09	.23		
.08	.045	.015	.01
.01	.04	.02	.165
.04	.275		
.065	.09	.14	.18
.055	.06	.0[illegible]5	.105
.1	.12		
.11	.145	.055	.065
.18	.04	.0[illegible]5	.175
.025	.12		
.035	.08	.125	.18
.04	.06	.1	.12
.13	.15		

```
VALUE OF EACH EVENT =

 .20931215      .06811025       .05010062      .1974027
 .09932744      .04743249       .04573236      .04743249
 .15220716      .03174279
POWER OF EACH ACTOR =

 .06254095      .14798829       .04115032      .10939
 .07161864      .05195147       .04460226      .13093215
 .07722564      .17244006
FINAL DIRECTED CONTROL BY ACTOR I OF EVENT J

 .02979673      .09183193      -.1,464072     -.03163405
-.00259207     -.13166521       .1,6767338     .13186521
 .04169331      .07651676
 0             -.43443182      -.26550679      .07494604
-.14863372     -.31190915       .32350459      .31190916
 .09720061      .18099601
 0              0               0              .46177851
 0              0               0              0
 0              0
 .10421563     -.32118515      -.21832247      0
 0             -.23060142       0              .23060143
-.07160258      .26761992
 .13647356      0               0              0
-.21561194      0               0              0
 .14116019      0
-.04989831     -.15255113       .26739628      .05263502
-.10367839      0               0              0
 0              0
 0              0               0              .30071317
 0              0              -.37066331      0
 0              .10374262
 .18712423      0               0              0
-.39308169      0               0              0
 .258067        .16017578
 0              0               .15414277     -.07624193
-.07728192     -.32562422       .16866475      .32562423
 .05073732      0
 .49289212      0               0              0
 0              0               0              0
 .33987899     -.21095445
PROBABILITY OF POSITIVE OUTCOME OF EVENT J

 .95050169      .09183192       .36153504      .89007313
-7.4505806E-09 -1.4901161E-08   .6291367      1.
 .92813742      .78904543
```

INCREMENT IN EXP. REALIZATION OF INTERESTS OF ACT.I FROM J

.04294286	.05797449	-.02308693	.03291563
.02486226	-.01790882	-.02859166	.00992284
.04361156	.03109083		
.02450976	.10033391	.02308693	.07522265
.01780861	.01271627	.03167963	.04055602

.03576759	.00648623		
-.01584243	.03747322	.23008926	0
0	.02631751	.15005659	0
-.03912096	0		
.0188222	.10263811	0	.1068714
.00658935	-6.42319211-05	.01037428	.02182635
.02231642	.01119982		
.0215122	.00678815	0	.01006362
.00072055	.0055971	0	.13509715
.01920289	.14956027		
-.0215565	.03621312	.04617785	-.00013534
.00785384	.05060531	.03007132	.02059575
.01551823	-.04928921		
-.02094063	.00293029	.16162248	.013381
0	.01842226	.14752308	.00800879
-.04427115	-.01054772		
.0238482	.04583765	0	.01623386
.07369685	.00817201	.03518714	.13374973
.01920289	.11436795		
.035322	.0085601	-.04617785	.03161163
.01780861	.01630493	-.04801448	.03255743
.09550036	.01699395		
.01127716	.00553059	0	.00710413
.0621161	-.01484949	-.03518714	.08683853
.0076106	.20939721		

EXP. VALUE OF COLLECTIVITY TO ACT.J

.54294287 .52450976 .48415753 .51882219 .5215122 .64185451
.77312839 .94249626 .71386609 .86983769

TOWARDS AN INTEGRATED CIRCUIT WHICH MAPS THE INTERACTION BETWEEN COLLECTIVE ACTION, COMMUNICATION AND PERCEPTION

THE FOLLOWING SYSTEM THEORETIC APPROACH HAS BEEN DEVELOPED AS A BASIS FOR HYBRID SIMULATION:

1 CONSIDER M EVENTS AND A NETWORK OF N COMMUNITIES REPRESENTED BY A N-SIMPLEX WITHIN THE REGION

$$I = \left\{ (X_1 , \ldots , X_M) \;/\; 0 \leqq X_i \leqq 1;\; i = 1, \ldots , M \right\}$$

AT ANY TIME t THE QUANTITY $X_{ji}(t)$ REPRESENTS COMMUNITY j's INTEREST IN EVENT i .

THUS EACH COMMUNITY IS REPRESENTED BY A POINT $(X_{j1}, \ldots , X_{jM}) \in \boldsymbol{S}_N$, AND EACH CONNECTION BETWEEN TWO COMMUNITIES BY SOME EDGE-OF-THE-WEDGE IN $\boldsymbol{S}_N$.

2 FOR ALL j AND ALL t WE HAVE

$$\sum_i X_{ji}(t) = 1$$

3 ANY COMMUNITY MAY EITHER RECEIVE, OR SEND A MESSAGE WHICH DEFINES OR BELONGS TO: A WEAK INTERACTION, AN INTEREST-CHANGING INTERACTION OR A STRONG INTERACTION. DENOTE THESE THREE TYPES OF INTERACTION BY $\lambda = 1, 2, 3$

4 LET $AE_j(t)$ BE THE SET OF COMMUNITIES WHO SEND A MESSAGE TO COMMUNITY j AT THE TIME t .

5 LET $AE_{ji}(t)$ BE THE SET OF COMMUNITIES WHO SEND A MESSAGE CONCERNING EVENT i TO COMMUNITY j .

6 LET $AE_{ji\lambda}(t)$ BE THE SET OF COMMUNITIES WHO SEND A MESSAGE OF THE TYPE λ CONCERNING EVENT i TO COMMUNITY j.
EXAMPLE:
$AE_{531}(t)$ IS THE SET OF COMMUNITIES WHO SEND A 'WEAK' MESSAGE CONCERNING EVENT 3 TO COMMUNITY 5.

7 LET $AR_j(t)$ BE THE SET OF COMMUNITIES WHO RECEIVE A MESSAGE FROM COMMUNITY j AT TIME t.

8 LET $AR_{ji}(t)$ BE THE SET OF COMMUNITIES WHO RECEIVE A MESSAGE CONCERNING EVENT i FROM COMMUNITY j.

9 LET $AR_{ji\lambda}(t)$ BE THE SET OF COMMUNITIES WHO RECEIVE A MESSAGE OF THE TYPE λ FROM COMMUNITY j CONCERNING EVENT i.

10 LET $A\Phi_j(t)$ BE THE SET OF COMMUNITIES WHO ARE NOT COMMUNICATING WITH COMMUNITY j.

11 LET $U_{i\lambda}(t, X_j)$ BE THE NORMALIZED AND SMOOTHED RATE OF THE GENERATION OF λ-MESSAGES BY COMMUNITY j CONCERNING EVENT i SUCH THAT

$$0 \leqslant U_{i\lambda}(t, X_j) \leqslant 1$$

12 LET $K_{\lambda\mu}(X_j, X_k)$ BE THE RATE OF INFLUENCE OF COMMUNITY $k \in \boldsymbol{S}_N$ ON COMMUNITY $j \in \boldsymbol{S}_N$, I.E. THE DEGREE TO WHICH μ-MESSAGES BY COMMUNITY k EXCITE THE EMISSION OF λ-MESSAGES BY COMMUNITY j. FOR ANY TIME t:

$$K_{\lambda\mu}(X_j, X_k) > 0 \quad \text{FOR} \quad k \in AE_j(t)$$

$K_{\lambda\mu}(X_j, X_k) = 0$ FOR $k \in A_j(t)$

$K_{\lambda\mu}(X_j, X_k) < 0$ FOR $k \in AR_j(t)$

13 IT IS ASSUMED THAT THE $K_{\lambda\mu}(X_j, X_k)$ ARE $\mathscr{L}$-INTEGRABLE, BOUNDED ON $I \times I$ WITH
SUP $|K_{\lambda\mu}(X_j, X_k)| = \varkappa_{\lambda\mu, jk}$ FOR ALL TIMES t.
FURTHERMORE,
$K_{\lambda\mu}(X_j, X_k) = 0$ IF $X_j \notin I$ OR $X_k \notin I$

14 BY $\Xi_\lambda(X_j)$ DENOTE THE RATE OF SELF-EXCITATION OF COMMUNITY j ON λ- MESSAGES.

15 LET $F_\lambda(X_j)$ BE AN EXTERNAL INPUT WHICH EXCITES THE GENERATION OF λ-MESSAGES BY COMMUNITY j.

16 CONSIDER THE WEIGHT FUNCTIONS

$$H_j(t) = H(t, X_j) = \sum_j^N c_j e^{-\beta_j t}$$

WHERE $c_j = c(X_{j1}, \ldots, X_{jM})$ AND
$\beta_j = \beta(X_{j1}, \ldots, X_{jM})$ ARE CONSTANTS WITH RESPECT TO TIME.
ASSUME THAT $H_j(t) \geq 0$ FOR $t \geq 0$

17 CONSIDER THE FINITE TIME-INTERVAL T AND DEFINE THE DOMAIN $D = T \times I$.
CONSIDER THE SPACE OF ALL FUNCTIONS $U(t, X)$ WITH $0 \leq U(t, X) \leq 1$, ABSOLUTELY $\mathscr{L}$-INTEGRABLE IN $X \in I$ FOR ANY FIXED $t \in T$, AND ABSOLUTELY CONTINUOUS IN t FOR FIXED $X \in I$.

