TELECOMMUNICATIONS AND URBAN DEVELOPMENT

by

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ABSTRACT

This thesis is broadly concerned with the relationship of communications to urban development. It specifically develops a communications perspective on spatial structure in the Vancouver, B.C., metropolitan area by examination of one communication variable, telephone traffic. Origin-destination calling data are used to identify communication networks, suggest functional associations, and relate social area structure to communicative (interactive) behaviour. A further purpose is to employ the above findings in developing suggestions as to possible imports of future communication technologies. For the first three chapters, the mode, i.e. telephone hardware, is held constant, in the fourth chapter the hardware is considered as a variable.

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And thank you to my parents for incredible patience.

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C H A P T E R I

The first chapters of this paper are broadly concerned with two questions:

1. Can intra-metropolitan, origin-destination telephone data be used as a comprehensive indicator of urban spatial relations -- can such a data base be used to produce a skeleton of urban structure?
2. If the answer to 1 above proves positive, what is the spatial structure of Vancouver, B.C., as revealed by these telecommunication relationships.

Thus, the first question is methodological and the second substantive.

Telephone Data

There are many measures of metropolitan structure and telephone calls represent only one of these. The contention is, however, that telephone calls do represent several important characteristics which facilitate a unique expression of urban structure. Some points which describe the nature of telephone calls are useful for an understanding of the data used.

1. Ubiquity - telephone ownership is above 90% of households and most everyone has access to phones.
2. Speed - This is a very important facet and determined much of its use.
3. Two-way - Such rapid two-way communication

plays an obviously important role in social and societal organization.

4. Cost - Phone calls are very inexpensive compared to other forms of travel and communication, and the cost is falling.

5. Privacy - Most phones have exclusive connections and it is against the law to 'tap'.

6. Routing - Phones are relatively free from physical barriers and have highly flexible routing.

7. Interconnections - New technological devices are providing for multiple use of telecommunication channels.

The above points summarize the distinguishing media characteristics of phone calls and suggest some relationship between telephone calls and the total circulation of information. Two other considerations are important. The content of calls differs in importance depending on whatever criteria are established. For the purpose of this study, however, there is no practical method to account for this. The assumption is made that the proportion of business to social calls to each point is the same for each area. This is not strictly accurate, of course, and a closer estimation can be obtained from the portion of business connections compared to private connections for any one area or level of aggregation.

Secondly, the length of calls must be assumed to be equal. A measure of three minutes per call is used and this is standardized by North American telephone companies.

Previous Studies Using Telephone Data

There have been many spatial and functional analyses of regions by using telephone data as a metric measure. Green (1955) used such data to establish a hinterland boundary between New York City and Boston. Siddal (1957) used the frequency of calls to show that towns in Alaska were mose closely connected to Seattle than to other Alaskan towns. Schroeder (1958) used long distance calling to determine the hinterland of Chicago. MacKay (1958), comparing a distance decay function with phone calling in Eastern Canada, established interaction boundaries. He identified barriers exerted by political and linguistic boundaries and found that for messages from a Quebec city ...

> English speaking cities behave as if they were five to ten times as far away from Quebec cities of the same size and separation, and those in the U.S.A. as if they were fifty times distant.

Using a graph interpretation of calls in Washington State, Nystuen and Dacey (1967) derived a hierarchy of functional regions highly correlated to other measures of regional analysis. A factor analysis of telephone traffic in Denmark was used by Illeris and Pedersen (1968) to indicate regional centres and influence zones. They found their results to compare favorably with several other methods used in previous studies of centrality. Ikle and Hammer (1957) correlated telephone and

airline traffic to distance and "propensity to interact". Finally, Simmons (1970) found phone calls, automobile movement and truck flows all closely related as measures of interaction of Canadian cities.

Telephone Data Base for G.V.R.D.

The studies previously mentioned that use telecommunication tend to support the first thesis of this paper -- that telephone data can be used meaningfully in urban analysis. None of the previous efforts, however, were specifically concerned with intra-metropolitan studies. Towards this end, telephone data, in the form of origin-destination volumes, were obtained for the Greater Vancouver Regional District (G.V.R.D.) Telephone Company.

This data represents telephone calling in twenty-two exchange areas which together comprise the geographical area of the G.V.R.D. (See Table I). It is displayed in the K x K matrix of Table I. Each column and row is numbered and labelled with a telephone exchange area prefix which corresponds to the first three digits of actual telephone numbers. The rows represent origins and the columns destinations, and the diagonal elements intra-zone calls. For example, entry 4:7 reports the calls that the Castle exchange area makes to the Fairfax exchange area. And the entry 4:4 represents the flow within the Castle exchange itself.

This measure is in the form of milliseconds or C.C.S. The time period

for each measure is the peak traffic hour for a morning in May 1968. Thus cell entry 4:7 means that the Castle Exchange (CAS) made calls to the Fairfax Exchange (FAI) during that hour totalling 55,100 seconds. The standard length of telephone conversations, as established by B.C. Tel is three minutes. Thus the entry could also read as approximately 305 calls. Since the original data is in the form of C.C.S. this measure was retained to minimize the loss of information in the data.

Two problems were encountered in assembling the flow volumes. Not all G.V.R.D. exchanges are directly connected, many go through trunking routes. An example is the North Shore, where calls from North Vancouver (NOR) and West Vancouver (WVN) to Ladner (LAD) and Beach Grove (BGR) are routed through the Mutual (MU) or downtown exchange. The original data sources show a certain volume from WVN and from NOR entering the Mutual tandem and BGR and LAD receiving a certain volume (b) and (e) respectively. It is then necessary to statistically calculate the specific origin-destination volumes. This was achieved by taking the percentage volume received by BGR and LAD ($\frac{b}{b - e}$ and $\frac{e}{b - e}$) and multiplying it by volume originating from WVN and NOR. The difference is then distributed.

It is the same method used by the B.C. Telephone Company. By putting actual tracers in the trunk lines, they have found it to be surprisingly accurate.

The other problem involves toll-calling. Forty-nine entries of a total 484 require a minimum toll charge of approximately thirty-five cents per three minutes. This undoubtedly exerts a rather strong bias on the volume of calling but is not accounted for in this study. The difficulty of any accurate weighting and the comparatively small number of exchanges affected rendered adjustments unnecessary.

Conceptual Context

It is recognized that there are many measures of urban structure. Traditional studies usually describe land use patterns to summarize the distribution of activities, population and growth. The major elements are the C.B.D. and related commercial components: zones of manufacturing and residential districts. Generally, there are three classic formulations:

1. The concentric zone theory of Burgess (1929) which employs notion of concentric zones radially expanding from a core.
2. Hoyt's (1939) residential sector theory which assumes that wedges or sectors of different rent levels exist in a highly differentiated pattern around the C.B.D.
3. The multiple-nuclei model formulated by Harris and Ulman (1945), which is a modification of the above two models. It assumes growth around several nuclei rather than around a single core.

Though these concepts provide valuable general insights into urban structure, their present value has been considerably eroded by growth processes of the last few decades. A population boom, rising incomes, changing socio-economic distributions and rapid technological development are some of the factors distorting the classical views. (Hoyt, 1971)

Chapin (1971) and Hagget (1968) have summarized some of the more recent theories of urban growth and structure. They may be seen to exist on a conceptual continuum from system oriented to process oriented. (Rogers, 1971) The system or micro approach "focuses on a particular site within an overall pattern and is concerned with the forces which determine the activity which will be carried on at that location". (Rogers, 1971) The process or micro approach instead examines a particular activity and analyses the behaviour of decision units. The work of Chapin and Weiss (1968) is representative of the latter, and Lowry's (1964) model building the former. Between these two frameworks and not mutually exclusive of either are several other modelling attempts.

These include the economic models of Wingo (1968), communication model of Meier (1962), interaction model of Weber (1964), the conceptual system model of Lynch and Rodwin (1962), the accessibility model of Guttenberg (1964), Hagget's (1968) functional regional models, and Berry's (1969) matrix formulations. Thus the diversity of approaches to urban

structure is readily seen.

This diversity, however, has a common though often implicit focus, the notion of a city as a communication system. The theory building of Meier (1962) and Weber (1964) are most representative of a communication emphasis. Such an approach focuses attention on the processes of human interaction. It is interaction, not place; communication, not land use which is the essence of life. (Simmons, 1969; Wilmoth, 1970; Deutsch, 1961; Friedman, 1968; Baran and Greenberg, 1967; Fleischer, 1962).

Within this context, the particular concern here is to map the inter-metropolitan spatial structure of the Greater Vancouver Regional District. The term "spatial" as compared to "aspatial" relates the pattern in which culture, activities, people and physical objects are distributed in space (Foley, 1964) and, in this instance how they are revealed through an analysis of a telecommunication variable.

This spatial patterning has two aspects. The formal is a static snapshot view of a metropolitan pattern at any one point in time. (Foley, 1964) The processual is the ongoing functional relations of the metropolitan communities. Within this conceptualization Webber (1964) suggested analysis of both these aspects of a spatially structured process. The structural or formal aspect has three components -- within-place activities (employment, residence, etc.) and between-place activities (communications, transportation) and

adapted spaces (use of space for within-place activities). The functional aspect is defined by the functional interdependence expressed as interactions. (Echenique, 1969) Generalizing these ideas slightly, Cripps (1969) has even suggested that the term urban structure is somewhat of a misnomer. Instead he finds ...

> the concepts of adapted space and communication channels to be the most general groupings of structural elements in present theory, and also the first distinguished categories for shaping urban structure in the post-Industrial ages.

Communication, however, even a single type such as the telephone, is difficult to categorize. Though it does link activities it can also be said to separate them. Further, it can be considered as an activity in itself, both between and within place, and its physical channels can be seen as adapted spaces.

Conceptual Background

To begin this study, the metropolitan area is conceptualized as an isotropic communications space. All points are assumed to be connected perfectly with no differentiation from place to place, or in one direction or another. (Nystuen, 1968) Also there is assumed to be no friction of distance, all points are connected equally and instantaneously. From this abstracted concept three independent variables are derived from actual telephone communication:

1. a directional orientation of phone traffic,

2. a distance of traffic origin and destination, and

3. a connectivity or volume of calls.

These variables in combination, are taken to define the communication network of the Greater Vancouver Regional District (G.V.R.D.).

Since this conceptualization is fundamentally geographical, Soja's (1969) generalized framework for spatial analysis provides a useful procedural referrent. It is represented in the following diagram:

Locational interaction	Spatial Structure	Functional Region	Spatial Analysis
Micro-spatial behaviour	Spatial System	Macro-spatial behaviour	Behavioural Implications
Locations attributes	Areal Association	Formal Region	Areal Analysis

Figure 1

Framework for Geographical Analysis (Soja, 1969)

The upper level of the diagram represents a fundamentally spatial approach which involves stress on interaction between points (or locations in space) and the organization of space into functional or nodal regions. The lower level focuses upon the attributes of places, the areal association of these attributes and the organization of areas into formal regions. In the centre, the spatial system indicates an integrative focus, and behavioural implications are positioned there

to suggest a potential for combining both areal and spatial analysis (formal and functional).

Within this framework, telecommunications constitute a pattern of human activity. Sampling telephone calls expresses relationships of people localized at points. Communications then are first associated with people and secondly with location, though initial emphasis in this study is on the latter aspect.

Previous Studies of Vancouver Spatial Structure

There have been several studies of different aspects of the spatial structure of the Vancouver region. Wolforth (1965) has done an analysis of residential location and place of work. He found that people employed in the Central Business District (C.B.D.) have more dispersed residences than those employed elsewhere, and that this distribution has a westward bias for those employed in the western section of the core area and an eastward basis for those employed in the eastern section. This is structurally reflected in the radially segregated socio-economic patterns of residence for the metropolitan area. Further, he found that peripherally located work places served more clustered residential areas.

Heichman (1969) used traffic volumes to compare the core area journey to work with the peripheral journeys to work. He found that the proportion of central workers per residential area drops with the distance from the core.

ORIG	1 ALP	2 AMH	3 BGR	4 CAS	5 CYP	6 DPC	7 FAI	8 HEM	9 LAD	10 LAK	11 NUT	12 NTN	13 NOR	14 PTQ	15 PTM	16 REG	17 RMO	18 STU	19 TRI	20 WVN	21 WHA	22 WRK	TOTALS
1 ALP	6678	589	106	273	1900	88	1363	2128	53	1200	4279	184	676	124	320	1379	583	292	2502	355	318	142	25241
2 AMH	663	9066	172	1470	598	144	2016	1323	86	1028	4248	158	1094	201	518	4050	291	291	1575	576	272	122	29962
3 BGR	93	229	3024	93	115	5	245	267	343	183	437	45	26	4	14	228	271 -		210	16	83	48	9992
4 CAS	282	1583	81	2472	299	68	551	526	40	514	1937	79	519	95	245	2031	143		693	273	136	61	13626
5 CYP	1974	577	160	309	8213	133	1167	2533	80	1123	3167	294	1017	87	481	1184	507 -		1527	535	561	292	25954
6 DPC	168	168	4	76	199	1117	160	239	2	315	422	6	717	340	102	231	114 -		181	212	15	3	5425
7 FAI	1441	2004	135	493	1152	112	7790	3112	67	1714	3442	263	857	157	486	2033	1210 -		3122	451	454	203	30618
8 HEM	2187	1159	721	545	2387 28	184	3930	11485	110	3771	3172	579	1401	258	664	1938	938 -		2774	737	999	448	35637
9 LAD	52	129	293	46	64	2	132	163	1319	183	235	45	18	400	10	123	164 -		113	644	83	48	3232
10 LAK	1092	648	163	420	1553	113	1077	2803	145	15261	4013	1041	629	619	2411	1217	794 -		1464	241	2172	13	37959
11 NUT	4051	3399	120	1479	2884	331	3066	3414	125	4386	37212	659	3700	400	955	6853	2014 -		6051	2275	1135	507	85014
12 NTN	286	170	60	110	402	9	345	681	138	1198	785	3932	71	34	93	331	208 -		400	18	1656	346	13020
13 NOR	810	1313	28	592	946	619	919	1405	23	633	4816	68	15646	51	460	1605	443 -		1293	2293	180	30	33371
14 PTQ	190	142	3	72	156	5	221	449	3	733	575	34	56	2852	639	22	16 -		263	15	71	2	6729
15 PTM	569	331	15	207	1119	69	583	1271	12	2250	1217	93	386	600	7302	552	284 -		618	160	929	30	18596
16 REG	1470	4143	231	2194	1135	193	2072	2006	116	1885	7722	289	1470	270	696	9284	1030 -		3219	774	499	224	40971
17 RMO	333	497	9	142	270	170	668	582	129	685	1459	105	220	1228	167	550	(2609)	1445	613	130	181	115	11113
18 STU	313	587	101	200	313	114	735	670	144	339	1331	147	230	13	234	578	1512	4915	597	154	210	101	13,448
19 TRI	2668	1639	163	647	1105	163	3209	3009	81	1865	6436	289	1633	190	489	3239	1045 _		7823	544	499	224	37385
20 WVN	496	804	1606	362	590	188	399	515	7 -	71	2773	30	2541	19	116	1127	135 ·	135	538	7401	30	16	18,501
21 WHA	411	244	92	158	518	18	525	1024	132	2457	991	1607	120	70	667	493	150 ·	150	542	35	9226	347	20019
22 WRK	141	250	43	61	201	3	225	327	62	129	450	68	33	69	33	139	9	219	219	16	158	4275	7616
TOTALS:	26358 10 S	29571 9 S	4950 20 S	13471 14 S	36649 7 S	3700 21 S	30498 7 S	40031 3 S	3444 22 S	48823 2 S	80349 1 D	10394 16 S	3061 6 S	7237 19 S	17075 13 S	39427 4 S	9809 17 S	12051 15 D	26337 5 S	18854 12 S	20038 11 S	7600 18 S	

Hardwick and Leigh (1965) examined the spatial organization of intra-metropolitan retail trade. For a somewhat similar suggestion as Wolforth's but using different data bases they proposed that the C.B.D. shopping areas are segregated and cater to distinct residential areas. More detailed analysis led to the conclusion that, in terms of retail trade, the metropolitan area was not only spatially segregated sectorally, but more generally consisted of two rings. The inner ring has a five mile radius where trip generation is not a function of distance but rather is concentrated in different areas according to the socio-economic appeal of the stores and the areal localization of socio-economic groups. (Hardwick, Leigh, 1965)

Finally, Hardwick (1971) has synthesized these and other studies into what is termed a "core-ring" model. This consists of two concentric rings. The inner ring is radially organized and focuses on the central core or C.B.D. The outer ring is circumferentially organized through a series of interconnected communities and workplaces. The importance of this model is that rather than viewing the metropolitan area as one large interacting system, it delineates two systems that interact more within each other than between each other.

