The modern digital computer has made major contributions to sociology in at least two general areas. Because of the computer's high speed and its ability to handle effectively the interrelationships among many and complex variables, we are enabled to perform more sophisticated analyses of data already gathered. For the first time it is possible to deal statistically with social systems as systems. Potentially of even greater benefit is the second contribution—the use of computers to generate data for the purposes of theory testing and development.

It has been traditional in sociology to express theory in verbal formulations. Words, of course, are weak tools for achieving precise statements of propositions, for studying the interrelationships among variables, and for learning the consequences for a social system if it operates according to the processes defined or implied by the theory. Once the processes of a theory are expressed as routines in a computer program, we can simulate the behavior of a social system which operates according to the rules of the given theory. To the extent that the observed outcomes of an experiment in a computer run match the observed outcomes of the identical experiment in a real-life system, the rules of the theory may be considered a sufficient (though not a necessary) explanation of the behavior.

Let us turn now to a description of HOMUNCULUS, an operating program in Information Processing Language, Version V, designed to simulate human interaction in small groups. The computer model is based on the theory advanced in a recent book, Social Behavior, by George C. Homans, which presents an explanation of elementary social behavior—that is, of "face-to-face contact between individuals, in which the reward each gets from the behavior of the others is relatively direct and immediate". Homans' model is one of social exchange, envisaging human behavior as a function of its payoff: in amount and kind, an individual's responses depend on the quantity and quality of reward and punishment his actions elicit. To explain elementary social behavior, Homans advances five propositions, based primarily on experimental psychology and classical economics, dealing with the effects of such factors as the frequency and recency of reinforcement,
stimulus and response generalization, and relative deprivation and satiation.

To simplify the problems of expressing concepts concerning human social behavior in a computer program, we followed the tactic of beginning with a simple interaction sequence between two hypothetical individuals. In *The Dynamics of Bureaucracy*, Peter Blau of the University of Chicago describes in detail a federal civil service office in which the men studied held the same title but varied in competence. As expected, the more skilled workers received more requests for assistance from their co-workers. While the participants in such consultations benefited, they still incurred costs in their exchange. That is, the agent requesting help was usually rewarded by being enabled to do a better job; however, he paid the price of implicitly admitting his inferiority to a colleague who by title was supposedly his equal. The consultant, on the other hand, gained prestige; nevertheless, he incurred the cost of time taken from his own work.

In our computer model of this social exchange we have programmed an interaction sequence beginning with an agent, Ted, emitting a symbol representing a request for assistance to his co-worker, George. The flow chart depicted in Figures 5 through 6 outlines our interpretation of the processes involved in operationalizing Homans' propositions for elementary social behavior. In our illustration, the programmed statement of Homans' propositions specifies the symbol-manipulating processes which enable our hypothetical consultant, George, to decide what action he will emit in response to Ted's request.

As we began to develop flow diagrams for the specific routines to represent each proposition, we found that the discipline of making decisions about how to program a computer to simulate social behavior gave us a different perspective in our thinking about how humans react in social contexts. This new frame of reference forced us to make explicit our conception of a person as an information-processing system. If our model of a person were to behave according to the principles set forth in Homans' explanatory propositions, the format in which he was described in the computer had to be such that he could perform at least the following activities: He had to be able to receive stimuli, recognize stimuli, store stimuli in memory, and compare and contrast stimuli; he had to be able to emit activities, differentiate reward and punishment, associate a stimulus situation with a response, and associate a response with a reinforcement; and, on the basis of past experience, he had to be able to predict the consequences of each contemplated response.

In the group setting he had to be able to discriminate among the members of the group, evaluate each social stimulus in terms of the specific person emitting it, and select a response appropriate to the specific other person in the given group. Our model thus pictures a person as an active hypothesis-testing organism capable of receiving, storing, analyzing, and reconstructing information. These human information-processing functions bear obvious similarity to the digital computer's symbol-manipulating capacities. Even so, the process of constructing such a social being in the computer was no easy task.