18 THE MONOTONICALLY INCREASING FUNCTIONAL

$$S(U)(t, X) = \frac{1}{1 + e^{-U(t, X)}}$$

MAPS $\mathscr{L}^{\infty}(D)$ INTO ITSELF. WE HAVE $0 < S(U) < 1$ FOR U BOUNDED IN $\mathscr{L}^{\infty}(D)$.

19 DEFINE THE OPERATORS:

$$(H\,U_{i\lambda})(t,\,X_j) = \int_0^t H_j(t-\tau)U_{i\lambda}(\tau,\,X_j)$$

$$(K_{\lambda\mu}U_{i\mu})(t,\,X_j) = \sum_k \sum_\mu K_{\lambda\mu}(X_j,\,X_k)U_{i\mu}(t,\,X_k)$$

$$L = \partial/\partial t + \Xi_\lambda(X_j)$$

20 THE SIMULATION OF THE RATES OF THE GENERATION OF λ-MESSAGES BY COMMUNITY j CONCERNING EVENT i IS GIVEN BY THE FOLLOWING DIFFERENTIAL EQUATION

$$L\,U_{i\lambda}(t,X_j) = S\left\{F_\lambda(X_j) + H\,U_{i\lambda}(t,\,X_j) + K_{\lambda\mu}U_i\,(t,\,X_j)\right\}$$

SUBJECT TO $U_{i\lambda}(o,\,X_j) = U_{i\lambda o}(X_j)$

21 THE FORM OF THE INTERACTION OPERATOR $K_{\lambda\mu}(X_j,\,X_k)$ REQUIRES A WELL DEFINED HYPOTHESIS WHICH IS NOT YET EMPIRICALLY TESTED.
EXAMPLE: IDENTIFICATION AMONGST THE ACTORS SUGGESTS THAT THE STRENGTH OF AN INTERACTION DEPENDS ON THE DISTANCE OF THEIR INTERESTS:

$$K_{\lambda\mu}(X_j,\,X_k) = \delta_{\lambda\mu}\,e^{-\mathrm{CONST}\,|X_j - X_k|}$$

22 INSTRUCTION: LET $\Gamma_{i1}(X_j,\,X_k)$ BE THE DEGREE TO WHICH WEAK MESSAGES BY COMMUNITY k ON EVENT i INCREASE COMMUNITY j's CURRENT CONTROL OVER EVENT i.

23 MOTIVATION: LET $\Gamma_{i2}(X_j, X_k)$ BE THE DEGREE TO WHICH MOTIVATING MESSAGES BY COMMUNITY k ON EVENT i INCREASE COMMUNITY j's CURRENT INTEREST IN EVENT i.

24 STRONG INTERACTION: LET $\Gamma_{i3}(X_j, X_k)$ BE THE DE DEGREE TO WHICH AMBIGUOUS MESSAGES BY COMMUNITY k ON EVENT i DECREASE COMMUNITY j's CURRENT CONTROL OVER EVENT i.

25 IT IS ASSUMED THAT THE $\Gamma_{i\lambda}(X_j, X_k)$ ARE $\mathscr{L}$-INTEGRABLE, BOUNDED ON $I \times I$ WITH $\sup |\Gamma_{i\lambda}(X_j, X_k)| = \gamma_{i\lambda,jk}$ FOR ALL TIMES t. FURTHERMORE,

$$\Gamma_{i\lambda}(X_j, X_k) \geq 0 \quad \text{ON} \quad I \times I$$

AND ZERO IF $(X_j, X_k) \notin I \times I$.

26 LET $\Theta_i(X_j)$ BE THE DEGREE TO WHICH CHANGES OF THE CURRENT CONTROL OF COMMUNITY j OVER EVENT i CANNOT BE EXPLAINED BY WEAK INTERACTION OR STRONG INTERACTION.

27 BY $O_i(X_j)$ DENOTE THE DEGREE TO WHICH CHANGES OF ACTOR j's INTEREST IN EVENT i CANNOT BE DESCRIBED BY MOTIVATIONS.

28 BY $C_{ij}(t, X_{ji})$ DENOTE COMMUNITY j's CURRENT CONTROL OVER EVENT i SUCH THAT $\sum_j C_{ij} = 1$.

29 COMMUNITY j's CURRENT CONTROL OVER EVENT i CHANGES ACCORDING TO

$$\frac{dC_{ij}}{dt} = S\left\{\sum_k [\Gamma_{i1}(X_j, X_k)U_{i1}(X_k) - \Gamma_{i3}(X_j, X_k)U_{i3}(X_k)] + \Theta_i(X_j)\right\}$$

SUBJECT TO $C_{ij}(0, X_{ji}) = C_{ij0}(X_{ji}(0))$

30 COMMUNITY j's INTEREST IN EVENT i IS CHANGED BY MOTIVATING MESSAGES ACCORDING TO

$$\frac{dX_{ji}}{dt} = S\left\{\sum_k \Gamma_{i2}(X_j, X_k)U_{i2}(X_k) + O_i(X_j)\right\}$$

SUBJECT TO $X_{ji}(0) = X_{ji0}$

31 LET R BE THE VECTOR OF POWER. TIME EVOLUTION OF POWER IS GOVERNED BY THE EXCESS DEMAND FOR CONTROLLED VALUES:

$$\dot{R} = \alpha(V(t)C(t) - R(t))$$

WHERE $C(t)$ IS THE CONTROL-MATRIX $[C_{ij}(t, X_{ji})]$

32 LET V BE THE VECTOR OF COLLECTIVE VALUES. THEN

$$\dot{V} = \eta(R(t)X(t) - V(t))$$

(FOR THE FORMAL PROPERTIES OF THIS SYSTEM SEE 19, 45, 20)

THE PRINCIPLES OF THIS MODEL ARE VERY SIMPLE FROM A CYBERNETIC POINT OF VIEW.
THERE ARE THREE TYPES OF MESSAGES: INSTRUCTIONS, MOTIVATIONS AND AMBIGUOUS OR PARADOX MESSAGES. THEIR GENERATION IS GOVERNED BY 'SELF-PRODUCTION', 'INTERACTION', 'EXTERNAL INPUTS' AND 'MEMORY'. THE EFFECTS OF THE INTERACTION-OPERATOR DEPEND ON THE DISTRIBUTION OF INTERESTS. ALL THE MESSAGES TOGETHER REGULATE THE DIRECTED INTERESTS AND THE AMOUNTS OF CONTROL OF THE COMMUNITIES.
THESE DETERMINE THE DISTRIBUTION OF RESOURCES R AND COLLECTIVE VALUES V.

THE HIGHLY INTERCONNECTED EQUATIONS MAY BE CONSIDERED AS THE FORMAL REPRESENTATION OF A 'SOCIAL DOOM'.

THERE ARE EVENTS WHICH HAVE TO BE CONTROLLED SINCE THOSE EVENTS SECURE THE COLLECTIVE SATISFACTION OF BASIC HUMAN NEEDS. THEY HAVE TO BE OF GENERAL INTEREST. HOWEVER, MAN'S INTEREST IS WORTH NOTHING AS LONG AS THERE EXIST EXTERNAL AUTHORITIES WHO MONOPOLIZE CONTROL OVER THESE EVENTS.

+1+ INDEED, THE ONE WHO IS INTERESTED IN WHAT HE CONTROLS, AND WHO CONTROLS WHAT HE IS INTERESTED IN; THE ONE WHO CONTROLS WHAT MOST PEOPLE ARE INTERESTED IN, IS THE POWERFUL. HE WILL POSSESS WHAT IS OF HIGH VALUE.

+2+ HOWEVER, AS LONG AS WE CONTINUE TO COMPARE HUMAN BEINGS ACCORDING TO THEIR POWER WHICH IS BASED ON CONTROL OVER THE VALUABLE EVENTS, AS LONG AS THERE EXIST THE GOODIES AND THE BADDIES, THE STRONG GUYS AND THE WEAK GUYS, STRUGGLE WILL GO ON AND ON.