Preliminary Graph Theory Interpretation

The initial analysis of this data consists of a graph theory interpretation of nodal regions developed by Nystuen and Dacey (1967). They

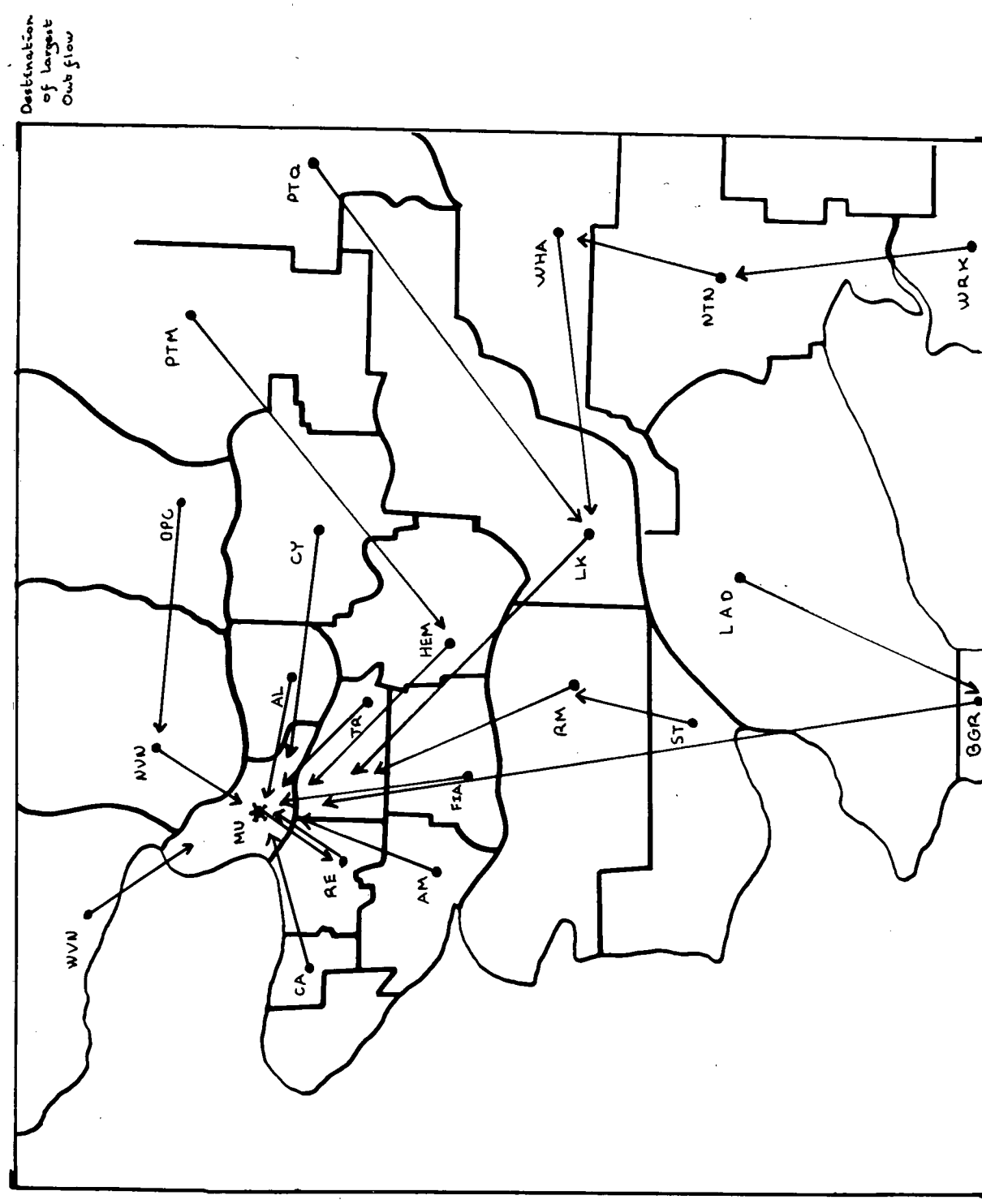
originally used it to define the regional structure of the State of Washington using long distance telephone calling data. Their findings were in general agreement with expectations and other studies of nodal structure. Here, the method is applied to a much smaller area on the assumption that for the scale of the study, the same type of dynamics are operative at a city-region scale as a state region. (Berry, 1966; Nystuen and Dacey, 1967)

Developed from theories of nodal regions and central place hierarchies (Berry, 1958), the technique recognizes that:

> . . . the direction of magnitude of flows associated with social processes are indicators of spatial order in the regional structure of urban society. Whether the flow is local and the city's hinterland or regional and to the rank ordering of cities, the notion of central or nodal point is dependent upon the levels of strongest association with the total flow.

(Nystuen and Dacey, 1967, summarizing Berry and Gavisen, 1958; Ullman, 1948; Whittlesey, 1954)

Thus by qualifying the degree of association between the exchange areas in the G.V.R.D. it should be possible to identify the networks of strongest association. These networks should outline the skeleton of urban organization. This skeleton is mapped in Figure 2. Each telephone exchange area has been collapsed to a point. The largest outflow or nodal flow of every area is mapped to its destination. These flows form the nodal structure of the region and display the functional association of the areas.

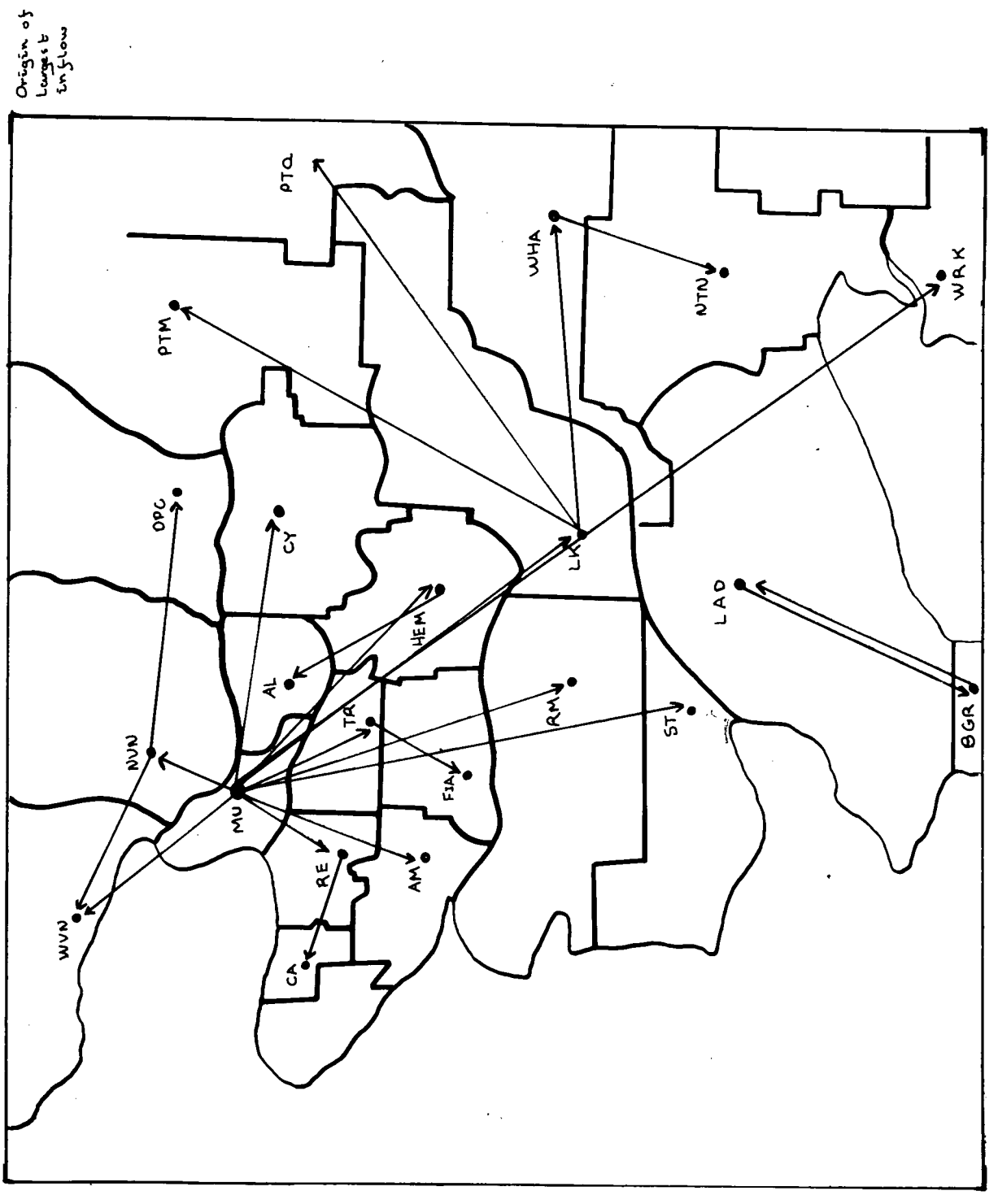

Destination of largest Owb flow
PTQ
PTM
OPC
CY
HEM
AL
TR
NVW
MU
FIA
AE
AM
WVN
CA
LK
WHA
NTN
WRK
LAD
AM
ST
BGR

In such a hierarchy of relations at least one point must be zero and is called a terminal or dominant centre. Each area is ranked according to its total inflow or messages. (See Figure 3) The dominant centre is one whose nodal flow is to a "smaller" order centre. Also, if area "a" is subordinate to area "b" and "b" is subordinate to "c", then "a" is subordinate to "c".

Framework of Present Study

The results of a preliminary analysis form a framework for the present study. On the basis of previously mentioned studies, it was expected that the spatial structure of Vancouver would resemble more the core-ring model than the more classical constructs. In accord with this hypothesis it was further expected that the influence of the C.B.D. as measured by degree of interaction would decline with distance, and the percent of intra volume compared with total communication would generally be greater in the peripheral areas. Also, if the C.B.D. is revealed as the central place of the region it should also be the transaction maximizing node, and will receive more calls than it originates. (Meier, 1961)

If the first contention is accurate, it can be taken as evidence that telephone data in the form of intra-metropolitan origin-destination volumes can be validly used as a gross measure of spatial


Origin of Largest Inflow
PTQ
PTM
OPC
CY
WHA
NTN
WRK
LK
LAD
BGR
HEM
AL
TA
RM
ST
NVN
FIA
MU
RE
AM
WVN
CA

relations by accurately delineating a skeleton of the G.V.R.D.'s spatial structure.

The results for the Greater Vancouver Regional District are displayed in Figure 2. It shows the nodal region as clearly dominated by the Mutual exchange area or C.B.D. These results are expected since Vancouver has traditionally been C.B.D. oriented. The central core has the highest population density, highest traffic counts, most commercial floor space and largest workforce.

The results also tend to reinforce Hardwick's (1971) view of "core-ring" model of urban structure. The Lakeview or New Westminster exchange is seen as a subcentre in the hierarchy, for Port Coquitlam or Whalley, Newton and White Rock. Also, though this data is not included in the original matrix, it is the destination of the largest outflow from Haney, Cloverdale, and Langley. Further the Richmond-Steveston area and Beach Grove-Ladner area suggest some independence. These are all peripheral areas (beyond ten miles of the C.B.D.) and are interacting in absolute terms, more among themselves than with the C.B.D. or any other part of the metropolitan area.

This is further evidenced by a graph of the origin of the largest outflow. (See Figure 3) Port Moody, Port Coquitlam, and Whalley

all receive the largest volume of messages from New Westminster. Ladner and Beach Grove appear as comparatively independent of the C.B.D. and the core influence is even more dispersed within the inner ring or metropolitan area proper.

The "core-ring" contention then, as revealed by observed communication patterns, appears as the emergent if not existent spatial structure of the G.V.R.D. Also the C.B.D. is the transaction maximizing node.

The following analysis proceeds within this framework. Chapter two defines and examines salient transaction flows. This is a measure of "greater than expected" intercommunication flows and is interpreted as an indication of social integration or lack thereof.

Chapter three explores the relationship of social structure and communicative (interactive) behaviour. It integrates the results of Chapter two with conventional social area analysis to examine some behavioural assumptions.

Chapter four suggests general implications of future teletechnology for patterns of urban structure, whereas in the previous chapters the hardware element was held constant, in this chapter, the analysis is taken as fixed and the hardware varied.

CHAPTER II

This chapter is concerned with a more refined analysis of the basic data matrix. Through a type of flow analysis the communication patterns of the G.V.M.D. are interpreted in terms of social integration. This is done by identifying the intercommunication flow, of unexpectedly large volumes.

Definition of Transactions

Meier (1962) established that an intensification of communications, knowledge and controls is highly correlated with the growth of cities.

> "The bonds that tie individuals to a city seem to result from the conservation and accumulation of some concomitant of these factors". (Meier, 1962)

On evaluating these bonds or relations the basic unit of analysis is the transaction. Broadly defined, a transaction implies exchanges between individuals or groups in society. It is an event involving at least the transfer of information, but may also include goods.

For the purpose of this study, transactions are point to point telephone conversations involving an exchange of information between participants. This measure of multi-functional relationships is believed to be an accurate indicator of such associations at a regional level of analysis. Though only a single index, individual telephone usage is multipurpose. Further, it has the advantage over the use of a series of indices, of eliminating the problem of weighing individual contributions of the many indices. Several

authors have concluded that telephone flows are one of the best single indices of all functional contacts. (Nystuen and Dacey, 1971; Hammer and Ikle, 1957)

On the basis of the above, telephone traffic may be used to indicate the flow and concentration of information within the urban systems. Meier (1962) has contended that wherever such flows are concentrated, behaviour is more ordered and predictable. Information here refers to a capacity to select from an ensemble of alternatives, be they social or economic, etc. Such information involves knowledge of an environment and is related to a potential for control. Concentrated flows of information then, indicate a certain level of mutual awareness among participants. Such levels of mutual awareness may be taken as indicators of at least potential socio-political integration. Thus units of society experiencing dense inter-communication volumes are the most likely to participate in collective action to promote perceived mutual interests. (Deutsch, 1964)

The Concept of Salience

Within this framework it should be possible to identify communities in terms of the probability of mutual transactions between individuals since their communications would be more frequent or important within these communities than within any others. (Deutsch, 1964) Such relationships are termed salient, and depend on the amount of time and resources used.

> "The study of the quantitative densities of transactions (salience) is the first step towards estimating the degree to which people are connected with one another". (Deutsch, 1964)

In developing the concept of salience certain assumptions must be explicated. Information exchanges may be of a mutually rewarding or mutually depriving nature. A telephone call to purchase goods on sale would be an example of the former and a call to complain of public services, an example of negative relationship. Such a normative evaluation of information content is extremely difficult in any situation and with the present data, impossible. It is therefore assumed that the majority of the telephone calling is of a mutually rewarding nature. Other assumptions are summarized by Soja (1969) as follows:

1. The greater the volume of flow between areas the greater the salience.
2. Salience indicates mutual awareness.
3. The greater the salience (mutually rewarding), the greater the likelihood of co-operation and integration.
4. An integrated territorial community is maintained by a complex pattern of information exchange which hinges upon a connected network of transaction flows.
5. Existing and potential levels of integration between areas will be reflected in mapping of salient flows. This approach shifts the focus from an examination of demographic characteristics to a more fundamental analysis of transaction flows.

