EVALUATION OF SOME MATHEMATICAL MODELS USED IN THE INVESTIGATION OF INTER-PERSONAL RELATIONSHIPS

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EVALUATION OF SOME MATHEMATICAL MODELS USED IN THE INVESTIGATION OF INTER-PERSONAL RELATIONSHIPS

by

Charles Harry Proctor

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PREFACE

Evaluation of theories is a highly questionable and somewhat "unscientific" undertaking. Any techniques which might be thought to serve this aim may in turn be "evaluated". The problem is very similar to the attempts to prove the validity of induction. Always, the principles of induction are called upon to prove their own validity.

A technique for evaluation can, however, be proposed if the ultimate "ends" or "goals" of a theory are stated or can be reasonably assumed. As these "ends" of science become more and more adequately articulated, the task of evaluation will become amenable to solution.

It will be the purpose of this thesis (after deciding upon certain modest "ends") to develop some techniques for validation. These techniques will then be applied to two theories, Chapple's interaction schema and the more mathematical portions of sociometry.

These two theories were selected partially because they are attempts to "mathematize" some aspects of a social science. Although these theories are not representative of either what is being done or what may be done in the area they may help to point up certain general consequences of mathematization. In addition, these particular theoretical systems deal with the small or primary group. This field of inter-personal relationships may be found to permeate all of sociology, if the conjectures of theorists in this area are confirmed. Thus, one of the purposes will be to investigate the tenability of such conjectures.

One word of caution is necessary. The immediate problems faced by the social scientist in working with any specific research project can never be fully anticipated. Consequently, all judgments of value must be made relative to these problems. The strongly polemic tone of the thesis can then be explained as a choice of "ends" not coextensive with the "ends" of most research projects.

The author realizes that an acknowledgment is due Dr. Leo Katz for a basic reorientation toward the statistical portions of sociometry. Another pervasive influence was contributed by the book, Structure of Social Action, (McGraw Hill, 1937) by Talcot Parsons, which, although not cited in the text, has been responsible for a large share of the theoretical orientation.

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I Introduction and Methodology

A scientific theory may be regarded as a "tool". The evaluation of theories can proceed on a basis similar to the process of evaluation as used in economic analysis if this "analogy" is accepted. The analogy is deemed acceptable as a convenient first approximation in evaluation procedures but its difficulties will soon become apparent. In economic analysis, "tools" have value insofar as their application is inexpensive and the results are desirable.[1] One can make a similar and more specific statement, in terms of theories, such as: theories have highest value insofar as their application requires a minimum of time, training, and expense, and insofar as the resulting explanation and/or predictions are detailed and widely applicable.

1 Although such a statement is extremely broad, its elaboration would require more space than is necessary for the purpose of drawing our analogy.

The two main variables, then, are (1) application, and (2) resulting explanations, which correspond to the "means" and "ends" in an economic analysis. An attempt will be made in this section to find categories by which these two variables can be described. That is, the possible "values" (in the mathematical sense) of these variables will be specified. But after this analysis has been completed the problem of comparing various combinations of these "values" (representing different theories) has not been solved. As a matter of fact, it does

not seem possible at this time to give a general solution (remembering that this problem of value is a moot question even in economics). This difficulty will be avoided by making only tentative statements concerning the value of a theoretical system as a whole. The problem of specifying the categories of the two variables can, however, be attempted.

The most adequate characterization of a theory in terms of "application" and "resulting explanations" would have to be done as a result of actual use of the theory. After trying the theory in many instances, some judgments would become possible. This procedure is quite tedious, and if by careful examination of the theory, a similar results could be obtained, the empirical tests would not be necessary.

It is hypothecated that such a procedure of examination can be developed to replace elaborate empirical tests. This procedure consists of delimiting three main areas of theoretical structure, namely (1) coordinating definitions, (2) logical consistency of the total theory, and (3) levels of integration.

Coordinating definitions describe the operations by which "raw" data are carried into concepts or, better, empirical constructs.[2] They are of the form: If (such and such "raw" data) is observed, then (such and such empirical construct) exists. For example (from sociometry), "If Bill says he would

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2 To examine "coordinating definitions" is similar to, but less inclusive, than examining "methodology".

like to work with John, then Bill 'chooses' John." "Chooses" or "a choice" thus becomes and empirical construct. For any coordinating definition to be adequate it must transform "raw" experience into some symbol so that no ambiguity in interpretation arises. Coordinating definitions will be useful focal points by which to examine the variable "means", alluded to in the second paragraph.

. Coordinating definitions to be valuable must:

(1) be "operational" or "objective" (i.e., different investigators should be able to apply them and make transformations of the same "raw" data into the same symbols),

(2) be efficient (i.e., should not demand extensive clerical or mechanical manipulations),

(3) be such that the terminology of the conceptual system should not bias interpretations (i.e., a term widely used in other theories should not carry any inapplicable meanings when used in the theory in question),

(4) minimize "feed back" (i.e., the operations should not react upon the group to any appreciable extent).

Logical consistency will be a comparatively simple problem if mathematical models constitute the theoretical structure. In the course of writing the thesis, however, it was found that what at first appeared to be a model was actually a series of empirical generalizations. Due to this fact, the theories

were never
formally reexamined for logical consistency. The problem of logical consistency is still overly simple, because the theories to be examined here show no elaborate logical development.[3]

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3 The reason for this will become apparent when we examine the area, "levels of integration". It will be seen later that theories of only a single level, preclude elaborate theoretical structure, and the two theories which will be examined consist of only one well developed level. Although the areas, logical consistency and levels of integration, are disjoint, most of the discussion of logical consistency will be carried out in terms of levels of integration.

The problem of examination of models is still a part of our job of finding categories to characterize the "ends" of our mean-ends schema. Even if the theories to be considered are not acceptable examples, some general characteristics of mathematical models can be noted:

Some of the advantages or positive values are:

(1) Rigor in logical treatment is, while not guaranteed, more possible by mathematization. This applies more strongly to the syntactic than the sematic level. That is, <u>relations</u> between the concepts, as defined by the functions in the model, are stated in logically complete and simple form. This allows efficient and effective criticism of the model. That is, with many sociological theories one may get the vague feeling that something is wrong but to pinpoint the difficulty is impossible (in many cases, for instance, because of implicit biases).

(2) Confirmation or disconfirmation becomes more precise. Confirmation by the use of probabilities[4] implies this type of

4 Freund, John E., "On the Confirmation of Scientific Theories", Philosophy of Science, 17:1:87-94, 1950.

theory while even the qualitative criteria[5] can be more easily

5 Beck, Lewis White, "Constructions and Inferred Entities", Philosophy of Science, 17:1:74-86, 1950.

applied.

(3) The use of an "universal" language such as mathematics allows a decrease in ambiguity among the initiate as well as a procedural familarity with such techniques among the uninitiated. This applies for instance to clerical help who can handle mechnical formulae without the mathematical background.

(4) An unexplored fund of models are waiting to be utilized, along with a tradition in mathematics of being able to modify and develop new ones(models) which might result in the discovery of a new inter-personal theory.

Some of the disadvantages are:

(1) Most discouraging is the fact that this is a type of theory construction demanding extensive research. Sociological or inter-personal theory may not have, as yet, reached that stage of evolution which would allow mathematization. It is quite obvious that the mathematization of physical sciences was possible only after a fund of empirical and theoretical discoveries had accumulated.[6]

6 Merton, Robert K., Social Theory and Social Structure, The Free Press, Glencoe, Ill., p. 85, 1949.

(2) A concentration upon formalization has the potentiality of "drying up" subject matter so that new discoveries become difficult. This means a preoccupation with syntax can, when the investigator has only limited time, exclude an investigation of semantics or, especially, pragmatics.

(3) Under the name of "mathematical models", many equations and statistical "slieght of hand" techniques may be forced into a theory. This constitutes a danger because the mathematically unsophisticate may erroneously respect such theory.

Insofar as any given mathematical model maximizes the "advantages" and minimizes the disadvantages it can be considered "valuable".

Levels of integration will be examined from two viewpoints. The first concentrates upon a particular theory, and the resulting levels are comperatively uniquely determined. The second approach consists of arbitrarily delimiting levels which are applicable to any sociological theory.

The first approach considers that those relationships which exist between the empirical constructs of any theory constitute the first level of integration. They might be called the class R_1. It may then be found that betweenmembers of the class R_1 certain other relationships exist; these relationships constitute part of the second level of integration, or belong to R_2. Other members of R_2 might be the relationships between some R_1 and an empirical construct. The other levels are added in the same way.[7]

7 By this approach, the resulting levels are relative to the particular theoretical structure, i.e., A_1 of one theory may correspond by content to the R_3 of another theory.

To use an example: a social psychological theory in which the unit of analysis[8] is the individual may be extended "up"

8 "Unit of analysis" refers to an area of behavior symbolized by the empirical constructs. In the following case it is the individual's (social) behavior.

into the field of group dynamics by defining the concept, "group", as some particular relationships of spatial position, psychological "inter"-reaction, etc. of certain individuals. This concept "group" may then be utilized to investigate (i.e., to give "meaning" to) some inter-group conflict, cooperation, or other situation which will be interpreted as indicative of a peculiar institutional structure. It may also be convenient to consider certain combinations of institutional structures as constutive of certain "mentality". "Mentality", in turn, may be a useful concept by which to investigate previously unstudied institutional structures. In this hierarchy we can discern four levels of integration: R_1 - "individual", R_2 - "small group", R_3 - "institution", and R_4 - "culture".