+3+ THEN, HUMAN INTEREST IS MANIPULATED BY 'MOTIVATING MESSAGES'. THEN WE ARE TAUGHT ' WHY WE OUGHT TO PREFER CERTAIN ACTIONS A IN ORDER TO GET X' BEFORE WE CAN MAKE UP OUR OWN MIND FROM THE EVIDENCE.

+4+ THE 'MYSTERIOUS' AND 'MYSTIFYING' FLOW OF INFORMATION WHICH TRANSPORTS ENORMOUS AMOUNTS OF INFORMATION AND INSTRUCTIONS (WHICH CAN BY NO MEANS BE COMPREHENDED BY THE GENERAL PUBLIC) WILL ARRANGE AND REARRANGE CONTROL SUCH THAT THE ONE WHO HAS POWER WILL SUPPRESS THE ONE WHO HAS NONE.

+5+ THE LEAST POWERFUL ACTORS WILL HAVE TO ENTANGLE THEMSELVES WHITHIN PARADOX HUMAN RELATIONS AND 'STRONG INTERACTION'. MANY OF THEM WILL HAVE TO LOSE 'CONTROL OVER THEIR LIFE'. STRONG INTERACTION AND DOUBLE BIND

WILL PROVIDE FOR THE ESSENTIAL SOURCES OF PSYCHIC MISERY AND CRIME.
AND SINCE NONE OF US HAS EVER BEEN EDUCATED TO LOVE, R WILL BE EQUAL TO $\sum_I V_I C_{IJ}$ UNTIL "ALL THE GOODIES HAVE KILLED ALL THE BADDIES, AND VICE VERSA". IN THIS SENSE, THE EQUATIONS OF MOTION OF SOCIAL EXCHANGE SYSTEMS DESCRIBE SYSTEMS OF ACTION WHICH ARE BASED ON THE EXISTENCE OF VIOLENCE.
THAT IS, SOCIAL EXCHANGE SYSTEMS WHICH ARE GOVERNED BY 'VALUE' AND 'POWER' REQUIRE A SEPARATIVE PSYCHOLOGICAL STATE OF PERCEPTION. THIS STATE IS DEFINED BY THE EXISTENCE OF VALUES THAT CAN BE MAPPED ONTO HUMAN BEINGS. THUS, INTERPERSONAL COMPARISONS SUPPORT DIRECTED STRATEGIES OF THE INDIVIDUALS WHICH ARE OF SEPARATIVE CHARACTER.
THE PRE-REQUISITE OF THE EQUATIONS IS VIOLENCE I.E. SEPARATIVE PERCEPTION. SINCE PRESENT SOCIAL SYSTEMS MEET THIS BASIC REQUIREMENT THE BASIC EQUATIONS OF COLLECTIVE ACTION ARE FULFILLED.

THE INNER MOST ABILITY OF MAN

"IT IS SECURITY AND SUCCESS THAT MOST OF US ARE AFTER; AND A MIND THAT IS SEEKING SECURITY, THAT CRAVES SUCCESS, IS NOT INTELLIGENT, AND IS THEREFORE INCAPABLE OF INTER-GRATED ACTION.
THERE CAN BE INTEGRATED ACTION ONLY IF ONE IS AWARE OF ONES OWN CONDITIONING, OF ONE'S RACIAL, NATIONAL, POLITICAL AND RELIGIOUS PREJUDICES; THAT IS ONLY IF ONE REALIZES THAT THE WAYS OF THE SELF ARE EVER SEPARATIVE".
(JIDDU KRISHNAMURTI, 1973)
CONSIDER THE FOLLOWING TWO-HEAD-HYPOTHESIS (A TERM KNOWN IN PHILOSOPHY):
THERE IS ONE REALITY 'OUTSIDE OURSELVES' CONSISTING OF THINGS, EVENTS, HUMAN BEINGS AND RELATIONS, OF MAN AND NATURE; AND THERE IS ONE ADDITIONAL EXPECTED OR

CONSTRUCTED REALITY 'INSIDE OURSELVES'.
THERE IS ONE REALITY PERCEIVED AS SOMETHING 'AT THE OUTSIDE', FROM WHICH A PICTURE IS MAPPED ONTO OUR SELF-SYSTEM; AND THERE ARE OUR FEELINGS AND THOUGHTS BY MEANS OF WHICH WE 'CONSTRUCT' SOME ADDITIONAL REALITY WHICH WE MAP ONTO THE OUTSIDE. 'EGO' IS LINKED TO THE INSIDE; 'ALTER' IS LINKED TO THE OUTSIDE.
THUS WE NEVER OBTAIN A CLEAR PICTURE OF THE REAL EVENTS SINCE WE HAVE TO ADD OUR SUBJECTIVE, CONSTRUCTED INTERPRETATION OF REALITY.
HUMAN PERCEPTION IS ALWAYS ACCOMPANIED BY A DESCREPANCY SINCE OUR EXPECTATIONS CONCERNING REALITY MAY CONTRADICT WHAT OUR CURRENT SENSUAL PERCEPTIONS TEACH US.
OUR 'MODEL' OF REALITY IS THE RESULT OF OUR HISTORY, I.E. A PRODUCT OF PAST INFORMATION PROCESSING.
THUS IT CAN NEVER MAP PRESENT REALITY.
OCCASIONALLY WE ARE AWARE OF THIS DESCREPANCY. THEN WE MAY POSSIBLE OBSERVE THE FOLLOWING:
THE LESS WE HAVE PAID ATTENTION DURING THE PAST, THE MORE WE ARE PSYCHOLOGICALLY BOUND TO IT, I.E. OUR THOUGHTS AND FEELINGS CIRCLE ROUND PAST EVENTS. AGAIN, WE LOSE PRESENCE AND ATTENTIVENESS.
THE MORE FRUSTRATION WE HAVE EXPERIENCED DURING THE PAST, THE MORE WE ARE BOUND. HOWEVER, IF WE ARE BOUND TO THE PAST WE BECOME FEARFUL TO FACE THE PRESENT. THUS, OUR FEARS MAY GENERATE FRESH FRUSTRATION, SINCE FEAR CREATES ITS OWN OBJECT. OUR EXPECTATIONS MAY GIVE EXPRESSION TO OUR NEEDS, BUT THEY CONTRADICT OUR ACTUAL EXPERIENCES. THIS CONTRADICTION MAKES US FEARFUL; AND IT IS FEAR THAT CREATES THE CONTRADICTION.
USUALLY MAN TRIES TO SOLVE THIS PRISONER'S DILEMMA BY THE AID OF THE FOLLOWING TWO STRATEGIES:

(1) WE TRY TO CHANGE 'THE OUTSIDE' SUCH THAT IT CORRESPONDS TO OUR EXPECTATIONS (THE INSIDE).
IN THIS CASE WE LOCATE THE SOURCE OF OUR CONFLICTS (THE CONTRADICTION) AT THE OUTSIDE.

(2) WE TRY TO CHANGE OUR EXPECTATIONS, I.E. THE INSIDE.
THEN WE LOCATE THE SOURCE OF OUR CONFLICTS AT THE INSIDE.

However, neither of these strategies can untie the knot: In both cases we seek guilt; we seek something which is wrong. Either there is something which is wrong with the outside (alter), thus we need to change it; or there is something which is wrong with the inside. In which case, we try to change 'ego'.
But we do not ask the question if something which happens, occurs, takes place, or comes to pass can be 'wrong' at all.
So, if we try to change the outside there are again two realities since we expect the outside to be something which can bechanged according to our desire.
However, the current events may contradict this subjective, expected reality.
In the second case we try to change the inside. But then there are again two realities: we anticipate a change of the inside. Thus, any event that indicates that we have not yet sufficiently changed the inside, contradicts our subjective demand for control over the inside.
Indeed, the outside as well as the inside are projections of our self-system. Thus there is neither a real inside, as there is no real outside as long as we separate the outside (alter) from the inside(ego).
We, the observers, separate the outside from the inside, the objects from the subjects.
Thus, if we make use of any one of our two strategies we only add one more claim to the images of our self system. As long as the subject separates from 'its' objects it observes reality from a very narrow view.
When we start to change the outside we separate from the objects which we need to manipulate. When we try to change the inside we observe 'ego' which now becomes an object of its own observations and separates from itself. Whatever strategy we use, it cannot distangle the knot, since in both cases we restrict our

