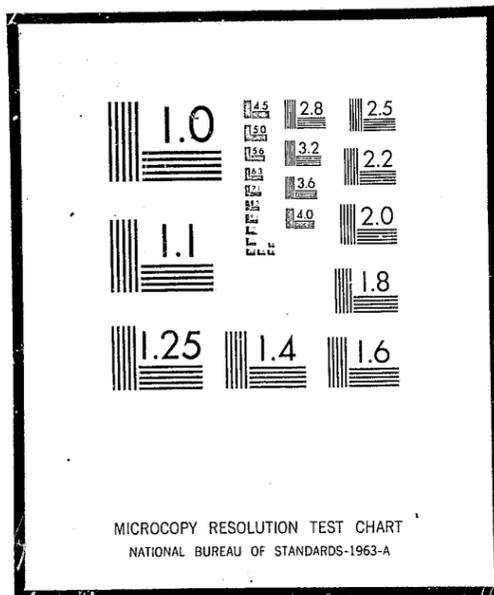# NCJRS

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1.0   ║ 2.8   ║ 2.5
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1.25  ║ 1.4   ║ 1.6
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CATIJ: A NEW SOCIOMETRIC AND ITS APPLICATION TO A PRISON LIVING UNIT

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Catij: a new sociometric and its
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Catij is a new and powerful device for describing the social structure of
a closed group up to about 120 in size. The method is described and a
full example of its output is given from a federal youth prison. Con-
sequences of the results are considered for our understanding of the
general aspects of human group dynamics.

Abstract

Catij: a new sociometric and its application to a prison living unit

A new sociometric technique is described which is generally more
powerful than prior methods for analyzing the structure of bounded
human groups less than about 120 in size. The method is applied to
a female cottage of 41 inmates and 11 staff members (counselors and
officers). Data from this application is presented and analyzed
regarding the dynamics of sub-group formation. Some general
findings are considered, including: 1) a numerical definition of
the word "clique;" 2) the role of weak links in a social struc-
ture; 3) the number of persons and "spheres of life" used by any
individual in a complex society to order his social relationships.

Part I

INTRODUCTION

It appears to us that there are two traditions in the field of social
networks analysis; one stemming from the work of American sociologists
such as Moreno and associates (1934 and on), Jennings (1945), Katz (1946),
etc., and one from the work of British anthropologists J.A. Barnes (1954),
Clyde Mitchell (1971) and Elizabeth Botts (1971). Our current work[1] is
aimed at bridging these traditions, using both formal and ethnographic
tools.

We have elsewhere introduced a technique, called catij, for describing
and analyzing social networks (Bernard and Killworth 1973, hereafter re-
ferred to as BK). That work concentrated on proving the formal adequacy
of the technique. In this paper we will present 1) a description of
catij, its use and its features of superiority over less powerful methods
of social network analysis; 2) the network produced by catij for a resi-
dence unit of a youth prison; and 3) a consideration of some implications
for our understanding of social group structure.

Part 2

CATIJ

A sociogram is usually constructed by asking for a respondent's
"three best friends," "three people you work with most," or a similar
limited choice of persons from a defined group. Sometimes the respondent
may be given the open-ended instruction: "choose the people you like best."
This is done in order to avoid the limited-choice constraint. However, as
Holland and Leinhardt (1973) have shown, the instructions nearly always bias

the resulting data towards a very small number of choices. The "structure"
of the social group is usually given in either of two ways: 1) by trans-
forming the data into a matrix in which the row-column entries correspond
to the given data (e.g. person A chooses person B if the (A, B) entry is
non-zero); or 2) by defining graphical (usually planar)[2] coordinates for
each respondent, and connecting pairs of points together in one-to-one
correspondence with the choices made. (The two forms of sociogram pre-
sentation are shown in figure 1.)

FIGURE 1 HERE

At least four things are wrong with this approach:

1) The sociogram obviously never says anything _about_ the data other
than to reiterate it in graphic form. In other words, the sociogram
is not a derived analysis of data; it _is_ the data.

2) The limited choice format means that the observed sociogram may
differ violently from the "perfect, real sociogram" which is
assumed to exist. (See Holland and Leinhardt, 1973 for a superb
demonstration of this effect, and Killworth, 1973 for a mathematical
demonstration of how this effect manifests itself).

3) It is quite possible that the essential line(s) between two disjoint
cliques may be omitted in the sociometric survey. For example,
sociograms commonly contain many isolates (Boyle, 1969).
Granovetter (1973) offers speculation that important links may only
involve weak acquaintances. If this is the case, the occurrence of
isolates is clearly an artifact of the method. (We will have more
to say on this in Part 4).

Fig. 1

Example of matrix and sociogram for 2-choice
data. A one-to-one correspondence exists for
sociogram, data, and matrix.
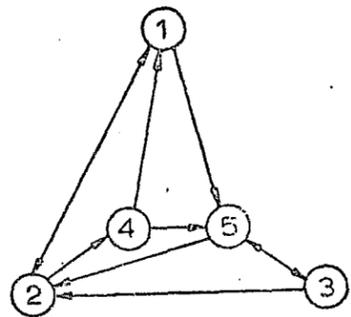
4) The network resulting from a limited choice sociogram usually possesses

a certain pristine neatness (cf. Boyle, 1969, figure 3).

Intuitively (and mathematically--see BK, figure 8) one knows that

complexity, rather than simplicity characterizes social relations.[3]

It is probably true that social _structures_ are vastly more simple--

mnemonically derived, perhaps, from complex relations sets. In other

words, it is likely that people carry around a rather limited set of

rules and chunks (named or unnamed) of social structures from which they

generate the infinitely large variety of social relations observable on

the surface. The search for a grammar of social relations has been a

pursuit in anthropology since the seminal work of Goodenough (1957) and

others in the area of kinship algebra, folk taxonomies and the like.

Such grammars are exceedingly rare (see Wallace, 1961, and 1965) and

are effective only for relatively simple overstructures. The sociogram is,

by definition, only part of the data of social relations. It should con-

tain as much of the data as possible rather than attempt to streamline in

the cause of comprehension, neatness, or some "structure" which it can

not (by definition) achieve.

An example of what is left out by a sociogram may make this last

point more clear. Sociometric analysis sometimes assumes the existence

of highly transitive relations among triads. If a L b and b L c, then

a L c is likely, according to this assumption. Some intuitive logic and

the pioneering work of balance theorists (Heider 1946, 1957; Abelson and

Rosenberg, 1958) made this assumption appealing. Recently, measuring the

data reported here, Killworth (1973) found that intransitivity was at

least as important a factor in the structure of social groups as transitivity.

Matrix

	1	2	3	4	5
1	x	1	0	0	1
2	1	x	0	1	0
3	0	1	x	0	1
4	1	0	0	x	1
5	0	1	1	0	x

Sociogram

Indeed, he observes that intransitivity _is_ the measurable or observable quantity rather than transitivity.

The catij device resolves many of the difficulties cited and may be a step towards producing a grammar for a complex set of social relations. By obtaining the data in an unlimited choice format, catij filters out many of the biases in the traditional sociogram. Since all possible triads can be counted and checked for transitivity or lack of it, the catij matrix provides much more data than the limited choice sociogram. In addition, its "massaging" technique filters out perturbations in the data, such as false rankings. Proof of these statements may be found in BK. Finally, catij cannot contain isolates--indeed, by definition the network obtained via catij is strongly connected.