Although in this thesis series of levels will be discerned by the above method, the resulting levels in the example introduce another technique. It may be more convenient to consider the previous four levels as a reference scale. Then a sociological theory may be examined as to "content". Depending on

the types of social behavior, both investigated and hypothecated, the theory can be compared to this scale. That is, any theory utilizing a concept analogous or identical to our "institutional structure" will (to this extent) automatically be assigned to the third level. This technique is useful when the first method cannot be applied, (for instance, when an author incompletely states his theory).

The difficulties of this latter procedure immediately raises broader questions: Of what use is this concept "levels of integration"?, Are these four levels delimited by any so called natural law of social behavior? The delimitation of levels allows rough decisions to be made on the "ends" or "goals" which a theory may attain. But there is no natural law involved in the choice of four levels; as a matter of fact such an arbitrary scale contradicts, in a sense, "natural laws". All social behavior is "naturally" explained as part of a single system, not four levels; but the "usefulness" of these levels is a more important criterion.

The levels of integration in a theory are directly related to both the "completeness" of explanation and the "wideness" of application. By completeness is meant the amount of detail in social situations which the theory can adequately explain. By "wideness" is meant the diversity of situations which the theory can explain. These two characteristics are not independent. They are (over a collection of theories) in a rough manner inversely related. In addition this inverse relationship is

due to the differing levels of integration of the theories. A greater number of levels implies more "completeness" while a lesser number implies more wideness.

Due to the vagueness in determination of all three characteristics, (completeness, wideness, and number of levels), the relationships are very rough. But to understand why the relationship should hold, consider an example of a low level theory, physiology. Physiology operates in sociology by setting up broad limits to behavior, but can not approach a detailed explanation. It has the characterists of wideness but not completeness.

Physiology is, however, different from our other levels, in that, its field of investigation is "closed".[9] The relation-

9 We must keep in mind that theoretical structures are "closed", not the empirical data or behavior.

ship within physiology are a large extent independent of higher levels. It will be found that the relationships within interpersonal theory are far from independent of our arbitrary higher levels.

In the following discussion we will consider only two types of theories with respect to levels of integration. These types are "horizontal" and "vertical" theories. Horizontal theories explain all of R_1 as the result of only a single integrating concept. That is, all relationships between empirical constructs reflect one principle, or are given "meaning" by only one syn-

thetic concept. Vertical theories, on the other hand, contain many levels, and for sociology they admit that analysis can be extended, either up or down, to new levels.

By the previous discussion, horizontal theories will be characterized, if they are logically well constructed, by a "wideness" but a lack of "completeness". Vertical theories, then, will be relatively "complete", but lacking in wide applicability.[10]

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10 This conclusion is valid for sociological theory only at the present time. It is a common observation that relatively "complete" theories are very restricted in application. This is partially a result of American sociology's concentration on only one society. On the other hand, anthropological generalizations capable of wide applicability give only a limited explanation of any social situation.

Now to summarize this attempt to characterize "means" and "ends":

(1) "valuable" "means" imply "valuable" coordinating definitions (see above p. 3).

(2) "valuable" ends imply "valuable" logical consistency which in particular cases implies a "valuable" mathematical model (see above p. 6).

(3) Depending upon whether wide applicability or completeness of explanation is to be "valuable" the theory should be respectively horizontal or vertical.

The application of these three "tests" to Chapple and sociometry will constitute the body of the thesis.

A few more points concerning specifically the field of

inter-personal relationships need to be mentioned by way of introduction. Any definition of this field is liable to be disproven by the existance of some theory purporting to be inter-personal but lying outside, to some extent, of our definition. Be that as it may, we will consider any theory inter-personal if:

(1) its field of investigation is the social behavior of individuals insofar as they act as members of a small, homogenous subgroup of any institutional structure, and,

(2) if the theoretical structure is relatively logically closed with respect to the above behavior.

The first part of our definition merely excludes the content of the institutional level. The second part requires that to some extent the theoretical structure represent a "system". That is, to some extent the theory should reflect the fact that these small groups are "organisms". Chapple's timed interaction schema deals first with pairs of individuals.[11]

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11 Eventually the schema is extended into all areas of behavior.

Since this area both fits under the above definition and is mathematical we can justifiably examine Chapple. Sociometry, on the one hand, is difficult to consider as a single theoretical system and on the other it is practically impossible to bother examining each and every research work done under the name, sociometry. For sociometry, then, we will first look at the theory's mathematical portions which will lead naturally to consideration of the principal theorists, Moreno and Jennings.

II Chapple's Interaction Schema

A. Field of Investigation.

Since this particular theory was designed to replace the "guess work" of current social anthropology,[1] its domain of inquiry is the whole of human social behavior. Actually the mathematical model is concerned with the non-symbolic nature of "interaction", (i.e., eliminating content) where there is face-to-face contact between participants. Furthermore, the more precise empirical generalizations concern the behavior of only two or three individuals at a time.

1 Chapple, Elliot D., "Measuring Human Relations: An Introduction to the Study of the Interaction of Individuals", Genetic Psychology Monographs, 22:1:3-147, 1940, pp. 5, 6.

B. Empirical Constructs and Their Coordinative Definitions.

Chapple has great respect for the empirical, observational, natural science approach. Thus there is no need to go into all of his definitions but just a few words, by way of example, about one of the most debatable, "origination".

"Given two individuals,we observe that one of the two manifests the first unit of action which is then followed by a unit of action manifested by the second individual. The first unit is regarded as the stimulus and the second unit as the response. The distinction between the two is that the first action is not preceded by an action of the other individual ... It may be regarded, therefor, as an origin or initiation of action to which theaction of the second individual is the terminus or response.[2]

2 Ibid., p. 25.

This is rather an abrupt introduction to Chapple's operational outlook but serves as an example of his orientation. All phenomena studied are related to the observational procedure and in this case we see a distinct bias for the laboratory situation. All individuals are under such close scrutiny that the "minute muscular activity" of one individual which is then followed by some change in behavior on the part of another individual can be recorded and termed an "origin of action".

Even more, Chapple goes on to say that although an individual may be manifesting muscualr activity the important observational point is to record the changes in pattern of this activity.[3]

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3 Ibid., p. 27.

It is the initial change in pattern on the part of one individual, immediately followed by a change in the activity pattern of another individual, which determines "origination".

Although "pattern" apparently caused no trouble to Chapple's observers, the criteria of an operational science would not admit such concepts as pattern. This is an intuitive notion which is subject to analysis just as is interaction. In the assignment of origination of action it seems very likely that the operational procedures would give way to observational biases. It is too difficult a task to be thoroughly objective.

In addition it does not seem plausible that the notion of follow says all that is implied. Two individuals may be working at adjacent machines, one may leave his machine, immediately afterwards the other may also leave; does this constitute a stimulus and a response? Unless the observer also noticed that

they both went in opposite directions or that the whistle blew just previously, he may be inclined to say so. This example paints a black picture but more subtle judgments on the part of the observer are not eliminated by the elaboration of "recipes".

In this section the primary goal is to develop a notational system capable of exhibiting the empirical generalizations. This notational system is not Chapple's and consequently one must be on guard against constructing a "straw man".

First we observe action on the part of individuals and discover that for purposes of this theory it can be characterized by five dimensions, (1) who is acting, (2) who stimulated him, (3) who does he in turn stimulate, (4) how long does he act, (5) during what space of total time. All of this information is embodied in equation(1).

$$(1) \qquad \sum_{n_1}^{n_2} {}_{\Sigma i}^{\Sigma j}{}_{\Sigma k} = \sum_{t = n_1}^{n_2} {}_{\Sigma i}^{f}{}_{\Sigma k}^{\Sigma j} \quad (t)$$

where Σi represents the individuals who are (is) acting,

Σj represents the individuals who stimulate(s) Σi,

Σk represents the individuals who Σi stimulates,

$\sum_{n_1}^{n_2} {}_{\Sigma i}^{\Sigma j}{}_{\Sigma k}$ represents the length of time Σi act(s) under the above conditions,

and n_1, to n_2 represents the space of total time.

Σj, Σi, and Σk are generalized notation which will be

replaced with specific letters if single individuals are involved. Σj, say, may be composed of individuals a, b, c, and d, either of the four or any combination of the four may be stimulating Σk and satisfy the meaning of Σj. $f^{\Sigma j}_{\Sigma i \Sigma k}(t)$ can be considered a function of time which, when the described action is going on, takes the value 1, and 0 otherwise. The summation can be over any desired intervals which are usually one second.

Now before we write any equations more concepts are awaiting definition in our notational system.

(a) Duration of event p = $E_p - B_p$,

where B_p is the value of t satisfying $f^{i}_{i \Sigma k}(t) = 1$, i being anyone of the Σk,

such that $f^{(\Sigma k)}_{(\Sigma k)(\Sigma k)}(t-1) = 0$,

and E_p is the first value of t following B_p satisfying

$f^{(\Sigma k)}_{(\Sigma k)(\Sigma k)}(t) = 0$,

such that $f^{(A-k)}_{k(A-k)}(t-1) = 1$, for all i = 1, 2, ..., $E_p - B_p$,

where A = (Σk) and k is <u>one</u> of the (Σk), with the general condition that the total membership of the event, (Σk), appear as either a stimulator, actor, or respondee.

(b) Mean duration of i's actions for event p = M_{ip}

where $M_{ip} = \dfrac{\sum_{B_p}^{E_p} f^{\Sigma k}_{i \Sigma k}}{n_{ip}}$,

where n_{ip} is the number of i's actions in event p, or the number of times $f^{\Sigma k}_{i \Sigma k}(t)$ jumps from 0 to 1 in the duration

of the event p.