PERCEPTIONS TO ONE HALF OF REALITY WHEREAS THE OTHER IS NEGLECTED. IF WE TRY TO FACE THE INSIDE WE PRACTICE SOME STUPID KIND OF MEDITATION WHILST SEPARATING FROM THE OUTSIDE. INDEED, ALL KINDS OF PRIESTS, THERAPISTS, GURUS AND RELIGIOUS AUTHORITHIES HAVE TAUGHT US TO FOLLOW THIS IDEAL. HOWEVER, IN REALITY THIS CLAIM FORCES US TO SEPARATE FROM BOTH, THE OUTSIDE AND THE INSIDE. WE SEPARATE FROM ALTER SINCE WE ARE WATCHING EGO; AND WE SEPARATE FROM THE INSIDE SINCE EGO BECOMES AN OBJECT OF ITS OBSERVATIONS.
ON THE OTHER HAND, IF WE ONLY TRY TO MANIPULATE THE OUTSIDE WE CANNOT BE AWARE OF THE INSIDE. THUS, WHATEVER WE DO WE MAY BE SURE THAT WE SHALL UNTIE THE KNOT. BUT THIS IS ONLY A PRETENCE SINCE IN REALITY WE CANNOT UNTIE IT BY RESTRICTING OUR PERCEPTIONS TO SOME PART OF REALITY WHILST ALL OF IT - THE INSIDE AS WELL AS THE OUTSIDE - IS SUBJECT TO PERCEPTION.
THE PROBLEM IS THAT WE WANT TO UNTIE THE KNOT. WE WANT TO GET RID OF THE DISCREPANCIES. THUS WE TRY TO APPLY OUR WELL KNOWN STRATEGIES WHICH ARE DERIVED FROM THE PAST.
IN REALITY WE ARE FEARFUL TO BECOME AWARE OF OUR OWN CONDITIONING AND THE SEPARATIVE TENDENCIES OF OUR MIND. WE MAY USE A HUNDRED STRATEGIES IN ORDER TO DISTANGLE THE DISCREPANCIES BETWEEN EXPECTATION AND REALITY - BETWEEN THE INSIDE AND THE OUTSIDE - THE KNOT CANNOT BE UNTIED. THERE IS NO WAY OUT OF THE PRISONER'S DILEMMA.
NOW, IF WE ARE FULLY AWARE THAT THERE IS NOTHING LEFT TO BE DONE, THAT IT IS ABSOLUTELY SENSELESS TO TRY TO CANCEL THE DISCREPANCIES: WHEN WE HAVE A DEEP INSIGHT THAT WE ARE COMPLETELY DETERMINED BY THE OUTSIDE:
CAN WE STOP ALL ATTEMPTS TO CANCEL OUR CONDITIONING?
CAN WE JUST BECOME AWARE OF THE WHOLE EXTENT OF OUR CONSTRAINT AND OUR FEAR TO BE 'NOBODY'. THIS IS THE EVENT WHICH PUTS AN END TO ALL SEARCH.

THEN THERE IS ONLY PERCEPTION.
BUT THERE IS NO 'UTILITY DIFFERENCE' BETWEEN THE OUTSIDE (ALTER) AND THE INSIDE (EGO).
INDEED, A MIND WHO STOPS ALL HIS SENSELESS ATTEMPTS TO DISTANGLE THE KNOTS WHICH ARE THE RESULTS OF SEPARATION, IS IN A STATE OF COMPLETE REST.
THIS IS A PSYCHOLOGICAL STATE OF FREEDOM WHICH IS INCOMPATIBLE WITH THE CONSIDERATION OF UTILITY DIFFERENCES AND THE SEPARATION BETWEEN SUBJECTS AND OBJECTS.
IT REPLACES INTERPRETATION BY INTEGRATED ACTION AND STRATEGY BY AWARENESS.

APPENDIX

I THE INTEGRAL KERNEL OF A DAMPED OSCILLATION UNDER AN EXTERNAL FORCE

II THE ALGEBRA OF CREATION- AND ANNIHILATION OPERATORS

Appendix I

The Integral Kernel of a Damped Oscillation under an external force:

$$\frac{d^2}{dt^2}\Psi + 2B\frac{d}{dt}\Psi + \Omega^2\Psi = K(t)$$

carry out a Fourier transformation

A

$$K(t) = (1/2\pi)\int_{-\infty}^{\infty} d\omega\, e^{i\omega t} A_o(\omega)$$

transform

B

$$\Psi(t) = (1/2\pi)\int_{-\infty}^{\infty} d\omega\, e^{i\omega t} f(\omega)$$

If we substitute this into our differential equation we obtain

C

$$(1/2\pi)\int_{-\infty}^{\infty} d\omega e^{i\omega t}\left(-\omega^2+2iB\omega+\Omega^2\right)f(\omega) - A_o(\omega) = 0$$

According to Fourier's theorem this can hold for all times only if the bracket-term vanishes

D

$$f(\omega) = \frac{A_o(\omega)}{\Omega^2 - \omega^2 + 2iB\omega}$$

with the help of *C* we get

$$\Psi(t) = (1/2\pi)\int_{-\infty}^{\infty} d\omega\, e^{i\omega t}\frac{A_o(\omega)}{\Omega^2 - \omega^2 + 2iB\omega}$$

If we make use of the inverse transform

E

$$A_o(\omega) = \int_{-\infty}^{\infty} dt\, e^{-i\omega t}\, K(t)$$

we arrive at

F

$$\psi(t) = \int_{-\infty}^{\infty} dt' \underbrace{(1/2\pi) \int_{-\infty}^{\infty} d\omega \frac{e^{i\omega(t-t')}}{\Omega^2 - \omega^2 + 2iB\omega}}_{G(t-t')} K(t')$$

G

The term

$$(1/2\pi) \int_{-\infty}^{\infty} d\omega \frac{e^{i\omega(t-t')}}{\Omega^2 - \omega^2 + 2iB\omega} K(t')$$

is well known. It is the integral-kernel of the inverse operator

$$(d^2/dt^2 + 2Bd/dt + \Omega^2)^{-1} = \mathcal{D}^{-1}$$

It is called the 'Green's function' of the differential equation

$$\mathcal{D}\psi(t) = K(t)$$

By quite formal inversion of $\mathcal{D}$ we obtain

$$\psi(t) = \mathcal{D}^{-1} K(t)$$

The inversion makes sense because we actually have

$$\psi(t) = \int_{-\infty}^{\infty} dt'\, G(t-t')\, K(t')$$ according to *F*

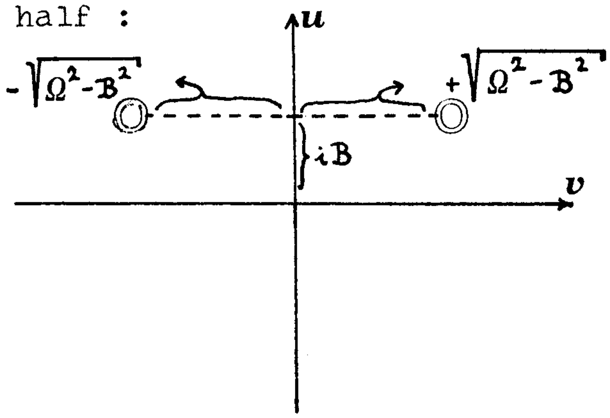
H

$$G(t) = -(1/2\pi)\int_{-\infty}^{\infty} d\omega \frac{e^{i\omega t}}{(\omega - \Omega_1)(\omega - \Omega_2)}$$

here we have set

$$\Omega_{1,2} = iB \pm \sqrt{\Omega^2 - B^2}$$

If we integrate in the complex plane we have two poles in the upper half :



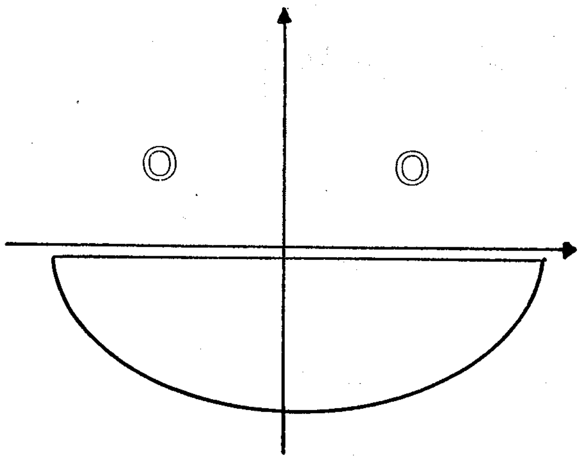
I Put $\omega = u + iv$, we have $e^{i\omega t} = e^{(iu - v)t}$

For $t < 0$ necessarily v must be smaller than zero in order to make

$$e^{i\omega t} \longrightarrow 0 \quad \text{as} \quad v \longrightarrow \infty$$

Therefore for $t < 0$ we have to integrate in the lower half :