The catij matrix is derived as follows. A group of people $\leq$ 120 is defined. The original purpose of catij was to describe communications networks in physically closed groups; any definition of closure will do, however. If the definition is spurious, the results will be spurious. A cottage of inmates in a prison proved to be an effectively defined group. The restriction on size of the group is related to the ability of respondents to organize the material presented rather than to any restriction in computer capabilities.[4]

Each person is given a deck of cards containing the names (and nicknames, if appropriate) of all the people in the group. The respondent is asked to sort the cards into four piles: 1) those with whom he/she has a _lot_ of communication; 2) _some_ communication; 3) _hardly any_ communication; and 4) _no_ communication. Operationalizing these instructions requires some ingenuity at times. The easiest method we have found is to ask people

who they "talk to" a lot, some, etc. "Rap with," "bullshit with" and other instructions might be indicated, depending on the situation. Attempts should be made to give each person an idea of what is required and substantially similar instructions should be used. Note that we are interested in _quantity_ of interaction rather than quality. A random sample of 80% of the group is required for good results (BK), and, clearly, the greater the participation, the more valid the results.

The piles are next arranged in order of interaction so that, in the end, an array of N-1 cards is produced for the total group, less the respondent. The arrays for each individual are combined to form a matrix (d_{ij}) so that the columns of the matrix represent distance to each j from each i. Distance is defined such that, if i ranks j nth, the distance from i to j is (n-1). Zeroes thus appear in the diagonal signaling that each i is zero units of distance removed from himself. The decision to use unit distance spacing is shown to be valid in BK.

The distance matrix, d_{ij}, is next transformed into a minimal distance matrix (min_{ij}) as follows: for each i and j in the group, d_{ij} is searched for the absolute minimal distance from i to j, given the possibility of up to N-2 intermediaries. In other words if,

$$i \rightarrow j = m \text{ units (i.e. the distance from i to j is m)}$$

and if $\quad i \rightarrow k = p$ units

and if $\quad k \rightarrow j = q$ units

such that $\quad p + q < m$

then, we may say we have found a distance from i to j which is less than m, the original distance given by the respondent. While we have found _a_ distance less than m, we can not be sure that it is the _least_ such distance

from i to j. This is done by continuing to search the matrix.

For example, if

$$i \rightarrow j = m \text{ units (the original distance)}$$

and

$$i \rightarrow z = a \text{ units}$$

and

$$z \rightarrow j = b \text{ units}$$

such that

$$a + b < p + q$$

then, we say we have found another distance less than m, and less than
p + q. The process is continued until the minimal distance from i to j
is obtained using one intermediary.

We now consider multiple intermediaries, as follows:

if

$$i \rightarrow j = m$$
$$i \rightarrow 1 = r$$
$$1 \rightarrow f = s$$

and

$$f \rightarrow j = t$$

such that $r + s + t < (a + b <) m$, then we say we have found a two-
intermediary distance which is shorter than any one-intermediary distance.
The process is continued for up to m − 2 intermediaries. (Since each
use of an intermediary implies the expenditure of at least one unit, clearly
no more than m − 2 possible intermediaries need be checked). Recall that
this is done for every i and j in the distance matrix. The minimal dis-
tances form the new matrix (minij) which is of itself not of great interest.
However, in the process of getting minij we have kept track of the number
of intermediaries used to achieve it. (If there are several possibilities
for getting the minimal distance we use the one with fewest number of
intermediaries). The various numbers of intermediaries used may be
represented diagrammatically by
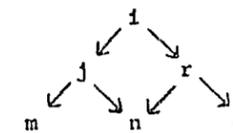
$$
\begin{array}{ll}
0 = \text{catii} \\
1 = \text{catij} = \text{catir} \\
2 = \text{catim} = \text{catin} = \text{catid}
\end{array}
$$

We have here introduced the third and most important of the matrices, catij
or the category matrix where each ij entry is defined as 1 more than the
number of intermediaries used. Catij, then, is the matrix representation
of the taxonomic tree structure for relations in a social group. Obviously,
the relations depicted depend on the question used to produce the original
distance matrix. We have used "talking to" and "communicating with." An
affective question such as "people you like" would result in a structure
of affective relations. Evidence to date indicates that the form of such
relations may be remarkably similar (Killworth and Bernard, forthcoming).
We would not claim that catij produces the social structure of a group.
There may be more than one social network, but catij clearly produces one
such structure consisting of a) a minimal route from each i to each j in a
group; b) one or more paths from each i to each j; and c) a listing of the
nodes which hold the tree together.

We have not made any claims for the actual route in which the minimal
distance is achieved (in fact, several routes typically occur). Nor have
we made claims about behavioral interaction. We still do not know whether
catij represents depth of communication, although it clearly does represent
part of some social reality. An informant, given the name of someone he
ranked 11th and which catij placed on his second row, usually says that he
perceives direct communication with that person, and not indirect. However,
this seems unlikely. If the human brain is limited as to the amount of
similar information it can process (as indicated, for example, by Miller,

1956), then it will be impossible for the informant simultaneously to process his relations with too many people. Some must inevitably be compartmentalized into groups attached to one or more of the people he _is_ capable at processing, corresponding (although not necessarily) to the rows and intermediaries of catij. Conversely, if asked point-blank about his 11th person, the informant is now not asked to juggle many individuals, but only one; in all likelihood he claims direct communication if he ranked an individual high, and indirect if he ranked the individual lower. Some tests carried out along the above lines seem to support this claim.

Thus, in spite of the fact that catij is a more powerful sociometric than previously available there remain a number of uncertainties. For this reason we cannot stress enough the need for serious ethnographic description as part of the technique. When combined with direct observation and with discussion of the results with key informants in the study group, catij's descriptive powers are quite strong. In the prison we studied, for example, all and only the bulldykes (active lesbians) were identified as the power brokers in the female living units. In two cottages we isolated groups of only three individuals, all of whom were known internal drug pushers. In another instance we isolated a group of two Alabama whites and a white student from Maine. At the time this group made little intuitive sense. About a week later, two of the three members of this group escaped together. 's it turned out, the third had been part of the plot and had withdrawn at the last minute. One should, of course, not get the impression that catij has the power to discover nefarious activities. In all these examples, interpretation could only be made after the fact using ethnographic evidence.

The program package used to produce and analyze catij is called the KBPAK. Program I searches the original data for errors and punches the original distance matrix when the data is clean. Program II produces and lists the d_{ij}, min_{ij}, cat_{ij}, and punches cat_{ij} as well. Program III describes cat_{ij} statistically, signalling those individuals who are row-one (i.e. direct) or row-two interactors more than others. Program IV does a row-by-row factor analysis of cat_{ij}, producing the important sub-groups in the matrix defined by those members with coefficients for a given factor larger than 0.6. These sub-groups may or may not constitute socially real cliques, but do represent groups of people whose outlook on the rest of the group is similar.

To date, strong internal group connectivity has been the rule, precisely because a column-by-column factoring was _not_ used. This is because relating correlating column-by-column compares each individual's placement of two people, and the relation between these placements is a function of the individual making the placement, not the two people concerned. Thus, there is no reason why correlating column-by-column would produce any sensible definition of sub-groups. In BK we noted that such a factor analysis produced no better results than a simple cluster analysis. Row-by-row anlaysis, however, produces intuitively sensible and powerful results--the reason is that routes from two similar individuals to the same person are being compared. These routes typically involve different collections of intermediaries within the same sub-group followed by a chain of intermediaries which are the same for both individuals. This means that the cat_{ij} row entries for i and j to any k are likely to be of the form $(n, n + p)$ or $(m + q, m)$ where p and q represent the differing numbers of intermediaries

used within the subgroup. Hence, a plot of catik versus catjk, for i and

j in the same subgroup, will appear as

FIGURE 2 HERE

thus giving a high degree of correlation between i and j as required.