(c) Mean duration of i's action for any given number, n, of actions within event p = S_{in},

where $S_{in} = \frac{g_i \sum k}{\frac{h \sum k}{n}}$,

where h is the time at which i started his first action, and g is the time of the last second of this nth action with $B_p = h$, $g = E_p$.

Chapple computed consecutive S_{in}'s for n = 5 in pair events ($\sum k = i + k$), that is, he summed the durations of i's first five actions and divided by five, summed the durations of i's next five actions divided by five, etc. He then noticed that adjacent values were approximately equal which led him to define the "slope".

(d) i's slope (between t = u and t = v) = $S_{i(v-u)}$,

$$S_{i(v-u)} = \frac{\overset{v}{\underset{u}{\sum}} \overset{i}{\sum} k}{5r},$$

where 5r equals the number of i's actions between t = u and t = v,

r being the number of S_{i5}'s combined;

u is the time at which the series starts and v is its end point.

(e) Adjustment between i and k between the time t = H and t = G = $A_{ik(G-H)}$,

where $A_{ik(G-H)} = \frac{\overset{G}{\underset{H}{\sum}} \overset{\sum k}{\sum k} - (G-H)}{\overset{G}{\underset{H}{\sum k}} \overset{\sum k}{\sum k}}$,

where $\sum k = k + i$.

C. Relations Between Empirical Constructs.

Although Chapple has devised, or rather suggested various other measures, the notation has already become rather involved. Before the accumulation of concepts passes the "point of diminishing returns", some of his propositions should be examined.

Propositions.

Chapple's determinental abstraction is: interaction can be considered as a process in equilibrium. As defined by Chapple equilibrium implies that, "...within definable limits, the relations of individuals are constant. ... an individual or a group, regarded as a system, returns to these constant values after the impressed force is removed;" intense or lasting forces may produce a permanent change in the system.[4]

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4 Ibid., p. 37.

Thus he expected these indices or concepts to show some consistent relations with each other, both over a series of events and, especially, within any single event as the individuals adjust to each other. There arose one hypothesis, (H), and three empirical generalizations, (E_1), (E_2), and (E_3), in this attempt to demonstrate equilibrium.

(H_1) $O_{i\,\Sigma j} - C_{\Sigma ji} - C_i = 0,$

where $C_{i\,\Sigma j}$ is i's total number of originations,

$O_{\Sigma ji}$ is i's total number of terminations,

and C_i is a constant.

This states that i's originations minus his terminations are

equal to a constant value. This constant value is a result of i's previous conditioning, thus should remain the same for broad intervals of time.

(E_1) For a series of pair events, ($\Sigma k = i + k$),

$$\frac{M_{ip}}{M_{kp}} = C_k^i \quad \text{for all p.}$$

(E_2) Within pair events,

$$K_{1i} \log S_{i(v-u)} + K_{2i} = \frac{{}^{v}_{u}{}^{i}\Sigma k}{v-u},$$

and for the same pair, i and k, this equation remains valid within a series of events.

(E_3) For successive intervals of two minutes the index $A_{ik(120-0)}$ gradually becomes stabilized at a small positive constant, A_{ik}, or $A_{ik(120-0)} \doteq A_{ik(240-120)} \doteq \ldots \doteq A_{ik}$, for individuals i and k who "adjusted" to each other.

Also in the nature of an empirical generalization the frequency distributions of duration of actions and durations of events are in the form of a J-curve which can be fitted by the exponential function, $dF = a\, e^{-bT} dT$ given by Chapple, which becomes $dF = \underline{a}\, e^{-aT} dT$, where T is the duration of either actions or events and F is the frequency of such actions or events. The constant a will differ for the two cases (actions and events).

D. Mathematical Model.

The first and most obvious fact is that we actually do

not have a mathematical model. We cannot discuss questions of syntax but only coordinative definitions. The emphasis which Chapple placed on operational definitions was reflected in the complex notational system which was necessary to represent the nuances of these definitions. What good is a notational system without any possibility for systematic analysis?

The "interpretations" which Chapple advances to explain E_1, E_2, and E_3 are simply that these uniformities prove the fact that interaction is "in equilibrium". It appears that this principle of equilibrium is capable of the most indefinite extension. Any uniformities at all can be used to prove its existence.

This is not the traditional use of the equilibrium concept in, say, chemistry. There the basic nature of any equilibrium of ionization concentrations can be derived a priori from the various amounts, the ionization and reaction properties of the compounds in solution. No such simplification has been achieved in the area of interaction. The fact that this indeterminant situation does not approach the natural science goal does not preclude that possibility, but does indicate the need for more analytic theorizing. Statements of empirical uniformities do not constitute a theory, logical interrelationship has yet to be added.

If we were to argue the adequacy of this demonstration using Chapple's criteria the conclusion would be more flattering. The important point to Chapple is the formulation of new

and refined concepts using accurate, sensitive measuring instruments. By generalizing the empirical findings new theories are born. But the point here is that in empirical generalizations one can find no assurances that the final theory will meet the criteria of sufficiency and adequacy either as a theoretical structure per se or as any explanation or solution to practical problems.

To demonstrate this, look at (E_1), (E_2), and (E_3). Each generalization contains experimentally independent concepts. (E_1) concerns a series of pair events, (E_2) deals with variable periods within an event, (E_3) refers to equal, two minute, intervals, while he also gives distributions covering both, series of actions and series of events. None of them are derivable or explainable on the basis of a compact number of postulates, nor do they appear capable of becoming postulates themselves.

E. Uses of Theory.

The most important contributions of this theory are "suggestions".[5] These suggestions allowed the construction of

5 Merton, Robert K., Social Theory and Social Structure, The Free Press, Glencoe, Ill., 1949, p. 91.

an empirically based social anthropological theory.[6] This

6 Chapple, E. D., and Coon, C. S., Principles of Anthropology, Henry Holt and Co. New York, 1942.

theory examines "set" events (involving more than two persons) with the purpose of defining some ordination of individuals.

With this theory, we are going outside the previous bounds of our delimitation of "interpersonal" theories.[7] But since

7 See above p. 11.

this notion of hierarchy or ordination is so important both to the sociologist and the mathematician it will pay us well to examine Chapple on this point.

First he extends the notion of "origin of action" to all events, separating those in which one member (i) of a pair originates (component i) from those in which the other member (k) originates (component k). The ratio of these components gives a basis for ordination in pair events.

Extending this to the set events we get: "a hierarchy is made up of individuals in interaction in which some individuals originate action for others who in turn originate for their group, and so on, depending upon the extent of the hierarchy."

As a result of this Chapple finds that institutions are characterized by three broad levels or classes. Class A are the originators; those individuals who serve exclusively as the initial stimulus leading to interaction among any subgroup of the institution; Class C, those individuals who exclusively end the interaction by an action which serves as a stimulus to no one; and Class B, individuals who in some situations or events originate, and in others terminate action.

If we define "originates to" as "includes" would it be possible that we do have a hierarchy or a partial ordering of the individuals in an institution?

Say $i \gtrsim j$ ("i includes j") if and only if $\sum_{n_1}^{n_2} f^{i}_{i \Sigma j}(t) > 0$,

where n_1 and n_2 determine a time span which should cover a week or so, and Σj is a subgroup of the institution, I, containing j.

Does this definition satisfy the three properties of reflexiveness, antisymmetry and transitivity? Reflexiveness: for all i, i = i. This may be considered correct from the standpoint that i responds to his own stimuli.[8] Antisymmetry: if $i \gtrsim j$ and $j \gtrsim i$ then i = j. Since no criteria for identification or equivalence have been set up we may accept this statement as a definition (otherwise we will have a quasi-ordering). Transitivity: if i = j and j = k then i = k. This is one point at which the ordering breaks down:[9]

8 Mead, G. H., Mind, Self, and Society, The University of Chicago Press, Chicago, Ill., 1934.

9 Another definition of inclusion to avoid this bottleneck would be: i = j if all the individuals to whom j originates are included in the group of individuals to whom i originates. This is simply set inclusion and does give a well-ordering.

$$i \gtrsim j \text{ implies } \sum_{n_1}^{n_2} f^{i}_{i \Sigma j}(t) > 0$$

$$j \gtrsim k \text{ means that } \sum_{t=n_1}^{n_2} f^{j}_{j \Sigma k}(t) > 0$$

where Σk is some subset of I containing k.

These two conditions do not necessarily imply that $i \gtrsim k$. It is difficult to understand how Chapple uses "hierarchy"

without the rationale to determine one. Even more basic than these formal considerations are the observational difficulties of determining origination which have been discussed above.

This theory's applicability to practical problems has apparently been demonstrated by Chapple's success in the area of industrial labor relations.[10] His basic principle for solu-

10 This impression was gained by the statement by Dr. Kimball that Chapple claims wherever an industry has taken his advice their problems are solved, otherwise they remain.

tion of any maladjustments is to restore the system to equilibrium. There may be alternative theories having this principle as a conclusion, but it, in itself, is innocuous. The fact that there should be some stability in human relations is perfectly admissable.

But the fact that this stability should be defined by (E_1), (E_2), (E_3), and (H_1) is not completely assured. Ask any individual, i, when he felt most "happy" and he is not likely to say, "I was interacting with k, our $A_{ik} = 0$, my K_{1i} and K_{2i} were stable, and $C^i_k = \frac{3}{5}$." He will be most likely to describe some incident in which he was enjoying an <u>unusual</u> experience, and his description will be in terms of the "content" of this experience.