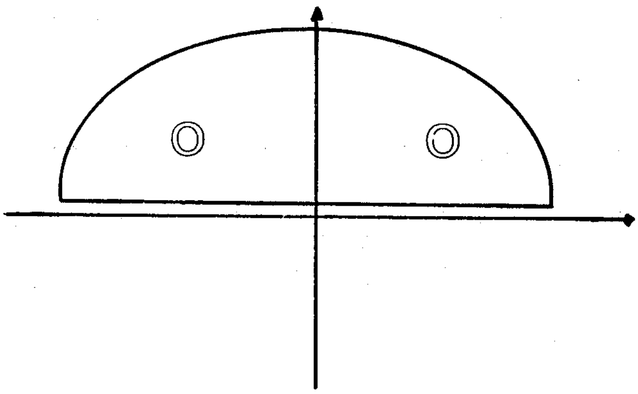
Thus



Since we are not surrounding any poles we obtain

J $\quad G(t) = 0$ for times $t < 0$

For $t > 0$ a similar argument leads to integration in the upper half plane :



Therefore by Cauchy's theorem the integration yields

$$G(t) = -\frac{2\pi i}{2\pi}\left[\frac{e^{i\Omega_1 t}}{\Omega_1 - \Omega_2} + \frac{e^{i\Omega_2 t}}{\Omega_2 - \Omega_1}\right]$$

we set

$$\bar{\Omega} = \sqrt{\Omega^2 - B^2}$$

then

K

$$G(t) = \frac{e^{-Bt}}{2i\bar{\Omega}} \left[e^{i\Omega_1 t} - e^{-i\Omega_2 t} \right]$$

or

$$G(t) = \frac{e^{-Bt}}{\bar{\Omega}} \sin \bar{\Omega} t \qquad \text{for} \quad t > 0$$

$$G(t) = 0 \qquad \text{for} \quad t < 0$$

This property of the Green's function is representative for causality.

The field

$$\psi(t) = \int_{-\infty}^{\infty} dt' G(t-t') \, K(t')$$

cannot oscillate before the external power $K(t)$ starts its effect (at time t') .

Suppose now that $K(t)$ effects the system in 'one moment' $t=t'$ 'infinitely strong' . This means that $K(t)$ is equal to Dirac's δ-distribution :

$$K(t') = \delta(t-t') = 0 \quad \text{for} \quad t \neq t'$$

such that

$$\int_{-\infty}^{\infty} \delta(t-t') dt' = 1$$

then we get

$$\psi(t) = \int_{-\infty}^{\infty} dt' G(t-t') \, \delta(t-t') = G(t)$$

This is a special solution of the damped oscillatory system

$$\mathcal{D}\psi(t) = K(t)$$

under the effect of a δ - impuls acting at time $t = t'$.

Now, consider the homogenous equation

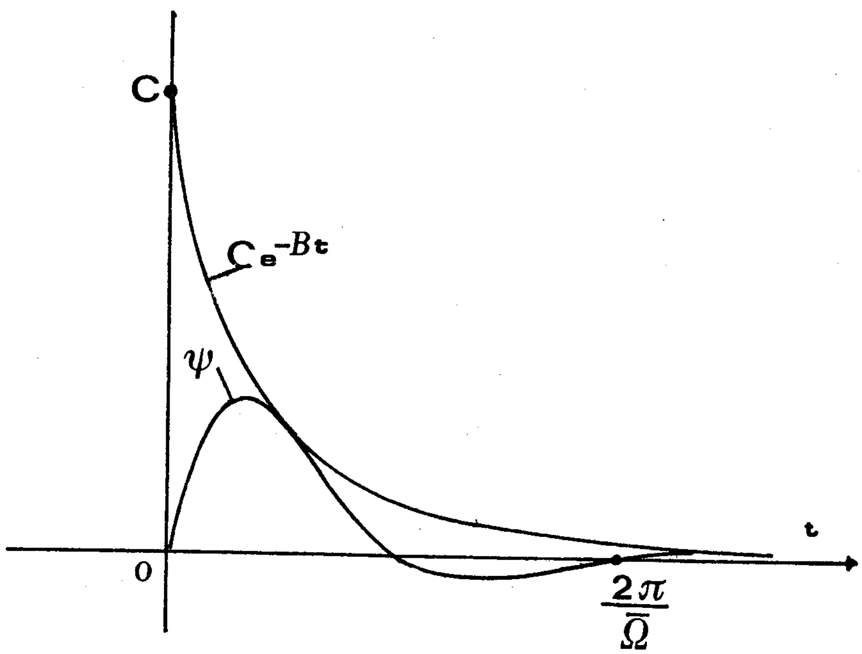
$$\mathcal{D}\psi(t) = 0$$

Its general solution is

$$\psi_{hom}(t) = C\, e^{-Bt} \sin(\bar{\Omega} t + \alpha)$$

where C is an arbitrary constant and α an arbitrary phase.

This solution is essentially similar to *K*. It represents damped oscillations with frequency $\bar{\Omega} = \sqrt{\Omega^2 - B^2}$ and frictional (damping) constant B :



There is damping of the amplitude by a factor $C\ e^{-Bt}$ and there is a change in frequency

$$\bar{\Omega} = \sqrt{\Omega^2 - B^2}$$

If there is no damping $B = 0$ we simply have $\bar{\Omega} = \Omega$ and

$$\psi(t) = C \sin(\Omega t + \alpha)$$

which is the general solution of the harmonic oscillation

$$\frac{d^2}{dt^2}\psi(t) + \Omega^2 \psi(t) = 0$$

Appendix II

The algebra of creation- and annihilation operators

1 Let $X \in R$

2 Let t be a real valued time variable.

3 Let $L(X, t)$ be a linear differential operator acting on $\mathscr{L}_2(dX, (+\infty, -\infty))$

4 For the present we do not specify qualities of L like boundedness, singularity or locality and we do not specify the class of functions to which Φ belongs. These can be derived in a most natural way if $L(X, t)$ is well known.

5 Our equation of motion is of the form

$$L\,\Phi = i(d/dt)\Phi$$

6 For the time being, let ϕ be called a 'state function' of the system. Let us also give the designation 'Hamiltonian System Operator' to L.

7 Remarks on the set of our demands:
We want to derive an operator-algebra which maps stimulated emission of statements. Thus, the finally derived v. Neumann Algebra should allow for 'Number -, Creation -, and Annihilation Operators'. Additionally the concept of state function should give meaning to

normed positive functionals over the C^* - Algebra which - for example - should map a state like $|2,1,2)$.

8 By ω_i $i = 1,2,3$ we design a real number which corresponds to an emitted quantum of type i.
It may e.g. represent the mean proportion of information of a disconfirming statement in the case of $i = 3$.
The investigation of ω_i does not effect the structure of our calculations.

9 Consider the operator $-i\frac{d}{dX}$, with $i = \sqrt{-1}$ which essentially means : 'differentiation with regard to variable X'.

10 Consider the commutator

$$\left[X, -i\frac{d}{dX}\right] = -iX \frac{d}{dX} + i\left(\frac{d}{dX}\right)X$$

11 We have

$$\left[X, i\frac{d}{dX}\right] \varphi(X) = -iX\varphi' + iX'\varphi + iX\varphi' = i\,\varphi(X)$$

Thus we get the resulting commutation relation:

12 $$\left[X, i\frac{d}{dX}\right] = i$$

13 Let H be the stationary Hamiltonian operator:

$$H = 1/2\left(- \frac{d^2}{dX^2} + \omega^2 X^2 \right)$$

It does not depend on time andhas to fit the corresponding eigenvalue equation:

14 $$1/2 \left(- \frac{d^2}{dX^2} + \omega^2 X^2 \right) \varphi_\varepsilon(X) = \varepsilon\, \varphi_\varepsilon(X)$$

where $\varphi_\varepsilon(X)$ are stationary eigenfunctions of H and ε its corresponding eigenvalues.

15 Until now we do not know about the values of the ε .

16 Consider the operator

$$A = (2\omega)^{-1/2} \left(\omega X + \frac{d}{dX} \right)$$

and

17 $$A^+ = (2\omega)^{-1/2} \left(\omega X - \frac{d}{dX} \right)$$

18 We calculate

$$A^+ A = (2\omega)^{-1} \left\{ \omega^2 X^2 - \omega\left(\frac{d}{dX}\right) X + \omega X \frac{d}{dX} - \frac{d^2}{dX^2} \right\}$$

By watching the 2-nd and 3-rd term within the bracket:

$$A^+ A = (2\omega)^{-1} \left\{ \omega^2 X^2 - \frac{d^2}{dX^2} + i\omega \left[X, -i\frac{d}{dX} \right] \right\}$$

by means of the commutator which we computed in *13* we obtain:

19 $$A^+ A = (2\omega)^{-1} \left\{ \omega^2 X^2 - \frac{d^2}{dX^2} - \omega \right\}$$

If we multiply $A^+ A$ with ω we simply get $H - 1/2\,\omega$

20 Thus $H = (A^+ A + 1/2)\omega$

21 Note:

We have decomposed the Hamiltonian into the product $A^+ A$ (seeing apart from the constant $1/2\,\omega$)

Further requirements:

We need to calculate the commutators related to A, A^+. Otherwise we cannot easily obtain results concerning the ε and operator algebra.