Fortunately, IPL-V was designed to handle the types of problems we faced. In our model a person is represented as a list structure composed of a hierarchy of list structures, lists, and description lists. A simplified presentation of the organization of a list structure of a person is depicted in Figures 1, 2, and 3. Among the data included are lists specifying an individual's identity, his general level of ability and his level of skill in social interaction and in certain specific tasks, his relative and absolute position

![Figure 1](image-url)
in certain groups, his images of his membership and reference groups, and lists containing elements of his past history and his resulting values and needs. Through exposure to various experiences an individual's list structure becomes modified to include a record of them. Thus, at the beginning of a run, he may be represented by a list structure of as little as 200 words. By the end of some fifty or one hundred interactions, he may require a thousand or more IPL words to describe him. In effect the individual learns from his experiences and keeps in memory the information that will enable him to behave more appropriately in future interactions.

The processes expressed in Homans' propositions determine the behavior of the person-models in HOMUNCULUS. Homans assumes that his propositions explaining elementary social behavior apply generally to all humans, regardless of their cultural backgrounds and institutional relationships. In operationalizing Homans' propositions, therefore, we designed the routines to be common for all simulated persons. However, the routines are so written that the information retrieved from the data list structures describing individual participants determine whether certain subroutines will be executed and what their outputs will be in specific interaction sequences.

Proposition 1. To illustrate some of the processing involved in our model as well as some of the problems encountered in translating verbal statements into computer routines, let us consider the dynamics of Proposition 1 (P1, Boxes IV through XXII in Figures 4 and 5). Homans states this explanatory proposition as follows:

If in the recent past the occurrence of a particular stimulus-situation has been the occasion on which a man's activity has been rewarded, then the more similar the present stimulus-situation is to the past one, the more likely he is to emit the activity, or some similar activity, now.5

Essentially this describes the effects of the psychological principles of stimulus generalization and response generalization. In formalizing this proposition as a computer routine, however, we found that the apparent clarity of the verbal statement actually cloaked certain ambiguities.

What, for example, is a "particular stimulus-situation?" In terms of the specific interaction sequence we have selected, does it include every request for help one has received, or does it include only requests from the same person for assistance on the identical problem within an identical social context? We decided to write routines to process in sequence two aspects of the "stimulus-situation." That is, we hypoth-
esized that a person receiving a stimulus, such as a request for assistance, would first react in a relatively global manner to the general situation itself; then he would consider the situation in terms of the specific individual emitting the stimulus. Thus, in our example, we interpreted the initial information processing implied by Proposition 1 (see P1, Box IV in Figure 4) to involve consideration by our office worker, George, of whether the activity received—in this instance, a request for help—is a general stimulus-situation in which his responses have been rewarded. In executing this process, a subroutine representing one of George's information-retrieval capacities searches a memory list of reinforced stimulus-situations to determine whether the present input is among them.

Let us take the positive branch of the flow diagram and thus assume that George has found that in the past he has been reinforced for responding to a request for assistance. His next consideration is outlined in Box X of the flow chart in Figure 5. Now George must determine whether his responses to a request for help have been rewarded by Ted, the person currently introducing the stimulus-situation.

In checking on past interactions with Ted, George must search deeper into his memory structure. At this point one subroutine locates George's image list of office colleagues, finds the sublist describing Ted, determines whether Ted has emitted the present stimulus to George previously and if so whether Ted has generally rewarded George's responses to such requests. If he thus determines that Ted has been an agent of reinforcement in past interactions involving requests for assistance, then George proceeds to retrieve the types of responses he has emitted to Ted. In our program George selects up to three activities from a memory list of responses Ted has rewarded (Box XXII, Figure 5); then he proceeds to process further information regarding these contemplated actions in order to select a response which he anticipates will net him a social profit.

It is apparent that we have adopted as a tactic the policy of including, as a group, stimuli which resemble each other but are not necessarily identical. This means, however, that our programmed people cannot discriminate degrees of similarity. No great difficulties arise, of course, in constructing routines to test gradations of similarity as called for by Homans' proposition. When we do include a test of similarity, it will require that we be more precise than Homans in specifying what we mean by "more" and by "similar." To develop this discrimination we plan to build a list of attributes describing various activities. One such attribute would have scaled values indicating the expenditure of energy required to emit an activity; another would have a range of values denoting the amount of time required to complete the given activity. Once these description lists for activities have been completed, a routine can be written to compare activities, determining the number of attributes two activities have in common as well as the degree of similarity in the values of their attributes. The criteria for judgment of similarity can be set as fine or as broad as desired. Our interest will

![Figure 5](image-url)

![Figure 6](image-url)
be the development of routines which simulate human decision processes as closely as possible.