Finally, program V subtracts catij matrices from one another, selecting

only those elements common to both, and describes statistically the pro-

perties of the resultant matrix. This allows for examination of time varia-

tion in a non-changing group, or the effect of new members and exiting

members on a group. Multiple matrices from a single group at a single time

may also be compared; e.g. two matrices developed by asking respondents

"who they talk to" and "who they like."

The catij technique was administered to the inmates of five residence

units at a federal youth prison. In the following section we describe the

research situation and the results from one of the living units.

Part 3   THE PRISON SETTING

The Robert F. Kennedy Youth Center in Morgantown, West Virginia was

originally built as a minimum security detention center for male criminal

offenders between the ages of 14 and 21. The Center (KYC) was established

as a showcase among federal prisons: the grounds were landscaped; the living

Fig. 2

Typical plot of cat_{ik} versus cat_{jk}, for
i, j in same group
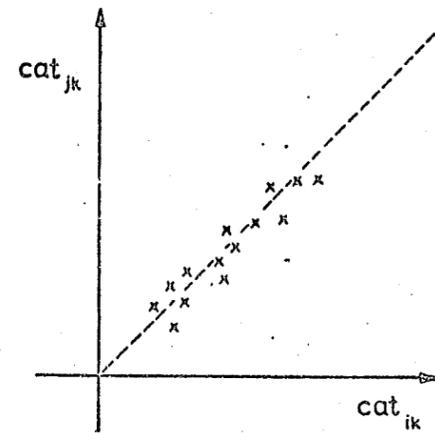
$$cat_{jk}$$

$$cat_{ik}$$

Fig. ...

units were made modern and spacious; the administrative offices were given
every facility; the school was equipped for the most modern vocational
training; and money was made available for the most extensive and advanced
rehabilitation programs known in the field of corrections. The population
of KYC was made up of mostly first-time offenders whose crimes were non-
violent and who appeared to be the best-risk recipients of the programs.
Between 1968 and 1971, the population structure of KYC reflected the re-
habilitation goals of the institution. Unfortunately, those goals remained
unattainable and in 1972 inmates appeared who were older (up to 25 years of
age), more sophisticated (multiple offenders), and convicted of violent
crimes. The most drastic change in the demography of KYC, however, was
the introduction of female prisoners. While the men still outnumber the
women, two of the five living units (called "cottages") are female. Sexual
relations between inmates (who are called "students") is forbidden; but,
of course, this rule is extensively circumvented as is the law against the
use of alcohol or drugs. We have selected the original women's unit ("C"
cottage) for description here for two reasons: 1) On entering KYC, inmates
undergo extensive psychometric testing and are segregated into four "be-
havioral characteristics" or BC groups: juvenile, violent, neurotic, and
gang-oriented-manipulators. Plans are underway for testing the women in a
similar fashion, but no such psychological segregation of female prisoners
has yet occurred at KYC. 2) Although we have obtained generally excellent
cooperation from participants in this study (averaging about 90% response),
C-cottage has produced our only square matrix (i.e. 100% response from 52
individuals).

At the time of this study (December, 1972) C-cottage housed 41 inmates
between the ages of 16-22. Twenty-nine were black, 11 were white and one

individual was classified by the institution as "spanish surnamed" or brown. Not surprisingly, the majority came from Eastern, urban backgrounds (nine were from Washington, D.C. alone, with three more from Maryland suburbs), though many other areas were represented: Houston and San Antonio; Cleveland; Birmingham; Oklahoma City; Detroit; Kansas City; Memphis; Philadelphia. Eighty-eight percent were from urban centers. Convictions were typically for non-violent crimes (check forgery, mail fraud, car theft, narcotics violations, and prostitution), although some cases of violent offenses were present (illegal use of explosives, bank robbery, armed theft).

The administrative goals of KYC allow each cottage supervisor to design his/her own program for rehabilitation. The program in use during this study followed a behavioral modification approach involving a token economy, soft point rewards, individual counseling, and small group sessions. As in all the units at KYC, a weekly "town meeting" was also used as a focal point for discussion of inmate problems. At one town meeting it was announced that the cottage had acquired a windfall of five dollars from some accruals. The expenditure was turned over to the inmates.

The discussion lasted 40 minutes. During the first ten minutes it was decided that douche powder would be the object of the purchase. One of the women would be given responsibility for purchase of powder at a local drugstore during a weekend "town trip" to nearby Morgantown. The next 30 minutes resolved the issues of who ould be entrusted with the purchase and what brand was to be bought. The supervisor felt the discussion was a "healthy means of engaging in group democracy and cooperation." Inmates were rather less genteel in their description of the exercise.

On entering the cottage each inmate is classified during a meeting with one or more of the four counselors and the supervisor. She is assigned

to a counselor and goals are set for her at the level of "trainee." These include the successful completion of some courses in the school, as well as personal behavior and achievement goals such as grooming, maintenance of living area, punctuality at group sessions, etc. The classification and goals are set according to the judgement of the counselors of the inmate's background and requirements. Apprentice goals take about six weeks to achieve if the inmate "accepts the program." Needless to say, the individualized programs do not always jibe with the inmates' own determination of their problems and solutions. Thus some inmates fail to "achieve their status" (i.e. make "apprentice" level) for two months. Peer pressure, and the sheer lack of privilege at the trainee level, eventually makes even the most obstinate individualist conform. If an inmate simply refuses to "accept the program" (doesn't go to school, keeps reticent at counseling sessions, etc.), she will be sent to the "adjustment center" known as G-cottage or "seg" for obvious reasons. Inmates in seg have virtually no priviledges and those sent there for violence are confined to the only locked cubicles on the compound.

Once a trainee makes apprentice she may wear her own clothes (prior to this she must wear prison issue) and she will be assigned a room of her own (until then she lives in a domitory wing of the cottage). In addition, she may use the soft points she receives for her chores to purchase more free time outside the cottage on the compound, later bedtime, more television viewing, and other privileges. She is entitled to periodic town trips on Saturdays, visits from relatives and friends, and other rewards. She is also assigned a new set of goals. After about three more months the apprentice may make "honors status." Honors students live in rooms with private toilet facilities and have relatively free run of the "campus"

or compound grounds. Honors students are eligible for "work release," in
which they work in town (if a job can be found for them) while residing each
night at the institution.

The program is administered by a staff of ten in C-cottage, including
a secretary, three officers ("guards," "hacks," "screws"), four counselors,
a chore officer, and a cottage supervisor whose loyalties are partly ad-
ministrative and partly to the line-officers and counselors. At the time
of this study C-cottage also had a part-time psychologist, a graduate student
in clinical psychology from nearby West Virginia University. KYC makes
rather extensive use of the university to buttress its personnel. The
psychologist was working on her doctoral thesis; most of the cottages have
at least one "student intern" from the departments of Social Work or Re-
habilitation Counseling at the university. Those departments require a
six-month internship for the M.A., and KYC serves as a convenient vehicle
for some of their students.

The structure of the staff follows government service lives. The
counselors are traditionally brought up through the officer ranks, while
supervisory personnel come up through educational achievement, and are
not necessarily from officer backgrounds. The result of this policy is
that most counselors come from a law enforcement tradition rather than an
academic tradition. Counselors usually have high school diplomas, and
possibly a year or two of college. If they attain a bachelor's degree,
they follow a different career trajectory which tends to remove them from
immediate contact on a counseling basis with the inmates. The influx of
female inmates produced a need for women officers and counselors. Some
women officers were pushed up rapidly to counselor status. This naturally

caused some friction among the male staff. The counseling staff of C-
cottage consists of two men (who came up through the ranks) and two young
women. All the officers were women as was the supervisor.