Transactional Flow Analysis

The initial procedure in operationalizing the concept of salience involves a transactional flow analysis suggested by Deutsch and Savage (1960). It is based on a null hypothesis of origin-destination independence. This is a technique which removes gross size effects which occur because of the arbitrary nature of the spatial units of analysis or area exchanges, providing for the assumption that the specific characteristics of originating and receiving zones will not affect the volume of traffic among them.

Goodman (1963) has provided a mathematical summary of the major calculations and it is outlined below. Using the original K x K data matrix (page), the null hypothesis states that the probability P_{ij} that an observation will fall in cell aij is:

$$P_{ij} = P_i Q_j \qquad \text{for } i = 1, 2, \ldots\ldots\ldots k$$
$$j = 1, 2, \ldots\ldots\ldots k$$

where

$$P_i \geq 0, \; Q_j \geq 0$$

$$\sum_{i=1}^{k} P_i = 1 \qquad \sum_{j=1}^{k} Q_j = 1$$

And the maximum likelihood estimates of the parameters P_i and Q_j are ai/n and aij/n respectively, where 'n' is the total volume of the table. Essentially then this operation is a simple probability

distribution which generates a new matrix of "expected values" (Table II). Since P_{ij} can be estimated by $ai.aij/n^2$, the estimated expected value of cell "aij" is Aij = ai.a.j./n where:

$$ai = \sum_{i=1}^{k} aij.$$

Relative Acceptance Index as a Measure of Salience

A further operation is required to determine how well this new data fit the null model and whether flows can be explained simply by the theoretical tendency of P_{ij}, of area 'i' to originate calls, and the theoretical tendency of Q_{ij} of area 'j' to receive calls as generated above. In order to do this a matrix of differences is calculated for each of the original K x K entries from the formula $D_{ij} = aij - A^{\#}ij$ (see Table III). D_{ij} is the difference in value between the actual observed entries, 'aij' and the estimated expected entries $A^{\#}ij$. From this matrix a relative acceptance index (R.A.) as suggested by Soja (1969) is calculated where: $RA_{ij} = (aij - A^{\#}ij) / A^{\#}ij$. It is this measure which indicates salient relationships by identifying zones with greater than expected densities of transactions. (See Table IV)

In deriving the actual values for the R.A. index, two threshold values are arbitrarily established. In the first instance a minimum absolute deviation was set at $D_{ij} - aij - A^{\#}ij - 150$. This was done to correct the tendency for the R.A. index to exaggerate values of small exchanges. For example, where aij = 4, and $A^{\#}ij = 3$, $RA_{ij} = .66$,

EXPECTED VALUES
1274. 1429. 230. 603. 1288. 179. 1474. 1935.
166. 2021. 4394. 503. 1598. 350. 825. 1906.
474. 582. 1756. 918. 969. 367.

EXPECTED VALUES
1512. 1697. 273. 716. 1529. 212. 1750. 2297.
198. 2400. 5216. 597. 1897. 415. 980. 2262.
563. 691. 2085. 1089. 1150. 436.

EXPECTED VALUES
252. 283. 45. 119. 255. 35. 292. 383.
33. 400. 869. 99. 316. 69. 163. 377.
94. 115. 347. 181. 192. 73.

EXPECTED VALUES
688. 772. 124. 325. 695. 97. 796. 1044.
90. 1091. 2372. 271. 863. 189. 446. 1029.
256. 314. 948. 495. 523. 198.

EXPECTED VALUES
1310. 1470. 236. 620. 1324. 184. 1516. 1989.
171. 2079. 4519. 517. 1643. 360. 849. 1959.
487. 599. 1806. 943. 996. 378.

EXPECTED VALUES
274. 307. 49. 130. 277. 38. 317. 416.
36. 434. 944. 108. 343. 75. 177. 410.
102. 125. 377. 197. 208. 79.

EXPECTED VALUES
1545. 1734. 278. 731. 1562. 217. 1788. 2347.
202. 2452. 5331. 610. 1938. 424. 1001. 2312.
575. 707. 2130. 1113. 1175. 446.

EXPECTED VALUES
2001. 2244. 361. 947. 2022. 281. 2315. 3038.
261. 3174. 6901. 789. 2509. 549. 1296. 2992.
744. 915. 2758. 1441. 1521. 577.

EXPECTED VALUES
163. 183. 29. 77. 165. 23. 189. 248.

21. 259. 563. 64. 205. 45. 106. 244.
61. 75. 225. 117. 124. 47.

EXPECTED VALUES
1916. 2149. 345. 966. 1937. 269. 2217. 2910.
250. 3040. 6609. 756. 2403. 526. 1241. 2866.
713. 876. 2641. 1380. 1456. 552.

EXPECTED VALUES
4291. 4814. 773. 2030. 4338. 602. 4965. 6517.
561. 6808. 14801. 1693. 5382. 1178. 2780. 6418.
1597. 1962. 5915. 3090. 3262. 1237.

EXPECTED VALUES
657. 737. 118. 311. 664. 92. 760. 998.
86. 1043. 2267. 259. 824. 180. 426. 983.
245. 300. 906. 473. 500. 189.

EXPECTED VALUES
1684. 1890. 304. 797. 1703. 236. 1949. 2558.
220. 2673. 5810. 664. 2113. 462. 1091. 2519.
627. 770. 2322. 1213. 1280. 486.

EXPECTED VALUES
340. 381. 61. 161. 343. 48. 393. 516.
44. 539. 1172. 134. 426. 93. 220. 508.
126. 155. 468. 245. 258. 98.

EXPECTED VALUES
939. 1053. 169. 444. 949. 132. 1086. 1425.
123. 1489. 3238. 370. 1177. 258. 608. 1404.
349. 429. 1294. 676. 714. 271.

EXPECTED VALUES
2068. 2320. 373. 978. 2091. 290. 2393. 3141.
270. 3281. 7133. 816. 2594. 568. 1340. 3093.
770. 945. 2851. 1489. 1572. 596.

EXPECTED VALUES
561. 629. 101. 265. 567. 79. 649. 852.
73. 890. 1935. 221. 704. 154. 363. 839.
209. 256. 773. 404. 426. 162.

EXPECTED VALUES
679. 761. 122. 321. 686. 95. 785. 1031.
89. 1077. 2341. 268. 851. 186. 440. 1015.
253. 310. 936. 489. 516. 196.

EXPECTED VALUES
1887. 2117. 340. 893. 1908. 265. 2183. 2866.
247. 2994. 6509. 744. 2367. 519. 1222. 2822.
702. 863. 2601. 1359. 1434. 544.

EXPECTED VALUES
924. 1036. 166. 437. 934. 130. 1069. 1403.
121. 1466. 3186. 364. 1159. 254. 598. 1382.
344. 422. 1273. 665. 702. 266.

EXPECTED VALUES
1010. 1134. 182. 478. 1021. 142. 1169. 1535.

132. 1603. 3485. 399. 1267. 277. 655. 1511.
376. 462. 1393. 728. 768. 291.

EXPECTED VALUES
384. 431. 69. 182. 289. 54. 445. 584.
50. 610. 1326. 152. 482. 136. 249. 575.
143. 176. 530. 277. 292. 111.

DIFFERENCES							
5404.	-847.	-124.	-533.	512.	-91.	-111.	192.
-113.	-821.	-115.	-319.	-922.	-226.	-505.	-527.
-182.	-296.	746.	-563.	-651.	-225.		
DIFFERENCES							
-849.	7369.	-101.	754.	-231.	-69.	266.	-974.
-112.	-1372.	-968.	-439.	-803.	-214.	-462.	1788.
-272.	-430.	-510.	-513.	-878.	-314.		
DIFFERENCES							
-159.	-54.	1979.	-36.	-140.	-30.	-47.	-116.
318.	-217.	-432.	-54.	-290.	-62.	-148.	-149.
51.	30.	-137.	-165.	-109.	-25.		
DIFFERENCES							
-406.	811.	-43.	2147.	-396.	-29.	-245.	-518.
-60.	-677.	-435.	-192.	-344.	761.	-201.	1602.
-113.	-171.	-255.	-222.	-387.	-137.		
DIFFERENCES							
764.	-893.	-76.	-251.	6889.	-51.	-349.	544.
-91.	-956.	-1352.	-223.	-626.	-303.	-368.	-775.
-232.	-364.	-279.	-458.	-435.	-86.		
DIFFERENCES							
-106.	-139.	383.	-54.	-100.	1079.	-157.	-177.
194.	-119.	-522.	-192.	374.	265.	-75.	-179.
-45.	-68.	-196.	15.	-193.	-76.		
DIFFERENCES							
-104.	279.	-143.	-238.	-410.	-105.	6602.	765.
-135.	-738.	-1889.	-347.	-1981.	-267.	-595.	-279.
30.	-192.	993.	-662.	-721.	-243.		
DIFFERENCES							
196.	-1085.	-143.	-402.	365.	-97.	715.	8447.
-151.	597.	-3129.	-195.	-1108.	-291.	-632.	-1019.
-275.	-446.	16.	-784.	-522.	-129.		
DIFFERENCES							
-111.	-54.	264.	-31.	-101.	-21.	-57.	-85.
1298.	-76.	-328.	-19.	-187.	-41.	-96.	-121.
21.	7.	-112.	-111.	-41.	1.		
DIFFERENCES							
-824.	-1591.	-182.	-486.	-384.	-156.	-1140.	-107.
-105.	12221.	-2596.	285.	-1774.	93.	1220.	-1649.
-316.	-479.	-1177.	-1119.	716.	-539.		
DIFFERENCES							
-240.	-1415.	-653.	-551.	-1454.	-271.	-1899.	-3053.

-436.	-2522.	22411.	-1034.	-1682.	-778.	-1825.	435.
-567.	-932.	136.	-815.	-2127.	-728.		
DIFFERENCES							
-371.	-567.	-58.	-201.	-262.	-83.	-415.	-317.
52.	155.	-1482.	3673.	-753.	-146.	-333.	-652.
-141.	-196.	-506.	1292.	1156.	157.		
DIFFERENCES							
-874.	-577.	-276.	-205.	-757.	383.	-1030.	-1153.
-197.	-2040.	-1794.	-596.	13533.	-411.	-631.	-914.
-406.	-549.	-1029.	1080.	-1101.	-456.		
DIFFERENCES							
-160.	-239.	-58.	-89.	-187.	-43.	-172.	-67.
-41.	194.	-597.	-100.	-369.	2759.	419.	-281.
-110.	-141.	-205.	-230.	-187.	-96.		
DIFFERENCES							
-370.	-722.	-154.	-237.	170.	-63.	-503.	-154.
-112.	761.	-2021.	-277.	-791.	342.	6694.	-852.
-207.	-287.	-676.	-516.	215.	-241.		
DIFFERENCES							
-598.	1823.	-142.	1216.	-956.	-97.	-321.	-1086.
-154.	-1396.	589.	-527.	-1124.	-298.	-644.	6191.
-255.	-430.	368.	-715.	-1073.	-372.		
DIFFERENCES							
-228.	-132.	-10.	-123.	-297.	31.	19.	-270.
56.	-205.	-476.	-116.	-484.	-142.	-196.	-289.
2400.	1189.	-160.	-274.	-245.	-47.		
DIFFERENCES							
-366.	-174.	-21.	-121.	-373.	-69.	-50.	-361.
55.	-738.	-1010.	-121.	-621.	-175.	-206.	-437.
1259.	4605.	-339.	-335.	-306.	-95.		
DIFFERENCES							
781.	-578.	-177.	-246.	-303.	-102.	1026.	143.
-166.	-1109.	-73.	-455.	-734.	-328.	-733.	417.
-177.	-338.	5222.	-815.	-935.	-320.		
DIFFERENCES							
-428.	-232.	-150.	-75.	-354.	58.	-670.	-888.
-114.	-1395.	-413.	-334.	1382.	-235.	-482.	-255.
-209.	-287.	-735.	6736.	-671.	-249.		
DIFFERENCES							
-599.	-890.	-90.	-325.	-443.	-124.	-644.	-511.
-0.	834.	-2494.	1208.	-1147.	-207.	14.	-1018.
-226.	-312.	-851.	-693.	8458.	56.		
DIFFERENCES							
-243.	-191.	-26.	-121.	-188.	-51.	-220.	-257.
12.	-481.	-876.	-284.	-449.	-95.	-216.	-436.
-29.	-57.	-311.	-261.	37.	4164.		

SALIENCE							
4.24	-0.59	-0.54	-0.55	0.48	-0.51	-0.08	0.10
-0.68	-0.41	-0.03	-0.63	-0.58	-0.65	-0.61	-0.28
-0.38	-0.50	0.42	-0.61	-0.67	-0.61		
SALIENCE							
-0.56	4.34	-0.37	1.05	-0.61	-0.32	0.15	-0.42
-0.56	-0.57	-0.19	-0.74	-0.42	-0.52	-0.47	0.79
-0.48	-0.58	-0.24	-0.47	-0.76	-0.72		
SALIENCE							
-0.63	-0.19	43.58	-0.30	-0.55	-0.86	-0.16	-0.30
9.42	-0.54	-0.50	-0.55	-0.92	-0.90	-0.91	-0.40
0.55	0.26	-0.40	-0.91	-0.57	-0.34		
SALIENCE							
-0.59	1.05	-0.35	6.60	-0.57	-0.30	-0.31	-0.50
-0.55	-0.53	-0.18	-0.71	-0.40	4.03	-0.45	0.97
-0.44	-0.55	-0.27	-0.45	-0.74	-0.69		
SALIENCE							
0.51	-0.61	-0.32	-0.40	5.20	-0.28	-0.23	0.27
-0.53	-0.46	-0.30	-0.43	-0.38	-0.84	-0.43	-0.40
-0.48	-0.57	-0.15	-0.43	-0.44	-0.23		
SALIENCE							
-0.39	-0.45	7.75	-0.41	-0.36	28.06	-0.49	-0.43
5.43	-0.27	-0.55	-0.94	1.09	3.52	-0.42	-0.44
-0.44	-0.54	-0.52	0.08	-0.93	-0.96		
SALIENCE							
-0.07	0.16	-0.52	-0.33	-0.26	-0.48	3.36	0.33
-0.67	-0.30	-0.35	-0.57	-0.56	-0.63	-0.59	-0.12
0.05	-0.14	0.47	-0.59	-0.61	-0.54		
SALIENCE							
0.09	-0.48	-0.39	-0.42	0.18	-0.34	0.31	2.78
-0.58	0.19	-0.45	-0.25	-0.44	-0.53	-0.49	-0.34
-0.37	-0.49	0.01	-0.49	-0.34	-0.22		
SALIENCE							
-0.68	-0.30	8.97	-0.40	-0.61	-0.91	-0.30	-0.34
60.88	-0.29	-0.58	-0.30	-0.91	-0.91	-0.91	-0.50
0.35	0.10	-0.50	-0.95	-0.33	0.02		
SALIENCE							
-0.43	-0.70	-0.53	-0.54	-0.20	-0.58	-0.51	-0.04
-0.42	4.02	-0.39	0.38	-0.74	0.18	0.98	-0.58
-0.44	-0.55	-0.46	-0.81	0.49	-0.98		
SALIENCE							
-0.06	-0.29	-0.94	-0.27	-0.34	-0.45	-0.38	-0.47