(E_1), (E_2), and (E_3) are concerned with physical phenomena, or more accurately, physiological phenomena. There is no criticism of this approach as long as it does not claim to be an attempt to describe all of human social behavior with the use of only physiological data. But when Chapple takes up the

question of content and the analysis of symbols by use of these physiological phenomena he gets into difficulty.[11]

11 "Measuring Human Interaction", op. cit., p. 111-127.

Humans run their lives with a value-attitude system which may be possible of analysis down to a conditioned response to some physiological interactional situation, but, after this situation has produced the value-attitude system, humans run their lives by this system and not by the original interactional situation.

Thus, Chapple's theory is an example of operationalism to the point of diminishing returns and a challenge to the emergent nature of social behavior which illustrates that physiology is a helpful tool but a poor master of sociology. However, it will be recalled that it is not the whole of sociology, but the field of interpersonal relations in which this theory was to be judged. By these standards it becomes more adequate and with its strong empirical demonstration takes its place as an important contribution.

In terms of the points of attack set forth in the Introduction we find that:

(1) Chapple's coordinating definitions were precisely stated except for parts of "origination".

(2) There are two levels of analysis, with one member of R_2, "equilibrium", giving "meaning" to all the empirical generalizations in R_1.

(3) The application of the theory requires extensive

clerical help and statistical manipulation and is chiefly useful in "suggesting" social anthropological analytic techniques. Chapple claims that the theory will predict interactional behavior, and the suggested theory has apparently been used with success in labor relations.

III Sociometry

A. Introduction.

Unlike Chapple's system sociometry has no unified theoretical structure, one will almost have to be imposed. All that exists is a collection of "post factum hypotheses".[1] This state

1 Merton, op. cit., pp. 90, 91.

of affairs has resulted from sociometry's preoccupation with very practical problems, and has been fostered by its comparative success in this field. Both being supported by and also supporting these two conditions, has been the basic technique of sociometry which consists of asking persons what they want and then attempting to satisfy these needs.

As an answer to a decided lack of theoretical precision, mathematical models have been proposed. We will be dealing here with two main types which are statistical analysis and matrix analysis.[2]

2 Sociometric techniques may arbitrarily be divided into four main areas: (1) sociogram construction, (2) "traditional" index construction, (3) statistical tests and (4) matrix manipulations. The first two have not been "mathematized" adequately enough to examine here, but the influence of these two areas permeates much of the discussion on the latter two.

The empirical constructs of sociometry are largely similar for both types of analysis. This is due to the fact that the essential data are mostly the type of expressed preferences or attitudes on the part of each individual toward a situation involving interaction with some other individual(s). These attitudes are elicited by the sociometric questionnaire, con-

taining the questions which verbally create some interactional activity and which ask the respondent how he would (does or did) feel about interacting with certain other individuals.

These two areas are separated only by the nature of the theoretical structures. Actually the terms are misleading, since statistics plays an important role in matrix analysis, while matrices are utilized in statistical analysis. The two areas refer to two developmental stages in sociometric theory, statistical analysis being the earlier and concerned primarily with testing certain a priori distributions while matrix analysis is a comparatively recent innovation, using certain matric manipulations and at the present time produces primarily a posteriori hypotheses.

Some basic empirical constructs are;

(1) Choice -- an expressed desire on the part of a certain individual to interact with some other individual.

(2) Rejection -- an expressed desire on the part of a certain individual to avoid interaction with some other individual.

(3) Criterion -- that specific interaction situation which is provided in the sociometric questionnaire as the basis for choices and rejections.

(4) Test population -- all the individuals to whom a given sociometric questionnaire (i.e., by specifying the criterion, number and types of choices and/or rejections) has been administered. These individuals will be identified by numbers, (1), (2), ..., (N).

To be able to mean the most and talk the least we will introduce the matrix of choices, C

$$C = //c_{ij}//$$

where $c_{ij} = 1$, if individual (i) chooses individual (j),
$c_{ij} = 0$, if (i) is indifferent to (j) or if i = j,
$c_{ij} = -1$, if (i) rejects (j).

To include more information, the values 1, 0, -1 can be replaced with finer degrees of choice or rejection, the matrix may become rectangular if there are more different individuals chosen than choosing, etc. In almost all of the following analysis we will deal with a N x N matrix, the same individuals doing the choosing are the only possible recipients of choices, and we'll use primarily the values 0, and 1 for c_{ij}. We will also deal with just a single criterion and require that each individual make exactly d choices.

It is then possible to consider the total information present by specifying values of c_{ij} for all i, j = 1, 2, ..., N. This total information will be called the "total choice-pattern". The i^{th} row of the matrix will (i)'s "outgoing choice-pattern" and the $(i)^{th}$ column will be (i)'s "incoming choice-pattern".

The matrix can be examined for peculiar structure and the following list gives some of the more important focal points of configurations. The column sum for the i^{th} column gives (i)'s "choice status" (the row sums are all equal to d). If

(i)'s choice status equals zero we will say, (i) is an "isolate". If $c_{ij} = 1$ and $c_{ji} = 1$ we will say the (i) and (j) form a "mutual" pair; if $c_{ij} = 1$ and $c_{ji} = 0$, we will say (i) and (j) form an "unreciprocated pair; and if $c_{ij} = 0$ and $c_{ji} = 0$, we will say that (i) and (j) form an "indifferent" pair. If $c_{ij} = 1$ and $c_{jk} = 1$ and $c_{kp} = 1$ and . . . and $c_{tf} = 1$ we will say that a "chain" exists between (i) and (f) of length equal to the number of choices involved. If $c_{ij} = 1$, and i is a member of some subgroup (a) while (j) is not a member of (a), then c_{ij} is an "inter-class" choice, if (j) is a member of (a) c_{ij} will be a "within-class" choice.

B. Statistical Analysis.

To develop any statistical techniques it is absolutely necessary to have some frame of reference or hypotheses. On the basis of these hypotheses, all the possible samples which might arise are divided into classes which are ordered on the basis of their probability of occurrence. Thus, if an observed sample belongs to some class (of possible samples) which has a very small probability of occurrence, the hypotheses can be rejected.

In the case of sociometric statistics we might define the population to consist of all the past and future total choice-patterns produced by a given sociometric questionnaire. In this case any given administration of the questionnaire will yield only one value, hardly enough measurements to constitute a test. However, it is possible to direct attention to some particular characteristic (or configuration) of the choice

matrix which will yield several measurements from a given choice matrix. In addition it will be possible to derive categories or values of such characteristics such that, if this characteristic of a given choice matrix falls in a certain category or has a certain value, some hypotheses can be rejected.

Instead of becoming tied up in abstractions, consider that all of the possible total choice-patterns constitute a class, S. Each specific total choice-pattern is associated with some element, c of S. Then form H_o, which states: the probability of occurence for any element c, P(c), equals $\frac{1}{\binom{N-1}{d}^N}$. H_o derives from a more general assumption that every different total choice pattern is "equally likely". Since there are $\binom{N-1}{d}^N$ possible different choice matrices, H_o results.

Now if we restrict attention to only the number of choices each individual receives, we can derive from H_o the probability that any individual will receive 0, 1, 2, ..., N-1 choices. Which turns out to be the respective termof the binomial expansion $\left(\frac{N-1-d}{N-1} + \frac{d}{N-1}\right)^{N-1}$.

To derive the previous binomial it would be possible to reason: the probability that (i) is chosen by a particular (j) equals $\frac{d}{N-1}$, of not being chosen, equals $\frac{N-d-1}{N-1}$, then, since, the number of possible ways of being chosen k times equals $\binom{N-1}{k}$, the probability of being chosen k times by any combination of persons equals $\binom{N-1}{k} p^k q^{N-k-1}$ which is the k^{th} term of the pre-

vious binomial. By only the use of H_o in relation to total choice patterns we can arrive at the same result, which is not surprising.

Although it would be desirable,[2a] a test has yet to be de-

2a A test of the choice status of just one individual at a time is a "rough" way of testing H_o. If the choice status of one individual allows H_o to be accepted, there are still a great number of other non-random configurations possible. This is true of any of the tests, however, but seems especially true of this particular test. This introduces some problems which the author is not capable of resolving, but can only suggest. There is obviously some "dependence" of these tests, i.e. a rejection of H_o for some particular configuration may be associated with rejection in another configuration.

signed for the frequency distribution of choice statuses for the whole group. It was at first suspected that some probability distribution of the variance for this distribution could be worked out by combinatorial techniques. But the problem becomes too complex (in a manner similar to deriving the probability distribution for mutual choices with $d > 1$).

With a similar argument we can particularize H_o to arrive at an expected frequency distribution of pair relations (mutual, unreciprocated, indifferent),[3] inter-class and within class

3 See below p..51

choices[4] a probability distribution of 0, 1, ..., N-1-d isolates,[5]

4 Loomis, C. P., "Political and Occupational Cleavages in a Hanoverian Village, Germany", Sociometry, 9:4:316-333, 1946.

5 Katz, Leo, The Distribution of the Number of Isolates in a Group, Institute of Statistics, University of North Carolina, Mimeo. Series 36, 1950.