Up to this point in our discussion of Proposition 1 we have considered only the positive branches—that is, what happens if George finds that the general stimulus-situation has been a rewarding occasion and that Ted has been an agent of reinforcement. But one may note that most of the items included in the flow diagram in Figures 4 and 5 outline processes accommodating the negative branches. For example, if George finds that in the past his responses to a request for help generally have not been reinforced (Box IV, Figure 4), he would still wish to ascertain whether he has interacted with Ted before (Box V) and if so, whether such interactions have proved rewarding (Box VII). If past interactions with Ted have had positive consequences, George may then select a response Ted has previously reinforced to try in this stimulus-situation (Box IX). Otherwise, George may decide to withdraw from what is likely to be another unrewarding situation (Box VIII). Even if he has not interacted with Ted previously (Box V), if George is a gregarious, other-directed American, he may still wish to continue the interaction; therefore, he can select some person similar to Ted (in terms of such attributes as sex, age, relative position in the group, etc.) to use as a reference source for determining appropriate action (Box VI).

Let us now consider the processing involved in the negative branch for the inquiry concerning the social context of the stimulus-situation. To be at this point in the program George would have ascertained that, in the past, responding to a request for help had generally proved rewarding (Box IV, Figure 4); however, he would have found, in considering the request in terms of the current stimulus person, that his responses had not been rewarded by Ted (Box X, Figure 5). A relevant question then is whether George previously has received this stimulus from Ted (Box XI). If he has not, then George will ascertain whether he really has interacted with Ted before (Box XII); if not, he will select a colleague similar to Ted to use as a reference source in processing Ted's request (Box XIII). To indicate the possibility that George is using a surrogate for the stimulus person in making decisions, references to Ted appear in parentheses.

If George finds that Ted has previously requested his assistance (Box XI), then the responses he made to Ted's request should be avoided since they did not lead to reinforcement (Box XIV). Indeed, in such a case George will wish to evaluate his relationship with Ted to determine whether interacting with him is worthwhile (Box XV). If it is not, he may end the interaction sequence then and there (Box XVI). On the other hand, if George has enjoyed contact with Ted (Box XV), he might try to recall whether he has observed Ted's asking other co-workers for assistance (Box XVII) and, if so, what their reactions were (Box XIX). If he lacks this knowledge of group activities (Box XVII), George still can select rewarded responses to requests for help from some other colleagues (Box XVIII). In either case, George will then ascertain whether the responses suggested are of the same type as those he emitted previously without receiving reinforcement from Ted (Box XX). If they are, George has little choice but to withdraw from what would probably be an unrewarding situation; otherwise, he can try again to elicit a positive reaction from Ted by emitting one of the untried responses (Box XXI).

Proposition 2. Homans' second proposition deals with the positive influence of the frequency and recency of reinforcement:

The more often within a given period of time a man's activity rewards the activity of another, the more often the other will emit the activity.\(^5\)

Reformulating this proposition for computer simulation posed a number of problems. It would have been relatively simple merely to set a counter for each reinforced response and then retrieve the desired information regarding reward frequency. However, we felt this procedure would not adequately simulate human information-processing systems. Of course, people do avail themselves of precise measurement scales and use various cultural artifacts—such as computers—to increase their accuracy. But in making estimates concerning frequencies and values of rewards ensuing from everyday social interaction, people seem to use a less re-
fined means of measurement. In programming this proposition, therefore, we devised a rather crude five-point ordinal scale for reward frequency, ranging from an estimate that a response was "nearly always rewarded," through a judgment that it was "rewarded about half the time," to an assessment that was "almost never rewarded."

At present we are experimenting with different means of manipulating this scale. One routine we have written increases the ordinal scale value for the reward frequency after three reinforcements of the response. This procedure, however, is not completely satisfactory. Indeed, one may argue that estimates of reward frequency are not necessarily independent of the emotional salience of the reinforcement. When HOMUNCULUS has reached the stage of simulating small-group behavior in controlled conditions, it should be possible to test various approximations of human judgments of reward frequencies from social interaction and to select the routines which simulate the actual behavior most accurately.