-0.78	-0.37	1.51	-0.61	-0.31	-0.66	-0.66	0.37
-0.35	-0.47	0.02	-0.26	-0.65	-0.59		
SALIENCE							
-0.56	-0.77	-0.49	-0.65	-0.39	-0.90	-0.55	-0.32
0.61	0.15	-0.65	14.17	-0.91	-0.81	-0.78	-0.66
-0.57	-0.65	-0.56	0.74	2.31	0.83		
SALIENCE							
-0.52	-0.31	-0.91	-0.26	-0.44	1.62	-0.53	-0.45
-0.90	-0.76	-0.31	-0.90	0.41	-0.89	-0.58	-0.36
-0.65	-0.71	-0.64	0.89	-0.86	-0.94		
SALIENCE							
-0.47	-0.63	-0.95	-0.55	-0.55	-0.90	-0.44	-0.13
-0.93	0.36	-0.51	-0.75	-0.87	29.58	1.90	-0.55
-0.87	-0.91	-0.44	-0.94	-0.73	-0.98		
SALIENCE							
-0.39	-0.69	-0.91	-0.53	0.18	-0.48	-0.46	-0.11
-0.91	0.51	-0.62	-0.75	-0.67	1.33	11.01	-0.61
-0.59	-0.67	-0.52	-0.76	0.30	-0.89		
SALIENCE							
-0.29	0.79	-0.38	1.24	-0.46	-0.24	-0.13	-0.35
-0.87	-0.43	0.38	-0.65	-0.43	-0.52	-0.48	2.00
-0.33	-0.46	0.13	-0.48	-0.68	-0.62		
SALIENCE							
-0.41	-0.21	-0.10	-0.46	-0.52	0.40	0.03	-0.32
0.76	-0.23	-0.25	-0.53	-0.69	-0.92	-0.54	-0.34
11.50	4.63	-0.21	-0.68	-0.58	-0.29		
SALIENCE							
-0.54	-0.23	-0.17	-0.38	-0.54	-0.73	-0.06	-0.35
0.62	-0.69	-0.43	-0.45	-0.73	-0.94	-0.47	-0.43
4.69	14.84	-0.36	-0.68	-0.59	-0.48		
SALIENCE							
0.41	-0.27	-0.52	-0.28	-0.16	-0.38	0.47	0.05
-0.67	-0.37	-0.01	-0.01	-0.31	-0.63	-0.60	0.15
-0.25	-0.39	2.01	-0.50	-0.65	-0.59		
SALIENCE							
-0.46	-0.22	-0.90	-0.17	-0.38	0.45	-0.63	-0.63
-0.94	-0.95	-0.13	-0.92	1.19	-0.93	-0.81	-0.18
-0.61	-0.68	-0.58	13.12	-0.96	-0.94		
SALIENCE							
-0.59	-0.78	-0.49	-0.67	-0.43	-0.87	-0.55	-0.33
-0.09	2.52	-0.72	3.03	-0.91	-0.75	0.02	-0.67
-0.60	-0.68	-0.61	-0.95	11.01	0.19		
SALIENCE							
-0.63	-0.42	-0.38	-0.66	-0.48	-0.94	-0.49	-0.44
1.23	-0.79	-0.66	1.88	-0.93	-0.90	-0.87	-0.76
-0.20	-0.32	-0.68	-0.94	(0.13)	37.87		

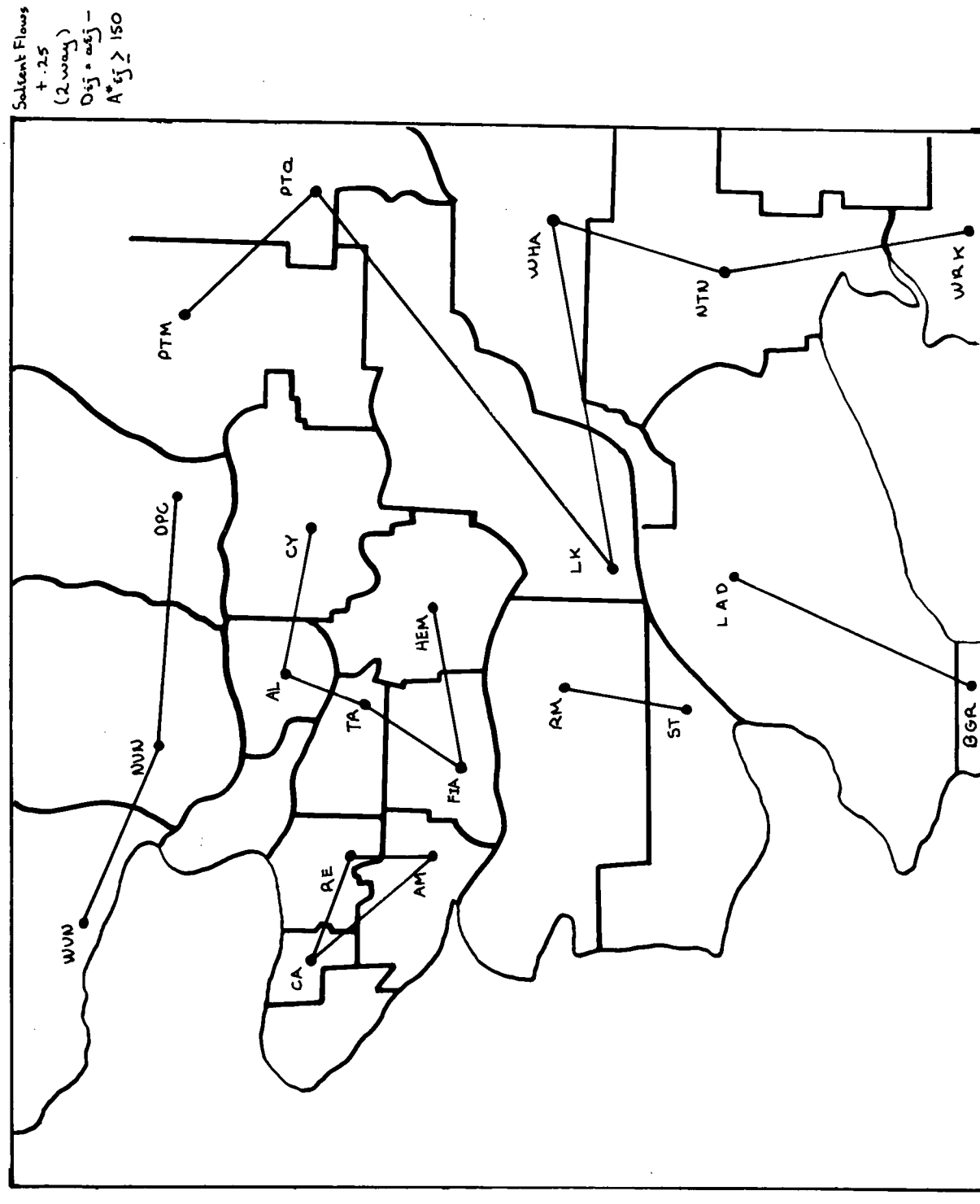
a significant rating for a comparatively small exchange. In the present study of the G.V.R.D., 150 is the median value of differences and it is felt that any lesser values do not constitute sufficient concentrations of information to be of comparative importance within the total region.

Also two values are chosen as critical thresholds for the R.A. index itself: RA $\leq$ .10 and R.A. $\leq$ .25. This means that for two areas to be salient, the flow of transactions in both directions must be at least ten per cent more than expected from the indifference model. The twenty-five per cent value is simply used to indicate an even greater intensity of transactions. Further, because of the arbitrary nature of these thresholds the two values provide a useful comparative check on the validity of the procedure. One-way flows for both thresholds are also mapped to minimize loss of information, however they are not considered salient.

It is expected that a mapping of derived salient relationships for the G.V.R.D. should reveal communities of interest interacting more within each other than with others. The 'core-ring' concept elaborated in the previous chapter will be strongly supported since the gross size effects of the C.B.D. as the central node will be eliminated.

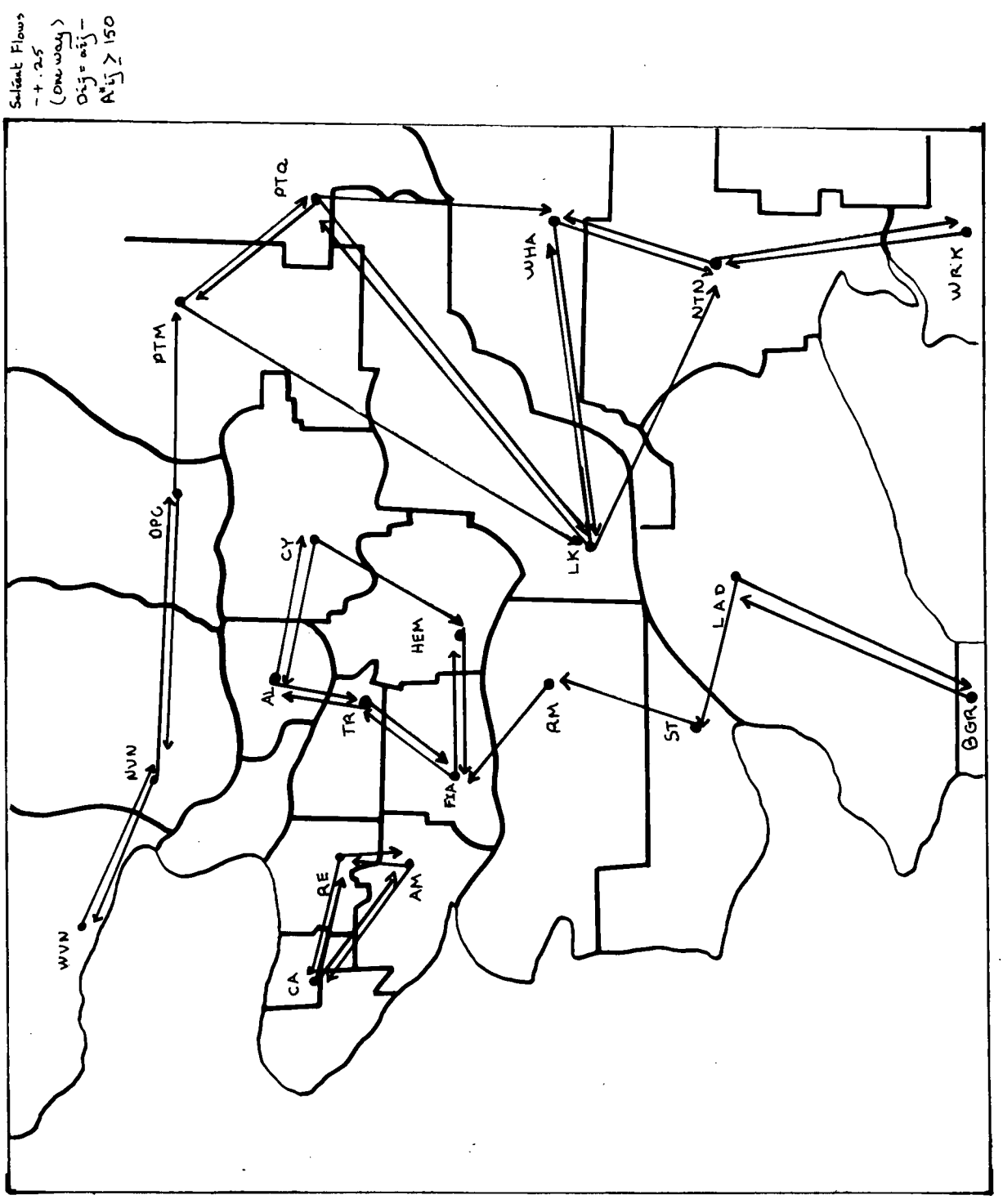
Discussion of Results

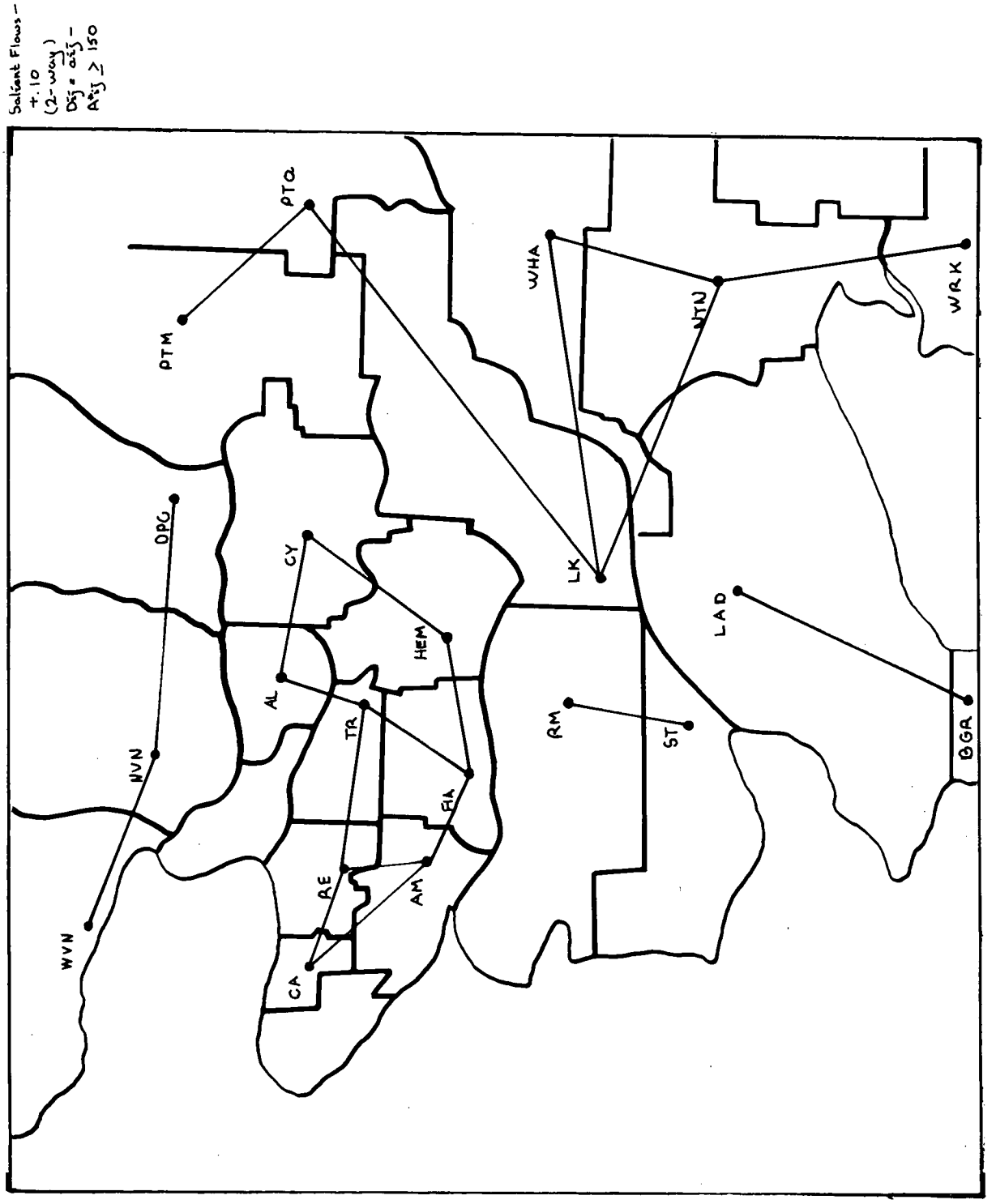
Figure 4 illustrates the salient two-way flows for volumes where RA $\leq$ .25, and $D_{ij} \leq 150$. (See Figure 4) What was previously seen