0, 1, ..., ad inter-class choices[6] where a = number of

6 Edwards, Daisy, Starkey, "The Constant Frame of Reference Problem in Sociometry", Sociometry, 11:4:372-379, 1948.

individuals in subgroup (a) , and 0, 1, ..., $\frac{N}{2}$ mutual choices

(when d = 1)[7]. In addition, the non-random factors operating

7 See below pp. 51-53

in the case of the choice status distribution can be, so to say, partialed out (by a posteriori restrictions on column sums) and a distribution for inter- and within-class choices can be developed.[8] Also an a posteriori distribution for choice

8 See below p..53

statuses can be developed.[9]

9 See below p..54

The "meaning" associated with a rejection of the particular null hypothesis is, as always, relative to the theoretical structure which attempts then to explain this peculiar phenomenon. The selection of the above points of attack on a choice matrix have, obviously, not been chosen by some whim of the statistician. The configurations have definite meaning to the sociometrist.

Two ineffectual (from the standpoint of this thesis) types of theory have currently been used in the analysis of sociometric data whenever this data shows itself capable of rejecting some set of the null hypotheses. These will be called the horizontal and more-horizontal approaches. The first theory is traditional sociometry, represented by Moreno, and the second is the type of theorizing found in the numerous research articles in Sociometry which are 99 44/100% pure empirical generalization.

In the first type any rejection of the null hypotheses can be explained by a single high level abstraction[10] called

10 The terminology, here, is remarkably confusing, in that, this "high level abstraction" is as far as content is concerned part of a "low level of integration" (i.e., physiological processes constitute a level of integration under psychology while they are a lower level of abstraction). Level of abstraction is more akin to a set inclusion property; processes (loosely speaking, events or objects) which constitute a high level of abstraction are more general or simple and include, as special cases, complex processes of the "lower" levels. Level of integration refers to a pattern of information which on a high level gives adequate explanation to most complex phenomena or processes and special cases of this total information will explain simpler phenomena or processes.

"spontaneity", "tele", or "God". This is seen clearly in an italicized quotation from Who Shall Survive:[11] "back of all

11 Moreno, J. L., Nervous and Mental Disease Publishing Co., Washington, D. C., 1934, p. 159.

social and psychological interactions between individuals there must once have been and still are two or more reciprocating physiological organs which interact with each other".

The second type is evinced by a long list of research designed to explore some peculiar configuration of the choice matrix.[12] In reality the term "theory" is used very loosely in

12 Some of the articles are:
Choice status:
Kuhlen, Raymond G. and Bretsch, Howard S. "Sociometric Status and Personal Problems of Adolescents", Sociometry, 10: 2:122-132, 1947.
Young, L. L., "Sociometric and Related Techniques for Appraising Social Status in an Elementary School", Sociometry, 10:2:168-177, 1947.
Northway, Mary L. and Wigdor, Blossom T., "Rorschach Patterns Related to the Sociometric Status of School Children", Sociometry, 10:2:186-199, 1947.

Seeman, Melvin, "A Situational Approach to Intra-group Negro Attitudes", Sociometry, 9:2-3:199-206, 1946. (Used, instead of social status, the near-sociometric scale of the Chio Social Acceptance Scale)

Frankel, Esther B., "The Social Relationships of Nursery School Children", Sociometry, 9:2-3:210-225, 1946.

Northway, Mary L., "Sociometry and Some Challenging Problems of Social Relationships", Sociometry, 9:2-3:187-197, 1946.

French, Robert L. and Mensh, Ivan N., "Some Relationships Between Inter-personal Judgments and Sociometric Status in a College Group", Sociometry, 11:4:335-345, 1948.

Crossman, Beverly, and Wrighter, Joyce, "The Relationship Between Selection-Rejection and Intelligence, Social Status, and Personality Amongst Sixth Grade Children", Sociometry, 11: 4:346-355, 1948.

Isolates:

McClelland, F. M. and Ralliff, John A., "The Use of Sociometry as an Aid in Promoting Social Adjustment in a Ninth Grade Home-room", Sociometry, 10:2:147-153, 1947.

Mutuals:

Deutschberger, Paul, "The Tele-Factor: Horizon and Awareness", Sociometry,10:3:242-249, 1947.

Inter-class:

Faunce, Dale and Beegle, J. Allan, "Cleavages in a Relatively Homogeneous Group of Rural Youth", Sociometry, 11:3:207-216, 1948.

Becker, Myron G. and Loomis, Charles P., "Measuring Rural Urban and Farm and Non-Farm Cleavages in a Rural Consolidated School", Sociometry, 11:3:246-261, 1948.

Criswell, Joan H., "A Sociometric Study of Race Cleavage in the Classroom", Archives of Psychology, No. 235, New York, 1939.

Lundberg, George A. and Beazley, Virginia, "'Consciousness of Kind' in a College Population", Sociometry, 11:1-2:59-73, 1948.

Loomis, Charles P., "Political and Occupational Cleavages in a Hanoverian Village, Germany", Sociometry, 9:4:316-333,1946.

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reference to this more-horizontal type. A set of empirical generalizations can hardly be called a theory, but it depends entirely upon the definition of theory. In this sense a theory would refer to a group of relationships obtaining between empirical constructs derived from a collection of raw data in some restricted area of inquiry.

In the more-horizontal type most of the "hunches" prior to research are implicitely formed, consequently a more important characteristic is the post factum nature of all the R_1. Jennings, although securely backed up by "psuedo-confirmatory" data, is a prime example of this tendency to post factum theorizing.[13] To this extent, then, she is subject to attack

13 Jennings, H. H., Leadership and Isolation, Longmans, Green and Co., 1950, Second Edition. The set R_1 is extended to cover a wide range of behavior, nevertheless she is weak in both "depth" and "height" analysis. Many of the correlations which she discovers are spurious: p. 53, while "what is done" becomes, "what should be done".

by theorists who would claim such research yields only "suggestive" hypotheses.[14]

14 Merton, op. cit., pp. 90-92.

Having carried out a polemic argument to this over exaggerated conclusion, it might prove valuable to discuss just what implications are justified as a result of statistical analysis. First, it seems a legitimate assertion that rejection of a hypothesis per se does not become an important indication that choice behavior is non-random. It is more important as an indication that with this <u>particular criterion</u> aspects of significant choice behavior become apparent. Another focal point of any rejection is the particular configuration being subjected to test, but this area has received extensive attention judging from the literature.

To introduce some measure of systematization, consider the "dimensions" or variables which must be eventually interrelated: (1) Nature of the group described in extra-sociometric terms (by control variable), (2) criteria, (3) configuration, (4) rejection or non-rejection of $H_{o:x}$ [where x is some particular configuration(s)]. To confirm any proposition for sociometry, deductions from the proposition should be capable of specifying the first three variables and correctly predicting the third.

While the last three variables are straight forward, the first is very complex, as a matter of fact to specify it would require most of sociological theory. We now have a hint as to the role of sociometry. Sociometry gives a picture of small group behavior which can be explained by interrelationships between group structure and the variables or concepts of psychology, sociology and anthropology. The concepts of these three areas enter into our four dimensional schema by way of the amorphous category, "nature of the group".[15] It may, however, be valuable to notice which areas the sociometrists have favored.

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15 To avoid spending too much time on such a ridiculously complex problemwe will only observe a few of the variables to be specified when describing the nature of the group: age, sex, race, and occupation composition, individual's reasons for membership (to increase economic, social, or political class position, artistic or pure friendship motives), group goals or normative system, size of group, frequency of meeting, past history, etc., ad nauseam.

Although sociometry does not attempt to specialize in psychological theorizing, this position is almost inevitable. To a large extent the explanation of the interrelationships between, (1), (2), (3), and (4) turns out to be psychological reasoning. This orientation is dictated by the nature of the raw data. Each individual chooses some other individual and these actions are first seen as due to some individual "reasons". It is quite possible to ask each individual why he makes such and such a choice with the response becoming a psychological datum. An analysis of these reasons becomes an integrative portion of theory on R_2. Consequently many empirical generalizations have been constructed to relate particular aspects of group structure to (extra-sociometric) psychological variables which relationships are then explained in psychological terms.

There is, however, another level possible and that would be a "social system", a concept on the third level of integration. The development on this third level would certainly allow sociometry a more important place in sociological theory, but various difficulties must be overcome. The basis for any hope in this direction lies largely in further development of matrix analysis which attempts to get at total group structure.

The previous discussion concerned with theoretical considerations can not become an excuse for avoiding a discussion of substantive theory. The previous four dimensions, waiting to be explored under rigorous and precise experimental conditions, may have to remain neglected for too long a time. But since

this thesis is not backed by original data the only way out is to look at the research and attempt to fit it in, deriving our levels of integration as best we can and demanding certain minimum statistical considerations.

The contribution to substantive theory which will be considered is the research of Moreno and Jennings. As was mentioned above Moreno is a horizontal theorist, but he has set forth various propositions capable of test. To quote again from Moreno:

"Tele is the factor responsible for the degree of social gravity operating between individuals and groups of individuals. It is responsible for the degree of reality of the social configuration above chance." This corresponds to our previous conception of the horizontal theorist in that every significant deviation from chance indicates to him "tele present". But Moreno does go on to define tele more completely as closely related to the number of mutual choices, and we will accept this more restricted definition.[16]

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16 Paul Deutschberger also following Moreno states, "The tele-factor may then be isolated as the characteristic ability of the given individual to create and to enter into mutual social relationships, ("The Tele-factor: Horizon and Awareness", Sociometry, 10:3:242-249, 1947, p. 243).

It is a major contribution of Jennings, however, which allows us to relate tele phenomena to the previous dimensions. Her argument, restated, would become: If (1) the particular

groupings under investigation are not designed specifically for objective, articulated, "mechanistic" goals, but, rather, are designed for the individual or personal ends of gaining companionship or "acceptance" (receiving positive affect); and (2) the criteria are unstructured interactional situations which are conducive to accomplishment of these personal ends; and (3) we concentrate upon investigation of pair relations, the result of a statistical test of pair relations will be rejection of the null hypothesis. If the first two conditions do not obtain, testing the pair relations will not necessarily imply a rejection.