When the processing for this proposition is completed (P2, Box XXIII, Figure 6), George has a rough estimate of the frequency with which Ted has rewarded each of the activities he is considering in response to Ted's current request for help. Homans' Proposition 2, taken alone, would lead to the expectation that George would then merely emit the most frequently rewarded response alternative. But other information must be processed before a decision is reached.

Perhaps here we should indicate how the program keeps all this material in immediate memory for George. Up to one hundred named private storage cells are assigned for this purpose, and instructions in each routine specify which cells it is to use for storing its findings. At present, George is using about fifty of these cells. In addition, important information available to all group participants—for example, what could be seen and heard during the last five interactions—is kept in named public storage cells.

Proposition 3. Among the other relevant factors that must be considered in selecting an activity to emit is the value of the anticipated reward. Homans' third general proposition states,

The more valuable to a man a unit of the activity another gives him, the more often he will emit activity rewarded by the activity of the other.5

Assessing the value of an activity is somewhat more complicated than estimating the frequency with which it occurs. Value has two components—one relatively constant, and the other, which we shall discuss in Proposition 4, relatively variable for the periods of time involved in the simple interactions comprising elementary social behavior. The value component referred to in Proposition 3 concerns an individual's rank-ordering of the subjective reward attendant on receiving one activity rather than another. With reference to our example, we might predict that George would find warm social approval involving Ted's complimenting him in front of colleagues to be more "valuable" than a half-hearted response of "Hmm, thanks," or an annoyed retort, "Well, sorry I bothered you."

At this point in our program, therefore, we have what game programmers term a "look-ahead." In considering Ted's request, George has "in mind" three responses he recalls Ted's having rewarded in the past, and he has estimated the frequency with which Ted has reinforced each response. Now he must consider more carefully the particular reward he expects Ted to give to each response so that he may determine the inherent worth of each anticipated reward (P3, Box XXIV, Figure 6). Taking in turn each activity George is contemplating, the routines executing this proposition retrieve the responses Ted has previously made to each, determine which one he is likely to emit now, and search description lists to find the subjective value of the reward for George.

Proposition 4. Homans' fourth proposition deals with the other component of value—the deprivation-satiation aspect, or the marginal utility of a given unit of activity.

The more often a man has in the recent past received a rewarding activity from another, the less valuable any further unit of that activity becomes to him.6
In contrast to the relatively constant intrinsic satisfaction aspect of value, the deprivation-satiation component varies over a range of possible rankings. Taking into account the amount of an activity a person has received, we note that he "values" that activity more when he has been deprived of it than he does when he is in a state of relative gratification. Thus, while social approval may be highly rewarding to an individual, if in the recent past he has received a great deal of this generalized reinforcer, then he is not likely to be so interested at the moment in receiving more.

In processing the information necessary for completion of this stage of the program, George must evaluate his relative deprivation with reference to the rewards he anticipates from Ted. George now has in immediately available memory a record of each activity he is contemplating and stored with each activity is various information about it, including the response he expects Ted to make to it. The routines which execute Proposition 4 search the description lists of each of the anticipated rewards to determine the degree of George's current deprivation or satiation with respect to them. A deprivation-satiation score based on a simple ordinal scale is stored as the value of a special attribute on the description list of each activity. In executing Proposition 5, which we shall discuss later, routines update the deprivation-satiation score whenever an activity is received.

With the information retrieved thus far George has an estimate of the relative frequency with which Ted has rewarded each activity he is considering emitting. Furthermore, he has predicted Ted's reaction to each of the projected actions and has determined how rewarding each of these anticipated reactions is to him, personally, as well as how deprived or satiated he currently feels with respect to each of these expected rewards. At this point, therefore, George can rank his contemplated responses in terms of their expected payoff. But he is not yet ready to emit the highest ranked action.