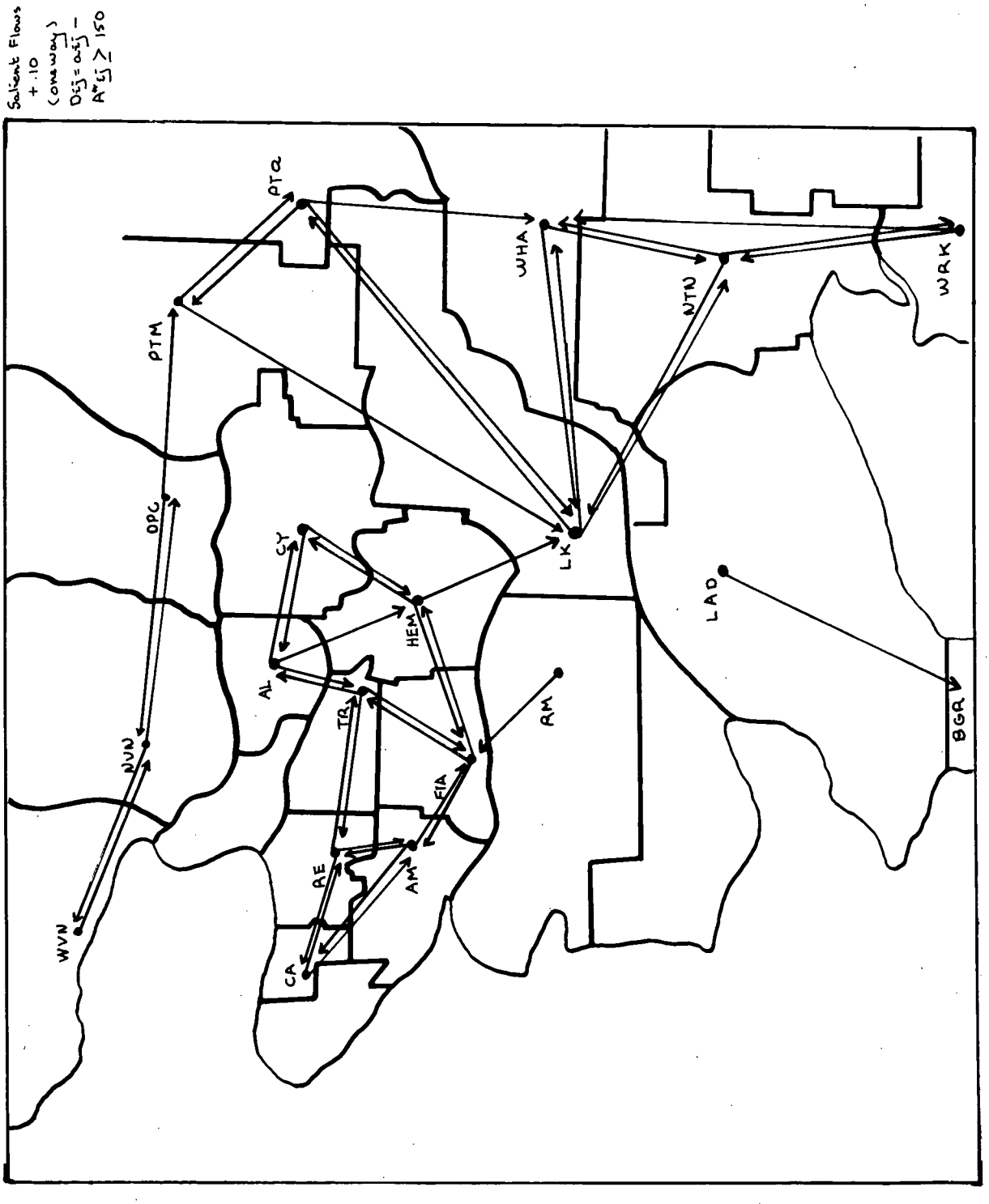

Solent Flows
+.25
(2 way)
Dij • aij –
A*ij ≥ 150
PTA
PTM
WHA
NTN
WAK
OPC
CY
LK
LAD
HEM
AL
TA
RM
ST
BGR
WWW
FIA
AE
AM
CA

as emergent in the graph theory interpretation of the nodal structure of the region is crystallized in this mapping. A sectoral core area of relationships are clearly delineated from a peripheral ring system. Port Moody, Port Coquitlam, New Westminster, Whalley, Newton and White Rock all interact with each other, to form a peripheral ring from the north to southeast. Ladner and Beach Grove form the ring to the southwest and it is included with Richmond and Steveston. On the north shore, West Vancouver, North Vancouver and Deep Cove form a circumference more strongly connected with each other than with other parts. The core area is segregated into west and east sectors, and is clearly separated from the above described peripheral system. The C.B.D. is not connected to either of these systems because the total volume it handles generates extremely high expected values which result in negative salience values.

Figure 5 illustrates one-way flow where: $D_{ij} \leq 150$, RA $\leq .25$. The mapping strongly reinforces the above analysis. Richmond to Fairfax is seen as the only interface activity of the two systems and the interaction in the eastern periphery is once again emphasized. Lowering the initial threshold of the R.A. index from $\leq .25$ to $\leq .10$ still does not change the communication pattern significantly, except for linking the east-west sectors of metropolitan area. (See Figure 6) Once again, lowering the parameters to RA = $\leq .10$ and mapping all flows, the pattern persists. (See Figure 7) Going to another extreme (Figure 8) where the

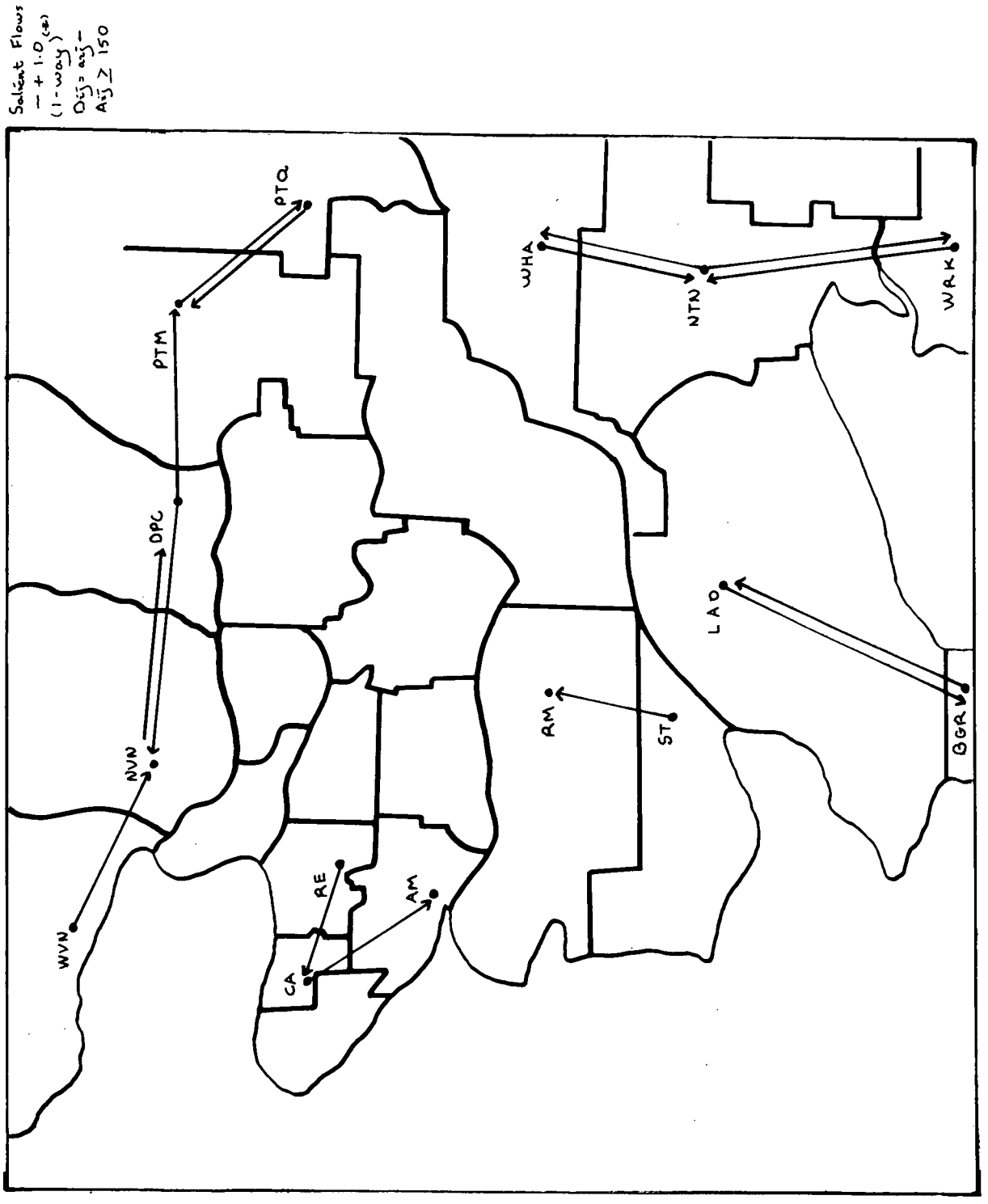

Salient Flows
- +.25
(one way)
$O_{ij} = a_{ij} -$
$A^*_{ij} \geq 150$
PTQ
PTM
OPC
CY
WHA
NTN
WRK
LK
LAD
HEM
AL
TR
AM
ST
BGR
NVN
FIA
RE
AMI
WVN
CA


Salient Flows –
+.10
(2-way)
Dij • aij –
Aij ≥ 150
PTM
PTQ
WHA
WTN
WRK
OPG
CY
LK
LAD
HEM
AL
TR
RM
ST
BGA
WVN
FIA
AE
AM
CA
WVN


Salient Flows
+ .10
(one way)
Dij = aij -
A*ij ≥ 150
PTA
WHA
NTN
WRK
PTM
OPC
CY
LK
LAD
HEM
AL
TR
AM
BGR
NVN
FIA
AE
AM
WVN
CA

R.A. threshold is raised to +1:0, creates a large loss of information but nevertheless retains the general structure outlined above.

It seems clear then, that communicative habits do reflect a discernible geographical pattern. In the Vancouver metropolitan area, these patterns correspond to previously mentioned geographic studies using more conventional data bases.


Salient Flows
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Dij = aij -
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CHAPTER III

The major intent of this chapter is to explore the relationship between social structure and communicative (interactive) behaviour. This analysis corresponds to the middle section of Soja's (1969) generalized framework on page . The intent is to synthesize the communication patterns of the G.V.R.D. with social area analysis through the basic assumption that social structure influences communicative behaviour in ordered and predictable ways. Such a relationship is not meant as strictly casual but rather circularly causal.

> "Spatial structure and spatial process are circularly causal. Structure is a determinant of process as much as process is a determinant of structure". (Abler, 1971)

Social Area Analysis

Social structure refers to the communities of a city as spatial expressions of social characteristics. (Bourne, 1971) It is a logical extension of studies of residential structure discussed in the first chapter, but with particular emphasis on more recent developments in the analysis and identification of social or ecological areas. Such studies usually occur within the framework of social area analysis.

Social area analysis was originally developed by E. Shevky. Its theoretical basis generally assumes that urbanization is a result of increasing societal scale which is reflected by increased structural differentiation. (Greer, 1962; Charde, 1972). The three major aspects of increasing societal scale are:

1. A change in the range and intensity of relations;
2. Differentiation of function;
3. Complexity of organization.

The first refers to functional occupational changes, mainly expressed by increasing proportions of the labour force involved in service and tertiary oriented occupations. Differentiation of function reflects changes in basic life styles such as increasing numbers of females in the labour force and increasing concentration of urban-centred relationships. Complexity of organization is evidenced by increasing diversity of publics through age and sex distribution, mobility and increasing diversity of interests. Charde (1970) summarizes the approach as:

> "..... an attempt to capture the range of interdependency and the increase of interdependency and therefore increase in scale, or aspects of increased scale such as change in the range and intensity of relations, differentiation of function and complexity of organization through the structural reflections of these changes".

In a seminal work, Shevky and Bell (1955) identified three structural factors as the basis of measuring social differentiation. Social rank is designed to reflect the changes in range and intensity of relationships. It generally consists of a composite index of socio-economic characteristics of income, occupation and education. Urbanization is meant to reflect the differentiation of function and indexes the variables of fertility, women in the labour force and single family dwellings. The third factor, segregation, reflects the diversity of

organization by tabulating ethnicity and relative concentrations of minority group population. Empirically then population is thus categorized by assembling census characteristics related to the three factors.

Criticism of Social Area Analysis

There are several legitimate criticisms of social area analysis. One is that it lacks a sound theoretical basis and more elaboration of the theory is needed. (Bell and Markos, 1964; Howley and Duneon, 1957) From a focus on social change in industrial societies the technique makes an abrupt shift to census tracts of much smaller regions.

> "The deficiency of the Shevky-Bell orientation is its failure to specify precisely how and under what conditions size is related to social differentiation". (Charde, 1970)

Further, the shortcomings of census tracts themselves impose severe limitations. (Murdie, 1971)

Another criticism is that the technique fails to specify exactly how differentiation occurs and the relationship between the three indices. (Charde,1970) Does a change in urbanization affect segregation and how? Also, the concept of social areas has no geographical reference and there are operational difficulties in combining the notions of social space and ecological space.

Despite these drawbacks, the social area approach is generally considered a useful measure of social differentiation. Recent work with factor and component analysis have provided a spatial dimension

to the analysis. Anderson and Bern (1961) did this for four cities in the United States and found that economic status is primarily distributed in sectors and family status is a concentric phenomena. (Murdie, 1971) McElrath (1962) in a study of Rome found that economic status and family status are both concentric and sectorial with large families of low economic status occupying the periphery. (Murdie, 1971) After applying social area analysis to Newcastle-under-Thyme, Herbert (1967) concluded that:

> ".....the social area map is meaningful and accurately differentiates the urban structure of Newcastle thus fulfilling one claim which may be made of the approach is that it summarizes several essential aspects of the social geography of an urban area. That social area analysis is a useful comparative tool has perhaps been demonstrated by the comparisons which have been made between the results of this study and those which have been obtained from other parts of the world". (Murdie, 1971)

Accepting the general validity of social area analysis then, it is possible to see that increasing scale, as it refers to numbers and intensity of human relations, is highly dependent on communication systems.

> "..... the underlying and organizing framework in the city consists of the media of interaction. The principal means of facilitating interaction of all types are the complex networks of transportation, communication, and linkages". (Bourne, 1971)

Such systems enable control of the material environment which makes largeness of scale possible. Without communications, inter-relationships through space and time are impossible.

Given that social differentiation and interaction are interrelated, our concern here is to examine the influence of social structure on communicative behaviour. The reverse process will be examined in the last chapter.

Literature Relating Communications and Social Structure

Taking the social area typology as a structural context, Orleans (1960) has employed the effects of social differentiation on interaction (contacts with others). He suggested that people will choose from perceived alternatives, those which are useful and available to them by reason of their social attributes. The constraints resulting from such attributes largely determine patterns of interaction, e.g. income, education, age, etc. These patterns are in turn determinants of a person's world view and life style. He points out:

> "An individual's recognition and evaluation of his environment is considered to be a function of scale as indicated by his social position and physical location". (Orleans, 1968)

In discussing urban processes from a general systems point of view, Buckley reached somewhat the same conclusion. He defines the socio-cultural level of a society as a shifting statistical or probability structure (or ensemble of constraints) expressing over time the transactional processes occurring among lower level (personality) structure. He postulates "..... the complexity of communication components of the system". (Buckley, 1968) Webber (1967) has also

attempted to link urban theory and communication theory. He sees communication channels as the basis of urban social structure and interaction, not place, as the essence of the city and city life. (Webber, 1967)

Meier (1962) has advanced perhaps the most comprehensive communication theory of urban growth. He feels that:

> ".....research on urban communications systems seem to provide much greater rewards, in the form of more powerful explanations, than does research in the more traditional fields of human ecology, geography, land economics, municipal administration and traffic study".