It is not understood why the program at KYC is not as effective as
it might be, but the facts are clear. The costs are high (about $34/day
per inmate) and the recidivism rate is not appreciably lower then in more
traditional, more secure, and less expensive institutions. A number of
problems, typical of penal institutions, continue unabated in C-cottage
(and in the institution generally). The staff defines homosexuality to
be a problem, yet lesbian activity is apparently common. Heterosexual
activity is outlawed, and is patently common. Drugs and alcohol are for-
bidden, but periodic "busts" make it apparent that these commodities are
in substantial supply. With this short background we may consider the
structure of C-cottage as shown by the catij output.

To facilitate understanding of the output, the inmates were numbered
(1-41) and the staff (42-52), although the programs allow arbitrary num-
bering schemes. For reference, nos. 42, 44, 49, and 52 are officers;
nos. 47, 48, 50, 51 are counselors; no. 46 is the supervisor; no. 43 is
the secretary; and no. 45 is the psychologist-intern.

The first operation performed on the catij output is a simple col-
lection of statistics on the occupants of each individual's first and
second rows, as a crude indication of the relative importance of each
person to the group structure. The mean number in any first row was
6.44. This may be compared to the data reported by BK, when catij on 44
informants out of 53 yielded a mean number of 7.17. Incomplete data will
invariably lead to more row-1 identifications, and, allowing for this,
there is little difference in the two mean numbers. (Note that 6.44 is

16ᵃ

the lowest mean found in any cottage at KYC, most of which lie in the range 7-8). The numbers on any individual's first row lie between 4 and 9 (SD 1.35).

However, if instead we analyze the position of any individual in all the others' hierarchies, large variations occur--the range is now from two occurrences on any first row (by no. 45, the cottage psychologist, whose doctoral work resulted in little communication) to 18 occurrences (by no. 35, one of a group of power brokers to whom reference will be made later). The mean number of occurrences is, of course, 6.44, but now with a SD of 3.35. Four inmates and four staff occur on over ten first rows. Eight inmates and two staff occur on three or less first rows.

More tangible information is obtained by factoring the rows of catij. By this process eleven groups, or "cliques" were obtained, each containing from two to seven people. Only occasionally are the groups completely connected internally, and in three cases (groups 9, 10, 11 all of three or less people) are not strongly connected; recall that the entire network is strongly connected, however. The groups are always "well connected" in the sense that many links do exist between the members of the group, and no group is less than weakly connected. Figure 3 shows the eleven groups, with links to other groups shown by the rosettes about each member of the group. Note immediately the remarkable number of connections between any group and the other groups. Only in a few cases, discussed below, is there any serious lack of communication between two groups--in fact, on average, each group has links (to and from counted indiscriminately) with 7.64 other groups, out of a maximum of ten.

FIGURE 3 HERE

Fig. 3

Groups within C-cottage, time 1. Links shown within group, and schematically to other groups. Persons are circled, groups enclosed within a square.
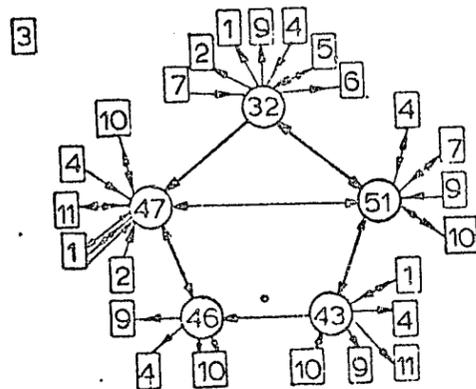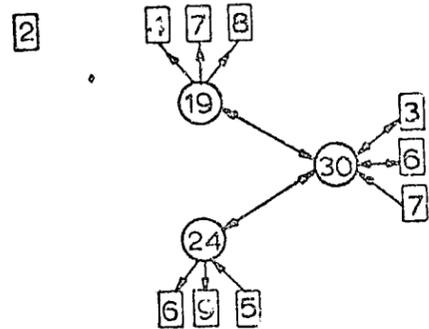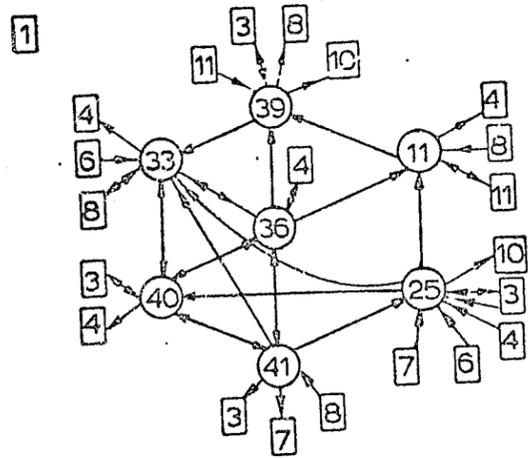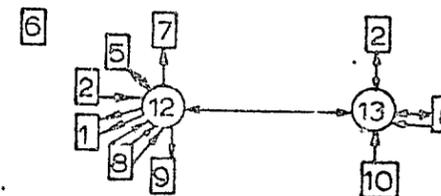
Fig. 8.
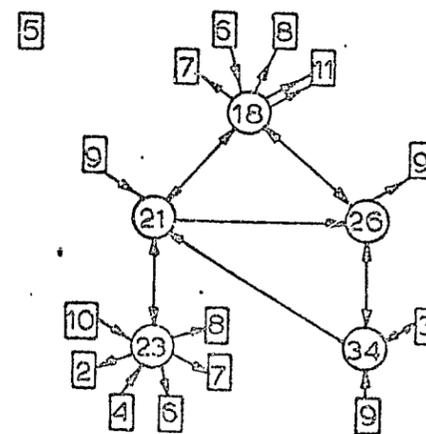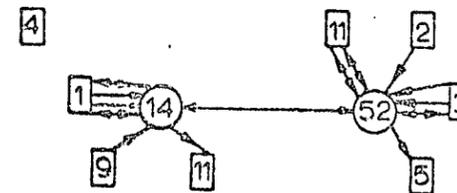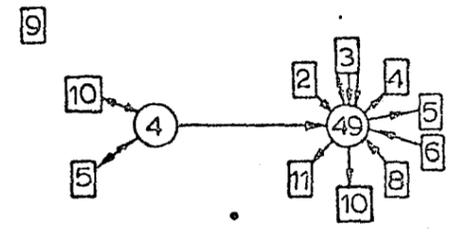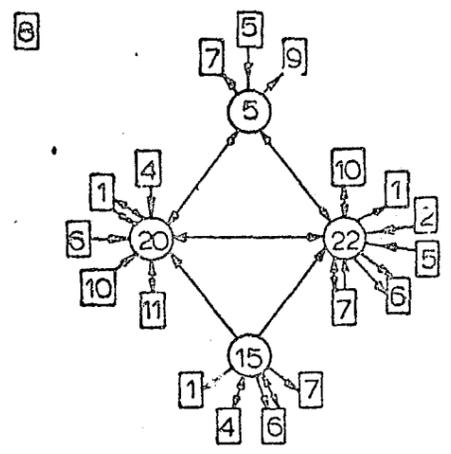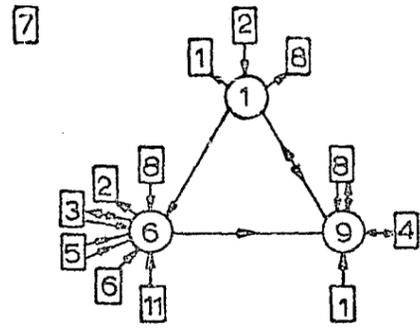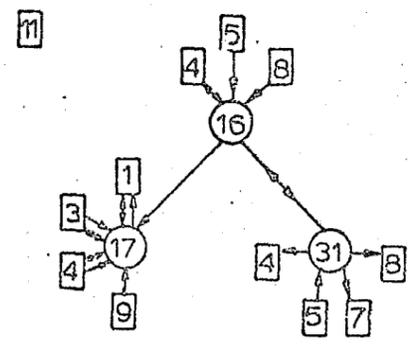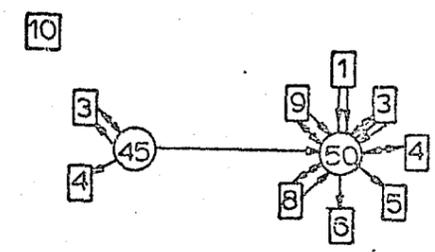
These eleven groups do not exhaust C-cottage, accounting as they do for only 38 people. Seven other people, serving as between-group intermediaries, are also important to the description of the group, leaving seven people which fall into neither category. These latter, namely 2, 3, 8, 37, 38, 42, 44 are mainly individuals who occur on few first rows, with the exception of 42 and 44 (seven and eight occurrences respectively). There are reasonable grounds for adding 42 to group three, but this will not be done here. Henceforth we shall consider only the other 45 people.