We need to know about the class of functions which fulfil *15* .

22 Calculation of the commutator $[A, A^+]$

$$
\begin{aligned}
A A^+ - A^+ A &= (2\omega)^{-1} \left(\omega X + \frac{d}{dX}\right)\left(\omega X - \frac{d}{dX}\right) \\
&\quad - (2\omega)^{-1} \left(\omega X - \frac{d}{dX}\right)\left(\omega X + \frac{d}{dX}\right) = \\
&= (2\omega)^{-1} \Big\{ \omega^2 X^2 + \omega\left(\frac{d}{dX}\right) X - \omega X \frac{d}{dX} - \frac{d^2}{dX^2} - \\
&\qquad - \omega^2 X^2 + \omega \frac{d}{dX} X - \omega X \frac{d}{dX} + \frac{d^2}{dX^2} \Big\} = \\
&= \frac{d}{dX} X - X \frac{d}{dX} = -i\left[X, -\frac{id}{dX}\right] = 1 \quad \text{by *13*}
\end{aligned}
$$

The same procedure can be carried out for the commutators $[A,A]$ and $[A^+, A^+]$. Then we get:

23 $[A, A^+] = 1 \qquad [A, A] = [A^+, A^+] = 0$

24 Therefore we have

$$
\begin{aligned}
H &= \omega(A^+ A + 1/2) = \omega\left\{A^+ A + 1/2\ [A, A^+]\right\} \\
&= \omega\left\{A^+ A + 1/2\ (A A^+ - A^+ A)\right\} \\
&= 1/2\ \omega\,(A A^+ + A^+ A)
\end{aligned}
$$

The 'bracket term' is called an Anticommutator of the operators A, A^+. It is usually assigned by $[A, A^+]_+$. Thus we have a representation of H by an anticommutation relation.

25 $H = \omega/2 \quad [A, A^+]_+$

There are still commutation relations of A and A^+ with the Hamiltonian which are missing:

26 $[A, H] = \omega(A A^+ A + 1/2 A) - \omega(A^+ A A + 1/2 A) =$
$= \omega [A, A^+] A = \omega A$

A similar relationship holds for A^+ :

27 $[A, H] = \omega A \qquad [A^+, H] = - \omega A^+$

28 We will show that these equations are 'shift operator equations'.

29 Let φ_ε be an eigenfunction of H corresponding to an eigenvalue ε of the Hamiltonian. Then we must have (*14*) :

$$H \varphi_\varepsilon = \varepsilon \varphi_\varepsilon$$

Let H act on a state function $A \varphi_\varepsilon$

30 $H A \varphi_\varepsilon = (A H - \omega A)\varphi_\varepsilon = A H\varphi_\varepsilon - \omega A \varphi_\varepsilon = (\varepsilon - \omega) A \varphi_\varepsilon$

We made use of *27*, *29* and the fact that constant ε has to commute with A.

31 Equation *32* makes clear that $A\varphi_\varepsilon$ is another eigenfunction of H which belongs to the eigenvalue $\varepsilon - \omega$ of H.

Thus operator A shifts the state function φ_ε such the 'spectral level' of H is 'lowered' by an amount of ω. Operator A annihilates a quantum of weight ω . Similarily we can calculate:

32 $$H \ A^+ \varphi_\varepsilon = (\varepsilon+\omega) \ A^+ \ \varphi_\varepsilon$$

Thus the operator A^+ raises the spectral level of H by creating quanta of weight ω .

33 A^+ is called 'Raising -' or 'Creation operator'.
A is called 'Lowering -' or 'Annihilation operator'.

34 The property of 'Selfadjointness' of a linear Operator
Let $\{\psi_i\}$ assign a **discrete** set of functions.
If the relationship

$$\int_{-\infty}^{\infty} \psi_m \psi_n \ dX = \delta_{nm}$$

holds, $\{\psi_i\}$ represents a set of orthonormal functions.
They are orthogonal and additionally is the Integral over the whole configuration space 'normed to unity'.

35 Consider the basic equation of motion:

$$-i \frac{d\psi}{dt} = L \psi \quad (*5*) \quad \text{with stationary } L$$

Then the Integral $\int \psi\psi^* \ dX$ is constant in time.
Thus we have:

$$\frac{d}{dt} \int | \psi |^2 dX = \frac{d}{dt} \int \psi \psi^* \ dX = \int \psi^* \frac{\partial\psi}{\partial t} \ dX +$$

$$+ \int \psi^* \frac{\partial\psi}{\partial t} \ dX = 0 \text{ using } *5* \text{ gives:}$$

$$\int \psi \; L^* \; \psi^* \; dX - \int \psi^* \; L\psi \; dX = \int \psi^* \; (\tilde{L}^* - L)\,\psi \, dX = 0$$

Here $\sim$ assigns the operation of transposing and $*$ designes complex conjugation.

The last equation of *35* can hold for arbitrary functions iff $\tilde{L}^* = L$

Realizing that $\tilde{L}^*$ defines adjoitness L^+, we obtain the result $L^+ = L$

Thus, L is a selfadjoint linear operator.

Therefore it has to have r e a l v a l u e d eigenvalues.

36 Recalling that H was a stationary operator we realize that it has real eigenvalues ε .

37 $H^+ = H$

38 It can easily be shown that:

$$(A^+)^+ = A$$

39 The product $A^+ A$ is positive definit. Therefore H cannot possess negative eigenvalues!

40 There must exist some state φ_o which cannot be lowered any more. Otherwise $\varepsilon - \omega$ would become negative. For this state we must have:

41 $A \; \varphi_o = 0$

If we use the X Representation *16* of operator A we get a first order differential equation for the ground state φ_o which will be assigned by u_o from now on.

42 The solution of *43* normalized to unity is:

$$u_o = (\omega / \pi)^{1/4} e^{-\omega X^2/2}$$

43 The repeated application of A^+ to u_o (*34*) allows for an investigation of the eigenfunctions u_n starting from ground state u_o.

44 $$u_n = (n!)^{-1/2} (\omega / \pi)^{1/4} 2^{-n/2} A^{+n} e^{-\omega X^2/2}$$

Let us call the coefficient left to A^+ ν_n.

Let $H_n(\omega X)$ be Hermite polynomials; then:

45 $$u_n = \nu_n H_n(\omega X) e^{-\omega X^2/2}$$

46

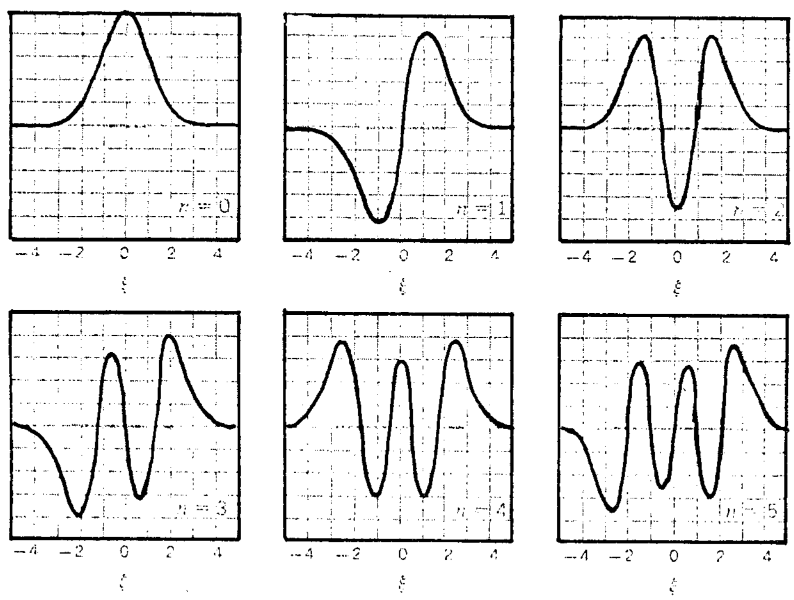


Fig. 10 Energy eigenfunctions for the first six states of the harmonic oscillator. [*After L. Pauling and E. B. Wilson, Jr., "Introduction to Quantum Mechanics,"* pp. 74–75 (*McGraw-Hill, New York,* 1935).]