Public communication (culture) is expressed in cultural interaction. In analyzing this process it becomes necessary to:

> ".....identify external boundaries and subdivisions of culture, the inputs and outputs, the elements and aggregates of elements that interact, the behaviour of these elements when subjected to specific conditions, the transformation that can be effected and the environmental constraints that apply". (Meier, 1962, p. 107).

Other communication oriented literature also supports a contextual analysis of social interaction or communicative behaviour. A sign is not received in isolation, it is part of a complex environmental situation. (Cherry, 1961) The interpretation of a communication depends on accumulated experiences of receivers, and are generally common to people in similar circumstances. (Cherry and Charde, 1970) Friedson (1954) finds that the use of mass media cannot be explained except by references to local audiences, their social character and their interaction patterns. Katz and Lazarsfeld (1964) and Merton

(1963) studying personal influence found that persons of like interest and social status influence each other.

The relationship between social structure and communication is further emphasized in the literature on diffusion of information and the "two-step flow" of communication. (Rogers, 1962) Coleman, Katz and Menzel (1957) demonstrated that the use of new drugs spread through the medical profession largely along the links of a social network. Generally, communications which influence others are mediated by members of interest groups which are basically alike in social composition to the rest of the interest group. (Charde, 1970)

Social Area Analysis in Vancouver

There have been three major social area type analyses done in the Vancouver area in 1961 census tracts. Peucker and Rare (1966) did a factorial ecology of Greater Vancouver which included 79 variables, Bell (1965) mapped the ecological structure of the Metropolitan area and Patterson (1972) performed a factorial ecology of the G.V.R.D.

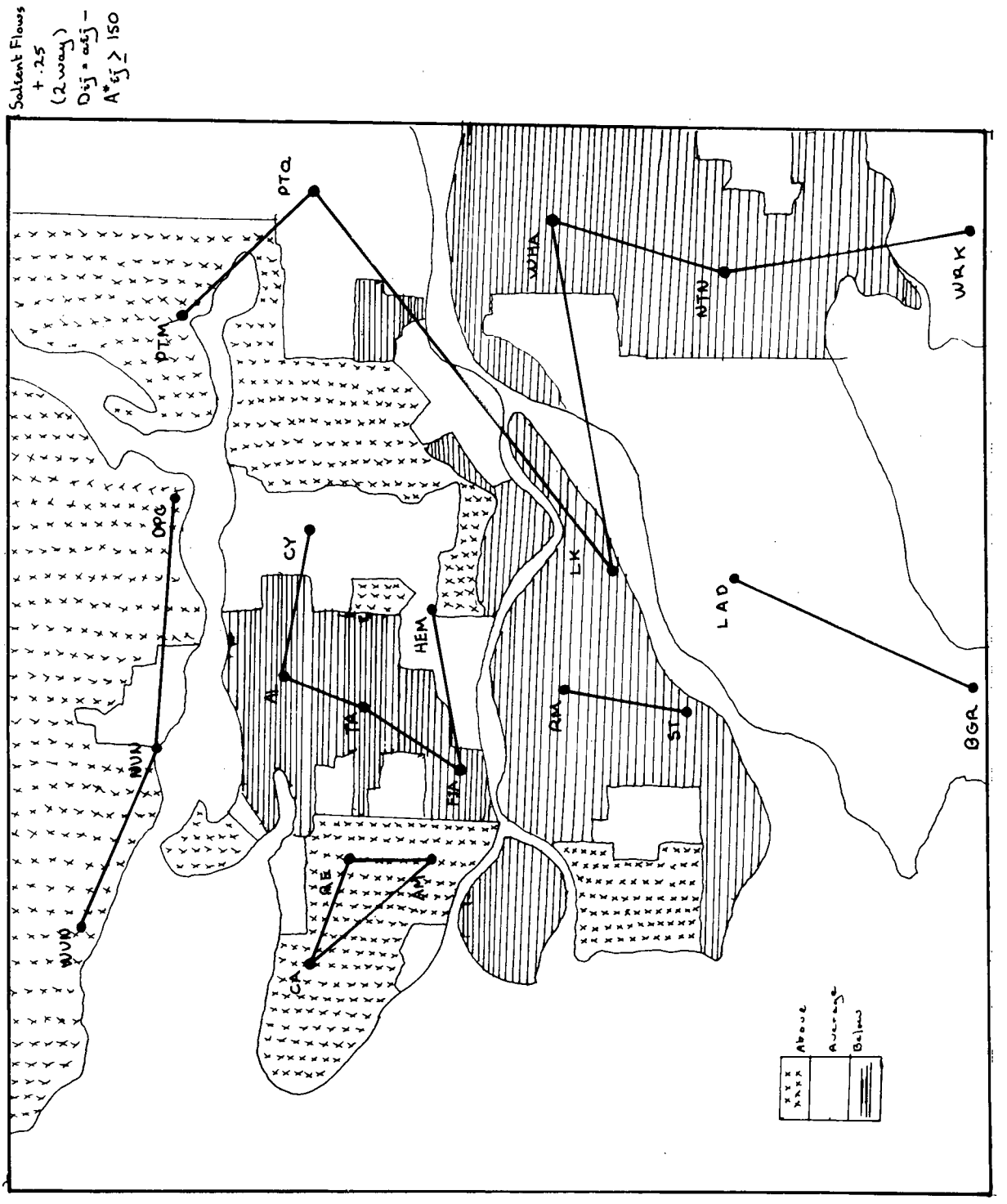
The three studies generally agree in the geographical distribution of social areas. Bell's indices are chosen for the present purpose mainly because of the clarity of their graphic presentation. This analysis must be considered more suggestive than conclusive since the tele-communication data is for 1968 and the social area data for 1961. It is, however, the most recent data available.

Having previously identified the salient communication networks, this map is overlaid on one displaying the spatial distribution of social differentiation measured by a socio-economic factor. It is expected that salient relationships will occur within or between like social areas. It is also expected that higher ranked socio-economic areas will have a larger range of communicative behaviour. This is measured by long distance calling both within and out of the province. Further, it is expected that since higher ranked socio-economic categories implies a higher resource availability to invest in interaction, they will have a greatest mean number of contacts.

All three expectations are closely related to the constructs of social area analysis. Accompanying an increase in scale is an increase in the range of interaction. (Wilson, 1945; Shevky, Bell, 1955; Charde, 1970) Webber (1967) has theorized that when people become more highly specialized as reflected in occupation and education they are increasingly involved in non-propinquitous communication. Both the range and number of contact measurements may be taken as indicators of increasing diversity of interests. Komorovsky (1946) and Wright and Hyman (1958) found that as the socio-economic level rises, people participate in more volunteer groups or organizations.

Discussion of Results

Figures 9 to 13 demonstrate that salient relationships do occur more within and between like social areas than among differentiated areas.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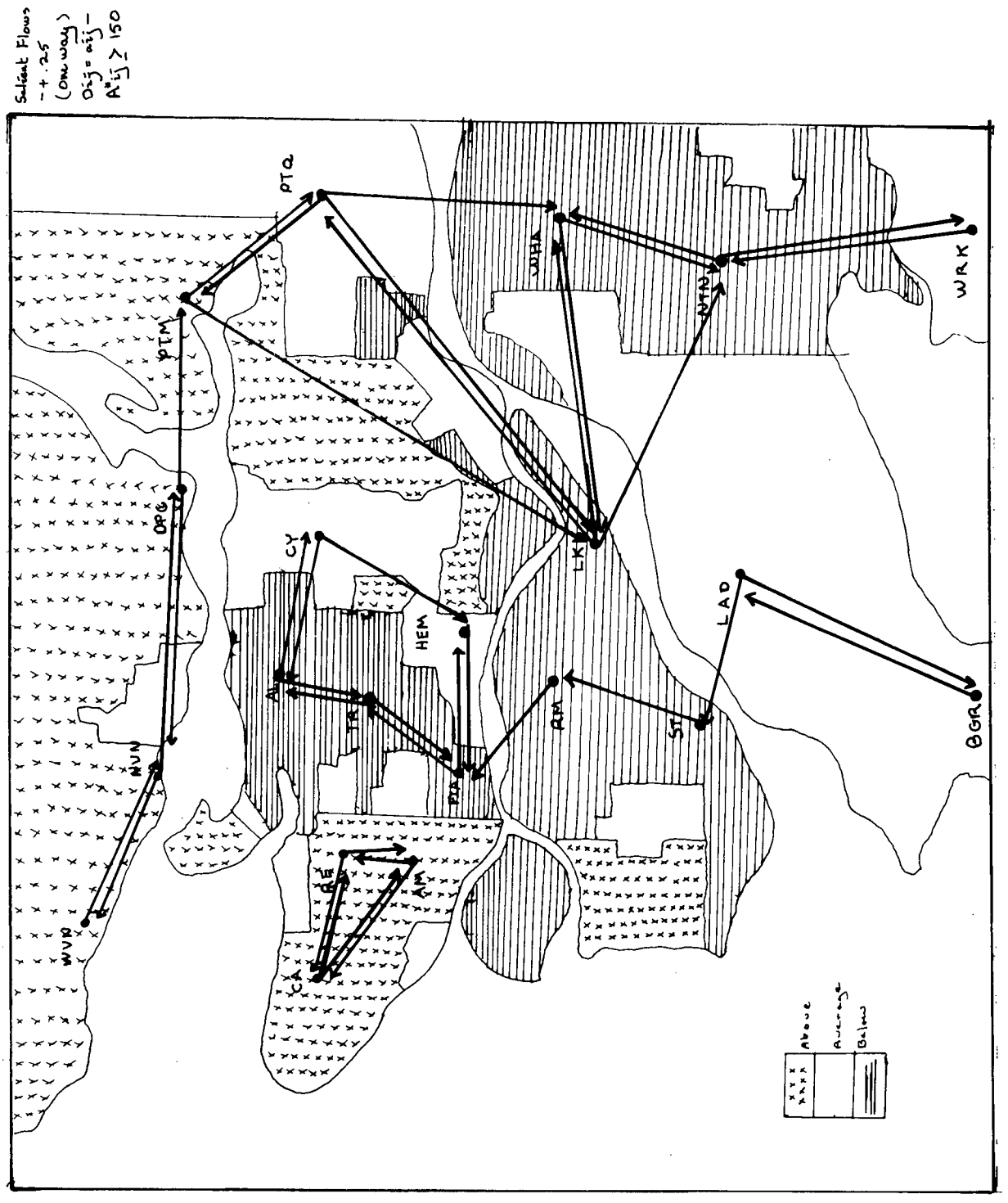
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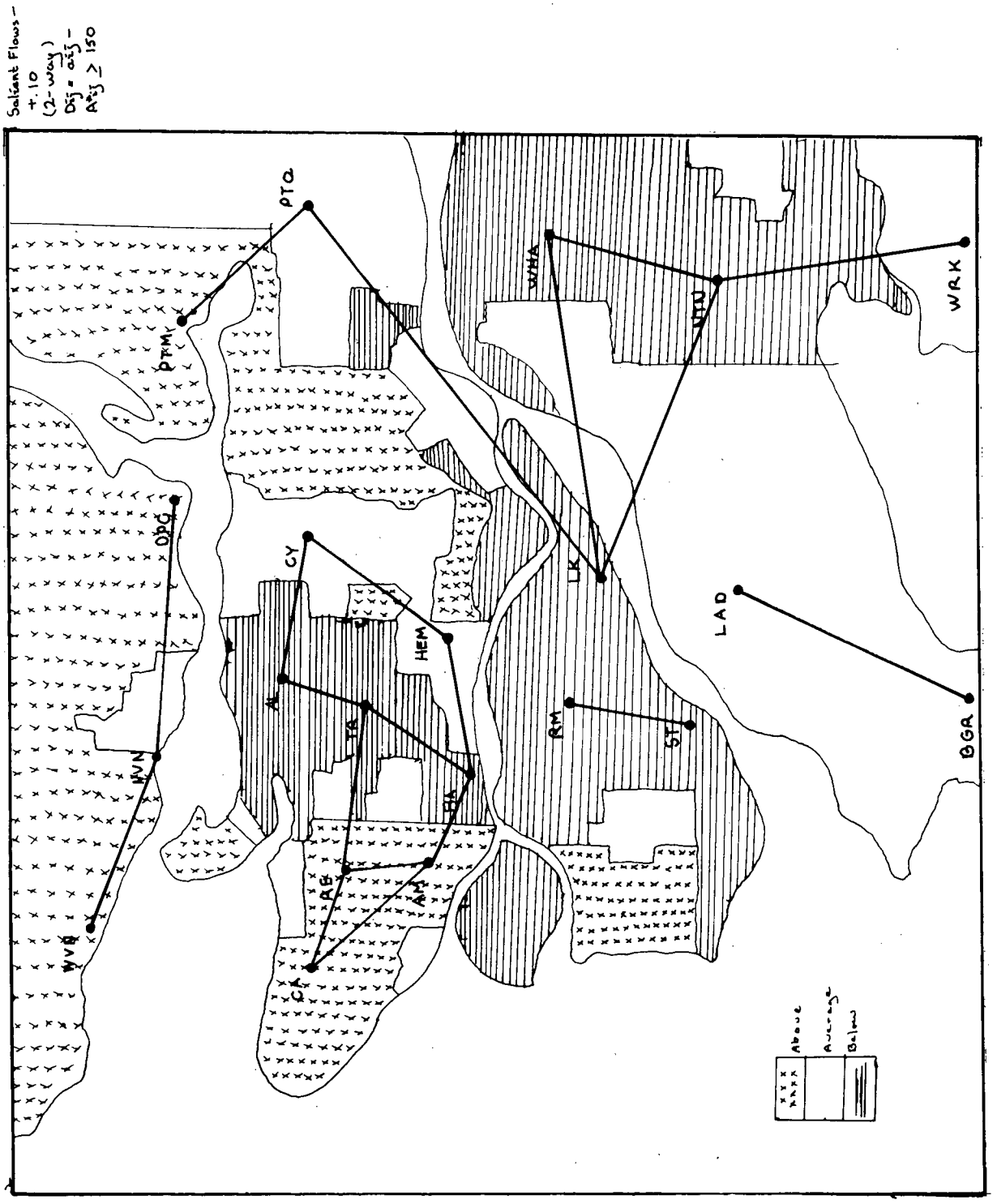
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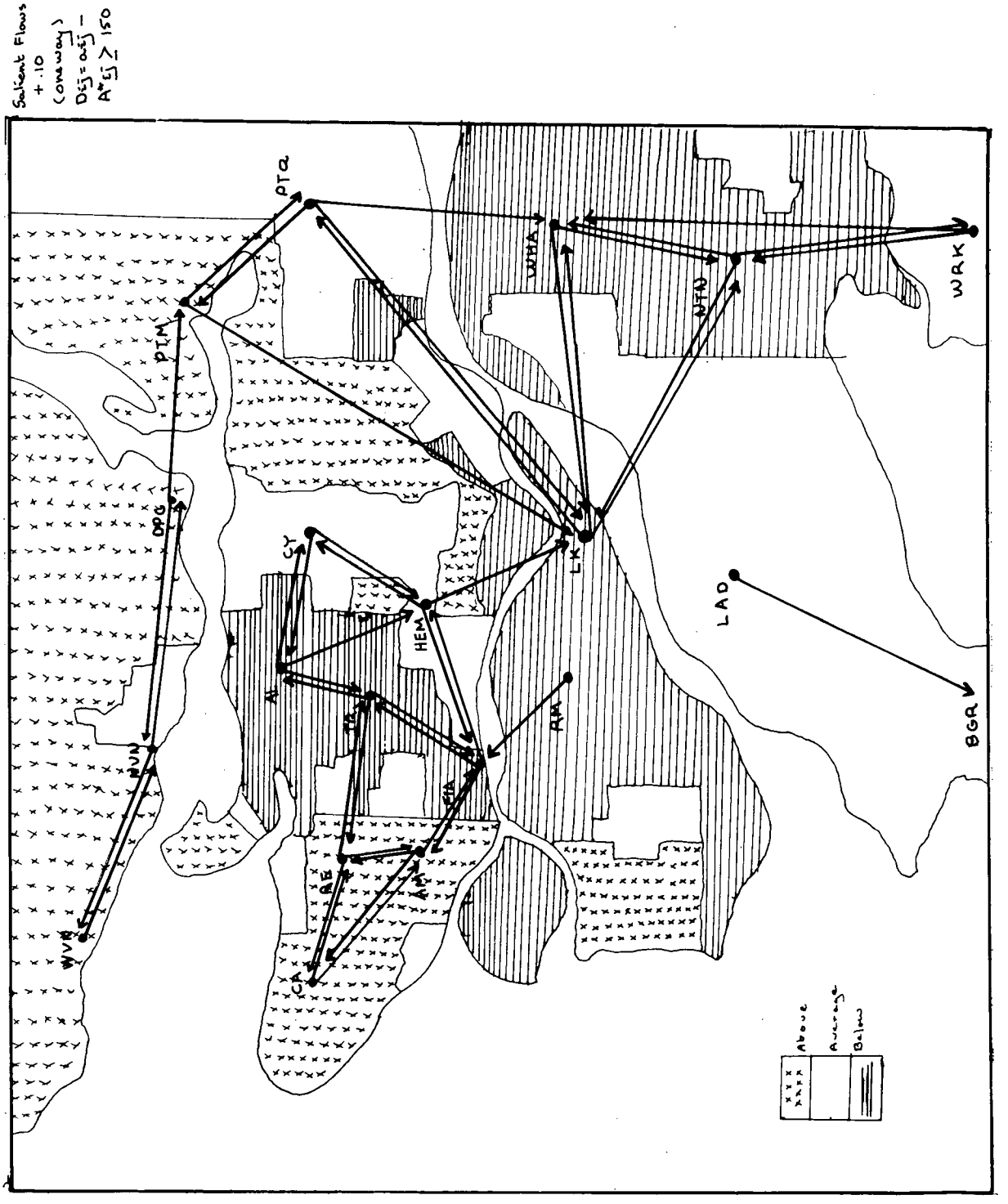
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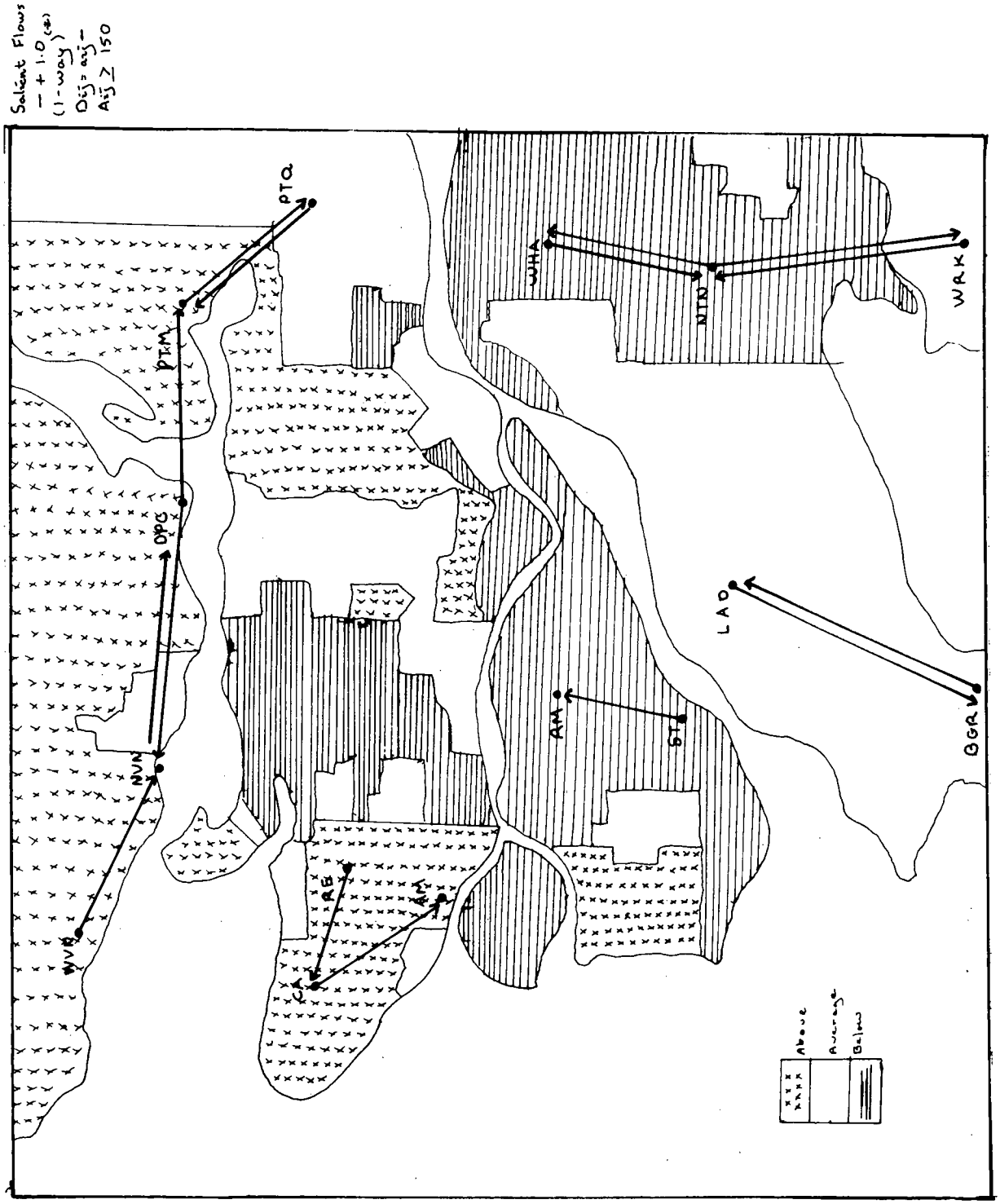
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This phenomena in part supports Webber's contention that a city region is a derivative of the communications pattern of the individuals and groups that inhabit it. (Webber, 1963)