Group one, the largest group, consists of seven black inmates. All are from urban centers, five from the southeastern area, and two from Kansas City. There is some evidence that regional origin may be a factor in social grouping (see Part 4), but the argument is strongest for persons from the same city. In this group, for example, the two from Kansas City were the only natives of that city in the cottage. The same is true for the two members of the group from Memphis. Group two is a mixed group--one each of white, black and brown inmates. Note that 30, (black) serves as an intermediary between 19 (brown) and 24 (white). Each serves as an exit point to a differing subset of the other groups. Group three is all white, and all but 32 are staff. Forty-six (supervisor) has connections exclusively to other staff groups; 43 (secretary) has a similar pattern, plus links to two groups of inmates. Fifty-one (counselor) is strongly connected to the staff groups, while 47 (counselor) appears to have excellent connections to staff and inmates alike. Note that 51 possesses links to both 32 (who seems an excellent intermediary from the staff to many inmate groups, both white and black) and to 28 (not shown), a powerful intermediary between groups of inmates.

It is not at all surprising to find the supervisor on the margins of the cottage structure rather than a central focus; it is important that she have good links to her staff and that they have good links to the inmates. In fact, from figure 2, it is obvious that counselor 47 is the buffer between the supervisor and the inmate population. It is worth noting that the supervisor agreed with this description.

Group four contains the rare combination of a mutual link between 14, a black inmate, and 52, a black day officer. This reflected a strong personal bond between the two which later dissolved when the inmate betrayed the relationship by not "shaping up." The officer was a very unusual staff member. She had direct links from only three of the other ten staff and had no direct ties to them. By contrast, 11 inmates had direct links to 52. She and 47 had among the highest number of links to them in the cottage. The difference is that 47 had four links to other staff. This reflected a genuine difference in their views of the institution and their careers in it. Fifty-two was disillusioned with the idea that KYC could provide effective help for young inmates, while 47 felt quite positively towards the program and his role in it.

Group five contains white inmates of urban background. The dichotomy between white and black is shown most tellingly by the fact that only one black inmate had any member of group five on her first row. Group six contained black, north, urban inmates, as did group seven. Group eight contains three blacks (5, 20, 22) and a white (15) who is not on the first row of any of the other members of the group. Curiously, 15 is on the first row of only three people, all of them black, and all of her first row are

black. Group nine is a white inmate (4) with the chore officer (49) on her first row. This is not reciprocated.

At first glance it may seem odd that a staff member and an inmate find their way into a group together. In the case of group four the link was mutual and reflected a genuine social bond. In group nine this is not the case. The factoring of the catij matrix produces groups by finding persons who see their relationship to the rest of the universe in a similar fashion. It is almost certain that they will have links to one another, but this may not be the case in a group of very few people. Forty-nine placed four on his second row, not his first; but persons four and 49 both interacted strongly with the staff.

Other difficulties exist when a group is patently too large to be a "clique" in the normal definition of the word. In B-cottage one factored group contained 18 persons. Thirteen of the 18 members of the group were whites from Tennessee, Kentucky, North Carolina and Florida. It just happened that the living unit had an unusually large component of southern whites at that time and this was reflected in the matrix. In sorting their relationships with others in the cottage, the white southerners exhibited a similarity identified by the row-by-row factoring.

Another group was composed of seven staff and one marginal inmate who was "never friends with anyone" and was "just used by the other black students whenever they want anything." Inmate scuttlebutt had it, moreover, that he "never took a bath except when his counselor couldn't stand to have him in the same room with him." Now this marginal student who shows up in the staff group is disowned equally by staff and inmates alike.

He shows up in the staff group only because he has 1) many row-1 contacts with the staff and 2) very poor communications links with his fellow inmates, just like the staff. The fact that he is a row-1 communicant for many of the staff is not indicative of any affection for him by the staff. He ingratiates himself, constantly makes minor requests of the staff for bandaids, cigarette etc. and is "generally a nuisance." Thus, in spite of his lack of personal appeal, he does communicate. "Some people," a counselor said "communicate because they're a pain in the ass."

The word "cliques" then, appears in quotes here, because there may be no social cliquing effect in the groups identified by the factoring of catij, but rather only a mathematical cliquing. It is up to the investigator to determine the cause of the grouping and, indeed, the group may be an artifact of independent but highly similar views of the social universe by a small number of people. As group size goes up (even to three persons) it becomes very unlikely that clumping is an artifact; but the possibility requires consideration. It is for this reason that we can not stress too highly the need for ethnographic investigation as an integral part of the catij methodology.

Group ten is another staff group, and group 11 another black, urban group. We may graphically illustrate the relative importance of each group as in Figure 4, where the members of each group have been submerged into a square box. Note that each line represents two row-1 connections. To improve the connectivity, the intermediaries mentioned previously have been added. The intermediaries are completely disconnected if 35 is removed from the diagrams--and, indeed, 35 is not an intermediary between groups, only between certain intermediaries. The lack of connectivity

FIGURE 4 HERE

Fig. 4

Schematic diagram of C-cottage, between-group
links. Each line represents 2 links, single
connections omitted. Some intermediaries have
been added. Persons are circled, groups
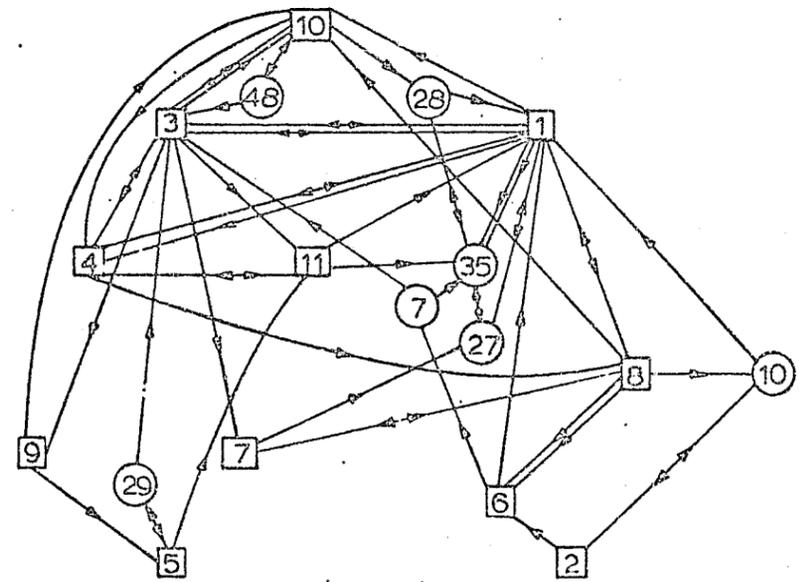enclosed within in a square.

between intermediaries is in agreement with the theory proposed by Kill-
worth (1973) from numerical grounds, that in any large social group 1)
there will be subgroups; 2) there will be a group of "knowers" of people
in the various subgroups; 3) these "knowers" will not be part of the
subgroups themselves; and 4) these intermediaries will not know each
other and in general would not be placed by a factoring into a common
subgroup.