Another important consideration is the cost of the proposed response. Homans defines the cost of an activity as the value of the reward obtainable through an alternative activity foregone in emitting the given one. In our example, George must forego working on his own assignment if he takes time to assist Ted; therefore George must determine the relative reward value of this alternative activity. To do this he follows a procedure analogous to that just described, processing information concerning the frequency of past reinforcement and the value of the anticipated reward ensuing from this activity as well as his relative satiation with the reward. Then he can compare the overall expected reward from his contemplated response to Ted with the anticipated reward from continuing with his own work, and he can compute what Homans terms the psychic profit—the reward of an activity less its cost.

Let us suppose George is tentatively planning to give Ted direct assistance on his problem because in the past Ted has praised him for this activity, and social approval is a reinforcement George values highly and one for which he feels relative deprivation at present. But let us also suppose that George has an important assignment to complete, and that taking time from it might detract from the quality of his work and thus lessen the approval he anticipates from his boss for a good job. In this case George would incur a loss rather than a profit in helping Ted directly; therefore, he will continue processing to see whether one of the other activities he was contemplating might yield a profit. In this illustration, George will probably decide that referring Ted to another source will net him a profit, since he expects some approval for this activity (albeit less than he would get from directly assisting Ted), and he will incur a very small cost in terms of time taken from his own work.

Having selected what he expects to be a socially profitable activity, George emits that response to Ted. At this point our program cycles, and the activity George has emitted becomes the activity Ted has received. Now Ted must process information in order to select an appropriate and profitable response to George.

Proposition 5. Distributive justice, the subject of Homans' fifth proposition, is perhaps the most complex of the concepts involved in the explanation of elementary social behavior. At the very least it requires consideration of
information at another level—that of social norms or accepted expectations for behavior within a group. Through repetition of interaction situations within a group, certain behavior patterns become stabilized so that expectations develop regarding what constitutes justice in the distribution of rewards and costs between persons: The greater a man's costs in a given interaction, the greater his rewards ought to be. But the implications of distributive justice go even further, taking into account a person's investments in an interaction—for example, his seniority, skill, experience, age, and sex. The greater the investment a person makes in an interaction, the greater the net profit he has a right to expect. Thus, according to the principle of distributive justice it is consensually expected that certain antecedent costs and investments should have as consequents certain types and degrees of reinforcement. Homans states the related proposition as follows:

The more to a man's disadvantage the rule of distributive justice fails of realization, the more likely he is to display the emotional behavior we call anger.5

More is included, however, for if a man receives rewards beyond those to which he considers himself entitled, he is likely to experience guilt feelings.

Translating this proposition into computer routines posed some of the most interesting problems we have yet encountered in working with HOMUNCULUS. In effect, the list structures of our agents had to be programmed to have consciences, and they had to include a repertoire of appropriate anger responses.

In essence, our programmed interpretation of this proposition asks whether a stimulus activity is appropriate in the given circumstances (P5, Box I, Figure 1). If so, then the person receiving it can process it as George did Ted's request, which he considered appropriate. If, however, the stimulus activity is judged inappropriate, then more complex behavior results. To illustrate this, let us shift to a description of the interactions between George and Tom, another worker in the same agency.

It is an accepted office norm that a worker who asks for help should do so openly in a manner acknowledging the superiority of his consultant with respect to the given problem. Tom, however, has been seeking aid from George in a rather devious manner, coming to George with "an interesting problem" and saying he would like to see whether George arrives at the same solution as he. This has occurred three times in the recent past, and on each occasion, Tom has greeted George's suggested solution with the comment, "Yes, you reached the same conclusions I did." George decides Tom is violating the norms of fair exchange by evading the cost of thanking him for his assistance and conceding his superiority. The fourth time Tom presents him with an interesting problem George angrily responds, "Look, why don't you do your own work!"

This description, of course, does not answer the question of how the computer is programmed to behave in such an all-too-human way. George is programmed to treat time spent solving a problem presented by another worker as being help to that person for which recognition and social approval are due. When his colleague responds to his efforts with an unrewarding confirmation that he arrived at the same conclusion, George finds this input inappropriate in terms of his expectations regarding distributive justice. Therefore, routines processing Proposition 5 change George's image list of Tom so that next time he expects greater recognition and thanks than normal to atone for the present evasion. After three repetitions of this interaction sequence the discrepancy between Tom's behavior and George's expectations will be so great that when George evaluates Tom's response he will plant a signal in his image list of Tom to indicate that interacting with him is not rewarding because Tom violates group norms.