Frankly, I have not been able to find confirmation of these hypotheses. Jennings uses only the comparison of per cents, Deutschberger's research design is not applicable, and Maucorps does not present the relevant data.[17] If, however,

17 Deutschberger and Maucorps(,Paul H., "A Sociometric Inquiry in the French Army", Sociometry, 12:1-3:46-80, 1949), have, nevertheless, derived certain internal properties of the tele phenomena such as; correctness in indentification by (i) of other persons choosing (i) is directly associated with the intensity which (i) chooses them (Deutschberger) and is associated with the number of mutuals in which (i) engages (Maucorps).

we accept Jenning's results as conclusive[18] does there exist

18 Not too dangerous an acceptance judging from the original data, Jennings, op. cit., p. 238-244.

an explanation for this phenomena? Jennings appears to favor some vague traditional sociological explanation for the latter,

or socio group, phenomena[19] while she turns to Moreno for an

19 Op. cit., p. 278.

explanation of the former or psychegroup, behavior.[20] Moreno offers the explanation, previously quoted, on terms of physio-

20 Op. cit., p. 276-7.

logical ultimate causes. Jennings then confuses the issue by explaining relationships between an individual's choice statuses and "mutual statuses" in the two cases as due to the prior and more pervasive psychegroup structure, with only the residual differences being due to some institutional or structure factors.[21]

21 Op. cit., p. 280.

Thus we have an elevation of the psychegroup or its index, the mutual choice, into a realm of the "most powerful" and "best" type of group structure, both from Moreno and Jennings.[22]

22 Moreno, J. L., "Sociometry and Marxism", Sociometry, 12: 1-2:106-143, 1949, p. 140. "The world is full of isolated rejected, rejecting, unreciprocated and neglected individuals." These individuals are in psychological misery.
Jennings, op. cit., p. 276.

When, we have dealt with the naive empiricism of Jennings and the mysticism of Moreno the systematization of statistical sociometry begins to fall apart. We still have the unmanageable numerous articles in Sociometry, but it does not seem valuable to attempt a synthesis here. The only way out is to get back on the mathematical theme, and investigate those few extensions

of structural analysis which purport to describe the total group.

C. Matrix Analysis.

One of the most prevalent phenomena of inter-personal relations and yet one of the most difficult to determine has been clique structures or subgroupings of the original group. The sociogram approach has attempted to study or at least determine cliques but has developed into an art rather than a science. Into the breach comes matrix analysis with answers as to how cliques shall be determined and studied scientifically.

There are two main types of solutions, one developed by Forsyth and Katz,[23] and the other by Perry, Luce, and Festinger.[24]

23 Forsyth, E. and Katz, L., "A Matrix Approach to the Analysis of Sociometric Data: Preliminary Report", Sociometry, 9: 340-47, 1946; and also Katz, L., "On the Matrix Analysis of Sociometric Data", Sociometry, 10:2:233-41, 1947.

24 Luce, R. and Perry, A. D., "A Method of Matrix Analysis of Group Structure", Psychometrika, 14:2:95-116, 1949.
Luce, R. D., "Connectivity and Generalized Cliques in Sociometric Group Structure", Psychometrika, 15:2:169-90, 1950.
Festinger, "The Analysis of Sociograms Using Matric Algebra", Human Relations, 2:2:153-56, 1949.
Festinger, L., Schachter, S. and Back, K., Social Pressures in Informal Groups, Harper and Bros., New York, 1950, pp.132-50.

The first technique consists of mechanically permuting the original choice-rejection (-1's allowed) matrix until the condition, $\sum_i \sum_j c_{ij}(i-j)^2$ equals a minimum, is satisfied. A simple solution to this problem has been intimated by Criswell[25],

25 Criswell, H. H., "Sociometric Concepts in Personnel Administration", Sociometry, 12:4, 1949, p. 299.

but as yet has not been published.

The resulting matrix (if cliques are present) will show clusters of + 1 choices along the main diagonal and the - 1's will be shoved into the corners off the main diagonal. These clusters of + 1's indicate that the individuals are choosing "into themselves" with greater frequency than "outside themselves", and if the clusters can be clearly boxed off the individuals involved are said to form a clique. The cliques farthest from the center of the matrix are placed there because they have negative or indifferent choices going to and/or coming from other individuals (principally those on the other end of the main diagonal). Thus we have some measure of "social distance" by using the final ordering of individuals. We also have a measure of social distance between cliques by the same principle. Those individuals near the center of the final array are the most generally accepted individuals for the total group while those individuals near the center of their cliques are most accepted by the clique.

This picture of the group structure provides a two dimensional picture, "social distance" and "cliques", but is very cumbersome to obtain. An extension to this technique has been suggested by Katz[26] which involves factoring the choice matrix.

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26 Op. cit., p. 240.

This implies that the group will show two structures, one for outgoing choice-patterns and one for incoming choice-patterns.

Since the individual could be expected tochoose himself, the communalities could become equal to 1.

The factorial structure for the outgoing choice-patterns and the incoming should show the same reference vectors and similar factor loadings which would indicate pure cliques. Any deviations from this ideal setup would show a lack of cleavage even if in both structures well defined clusters of individuals separate out, but the group would also show a "disorganization" if these two structures refused to coincide. It is possible (says Dr. Katz) to arrive at a single factorial structure.[27]

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27 Since this would necessitate a symmetric matrix it appears the unreciprocated choices could become 1/2 or in general a new c_{ij} could be defined, $c_{ij} = \frac{c_{ij} - c_{ji}}{2}$. This, however, is not what Katz had in mind.

Considering that we have this new single structure it would yield to(o) many interpretations. The cliques could easily be defined as those individuals having high loadings on a particular reference vector. The relationships between cliques could be examined by the angles between reference vectors ("distance between" defined proportional to the "angle between"). The "leaders" of the cliques are those individuals having the highest loadings. The "carriers" of information would be individuals having loadings on many reference vectors. The individuals who have the largest communalities will be most "integrated" (i.e., they don't have to "water-down" their choice output or intake because they missed mutuality).

The approach by Luce, Perry, and Festinger is quite simple in essence. By taking successive powers of C (with - 1's omitted) the various chains or networks become apparent. To see this let c^2_{ij} be the i, j^{th} element of C^2, then,

$$c^2_{ij} = c_{i1}\, c_{1j} + c_{i2}\, c_{2j} + \cdots + c_{iN}\, c_{Nj},$$

which equals the number of three person chains connecting i and j (these are called chains of "length 2"). Since c_{ij} = either 0 or 1, a contribution of 1 to c^2_{ij} will only result if, for some (k), $c_{ik} = 1$ and $c_{kj} = 1$ or (i) chooses (k) and (k) chooses (j). Elimination of redundancy in chains of length greater than 2 is laborious but possible.[28]

28 Katz, L., An Application of Matrix Algebra to the Study of Human Relations within Organizations, Institute of Statistics, University of North Carolina Mimeo. Series, 1950.

This technique seems limited to a study of communication processes.[29] However, communication is by no means unimportant.[30]

29 "Cliques" can also be determined but we will not go into this application since the definition of a clique is almost too restrictive to be of great value.

30 See Festinger, Schachter, and Back, op. cit..

There does seem to be some possibility of extending its use into "influence" studies where individuals choose others as "having 'influence' over me" or "under my 'influence'" in which case the chains would become hierarchies of power. One important twist is its use in determination of "carriers" or indi-

viduals who can spread news quickly. To find these individuals the sum $C + C^2 + C^3 + \ldots$ is formed and when some individual has filled in his row with entries greater than zero he will communicate to every member of the group in at least the number of steps corresponding to the last power of C required.

There is one more matrix approach which should be briefly mentioned, since a report on it appears in Sociometry.[31]

31 Cervinka, Vladimir, "A Dimensional Theory of Groups", Document 2531 American Documentation Institute, Washington, D. C., the report by S. C. Dodd in Sociometry, 11:1-2:100-7.

Cervinka allows his matrices to lead him around to such an extent the information he demands is practically impossible to obtain and the manipulation, consequently, becomes far too cumbersome. He does manage to suggest the extension ofmatrices out beyond the test population into other areas. That is, instead of an N by N matrix we have a N by N + M where the extra M variables are attitudes toward ideas or objects outside of the test population. This extension seems capable of yielding valuable information by, say, factoring this N by N + M matrix (using column intercorrelations). Then the attitude variables could be seen in relation to clique formation, etc.

D. Conclusions.

Now that sociometric "theory" has been presented, some attempt will be made to summarize its properties with respect to coordinating definitions and levels of integration.

(1) Coordinating definitions for sociometry appear quite adequate. There is, sometimes, a difficulty

in naming indices. The name of an index carries the implications of the originator, and sometimes these are debatable. For instance, what we have called "choice status" is also termed "social status". This latter concept has decided resonances of meaning, that are not at all applicable in most cases. But, since we do not deal in indices except in matrix analysis, it is only for this area that the definitions are debatable.

(2) Levels of integration has been "over-hashed", but a summary may help. No mathematical models exist for sociometry; the mathematical manipulations are merely "techniques". As a matter of fact, no theoretical system exists for sociometry. Sociometry is a technique, applicable to investigations on any level of integration, and the data can be explained on any level of integration. Our substitute theoretical scheme suffers from this same malady, "uneven emphasis upon experimentation and data collection, without the theory to back it up."