On the basis of long-distance calling, it does not appear that higher level socio-economic areas have a larger range of communicative behaviour. Table V displays the absolute rank of exchange areas as measured by the number of intra-provincial and out-of-province calls. Only seventeen areas are used since it was impossible to obtain comparable data for the LAK, WHA, WRK and NTN exchange areas. If long distance calling can be taken as one measure of the range of interaction, no strong relation between its frequency and socio-economic rank emerges.

The picture is even more uncertain using a relative ranking obtained by dividing the number of calls per exchange area by the number of terminal connections or telephones. (See Table VI) There may be a partial explanation for the intra-provincial ranking since this includes toll calls within the G.V.R.D. A further explanation for the ranking of out-of-province calls was sought by looking at all number of business connections out of the total terminal connections. This is shown in Table VII. Once again, no substantive relation emerges. It can thus only be concluded that for the G.V.R.D. and the given data base there is no relationship between the range of communicative behaviour and levels of socio-economic areas.

TABLE V

Absolute Ranking for long-distance calling (in number of messages) for intra-provincial and out-of-province data for the week ending July 10, 1971.

Intra-Provincial			Out-Of-Province		
rank	exchange area	MSG	rank	exchange area	MSG
1	MU	60746	1	MU	59815
2	NOR	27517	2	RE	12237
3	CA	22091	3	TR	10358
4	RE	20663	4	NOR	8531
5	TR	18560	5	CY	8109
6	DTM	17526	6	AL	8024
7	HEM	16350	7	HEM	7880
8	CYP	15507	8	AM	5873
9	AL	11481	9	RMD	5868
10	FAI	10172	10	FAI	5787
11	WUN	10028	11	LAD	3925
12	AM	9776	12	WUN	3885
13	RMD	7763	13	PTM	3715
14	STV	4686	14	CA	3329
15	BGR	4517	15	STV	2536
16	LAD	3621	16	BGR	1119
17	DPC	2908	17	DPC	1043

Data from B.C. Telephone Company.

TABLE VI

Relative Ranking for long-distance calling (in number of messages) for intra-provincial and out-of-province data for the week ending July 10, 1971 (messages divided by number of terminal connections in each exchange area).

Intra-Provincial		Out-Of-Province	
Relative rank	exchange area	relative rank	exchange area
1	LAD	1	LAD
2	BGR	2	MU
3	MU	3	RMD
4	PRM	4	CYP
5	DPC	5	DPC
6	RMD	6	CA
7	NOR	7	BGR
8	WVN	8	AL
9	CYP	9	TR
10	TRI	10	RE
11	RE	11	NOR
12	AL	12	WVN
13	HEM	13	PTM
14	CA	14	AM
15	STU	15	HEM
16	AM	16	STU
17	FAI	17	FAI

TABLE VII

Absolute and Relative ranking for originating flow volumes by area exchange.

	Absolute Ranking		Relative Ranking (divided by number of terminal connections)
1	MU	1	DPC
2	RE	2	MU
3	HEM	3	BGR
4	LAK	4	CA
5	TRI	5	RMD
6	NOR	6	NTN
7	FAI	7	WVN
8	AM	8	CYP
9	CYP	9	LAD
10	AL	10	WHA
11	WHA	11	PTM
12	PTM	12	AM
13	WVN	13	STU
14	CAS	14	LAK
15	STU	15	TRI
16	NTN	16	NOR
17	RMD	17	HEM
18	WRK	18	PTQ
19	PTQ	19	FAI
20	BGR	20	AL
21	DPC	21	REG
22	LAD	22	WRK

The third expectation, that higher ranking socio-economic categories will have a greater number of contacts because of more resources to invest in interaction, was also negated.

Table VII shows the absolute and relative rankings for the flow volume originating in each exchange area. Once again, a more comprehensive analysis is required to negate or substantiate any behavioral hypothesis.

C H A P T E R I V

In the previous chapters, the relationship of telecommunications to urban analysis was explored. It was found that by using telephone data as a measure of locational interaction, a functional region and its spatial structure could be identified. Next, locational attributes and their areal association were related to the spatial analysis through a series of behavioral assumptions. Throughout, the channel of communication has been held constant, here, the hardware or mode will be considered a variable and the activity, i.e. communicating, the dependent variable.

To begin, it will be useful to explore some recent telecommunication innovations that have contributed to what is loosely referred to as the 'communications revolution'.

Telecommunication Technology

In 1947 Bell Telephone laboratories developed the transistor, and solid-state components replaced the vacuum tube almost completely. The transistor allowed for low cost, miniaturized, high speed, low power drain electrical devices such as the computer and radio. Presently, the offspring of the transistor, integrated circuits and large-scale integration, have increased the advantages of solid-state technology by orders of magnitude. Originally an integrated circuit device cost $250 to $600; today integrated circuit devices are mass produced in 50,000 piece lots and sell for $2.50. Large scale integration permits placing the equivalent of hundreds of transistors on a single pinhead. Hence, we have electronic telephone switching,

communications satellites, and enormous capacity computers.

The second major development in telecommunication technology is the increase in capabilities of transmission devices. Actual use of lasers has already been demonstrated in laboratories and their theoretical capacity for T.V. channel and voice transmission is for all practical purposes limitless. Of course there are many difficulties in utilizing this capacity, but the principle has been applied.

The great advantage of communication satellites is that distance is not a factor in transmission cost. Employing satellites in a communication system means that cost of communicating ten miles is the same as for communicating 10,000 miles. Like most communication devices, the satellites are experiencing growth and decreasing cost.

Satellite	Year of First Use	Number of voice-grade 2-way teleph. circuits	Treatment cost (US) per circuit yr.
EARLY BIRD	1965	240	15,300
INTEL SAT II	1966	240	8,400
INTEL SAT III	1968	1200	1,450
INTEL SAT IV	1971	6000	500

Micro-wave technology is familiar to most. It is limited to line of sight relay towers and a narrow range within the spectrum frequency. Presently in the United States some private companies operate their own micro-wave system for transmission of computer data and voice signals.

The development of cable technology has led to the notion of the "wired city". CATV (cable television) is extremely versatile and can carry almost anything one would want to transmit, as well as providing feedback of two-way communication capability with a 20-80 channel capacity. Furthermore, it provides excellent reception, is inexpensive, can be integrated with satellites and doesn't deplete the broadcast spectrum resource. It is interesting to note that the growth of CATV has been from "hinterland to heartland" and is just presently penetrating major urban centres. It has also experienced constant political and regulatory harassment. Nevertheless its growth is impressive, as shown in Figure 14.

Other transmission devices include the video phone; allowing audio-visual communication; long-range facsimile capable of printing a newspaper in your living room in six minutes; ultramicrofile permitting the miniaturization of a library of 100,000 volumes to the cubic content of three filing cases; electronic video recording (EVR) devices enabling TV program recording and production. The list is by no means exhaustive, rather merely suggestive of some of the more obvious developments.

The third major development within the continuing trend of lower cost, lower power drain and miniaturization in electrical technology is, of course, the computer. W.H. Ward of Rand notes in comparing

FIGURE 14

GROWTH OF CATV INDUSTRY
(As of January 1 of Each Year)

Year	Operating Systems	Total Subscribers
1952	70	14,000
53	150	30,000
54	300	65,000
55	400	150,000
56	450	300,000
57	500	350,000
58	525	450,000
59	560	550,000
1960	640	650,000
61	700	725,000
62	800	850,000
63	1,000	950,000
64	1,200	1,085,000
65	1,325	1,275,000
66	1,570	1,575,000
67	1,770	2,100,000
68	2,000	2,800,000
69	2,260	3,600,000
1970	2,350	4,500,000

Source: Television Factbook, Vol. 39, p. 79-a.
"During the periods Jan. 1/54 to Jan. 1/70, the number of commercial T.V. stations increased from 354 to 677, whereas cable systems increased from 300 to 2,350".

Proceedings, 9th I.E.E.E., July, 1970.

the computers of 1953 to those of 1965 that:

> "..... the 1953 machine weighed about 5000 lb., had a volume of 300 to 400 cubic feet, and required about 40 kilowatts of power. The contemporary computer (1965) is a hundredfold lighter (about 50 lb.), a thousand times smaller (about 1/3 cu. ft.) and requires 250 times less power (150 watts). Moreover, it has twice the storage and runs ten times as fast .....".

In 1954, there were less than 1,000 computers in the U.S.A. In 1968, there were 30,000 representing a capital investment of over $11 billion. Their influence is ubiquitous.

As long ago as 1965 it could be said that, 'At least a dozen of the 20,000 computers in the U.S. have touched your life since you woke up this morning. They're processing your cheques, keeping your credit card accounts, figuring the market averages you hear on the news, blending your livestock concentrates, helping predict tomorrow's weather, and formulating your breakfast sausage. All this in the short years since the computer age began'. The phenomenon is well known, and it should not be necessary to elaborate.

Aside from the obvious, what is generally important in these developmental trends in communication technology is that it is presently advanced beyond our ability to use it efficiently. However, communications never exist in a vacuum and their history is one of creating demand. Furthermore, it is possible not only to interlink all of the above innovations but also to connect them with all existing media hardware such as telephones, printing presses, and television. The potential

social, economical and political impacts are staggering. An indication of this phenomenon is contained in a description of present television usage by a member of the U.S. Federal Commission (F.C.C.), N. Johnson.

> "Americans receive decidedly more of their education from televisions than from elementary and high schools. By the time the average child enters kindergarten he has already spent more time learning about his world from television than the hours he would spend in a college classroom earning a B.A. degree.
>
> There are 60 million homes in the U.S. and over 95% of them are equipped with a television set. (More than 25% have two or more sets.) The average male viewer, between his second and sixty-fifth year, will watch television for over 3000 entire days - roughly nine full years of his life".