The picture presented of the network in Figure 4 is, of course, highly
oversimplified. For comparison, Figure 5 shows the entire network (with
directionality omitted for clarity). We cannot overstress the complexity
of such a diagram; any selective treatment must inevitably result in
possible important links being omitted. However, selectivity is im-
portant for the comprehension of all but the smallest networks, for
complexity exists at all levels. Consider Figure 5. This shows, in block
format, merely some of the possible routes from groups two to ten and vice
versa. Note that directionality is very important--typically between
group links are not reciprocated whereas within-group links are. Some
interpretations of this are given in Part 4.

Of all the inmate intermediaries, only 29 is white, and serves as
intermediary solely between white groups. Forty eight is a staff member
and serves only as an intermediary between staff groups. Intermediaries
27, 28 and 35 were all recipients of very large row-choices (e.g. 19 for
no. 35) although, as seems to be common, they possess no more than the
mean number at row-1 entries themselves. It is significant that these
three are all and only the bulldykes (active female homosexuals) in
C-cottage.

Fig. 5

Total communication within C-cottage as
drawn on a Calcomp. Directionality is
omitted. Placement of persons corresponds
approximately to Fig. 4.
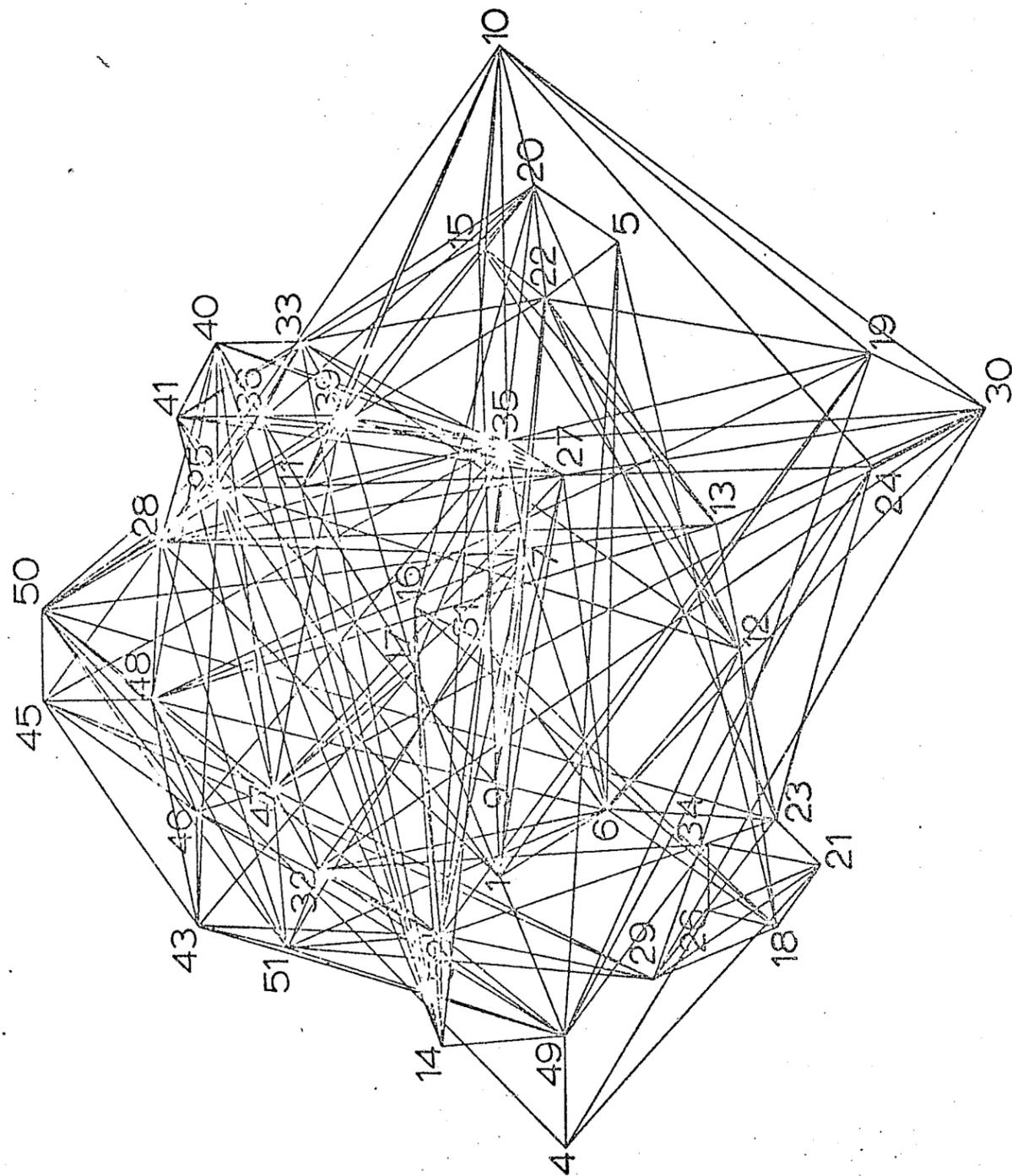
In fact, observation and interviews with staff and inmates in C-cottage showed these individuals to be the most socially powerful inmates in the group. Consider these power brokers' relationship with the staff. Twenty-eight had four   row-1 links from the staff and reciprocated only one; person 27 had one non-reciprocated link to a staff member (her counselor); and 35 has two links from staff but neither are reciprocated. The implications are serious. One is that the staff is ignorant of the role of these individuals. When we briefed the staff on our initial findings they professed little knowledge of the social control exercised by persons 27, 28, and 35. On the other hand, since homosexuality is defined as a severe problem, we have no way of knowing if the staff's professed ignorance was not evasive. For example, when asked "who are the most powerful and important inmates?" they did not mention 27, 28, or 35. When we showed them our results, however, they agreed with us and offered cavils regarding the way in which we had phrased our original question.

Another implication of the position of 27, 28, and 35 is that the staff has no control over the inmate section of the social structure. The power brokers simply do not communicate well with the staff. On the basis of our observations at KYC in general, it is suggested that the power of inmates (vis-a-vis their peers) is eroded by their reciprocating communication with the staff. This is an obvious fact, but worth noting since it reinforces the growing awareness among penologists that prison society and culture is simply independent of the goals, aspirations and motivations of even the most enlightened and dedicated institution. (See, for example, the work of Grosser (1970), Cressy (1961), and Sykes (1958).

Part 4

Having presented a numerical technique and the details of a social group described by that technique, we may now consider some of the more basic sociological implications. Conclusions are drawn from data collected in five cottages (two of them on two occasions) and from an analysis of the case-management staff of XYC. The latter included a senior executive who is considered part of the institution's top management group. Below him were a series of "lieutenants" and a "captain" (local jargon for senior watch supervisor and his group). Below them were all the officers on duty, all the counselors in the cottages, and the secretaries for the cottages, records department and senior personnel.

1. It is of interest to inquire what observable social factors effect the formation of subgroups within XYC. The question of sex enters by definition only incidentally. Male counselors in female cottages are obviously associated with female inmates and vice versa; but this is hardly significant. The role of the bulldykes in C-cottage has been noted in Part 3. There is no equivalent role played by male homosexuals in any of the male cottages.