In *46* the first 6 eigenfunctions of the Hamiltonian are plotted. Each u_n represents a state $| n)$ of n emitted statements. It can be figured out visually that a state corresponding to e. g. 5 quanta **represents** a higher stimulation than a state corresponding to **one single quantum**

47 The spectrum of H :

Recall *26*;

$$H \varphi_o = \omega (A^+ A + 1/2) \varphi_o =$$
$$= \omega A^+ (A \varphi_o) + \omega/2 \varphi_o =$$
$$= \omega/2 \varphi_o \quad \text{because of *43*}$$

Thus the spectrum is bounded from below by the value $\omega/2$. Repeated application of A^+ shifts up the whole spectrum:

$$\omega/2, \quad 3\omega/2, \ldots\ldots (n + 1/2)\omega \quad , \ldots\ldots$$

48 The spectrum of the number operator N :

Since $H = (A^+A + 1/2)$ the eigenvalue of $A^+ A$ can be obtained from the eigenvalues of H by dividing through ω and substracting 1/2.

Thus the spectrum consists of the non-negative integers 1, 2, ..., n, ...

49 We say that N 'counts' the number of emitted statements.

50 Equations *15*

$$H = 1/2 \left(- \frac{d^2}{dX^2} + \omega^2 X^2 \right)$$

18

$$A = (2\omega)^{-1/2} \left(\omega X + \frac{d}{dX} \right)$$

19

$$A^+ = (2\omega)^{-1/2} \left(\omega X - \frac{d}{dX} \right)$$

are the X Representations of operators H , A and A^+. The u_n are representatives of states of 'n emitted statements'.

51 To each n-state there corresponds exactly one function u_n which we have briefly assigned by $| \, n \,)$. The $| \, n \,)$ constitute a Hilbert space with ∞ many dimensions.

52 The eigenvalues of the Number operator are the n's

$N \, | \, n \,) = n \, | \, n \,)$.

53 For the time being, by $(\, n \, | \, N \, | \, n \,)$ we mean the integral

$$\int_{-\infty}^{+\infty} u_n \; A^+ \; A \; u_n \, dX$$

Since we have *54* :

$$(\, n | \, A^+ \; A \, | n \,) = (\, n \, | \, n \, | \, n \,) = n \, (\, n | \, n \,)$$

54 From *53* it can be seen that $A \, | \, n \,)$ represents a Hilbert vector with norm $n \, (\, n \, | \, n \,)$ unless $n \neq 0$.

55 Because of *25* we have

$(n \mid A A^+ \mid n) = (n \mid 1 + A^+ A \mid n) = (n \mid n) +$

$(n \quad A^+A \quad n) = (n \mid n) + n(n \mid n) =$

$= (n+1) \quad (n \mid n)$ Thus

56 $A^+ \mid n)$ which is certainly not zero represents a vector with norm $(n+1)(n \mid n)$

57 Equations *32*, *33* hold

$HA \mid n) = (n-1) \; A \mid n)$

$HA^+ \mid n) = (n+1) \; A^+ \mid n)$

58 If $n > 0$, one successfully forms the lower set of eigenvectors by applying operator A repeatedly:

$A \mid n), \; A^2 \mid n), \; \ldots\ldots\ldots, \; A^r \mid n), \; \ldots\ldots$ belonging respectively to the eigenvalues:

$n-1, \; n-2, \; \ldots\ldots, \; n-r, \; \ldots\ldots, \; 0$ bounded by the 0.

One also forms the upper set of vectors by applying A^+:

$A^+ \mid n), \; {A^+}^2 \mid n), \; \ldots\ldots\ldots, \; {A^+}^r \mid n), \; \ldots\ldots$

which belong to eigenvalues

$n+1, \; n+2, \; n+3, \; \ldots\ldots\ldots$

59 The vectors $A^r \mid n)$ and ${A^+}^r \mid n)$ thus constructed are (as can be seen from *56*, *58*) not normalized to unity.

6o To obtain an orthonormal basis of the Number operator up to an arbitrary phase, it suffices to multiply each of the $A^r |n)$, $A^{+^r} | n)$ by suitable constants, which are deduced form *56*, *58* norms. Thus,

61 $A |n) = n^{1/2} | n - 1), A| 0) = 0$

62 $A^+| n) = (n + 1)^{1/2} | n+1)$

63 The basis can be generated cyclically:

$$| 1) = A^+ |0)$$
$$| 2) = 2^{-1/2} A^+ |1) = 2^{-1/2} A^{+^2} | 0)$$
$$\vdots$$
$$| n) = (n!)^{-1/2} A^{+n} |0)$$

64 *61* and *62* hold, thus

$$A^+ A |n) = A^+ n^{1/2}| n - 1) = n^{1/2} (n+1-1)^{1/2} |n) =$$
$$= n| n)$$

The eigenvectors $|n)$ actually obey the eigenvalue equation

$$N | n) = n |n)$$

and their norm equals 1

$(n |m) = \delta_{nm}$ corresponding to $\int u_n^* u_m \, dX = \delta_{nm}$

The $|n)$ form a complete set of orthonormal vectors and constitute a basis of the dynamic space $\mathscr{E}$ of the quantum system

$$H\varphi = \varepsilon\varphi$$

65 Note that the most important equations were set up by means of pure algebraic calculations.

The N Representation

66 From equations *61*, *62*, *64* we can easily derive the representative matrices of the operators A, A^+, N

by means of functionals arranged through the u_n.
Of course also X and d/dX have to be matrices in this representation.

67 Calculation of the matrix elements $(n|\ A|n+1)$:
By applying *63*: $(n|A|n+1) = (n|\ (n+1)^{1/2}|\ n) = (n+1)^{1/2}\ (n\ |n) = (n+1)^{1/2}$

These are the only non-vanishing matrix elements, because

68 be r an integer $> -n$; we have

$$(n|\ A\ |n + r) = (n|\ (n+r)^{1/2}|n + r - 1) =$$
$$(n+r)^{1/2}\ (n|\ n+r-1) = \begin{cases} 1 & \ldots. r=+1 \\ 0 & \ldots. r \neq 1 \end{cases}$$

because of the orthonormality of the u_n.

69 Calculation of the matrix elements $(n+1\ |A^{+}|n)$:

$$(n + 1|A^{+}|\ n) = (\ n+1|\ (n+1)^{1/2}\ |n+1) =$$
$$(n+1)^{1/2}\ (\ n+1|\ n+1) = (n+1)^{1/2}$$

These are the only non-vanishing matrix elements, because

7o $(n+r|\ A^{+}\ |n) = (n+1)^{1/2}\ (n+r|\ n+1) =$

$$= \begin{cases} 1 & \ldots r = 1 \\ 0 & \ldots r \neq 1 \end{cases}$$

71 The matrix elements of N:

$$(n|\ N\ |m) = (n|\ A^{+}|A|\ m) = (n\ |A^{+}\ m^{1/2}|m-1)$$
$$= (n|\ m\ |m) = m\ (n\ |m) = \begin{cases} m & \ldots. n=m \\ 0 & \ldots. n \neq m \end{cases}$$

N has a non-vanishing diagonal which consists of the non-negative integers.
If we adopt the convention of arranging the rows and columns of these matrices in the order of increasing quantum numbers; thus relating the uppermost row to n = 0 and the next ones to n = 1, n = 2, ... we find the N Representations:

72
$$N = \begin{pmatrix} 0 & 0 & . & . & . & . \\ 0 & 1 & 0 & . & & \\ . & 0 & 2 & & & \\ . & . & . & 3 & & \\ . & & & & . & \end{pmatrix}$$

73
$$\mathbf{A} = \begin{pmatrix} 0 & 1 & 0 & . & . & . \\ . & 0 & 2^{1/2} & 0 & . & \\ . & . & 0 & 3^{1/2} & & \\ . & & & & . & \end{pmatrix}$$

74
$$A^{+} = \begin{pmatrix} 0 & 0 & . & . & . & . \\ 1 & 0 & . & & & \\ 0 & 2^{1/2} & 0 & . & & \\ . & 0 & 3^{1/2} & 0 & & \\ . & & & . & & \end{pmatrix}$$

75
$$H = \begin{pmatrix} \omega/2 & 0 & 0 & . & . & . \\ 0 & 3\omega/2 & 0 & . & & \\ . & 0 & 5\,\omega/2 & 0 & & \\ . & . & 0 & 7\,\omega/2 & & \\ . & & & & . & \end{pmatrix}$$

76 Obviously we may obtain the matrix representation of X through the definitions *18*, *19* :

$X = (2\omega)^{-1/2}\,(A+A^{+})$

$$X=\begin{pmatrix} 0 & 1/(2\omega)^{1/2} & 0 & . & . \\ 1/(2\omega)^{1/2} & 0 & 1/\omega^{1/2} & 0 & \\ 0 & 1/\omega^{1/2} & 0 & (3/2\omega)^{1/2} & \\ . & 0 & (3/2\omega)^{1/2} & & \\ . & & & . & \end{pmatrix}$$

So far we have given the representation of the operator algebra concerned with equation *16* in case of a single Number operator. What we need now, is a gerneralization to three (n) types of quanta. Accordingly we will have three Number operators.