The next time Tom asks for an opinion after this warning signal has been set, George will respond by displaying anger or by storing up aggression to be expressed against someone else. In the computer program an anger response involves emitting behavior punitive to another person. But before actively punishing Tom, George will first assess the consequences to himself of such behavior. In one possible interaction sequence, if George finds that Tom is in favor with George's own boss, he may sup-
press his aggression at the moment and then release it the next time he interacts with a subordinate.

The routines processing the negative branch of Proposition 5 (Box II, Figure 4) thus not only modify image lists but also use some of the routines from the other propositions to evaluate the probable consequences of direct anger responses. Depending on the outcome of this processing, the program either proceeds to Proposition 1 or the interaction is terminated.

Once HOMUNCULUS was operating effectively—so that it simulated behavior characteristic of the civil service office discussed earlier—we faced the problem of how the model could be used to provide a more general test of Homans’ theory and also to simulate across a broader range of experiments involving both individual decision-making and group interaction. Actually, the model as first completed could have been used; however, the task of building a complete repertoire of activities appeared overwhelming, especially when we confronted the need to provide to each group participant with a complete history of activities received from and emitted to each of the others plus the values and costs of each activity in each situation.

In our new program of activities we have adopted a scheme of twelve categories which appear to encompass all problem-solving activities. These categories include six dimensions of group interaction: 1) communication problems where an individual either gives orientation (information, repetition, clarification, and confirmation) or asks for orientation; 2) evaluation problems where an individual either offers an opinion (evaluation, analysis, and expression of feeling) or asks for an opinion; 3) control problems where an individual either presents a suggestion (direction and possible ways of action) or asks for a suggestion; 4) decision problems, where an individual either agrees (shows passive acceptance, understands, concurs, and complies) or disagrees; 5) tension reduction problems where an individual either releases tension (jokes, laughs, and is satisfied) or displays tension; and 6) reintegration problems where an individual either shows solidarity (by raising the other’s status and by giving help and reward) or shows antagonism.

On the basis of laboratory studies of small groups we know the approximate frequency of each type of activity, the changes in relative frequency of each type of activity through time as a group interacts, and the types of responses likely to occur to each type of activity. This information is programmed into reference groups, and data such as the appropriateness of a given response to an activity differ for various reference groups—e.g., for management, as contrasted to a labor union. When the individual participant does not have in his own repertoire sufficient information to select a response to a stimulus, he checks with his reference group to find one to consider.

As the program is now written we no longer specify the first actor and action. Currently we are running interactions among triads. When the program begins operating, control is turned over to the master executive routine. This checks to determine whether a member of the triad needs to act. If so, control is turned over to the actor. If not, the need for interaction of each member is incremented by a figure determined by his basic need for social interaction plus his energy level. The program cycles until some member passes the threshold level, and then he assumes control.

If the initiator knows one or both of the other members of the triad he selects the one with whom to open interaction on the basis of expectations for securing a rewarding response. If the group is composed of unacquainted members, the initiator evaluates the other two and selects the one whose characteristics lead to a prediction of rewarding interaction. This involves assessing the “personas” or public images of the other members and comparing their characteristics with his own self-image to determine compatibility.

If the initiator knows the person he has selected, he usually chooses an activity to emit on the basis of past experience. Otherwise, he consults his primary reference group to find an activity likely to lead to positive reinforcement when emitted to a person like the one chosen—that is, to an individual who is, say, more skilled in the task than he, less skilled in social interac-
tion, one level above him in social background, and an adherent of similar reference groups.

Interaction thus begins and proceeds according to the flow diagram discussed earlier. The propositions guiding behavior remain the same; however, because of refinements introduced—for example, in the routines enabling one member to interrupt another before he has opportunity to emit a chosen activity—the process has become more complex. A programmed member may keep in available memory at least two sorts of activities he may wish to emit: a normally selected response which was prevented by someone else's interruption, or an anger response which the individual suppressed because of the given circumstances. The need to emit such thwarted responses fades as other activities intervene, so that after five activities have been emitted by others, the individual "forgets" having been interrupted and goes on to select other activities. However, the mere fact of being interrupted raises his need to participate, and increases the likelihood of his interrupting in turn to carry out his previously selected activity or to shift his attention to other activities.