Color seems to be the main driving component in cliques, and typical examples were given in Part 3. In virtually every group within five cottages, the black-white split was significant at the one percent level or better. The position of brown inmates is somewhat ambivalent. Within the confines of color, geographical location is important. We coded home town of inmates by a single North or South and examined the subgroups for evidence of significant structuring within the limits set by the color of

the inmate. Several cottages contained such uneven ratios of whites to blacks or North to South that comparison was invidious; however, on four occasions (i.e. in four groups from the factoring process) we found splits between North and South significant at the 6, 2.7, 2, 0.1% levels. Attempts to include the effects of urban versus rural backgrounds gave no significant results; nor did the crime for which inmates were convicted seem to play any part in their social grouping.

Since the number of links between black and white is scarce, how many inmates serve as cross-color intermediaries? For this purpose, define an intermediary to be an informant who allows two way communication between a black and a white group; he may or may not be a member of either group. Then the following applies to all the cottages tested: such intermediaries are extremely rare—usually two to a cottage at most. The same intermediary may be used between various groups. If the intermediary is not a member of either group, he is white; if he is a member of one group, then he is black (this statement fails only four times in all the cottages). Intermediaries do not usually communicate. It is tempting to hypothesize that these statements imply that whites make more effort to communicate than blacks (since a position as an intermediary between white and black groups presumably implies greater diplomatic tensions than a black on the edge of a group communicating with whites).

Granovetter (1973) noted that envelopes in the small-world problem were lost more frequently during or after the crossing of a strong black-white link than a weak one. We shall define a strong link between i and j to be one for which d_{ij} is "small" in some sense. Then it turns out that black-white intermediaries are no weaker than more general intermediaries

in the various cottages. The relative strengths of intermediaries may
be summarized as follows: the mean ranking between those in a group who
had row-1 links was 2.59; the mean ranking between all members of a
group, regardless of whether they are linked or not, was 10.58; and the
mean ranking between a member of one group and a row-1 communicant in
another group was 5.42. In other words, the only weak parts of the net-
work are those non-links within groups, whereas links between groups
are strong (although not as strong as links within a group). The defini-
tion of a "small" d_{ij} is of course subjective, but it seems to us that,
for these networks at least, Granovetter's (1973) speculation concerning
the importance of weak lines is unfounded. This is not to say, however,
that for larger networks we would continue to find this pattern. If,
as we will suggest below, an individual has 20-30 other people on the first
row of his total ego-centered network (i.e. including all aspects of his
life) then it may be plausible that it is weak links which connect various
sectors of his network. More numerical evidence is necessary if this is to
be confirmed.

2. A frequently occuring problem is that of defining a "suitably
closed" group to which catij can be administered. Naturally occurring,
physically closed groups, such as a large-scale mountaineering expedition,
ships, nuclear submarines and the like, are rare, and study of completely
closed groups has been of necessity confined to artifically formed groups
(e.g. the NASA sponsored Penthouse experiments). In this case the members
of the group are usually paid for their services, and hence the group
hardly counts as a naturally occurring system.

In general, then, any individual is a member of several different
social systems simultaneously: work, family, social life, etc. These
may or may not be intersecting. Presumably people are able to process
all these systems simultaneously precisely because they are never asked
to do just that. We compartmentalize the various sectors of our life
and recall them when necessary. For example, when we administered catij
to each of the KYC cottages, the staff placed about seven people on their
first row; some staff, some inmates. Later we administered catij to
the case management staff (over 100 people) of all the cottages; a mean
first row of about eight people was found—some staff from the individual's
own cottage, some from other cottages. From Miller's (1956) classic
article on the subject, it is unlikely that we process the (say) 12 people
involved, in addition to the (say) seven people involved in family life
and the further (say) seven involved socially—at least not simultaneously.
On the other hand, the "small world" experiments of Milgram (1967) indicate
that the passage of an envelope between any two individuals in the U.S.,
via personally-acquainted intermediaries, can be achieved by the use of five such
steps on an average. A crude estimate, of the number of such inter-
mediaries possessed by any individual can be obtained by assuming the
U.S. to have a population of 200 million random individuals, each of which
has N intermediaries. Then, neglecting the effects of clustering,
physical constricture of environment, etc. (some of which are dealt with by
Shaw, 1964), an envelope released from one individual could
reach any of N individuals after one step, N^2 after two steps, and N^r after
r steps. If N is reasonably large (> 10, say) then overlapping effects

are negligible. Then, putting $N^r = 2 \times 10^8$, we have $N = (2 \times 10^8)^{1/r}$.

For $r = 6$, this gives $N = 24$; for $r = 5$, $N = 46$, for $r = 7$, $N = 15$.

If we take the median value of $N = 24$ as an order of magnitude estimate, this would indicate that an average individual is involved in three-four psuedo-closed networks, each of which contain seven-eight intermediaries. This agrees with the suggestions made above, but of course remains little more than a guess.[6]

Hence the problem of defining a closed system is difficult. Social and family life are apparently unclosed, and problems remain even in work-oriented situations. For example, consider again the case management data versus the cottage data. These are both part of the work-system of a staff member of a cottage. Would we obtain differing answers if we asked such a staff member to arrange cards for both the administration and his cottage simultaneously? Assume that the relative rankings (i.e. within case management or within the cottage) remained unaltered. It is then probable that there will be a difference between the occupants of (a) the first row derived from the full card sort (case management U cottage) and (b) (the first row from case management U the first row from the cottage). Even though there are a variety of cases in which set (a) will be a subset of set (b) or vice versa, how will we know which set to believe? Which represents, in some sense, the social structure we are trying to measure?

The answer, in general, must inevitably depend on ethnographic and other evidence. For example, we feel that results from both sets of

data referred to above are valid, although the union of the two may overestimate the number of row-1 communicants perceived by a staff member.

3. We have noted previously (Part 3) the existence of a two-culture system in C-cottage, and our results indicate that such a structure is the rule, not the exception, for all the cottages. When links between staff and inmate occur (as they must) they are usually one-way. In a very few cases, a guard or counselor would score high row-1 scores as a direct communicant with the inmate population, typically through personal bonds of some form. In all such cases, however, the staff member would not score well as a communicant with the other staff. For example, Table 1 shows the correlations between two sets of row-1 scores: (a) the correlations between the number of times a staff member occurs on the first row of other staff and the number of inmates on his first row, and (b) the correlations between the number of inmates on a staff member's first row and the number of staff on his first row.

Table 1

Correlations on staff-inmate interaction

Cottage	(a) from staff-to inmates	(b) to inmates-to staff
J	-0.42	-0.37
B(time 2)	-0.59	-0.83
B(time 1)	-0.60	-0.71
C(time 2)	-0.09	-0.73
D	+0.38	-0.67
C(time 1)	+0.12	-0.81
A	+0.01	-0.82

Thus, only in D cottage was there any evidence that communication with

inmates was accompanied by communication from staff. In J and B

cottages (on both occasions of data collection from the latter) the

evidence points strongly to the opposite: namely that a staff member

who communicates well with the inmate population is not perceived fre-

quently as a direct communicant by the other staff. Further evidence

is given by column (b), which shows that if a staff member communicates

with inmates, he is unlikely to communicate with staff, and vice versa.

However, it is worth noting that such high correlations are caused partly

by the limitation imposed psychologically upon each person. If, for

example, every staff member had exactly Q members on his first row,

divided arbitrarily between staff and inmates, then the correlation

would be exactly -1. Because differing individuals perceive differing

number of row-1 intermediaries, this correlation is reduced.

The general result concerning the lack of communication by staff

to one of their number who knows many inmates is strengthened if we

consider the case management study. A similar correlation to (a) in

Table 1 can be computed for the staff in each cottage, using now all

the case management staff. Correlations of almost the same order are

obtained for J, B-2, and B-1 (-0.49, -0.50, -0.52 respectively).