If we might be allowed another chance, there is the possibility of interpreting sociometric data by use of Merton's, "Paradigm for Functional Analysis".[32] Sociometrist have a

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32 Merton, op.cit., pp. 49,ff.

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tendency to be organismic and a type of analysis evolved from physiology should show some correspondence with Moreno's interpretations. In addition analysis of the various levels of integration can be separated in discussion of the "unit subserved by the function".[33]

33 Ibid., p. 31 where Merton mentions "concepts of psychological function, group function, societal function, cultural function, etc.". The correspondence between these "concepts" and our four levels is not fortuitous, but gratifying.

The mechanical job at grinding out a paradigm for the functional analysis of sociometric data would, then, start somewhat like:

I) The items to be analyzed are (from statistical analysis) the facets of the total choice-pattern which lead to rejection of the respective null hypotheses. These configurations indicate non-random choice behavior and demand explanation. From matrix analysis we have "cliques", "social distance", "carriers", etc.

II) Motivation or "reasons" for choices as reported by individuals in the test population constitute valid data when analyzing choice behavior in terms of the psychological (integrative) level, but are meaningful for other levels only with qualification.

III) Functions of each particular structure:

1) The choice status hierarchy.

On-going system for which the configuration or item has function.	Functions.
Psychological Level: First the structure or model of personality	a) For the psychological level a high choice status manifestly indicates that the person receiving it is socially ac-

should be constructed for each individual, then the peculiar choice status which he occupies will react upon this structure and its effect can be hypothecated. In this connection it seems advisable to use a "basic personality" (a la Kardiner) so that functions can be imputed (to the choice statuses) having more general applicability. It seems that in general a Neo-Freudian schema would allow easier interpretation, since a dynamic psychology fits easily into the functional or organismic approach.

cepted and will derive the consequent increase in security (i.e., his ego is validated) but a latent function may be that this individual is increasingly motivated to maintain his position with resulting instability in his personality. The low man on the choice status hierarchy is admittedly in an unfortunate position. Non-acceptance by a group will naturally lead to some type of personality disorganization if the individual values highly participation in the particular criterion. The effect of the non-random choice status upon the individual personalities must, of course, always be judged relative to the particular personality structures and to the criterion. But since a "basic" personality structure would ordinarily demand some social activity, frustration of this "desire" could be expected in the case of the under chosen.

Interpersonal Level:
The small informal groups to which this term refers are in actual practice the most important (on the basis of permanency and intensity of their existence) subgroups of some institutional structure(s), they are designed to afford the membership almost pure companionship and thus demand only that they be maintained, and that there be some minimum amount of "meeting of minds".

b) For the inter-personal level a high choice status bestows the role of leadership or more accurately indispensability (i.e., in very few interactional situations is this individual omitted). This will lend unity to the group if the individual with the high social status "represents", so to say, the entire group. If, however, there are two or three individuals receiving high choice statuses and their "constituencies" are mutually exclusive the result may well be a dysfunctional cleavage of the group. The under chosen individual's frustrations may result in his taking a dim view of all group activities and thus becoming a dysfunctional or dampening factor. The piling up of individuals on particular choice statuses may indicate a very democratic distribution of choices and also may indicate cleavages (which can be studied separately).

This type of analysis must then be carried out for all configurations over all levels of integration. The additional points which Merton requires (mechanisms, alternatives, limits, change, validation, and implications) can in like manner be added.[34] The theory may then become a legitimate portion of

34 I will avoid the usual comment, "There's a thesis topic here".

the social sciences, but would it become a valuable one?

By our previous criteria of value, existing sociometric theory is not worth too much. It is not because of the expense and trouble associated with collecting the data or in the techniques of analysis. Actually it is in this area that sociometry is most valuable, excepting, perhaps, the techniques of matrix analysis which can, however, be handled by clerical workers. But when we come to consider the scope and accuracy of the explanations and predictions we are forced to demand a high degree of theoretical rigor which sociometry cannot produce. It might be conjectured that if sociometry were to adopt the paradigm such shortcomings would be eliminated. The result would then be a quick efficient technique of exploring, particularly small groups. It will be found, necessarily, that since choice behavior does not sample a very large area of social behavior the conclusions from sociometry will remain rough first approximations. But such conclusions are easily valuable.

IV Technical Note

A. Expected Frequency Distribution for Pair Relations.

The probability distribution for the combination of values (0, 1) for c_{ij} and c_{ji} is given in Table 1. Since the total possible number of pairs is $\binom{N}{2}$ the expected fre-

c_{ji} \ c_{ij}	1	0
1	$\left(\frac{d}{N-1}\right)^2$	$\frac{d(N-1-d)}{(N-1)^2}$
0	$\frac{d(N-1-d)}{(N-1)^2}$	$\left(\frac{N-1-d}{N-1}\right)^2$

Table 1.

quencies are:

mutual pairs, $\binom{N}{2}\left(\frac{d}{N-1}\right)^2$ $(c_{ij} = c_{ji} = 1)$,

unreciprocated pairs, $\binom{N}{2} \frac{2d(N-1-d)}{(N-1)^2}$ $\left(\begin{matrix} c_{ij} = 0 \text{ and } c_{ji} = 1 \text{ or} \\ c_{ij} = 1 \text{ and } c_{jk} = 0 \end{matrix}\right)$,

indifferent pairs, $\binom{N}{2}\left(\frac{N-1-d}{N-2}\right)^2$ $(c_{ij} = c_{ji} = 0)$.

The observed frequencies can be compared by χ^2 test with two degrees of freedom.

B. Probability Distribution for 0, 1, ..., $\frac{N}{2}$ Mutual Choices when $d = 1$,

1) The total number of choice patterns for the group is given by $\left(C_d^{N-1}\right)^N$ which $= (N-1)^N$ in this case (each individual

can make d choices to any of N-1 persons, C_d^{N-1}, and, since there are N individuals, the Nth power of C_d^{N-1} gives the total number of patterns for the group).

2) The number of choice patterns which include at least one mutual choice = $C_2^N(N-1)^{N-2}$ (1 mutual implies a pair of individuals, and C_2^N gives the number of ways this may arise; then when d = 1 these two individual's choices are determined and the remaining N-2 persons have N-1 possible ways to choose, thus the $(N-1)^{N-2}$ term).

3) The number of choice patterns which include at least 2 mutual choices is given by $C_4^N \frac{C_2^4}{2}(N-1)^{N-4}$ (when d = 1, 2 mutuals must involve 4 persons and these can arise in C_4^N ways. The pairing of these 4 can be done in $\frac{C_2^4}{2}$ ways since both pairs are determined when only one pair is assigned; as before there are N-4 persons who still retain N-1 possible ways of choosing).

4) By the same procedure we can derive the number of patterns including at least 3 mutuals, $C_6^N C_4^6 \frac{C_2^4}{2}(N-1)^{N-6}$; 4 mutuals, $C_8^N C_6^8 C_4^6 \frac{C_2^4}{2}(N-1)^{N-8}$, etc., until some one of these equals 0.

5) Then to derive the probability that exactly k mutual choices will occur subtract the number of ways that at least k + 1 mutuals occur from the number of ways that at least k mutuals occur and divide the result by the total number of choice patterns. Simplifying we get:

$$P\left[k \text{ mutuals}\right] = \frac{N(N-1)\ldots(N-2k+1)\quad 2(N-1)^2-(N-2k)(N-2k-1)}{(N-1)^{2(k+1)}\quad 2^{k+2}}$$

The derivation of this distribution for $d > 1$ requires the elimination of extensive overlap in the sets of choice patterns; a task requiring much patience and consequently not attempted here. Since most questionnaires requiring d = 1 are useless the only possible way to utilize such a distribution would be to consider only those mutuals composed of first choices.

C. Frequency Distribution for A Posteriori Inter- and Within-class Choices.

This distribution becomes a simple case of a chi-square test for a 2 x 2 table.

	Ingroup (a)'s incoming choices.	Outgroup (b)'s incoming choices	$\sum$
Ingroup (a)'s outgoing choices.	C_{a-a}	C_{a-b}	C_a
Outgroup (b)'s outgoing choices	C_{b-a}	C_{b-b}	C_b
$\sum$	C_{-a}	C_{-b}	C_t

$$\chi^2 = \frac{(C_{a-a}\, C_{b-b} - C_{b-a}\, C_{a-b})^2\, C_t}{C_{-a}\, C_{-b}\, C_a\, C_b}$$

No restrictions on the number of choices which an individual makes are necessary. Rejections may be analyzed similarily and separately, with the interpretion remaining the same if the term within brackets is negative rather than positive.

D. A Posteriori Distribution for Choice Statuses.

A possible fit for the choice status distribution was suggested by Greenwood and Yule (Journal of the Royal Statistical Society, 83:255-279, 1920). The basic hypothesis is that perhaps each individual has a different potentiality for drawing choices; maybe this "drawing power" is distributed as some binomial, and the whole function is poisson. We can then get a distribution for choice statuses. This fit is compared with observed data collected on a group of Michigan county agents.[1]

1 Loomis, C. P., "Demonstration in Rural Sociology and Anthropology: A Case Report", Applied Anthropology, 6:1:10-25, 1947.

Choice Statuses	Observed Frequencies	G. and Y. Frequencies
0 - 2	9	7.299
3 - 5	12	16.313
6 - 8	20	17.381
9 - 10	17	13.504
12 - 14	3	9.552
15 - 17	11	5.972
18 -	7	7.979
	78	78.000

χ^2 for G. and Y. = 11.68 P = .02 (4-d.o.f.)