Discontinuity and annoyance responses are likely to arise when activities are focused on social-emotional areas and when a series of interruptions occur. When the focus is on task areas, interruptions may lead to annoyance responses, but the discontinuity usually does not appear because the activities continue within the context defined by the given task. Memory of anger responses does not deteriorate so rapidly, but even this disappears after a series of twenty activities.

We mentioned that at present we are running experiments dealing with three-person groups and discussed the processes through which interaction within the group is initiated. Some of the findings in this area have proved to be of theoretical interest. For instance, a group of three unacquainted persons usually breaks down into a pair and an isolate. On the other hand, a group of three already acquainted persons remains a group of three if all the pair relationships are positive. If the pair relationships are not all positive, the outcome is more complex and may range from a relatively unstable group of three to three isolates who never become a group.

Outcomes from such interactions using HOMUNCULUS help explain what happens. Sooner or later a member of the unacquainted group initiates interaction with one of the others. Each time this pair's interactions prove rewarding, information is stored in their image lists which lessens the cost of finding rewarding acts to emit to each other and increases the expectation of a rewarding response. Thus the rate of interaction between them increases, the repertoire of rewarding activities increases, and the likelihood of the bond's being disrupted lessens. The third man does not have the opportunity to let the other two know how rewarding he might be and remains an enigma. Thus the interaction leads to a dyad and an isolate.

But if the first interaction is punishing to one or both of the two involved, the probability becomes higher that interaction will be initiated with the third person. Assuming that his values and norms make rewarding interaction likely, then whichever one captures him first will, in most instances, form a dyad with him and leave the slower moving man as isolate. If no rewarding pair is found, then in most circumstances a group never forms.

With a group of three persons who already know and like each other, the same principles lead to different outcomes. Each has already established a repertoire of activities that he knows he can emit to the other two and that will be rewarded. Therefore, when there is slight satiation with the rewards one of them can provide, attention is temporarily transferred to the other. Occasionally, also, the interrupt mechanism leads the one not yet active in the group to join the conversation. Since the others have experienced rewarding interactions with him, he is not rebuffed.

In reaching beyond the simulation of small-group laboratory experiments, we have begun planning experiments to use HOMUNCULUS to test theories of organization design. None of these will be programmed and on the machine for at least a year, and probably longer. This appears to us to be a particularly promising area in which to blend contributions to sociological theory and to organizational practices.
As our first study in this area we plan to examine the relative effectiveness of the traditional authoritarian hierarchy vs. the multiple-overlapping-group design advocated by Rensis Likert.

In the traditional structure, communication occurs between adjacent men up and down the line, with information transmitted up, decisions made at the top, and instructions flowing down the line. Theoretically, lateral communication does not occur. In the overlapping-group organization, each member within a group is in regular communication with every other member; decisions are reached by the group rather than the superordinate; and the members are responsible for passing on the information to other groups of which they are members.

Computer simulation of decision-making activities by both types of organization is expected to produce information showing the relative efficiency of the two designs. Such factors are considered as the amount of information available to those making decisions; the effect of the decision-making process on the motivation of the workers to perform; and the impact of each type structure on the satisfaction of individual workers, on their sentiments toward each other, and on their sentiments toward the organization.

CONCLUSION

In our discussion of HOMUNCULUS as an application of computer simulation to problems of sociological or social-psychological theory we have tried to demonstrate that research involving computer models not only plays the passive role of testing and verifying theory; it performs active functions for the development of theory. Formulating a theory as a computer model affords one a relatively tractable representation and possibly a more meaningful conceptualization, having increased precision as a result of the clarification of concepts the programming process necessitates. This organizational function of the model is further enhanced by the computer’s capacity actually to set the theoretical processes in motion and output data generated as logical consequences of hypothesized processes. While investigating the extended logical consequences of a theoretical system is in itself a rewarding activity for a social theorist, another benefit involves the possibility of generating unanticipated findings leading to refinement of theoretical constructs or elaboration of a theory and to experimentation directed to the verification of new hypotheses. This possible serendipity bonus in addition to the increased precision, tractability, and dynamic capacity of a computer model gives the social theorist ample reward for the cost of translation from verbal formulation.

REFERENCES