Hence, in these cottages, at least, we are led to the conclusion already

shown by other techniques in Part 3 for C cottage: namely that despite

the efforts by the staff, the inmates produce their own discrete social

system.

Another interesting split in the social system of the prison occurs

in case management. The range of times for which an individual showed up

as a row-1 communicant for all others in the group perfectly reflected

the bureaucratic hierarchy imposed on the group, with the exception that

the senior officer--who was part of the "central administration"--did

not do any better than high average on this raw score. The four lieu-

tenants and the captain scored between 19 and 28. Ten low ranking of-

ficers, counselors and secretaries scored from one-three. Significantly,

50 percent (5) of the lowest ranked personnel were women; only 30 percent

of the total group were women. The trend continued on up through the

distribution of the ten persons scoring four: 50 percent were again

women. Taking the extremes, the top 30 percent of the group scored ≥ 9,

with six women and 25 men. The lowest 30 percent scored ≤ 5 with 13

women and 17 men. A Chi square of 4.92 shows this distribution of women

to be significant at beyond the .05 level, with one degree of freedom.

This level would be exceeded if all N were accounted for. The 30 percent

scoring between five-nine, however, were intentionally removed in order

to be as severe as possible on the data. The descriptive statistics show

exactly what might be expected in this type of bureaucracy. Recall the

grounds for jealousy by men incurred after the need for women counselors and

officers appeared with the opening of female cottages at KYC.

4. Figure 6 represents the possible "routes" from anyone in group 2

to anyone in group 10. As in Figure 4, each link represents two real

links, and single links have been suppressed. Hence routes other than

those shown in Figure 6 are also possible. Any non-looping circuit may be

followed to get from anyone in two to anyone in ten. Now the language

we have used here is definitely misleading in the sense that we really

have no idea what a social network "route" means. Although it is very

disconcerting, we must admit that the phrase "get from anyone in two to

anyone in ten" has no operational definition, save the algorithm required
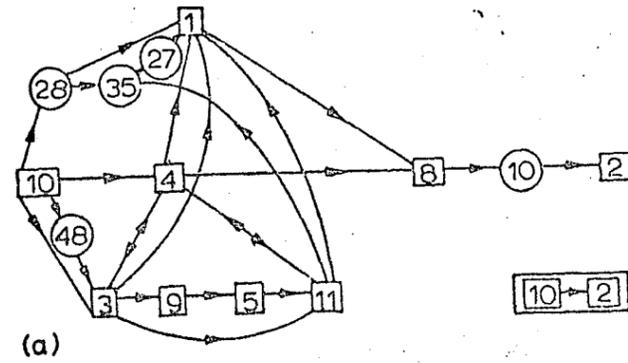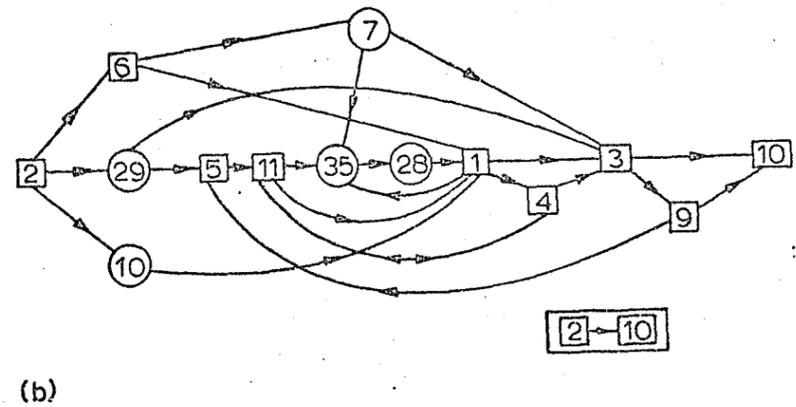
FIGURE 6 HERE

(a)

Fig. 6

Possible routes from (a) group 10 to group 2; (b) group 2 to group 10. (Note the asymmetry). Each line represents 2 or more links. Persons are circled, groups enclosed within a square.

(b)

Fig. 6.

to trace the non-looping paths between individuals. Of course, no more
could be said for any other sociometric. But, as we have shown above and
elsewhere (Part 2, this paper, and BK) catij is obviously measuring some-
thing more than would be found by standard sociometric methods. In terms
of a small world problem, then, we would expect an envelope to be de-
livered directly--if for no other reason than the spatial and temporal
conditions in a small, closed social system make any other behavior im-
probable. We might hypothesize that a rumor would follow one of the
plausible routes between persons in groups 2 and 10. But this is im-
possible to test. So, in the end we are still stuck with the same dis-
turbing question: What does figure 5 (and the larger picture of the whole
cottage shown in figure 4) mean? Here is our answer, thus far.

Part 5

CONCLUSION

1) We believe that a social structure exists in established groups, such
   that it is stable to minor fluctuations at the local level within the
   system.

2) Perception, or intuition about ones own place in the structure, is
   limited to a) one's own direct communicants (i.e. about 7 ± 2 people)
   and about 70 percent of one's secondary communicants. In fact, some
   surprises occur to people for the other 30 percent; these result from a
   simple lack of knowledge about who one's primary communicants have as
   their primary communicants.

3) We believe the perceived social network of an individual to be a sub-
   set of the total network (a physical entity) which is, by definition,
   describable.

4) Catij describes the physical entity referred to as the social structure.
   Admittedly, the description is crude, but it is less crude than any
   other description of which we are aware.

FOOTNOTES

[1]This work was carried out with support from the Federal Bureau of Prisons through the Research office of the Kennedy Youth Center, Morgantown, West Virginia. Our special thanks are due to Loren Karacki and Helene Cavior, Directors of Case Management at KYC. Richard Kuzalski, programming consultant at West Virginia aided in data processing. The inmates and staff at KYC are tested to death; to them we owe immense gratitude for patience and aid. Write-up and continuing research are supported by the Office of Naval Research.

Neither the Federal Bureau of Prisons nor the Office of Naval Research is responsible for any statement or conclusions in this paper. This paper does not represent the views of either agency and is solely the work of the authors.

[2]On rare occasions, 3-dimensional displays are attempted. A particularly imaginative example from multidimensional scaling (and hence, not a sociogram) may be found in Stefflre, 1972.

[3]Various possible effective communications patterns have been suggested in the literature--e.g. the wheel vs. the circle (Leavitt, H.J., and Knight 1963). Buried in the complexity of various prison cottage networks (see Part 3) one may find both wheels and circles, each garnished with extra links. Curiously, these occur among the inmates (who possess no common goal or reason for being in prison) as well as among the task-oriented staff. The implication appears to be that social group may ensure effective communication by combining such shapes as the wheel and circle modes of interaction.

[4]Current work is aimed at increasing the size of the group discribable by catij; however, this requires sampling procedures which have not been fully developed. In fact, the primary disadvantage of catij compared with the sociogram is the increased time necessary to administer the instrument. Work currently in progress has eased this disparity. Empirical testing is still very limited, but it appears that catij can handle groups of about 200 in size. For groups of about 40, the full catij matrix is obtained by sorting only the top 15 persons. For groups of 200, about 25 should suffice with no loss of generality or information.

[5]The basic algorithm (which is, of course, much neater than that described here) for producing the minimal distance from i to j is given in Acton (1970).

[6]While we are guessing, though, we would venture that anthropologists doing network studies would find that primary contacts cluster around two dozen. This calculation becomes very important for the small world problem. Milgram (1967) noted that people have about 500 acquaintances from whom they might choose in order to initiate a small-world folder path. Our hunch is that experimentation will show people using the same 7 or so initiators for the most wildly divergent kinds of problems; and in any case, no more than about 24. Experiments are currently planned to test this hunch.

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