Generalization to 3 quanta

77 Let $\mathscr{E}_1$ be the space of dynamical states related to variable X_1. $\mathscr{E}_2$ and $\mathscr{E}_2$ correspond to spaces X_2 and X_3.

78 Consider the state space

$$\mathscr{E} = \mathscr{E}_1 \otimes \mathscr{E}_2 \otimes \mathscr{E}_3$$

which is the tensor product of the $\mathscr{E}_i$ $i = 1,2,3$

79 In each space $\mathscr{E}_i$ there act operators A_i, A_i, N_i, H_i as defined previously.

8o In each space $\mathscr{E}_i$. there exists a ground state $|\,0_i)$

such that each vector $|n_i)$ can be generated cyclicly by means of A_i^+ (recall *63*) .

$$|n_i) = (n_i\ !)^{-1/2}\ A_i^+\ |\ 0_i)$$

81 A state function in $\mathscr{E}$ is defined by

$$|n_1,\ n_2,\ n_3) = |n_1)|\ n_2)\ |n_3)$$

In analogy with *23*, *24*, *27*, *41*, *61*, *62*, *64* the following relationships have to hold:

82

(a) $\left[A_i,\ A_j^+\right] = \delta_{ij}$

(b) $\left[A_1,\ A_j\right] = \left[A_i^+,\ A_j^+\right] = 0$

83 $H_i = (A_i^+\ A_i + 1/2)\ \omega_i$ where ω_i relates to *8*

84 $\left[A_i,\ H_j\right] = \omega_j\ \delta_{ij}\ A_j$

since

$$A_i\ (A_j^+\ A_j + 1/2)\ \omega_j - \omega_j\ (A_j^+\ A_j + 1/2)\ A_i =$$

$$\omega_j\ (A_i\ A_j^+\ A_j - A_j^+\ A_j\ A_i) = \omega_j\ (A_i\ A_j^+\ A_j - A_j^+\ A_i\ A_j)$$

$$= \omega_j\ \left\{A_i\ A_j^+\ A_j - (\ \delta_{ij} - A_i\ A_j^+)\ A_j\right\} = \omega_j\ \ \delta_{ij}\ A_j$$

because of *82* (b) and *82* (a).

Quite similarily we investigate:

85 $\left[A_i^+,\ H_j\right] = -\ \omega_j\ \ \delta_{ij}\ A_j^+$

86 The products $N_i \equiv A_i^+\ A_i$ are Number operators which obey the eigenvalue equation:

$$N_i\ |n_i) = n_i\ |n_i)$$

87 $A_i \, |0_i) = 0 \qquad i = 1,2,3$

88 $A_i \, |n_i) = n_i^{1/2} |n_i - 1)$

89 $A_i^+ \, |n_i) = (n_i + 1)^{1/2} \, |n_i + 1)$

9o The operator $N \equiv \sum_i A_i^+ A_i$ is the total-number-operator of the system. It counts the total number of quanta whithin the system.

91 The total Hamiltonian is

$$H = \sum_i H_i = \sum_i \omega_i \, [A_i^+ A_i]_+$$

92 $H \, |n_1, n_2, n_3) = (H_1 + H_2 + H_3) \, |n_1, n_2, n_3) =$

$$\sum_i \omega_i \, (n_i + 1/2) \, |n_1, n_2, n_3)$$

93 Given an eigenvalue n of the total-numberoperator we find out; there exist as many possible arrangements of number n_1, n_2, n_3 as there are partitions of the number n

$$C^n_{n+2} = \frac{(n + 2)\,!}{2.n\,!} = (1/2).\ (n+1)(n+2)$$

giving

$$n_1 + n_2 + n_3 = n$$

94 Thus we say that an eigenvalue of H is $(n+1)(n+2)/2$ - fold degenerate.

95 Note: This property of the field suggests invariance - properties of H under the action of SU 3 - operators, where SU 3 is the symmetric unitary group of order three.

96 There exists a cyclic generation of the $|n_1, n_2, n_3)$:

$$|\, n_1, n_2, n_3) = (n_1! n_2! n_3!)^{-1/2} \, A_1^{+\,n_1} A_2^{+\,n_2} A_3^{+\,n_3} \,|\, 0,0,0)$$

97 Relationships until *99* characterize the algebraic properties of the system in the case of a stationary Hamiltonian. Of course, these equations later have to be expanded because we have to incorporate time evolution of the operators.

Remarks on the structure of the operator algebra as was presented until now

98 There is a Hilbert space of state functions denoted $\mathscr{E}$.

99 $\mathscr{E}$ is cyclic (recall *99*).

1oo In $\mathscr{E}$ there act linear operators H, N in each component $\mathscr{E}_i$ the operators A_i, A_i^+, N_i, H_i.

1o1 We have selfadjointness for numbers:

$$N^+ = (A^+ A)^+ = A^+ A^{+^+} = A^+ A = N$$

$$N_i^+ = (A_i^+ A_i)^+ = A_i^+ A_i = N_i$$

1o2 and for the Hamiltonians:

$$H^+ = H$$

$$H_i^+ = H_i$$

1o3 These relations together with the commutation relations computed can be regarded as the generating relations of a Lie - Algebra or in a further sense, of a C^* - Algebra.

1o4 Note:

Let X_ϱ , X_σ , X_τ represent linear operators of a hilbert space $\mathscr{E}$.
A set of operators which obey the commutation relations

$$\left[X_\varrho , X_\sigma\right] = C^\tau_{\varrho\sigma} \; X_\tau$$ is called 'Lie - Algebra'.

This means that any commutator of two of the operators equals a linear combination of operators of the set.

The $C^{\tau}_{\varrho\sigma}$ are constants. Operators C_{ν} which commute with all the other operators are called 'Casimir - operators':

$$[C_{\nu\iota}, X_{\varrho}] = 0 \text{ for all } \nu, \varrho$$

There may exist commuting operators within the set. We will decide to choose as many commuting operators as we can find. At the same time these operators have to commute with the C_{ν}. Let these operators be assigned by H_i.

1o5 Note:
The H_i commute with the Casimir-operators. Therefore we can always find a complete set of state functions which are simultanous eigenfunctions of all the operators C_{ν} and H_i with eigenvalues c_{ν} and h_i:

$$|c_{\nu}, h_i)$$

1o6 But then the rest of the set of operators X_{ϱ} can be determined completely by a set of 'shift-operators' analogous to A and A^+. We will assign these by S_{α}. They obey quite similar commutation relations like the A_i and A_i^+ :

$$[C_{\nu}, S_{\alpha}] = 0$$

$$[H_i, S_{\alpha}] = \alpha_i S_{\alpha}$$

1o7 Thus the S_{α} shift the eigenvalues of an operator H_i by an amount α_i.

$$S_{\alpha}| c_{\nu}, h_i) = K (c_{\nu}, \alpha, h_i) |c_{\nu}, h_i + \alpha_i)$$

The constants $K (c_{\nu}, \alpha, h_i)$ are obtained by algebraic calculations which are quite similar to the calculations which lead to *63* or *91*.
The complexity of the '$K (c_{\nu}, \alpha, h_i)$-calculations' depends essentially on the size of the operator-set $\{X_{\varrho}\}$. Equation *11o* together with

1o8 $H_i \, |c_\nu, h_i) = h_i \, |c_\nu , h_i)$

define the representative matrices of the operators according to a complete set of states. If we start with any special state $|c_\nu, h_i)$ the complete set of states can be generated by repeated applications of the shift-operators S_α .

1o9 For the present this should be taken as a hint only: Since our system of 'verbally communicating actors' is mainly concerned with time series of 'accepting - accepted, rejecting - rejected, disconfirming and disconfirmed statements', assigned to each actor, we obtain for each total number of statements n (t) a number (n+1) (n+2)/2 of possible arrangements n_1, n_2, n_3 such that

$n\,(t) = n_1 + n_2 + n_3$.

If we now consider the n_1, n_2, n_3 as number operators acting in some cyclic hilbert space , this suggests invariance of the total number operator under the action of operators which are representative for operators of the symmetric permutation group S_3. The corresponding group which additionally establishes authomorphisms of the underlying hilbert space $\mathscr{C}$, that is : isomorphisms from $\mathscr{C}$ onto $\mathscr{C}$, has necessarily to contain unitary operators. This group is called 'symmetric unitary group of order 3' and its generating basis can actually be built up by creation- and annihilation operators A_i^+ and A_i respectively. Vice versa SU 3-operators provide for a generating basis of the operator algebra of our system.

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