Thus, although the G. and Y. distribution is close to the observed, it does not yet fit. A more fortunate selection of class limits would have given a lower chi-square.

V Summary and Conclusions

To more systematically evaluate Chapple's interaction schema and sociometric theory, a review of their properties in relation to the categories of "application" and "resulting explanations", as discussed in the Introduction, is in order.

Since it is the task of coordinating definitions to precisely determine which operations are to be performed in transforming raw data into a conceptual system or empirical constructs, these definitions become the focus of an examination of research techniques. In both systems the definitions are sufficiently adequate and objective. There is the possible exception of Chapple's definition of "origination" and the dubious, but unavoidable, practice in sociometry of naming indices with terms widely used in other fields.

In the area of the "efficiency" of the definitions, both systems show a common disadvantage. They require rather extensive and expensive mechnical manipulations. Chapple uses a timing device and sociometry manipulates matrices, both requiring clerical expence. It does seem, however, that the advantage of "objectivity" offsets this added expense.

Another methodological problem concerns the group feed back process which in both of these systems is "dangerous". This process involves the reaction upon the group by the collection of data; that is, the group may actually change its behavior <u>because</u> of the investigation. The passive nature of data collection by the Chapple system would be an advantage if the

individuals were not conscious of the observer.

Sociometry's problems are more complex, and feed back is maximized if rejections are included in the questionnaire. Such attitudes as are elicited by the sociometric questionnaire are not widely considered as "public" property. If the information is not kept confidential, it has a tendency to create jealousy, false security, or perhaps, it is seen as "votes" for which to "campaign". The usual assurances of annonimity are never completely effective. Outside of these considerations the individual himself may become overly self-conscious and create a "false front" as a result of verbalizing, for the first time, his preferences. These difficulties are, again, common to most social research.

When discussing the value of the "pure" theory in these two systems it will be well to note that the emphasis has shifted from the non-existent mathematical models to more general "theory". It is very difficult to assess the scope of application for these two theories. Both Chapple and the prime representative of sociometry, Moreno, believe their respective theories capable of providing the groundwork for explanation of almost all social behavior. If they imply by this that relatively complete explanations of any social behavior can be produced from either of these theories, such claims are untenable. In all justice to both theorists, this is probably not their implication. They are stating, rather, that their propositions will hold true for any social behavior.

The question now becomes one of determining the limits of applicability for these two theories.[1] If Chapple's theory

1 This problem of limits is still not adequately treated in most theoretical discussions.

is extended to all possible relevant measurements of timed interaction, if some relationships are discovered which will determine (i.e., within the system of timed interaction) "changes" in equilibrium, and if this completed system is then brought into relationship with "social behavior", we could examine the extent of the "social behavior" and be able to describe the "limits". At the present time it is possible to make only rough predictions of an individual's favorable or unfavorable "reaction" toward conversation with another individual if both individuals' previous interaction behavior is known. This seems to be a more restricted area of social behavior.

For sociometry these limits are even more difficult to determine. Moreno does not use the sociometric questionnaire alone, and invariably those who do utilize many and varied criteria, number of choices, etc. For each possible form of the questionnaire, then, there are different areas for prediction and explanation. There are, however, certain conclusions possible in the face of particular sociometrically determined group structures. Such phenomena as "favoritism", cleavages, isolation, cohesion, etc., can be found to be present or lacking in almost any group.

Insofar as there are general consequences of these struc-

tures, these consequences will determine the limits of sociometry. Such consequences have not been thoroughly investigated, but perhaps the functional approach will be better able to do the job. It does seem apparent that these limits will not be very extensive, but they will probably hold true for many varying types of groups.

The fact that these consequences will hold true over many types of groups, along with the almost universal existence of conversation, allows a better understanding of the belief (on the part of both Chapple and many sociometrists) that such systems will pervade all explanations of social behavior. This fits easily into a previous point. That is, both of these systems represent a comparatively high level of abstraction and a comparatively low level of integration. For systems of this type it is possible to predict that they will not be capable of "complete" explanations for comparatively complex data, but their limited conclusions are valid over a wide variety of social situations.

To prove this proposition consider that in both systems the only member of R_2 was a psuedo-physiological concept (equilibrium and tele). If this concept is a valid one then it will operate in social science as does any other physiological concept: to establish broad limits, but far from a complete explanation of social behavior. The fact that these concepts (equilibrium and tele) are not true physiological concepts, but are actually sociological implies that they

operate similarily, but in a lesser "degree". That is, compared to physiological concepts, they establish less broad limits, and more complete explanations, but maintain their same relative position with respect to "most" other sociological concepts.[2]

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2 An empirical test of this property has been furnished by the apparent applicability of the Chapple system (i.e., the social anthropological one) in cross-cultural analyses.

As a summary statement of the "value" of these theoretical systems, one must first propose that they become more logically unified as opposed to their present emphasis upon empirical uniformities. Then, it is"logical"to suppose that their contributions will become widely applicable, and consequently, "valuable".

IV Conjectures on the Broader Aspects of Inter-personal Theory

In the course of the above development (of a technique of evaluation and application of this technique to two theoretical systems) the specific role of inter-personal theory in sociology was not adequately delimited. Some attempt was made by way of the paradigm to define this role (i.e., as one of the "on-going systems for which the configuration or item has function"). Nevertheless, some further discussion of this role in terms of a general theory of small groups would be helpful in ascertaining the specific "goals" or "ends" of inter-personal theory.

It has already been hinted that the goals of inter-personal theory are much more limited than any complete explanation. An analysis of the inter-personal field will make this clearer. In the small or primary groups, interaction between members is not governed by the broad social norms, but rather by the principles of "pure sociability" (to use Simmel's term). The rules of behavior are a product of, or contributed by, the specific interactional situation; that is, they are (to a greater extent than, say, institutionalized behavior) formed "on the spur of the moment".

To understand this consider that:

(a) by the typical schema for "acquired rewards" individuals learn to value associating or interacting with other individuals as an end in itself,

(b) such an end operates as a partial determinant for "institutionalized" behavior, but in the absence of an institutional structure it continues to operate.

Admitting the existence of such an end (i.e., operating as a "desire") we have now to specify the type(s) of small group structures which will be formed in the absence of institutional factors (e.g., groups of persons occupying similar statuses within the same or similar institutional structures). The problem, however, is not set up so that we need consider only that there be some minimum of interaction which will satisfy this "desire" for sociability; and, then, deduce certain group structures which will maintain interaction. This end which we mentioned is "fully equipped" with other behavior patterns. Not only do individuals associate a value with interaction per se, they also have developed behavior patterns for satisfying such a value.

Thus we go back to social institutions to determine which behavior patterns will be most likely brought forth in a situation such as the small group. A set of behavior patterns called "basic personality" appear to answer our needs, these behavior patterns are acquired by individuals all through life but primarily are formed in the earlier years up to say, 8 to 10 years.

The small group structure if it actually depends upon such behavior patterns will be relative to a given culture. For

this society we could distinguish the authority pattern of parent over child and insofar as this prevails predict some well defined hierarchy of influence or power in the small group. We could also predict that insofar as the society favors a conjugal type family that any "closely knit" group will be comparatively small; and insofar as group members come from an "average" family they will form these "closely knit" groups.

The influences from the family are to an appreciable extent tempered by each member's experience as a member of some children's clique or "peer group". Such experiences will have a "democratic" influence. They predispose members to form group norms after an abstract principle of "justice", or "fair play", which insists that every member has equal rights, etc.

In like manner we could deduce other properties of interpersonal relationships. Each of these properties then would have limited validity depending upon the extent to which the group members have been subjected to the "common" cultural norms.

But the maintenance of a small group has certain unique properties which will operate upon the members of such a group. Each member in attempting to keep the group going (we have seen that each member is motivated) will be forced to modify to some extent his culturally relative behavior patterns. Such a principle gives rise to a group's "internal dynamism" while the previously considered behavior patterns constitute an "external dynamism". The fusion of these two variables with a given social environment determines small group structure.

What has been termed "dynamism" is in reality "not (at the present time) understandable". The term dynamism indicates this lack of knowledge; for, although it appears to be a reputable term, actually, not many social theorists appear to understand its meaning. It usually occurs when the variables and functional relationships are not specified, but where there seems to be some uniformity of behavior.

One method of avoiding the over-generalizations of a "dynamic" interpretation is to utilize the concept "basic personality" in combination with a series of deductions concerning "requirements for maintaining a small group". Both of these concepts will yield broad properties of group structure which may then be found to form a "first approximation" to this structure.[1]

1 Such a procedure is akin to the type of analysis afforded by the paradigm for functional analyses.

The specific contribution by inter-personal theory to this method is in the description and analysis of "internal dynamism" or "requirements for maintaining a small group". Such an analysis, then, can be concerned with deductions such as, "some norms of interaction are necessary, among these: a relatively stable time at which interaction will take place, a relatively well defined pattern of influence, some techniques by which deviant members are "forced" to conform or techniques by which they can be eliminated from the group, etc."

Sociometry (more than Chapple) attempts to make such con-

tributions, and this development goes hand in hand with Moreno's insistence upon analysis of social behavior "in situ" or as it is happening. To this extent, then, sociometry fills the role of an inter-personal theory. Chapple on the other hand mixes the roles of the anthropologist, social-psychologist, and physiologist so that it is difficult to discern his exact position with respect to inter-personal theory.

The analysis above has also given support to the thesis that "limits" to inter-personal theory's ability to explain social behavior need to be more adequately delimited. Although such a delimitation has been attempted, much more needs to be done