> ".....investments in television advertising have increased from $300 million in 1952 to $900 million in 1956 to $18 billion in 1968".

> "Alberto Culver rrelies almost exclusively on television advertising, and pushed its sales from $1.5 million in 1956 to $18 million in 1969. The manufacturer of the bottled liquid cleaner Lestoil undertook a $9 million television advertising program and watched his sales go from 150,000 bottles annually to 100 million in three years - in competition with Proctor and Gamble, Lever Bros. and others. The Dreyfus Fund went from assets of $95 million in 1959 to $1.1 billion in 1965 and concluded 'T.V. works for us'."

> ".....what we sometimes fail to realize moreover, is the political significance of the fact that we have become a nation of cities. Nearly half of the American people live in the six largest states ..... Those states, in turn, are substantially influenced (if not politically dominated) by their major population industrial-financial-media centres such as Los Angeles, New York City, Chicago, Philadelphia - the nation's four largest metropolitan areas. Thus, to have a major newspaper or T.V. station in one of

> these cities is to have significant national power. And the number of interests with influence in more than one of these markets is startling".

Teletechnology and Urban Structure

Within this context, what is specifically important to this study is the manner in which such teletechnology affects and will affect urban structure. Generally, the post-industrial development of "advanced" nations is urban and information intensive. As early as 1962 it was recorded that:

> ".....in terms of the merely quantitative and commercial activities of men, the codifying and moving of information by technology has become easily the largest in the world. The A.T. & T. Company which moves only information has a capitalization several times larger than that of General Motor Corporation. The production and moving of heavy commodities is now a smaller affair than the codifying, exchange, and consumption of information.....". (McLuhan, 1962)

The functional significance of this replacement of the industrial paradigm to one related to services and communications is best examined by determining the groups in society who are most concerned with them.

Jean Gottmann (1961) has identified the 'white collar revolution' as a dominant trend in economically developed nations. In 1966 in the U.S. 52.2% of the gainfully employed were either service or white collar workers. (Abler, 1970) Within this occupational category he further delineated a quaternary sector of economic activity. Originally the quaternary sector was meant to include only managerial, professional and

higher level technical personnel. (Gottman, 1961) More recently he has extended the category to include the upper strata of clerical occupations. (Gottman, 1970)

Abler (1970) defined the relationship between the quaternary occupations and communication systems as that between producer and tool.

> "Decision-makers fabricate decisions. Information is their raw material and commands are their finished products. Intercommunications media are the instruments by which raw materials are assembled and finished products disseminated". (A & G, 1970)

As such, the quaternary group represents a control subsystem in the general system of urban organization. This control group and their means of control - communication system have distinct locational association.

Both are products and producers of the urban environment. Whether considered at the scale of the individual, the economic and political organization, or at a world scale, urbanism, quaternary activity and intensive communications are almost always coincident. (Abler, 1970; Sjoberg, 1965; Davis, 1955) This functional and locational association has historically involved centralized control. With the increased communication capacity mentioned earlier, it is possible to rearrange existing areal relationships of social and economic activities.

In the first chapters, an idealized communication space with equal two-way accessibility to all points was posited as a conceptual framework.

Then a communication channel was given and the actual flows examined, from functional and behavioural perspectives. Here, it is suggested that such an idealized isotropic communication space is not only likely but probable.

Since it was also stated that the relationships between hardware (structure) channels and software effects (function) was circularly causal, it remains to make some tentative suggestions concerning the effect of increasing channel capacities on given spatial structures.

To date, there has been little work of substance that examines this issue. Most efforts are highly speculative and proposed one of three basic possibilities: dispersion of urban population, increased concentration or no change. Abler (1970), Berry (1968), Colin (1971), McLuhan (1962) and others see a decentralized urban organization as a result of greatly enlarged communication capabilities. More personalized available inter-communication devices provide for the socialization of the means of communications. This leads to the decentralization of control functions. (Abler, 1972) A good example is provided by quaternary industries mentioned earlier. The usual industrial locational factors of labour, raw material and market are not wholly relevant.

Hagerstrand (1970) suggested a more functional analysis based on organizational or informational classifications of different economic activities. He found that within the Swedish economy administrative units (information or decision units) tended to concentrate while

operating units (production or manufacturing units) tended to an increasingly scattered location.

Communication/Transportation Substitution

A basic tenet of this paper is that cities exist to facilitate interaction, or in effect, they are substitutes for transportation. A critical question, then, is to what degree will communication substitute for transportation and hence for cities as we presently know them? There is no clean-cut answer and probably each urban organization will react somewhat differently. Goodwin (1963) relates the problem to the importance of computer technology.

> "The changes now taking place in the mechanics of decision making may have either of two opposite results with respect to the location of management centres. On the one hand, the reduction in the number of employees needed to staff a headquarters office may hasten the concentration of decision making in a few locations; on the other hand, it may well mean dispersion of headquarters because of the flexibility of data flows through a computer. One must be aware of its great potential for changing the pattern of "office cities".

Still others see a complementary role where the purpose of travel may be altered but not necessarily the frequency. Willmoth suggests that whether or not communications technology is a centrifugal or centripetal force is not as important as the effect of other factors brought into play by the diminishing of distant constraints. Within the new technological framework, the outcome will be determined by organizational change and levels of social acceptance. On the other hand, with more emphasis on planning it becomes likely that the existing urban structure will

influence the technology. Hence, we would see rapid development of substitutable technology in Japanese cities suffering severe internal congestion and pollution.

Those who foresee high levels of substitution and dispersion view amenity resources as the future location determinants as traditional time-distance costs are collapsed. They cite several explanatory factors. The costs of communication are declining much more rapidly than those of transportation. Personal goods transport has an increasingly expensive service component cost. Urban travel time has not decreased and the upper limit of personal travel time allocation is being approached. Present transportation modes make significant demands on scarce resources while polluting physical and social environments. Advocates use these reasons to encourage dispersion and decentralization and view the C.B.D.'s as future museums. Others, using the same reasons suggest that broader choices should be seized upon by cities to become intensively specialized communication concentrations or higher-order centres. In summation, speculation about the substitution process covers a vast spectrum of opinion.

To date, little research has been undertaken to predict the substitution effect of communication/information technology. Indeed, knowledge of past and present relationships is sparse. Towards this end, Willmoth (1970) presents a four step research strategy:

1. understand present relationships.
2. forecast possibilities (mainly technological).
3. forecast possibilities (susceptibility to substitution social acceptance, etc.)
4. evaluate (II) against criteria (e.g. will change be to the advantage of any particular group.)

Within this general framework three main approaches have been attempted. They are:

1. relative performance of different media.
2. relative costs of different media.
3. influence of non-economical non-quantifiable factors.

For immediate purposes the relative costs approach seem most pertinent to the transportation problem. Three methods of analysis will be briefly considered; simple cost accounting, an evaluation matrix, and a consumer indifference curve.

Memmot (1963) outlines the main phases of pilot study as:

1. identifying person and vehicle trips by purpose.
2. roughly determine proportions susceptible.
3. for susceptible trips, determine communication equipment required.
4. determine willingness to pay for communication in lieu of travel.

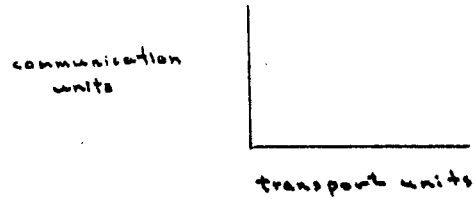
5. determine all cost characteristics.
6. thus determine economics potential for substitution.
7. determine equipment that can be provided at amount people are willing to pay.
8. determine probable rate of social acceptance and adjust.
9. determine potential use of social acceptance rate for urban transport and communication planning.

Healy applies weights to a profit measurement matrix to arrive at the following decision matrix:

	Employee		Company		Society	
Economic	11	11	12	12	13	13
Psychological	21	21	22	22	23	23
Social Environment	31	31	32	32	33	33

A simple decision model specifies that the net gain to recipients must be positive if substitution is to be rewarding. Thus, a decision to substitute would be affirmative if the receiver (employee, company, society) viewed the utility or profit (economic, psychological, Social) as positive. Of course, weights must be applied to account for a plurality of interests among receivers, and to standardize dimensions. Within this content, the model states that the net profit of employee, company and society must each exceed zero. It is useful in that it provides a framework for evaluation of community effects of substitution as well as the probability of such action.

The third method suggested employs the economists familiar indifference curve:



Units can be measured by money or time or a combination of both. The model may be useful for rough theoretical guess estimates but the problems of such a comparative-static model seem to rule out its ultimate usefulness. Assuming a fixed expenditure for two services hides many of the complexities of the substitution process. An example is that many trips are for the purpose of communicating and much communicating is to encourage trip making. In fact, at a fundamental level the difference between transport and communication is obscure. Stuffed (1969) indicates that it is a difference of degree not principle:

> "It is the relative amount of energy being moved that, traditionally, determines whether the movement of matter and energy involved is classified into either category".

Hopefully, what does emerge as clear is the highly interactive nature of communication, transportation, and urban development. Communications have an increasingly significant reciprocal effect on a transportation model's major components of modal split, generation and distribution. To optimize or predict the function of either, it appears as essential to critically examine the intra and inter-relationships. Their importance in determining urban development cannot be overstated.

Summary and Conclusions

Most urban studies tend to neglect any serious consideration of communications. This paper has attempted to use communications both as a given metric and as a variable. In the first instance, it was assumed that it was possible to derive a comprehensive and meaningful picture of urban spatial relations using communication data in the form of origin-destination flow volumes.

In the first two chapters, effort was focused on interaction between points representing telephone exchangesareas through the G.V.R.D. Through a graph theory interpretation, a functional or nodal region was identified. This closely corresponded with what was expected from other factors and studies. The C.B.D. is the transaction maximizing node and receives more calls than it originates. Further, its influence, as measured by degree of interaction, declines with distance.

Transaction flow analysis was then used to develop a concept of salience for a more detailed analysis of the region. It was found that the spatial structure of the G.V.R.D. closely corresponded to a "core-ring" model also supported by previous studies.

Next, social area analysis was used to determine the areal association and locational attributes of formal regions in the G.V.R.D. Behavioural assumptions were then posited in an attempt to synthesize concepts of

spatial and social structure. It was found that areas alike in socio-economics characteristics do communicate more with similarly characterized areas than with other areas. The ranking of socio-economic areas, however, was not found to be strongly correlated either to the range or number of contacts initiated by an area.

Finally, recent developments in communication technology were reviewed to suggest possible future impacts on urban structure. The largest probable impact seemed to involve the notion of communication/transportation substitution which has potential for dispersing populations. Some tentative suggestions for further research in this area were offered.

BIBLIOGRAPHY

Abler, R., Adams, Gould, Spatial Organization, Englewood Cliffs, N.J., Prentice Hall, 1971.

Abler, R., The Geography of Inter-Communication Systems: The Post Office and Telephone Systems in the U.S. University of Minnesota Ph.D. dissertation 1968-9.

Berry, B., "Cities as Systems Within Systems of Cities", Regional Science Association Papers and Proceedings, 1966.

Berry, B., and Horton, E., Geographic Perspective on Urban Systems, Englewood Cliffs, N.J., Prentice Hall, 1970.

Berry, B., and Marble, D., Spatial Analysis, Englewood Cliffs, N.J., Prentice Hall, 1948.

Bourne, L., Internal Structure of the City, Toronto, Oxford University Press, 1971.

Buckley, W., Sociology and Modern Systems Theory, Englewood Cliffs N.J., Prentice Hall, 1967.

Burgess, E.W., "Urban Areas" in Chicago: An Experiment in Social Science Research, Smith, T. and White, L., (ed.) Chicago, University of Chicago Press, 1929.

Charde, P.M., A Contextual Analysis of Communication Networks in a Metropolitan Area, unpublished Ph.D. dissertation University of California, Los Angeles, (Diss. Absts. 31:4281-A), 1970.

Chapin, F.S., Urban Land Use Planning, Urbana, University of Illinois Press, 1965.

Cherry, C., On Human Communication, Cambridge Mass., M.I.T. Press, 1966.

Cherry, C., "Electronic Communication: A Force for Dispersal", Official Architecture and Planning, 33, 1970.

Chercher, L.G., Dardick, A.S., Firstman, S.I., and Bretz, R., Telecommunications in Urban Development, Santa Barbara, Rand Corp., memorandum 6069, 1969.

Chorley, R.J. and Hagget, P., "Models, Paradigms and New Geography in Socio-Economic Models in Geography, Chorley and Hagget (eds.), London University Paperbacks, 1968.

Cripps, E.L., An Introduction to the Study of Information for Urban and Regional Planning, Whiteknights Reading, 1961.

Deutsch, K., "On Social Communication in the Metropolis", in Radwin, L.'s (ed.), The Future Metropolis, London, Constable, 1962.

Deutsch, K., "Communication Theory and Political Integration" in Jacob, P.E. and Tascono, J.'s (eds.) The Integration of Political Communities, Philadelphia, Lippincott, 1964.

Deutsch, K., Nerves of Government, New York, Free Press, 1966.

Deutsch, K., Nationalism and Social Communication, Cambridge, M.I.T., 1966.

Deutsch, K., and Savage, R.I., "A Statistical Model of the Gross Analysis of Transaction Flows", in Econometrics, Vol. 28, No.3, July 1960.

Edwards, E., Information Transmission, London, Chapman and Hall, 1964.

Fabun, D., The Dynamics of Change, Englewood Cliffs N.J., Prentice Hall, 1968.

Fabun, D., Dimensions of Change, Toronto, Glencoe Press, 1971.

Filani, M.O., Substitutability of Communications for Transportation: A Bibliographic Survey, Transportation and Traffic Safety Center, The Pennsylvania State University, September, 1970.

Friedman, J., "An Information Model of Urbanization", Urban Affairs Quarterly, December, 1968.

Goldhammer, H., and Westrum, R., (eds.) The Social Effect of Communication Technology, Santa Barbara, Rand report R-456-RSF, 1970.

Gotlieb, A.E., Instant World: A Report on Telecommunications in Canada, Ottawa, Information Canada, 1971.

Gottmann, J., "Urban Centrality and the Interweaving of Quaternary Functions", Ekistics, 29, 1970.

Gottmann, J., Megopolis, New York, Twentieth Century Fund, 1961.

Greenberg, E., "Wired-City Television Revisited", Proceedings of the I.E.E.E., 58. 7, July 1970.

Greer, ., The Emerging City, New York Free Press, 1962.

Hagerstand, ., "Aspects of the Spatial Structure of Social Communication and Diffusion of Information", Regional Science Association Papers, Vol. XV, 1965.

Hagget, P., "The Spatial Structure of City Regions" Centre for Environmental Studies Working Papers, Vol. 2, Cambridge, 1968.

Hagget, P., Locational Analysis in Human Geography, New York, St. Martens Press, 1966.

Hammer, C., and Ikle, F.C., "Intercity Telephone and Airline Traffic Related to Distance and the 'Propensity to Interact'", Sociometry, 20, 1957.

Hardwick, W., "The Emergence of a 'Core-Ring' Urban Pattern", in Geographical Approaches to Canadian Problems, Gentilcore, R.C. (ed.), Scarborough, Prentice Hall, 1971.

Harris, C.D. and Ullman, E.L., "The Nature of Cities", Annals of the American Academy of Political and Social Science, CCXLI, November, 1945.

Healey, T.J., "Transportation of Communications: Some Broad Considerations", I.E.E.E. Transactions on Communication Technology, 16, 1968.

Hough, R.W., "Future Data Traffic Volumes", Computer, 3, 1970.

Hoyt, H., The Structure and Growth of Residential Neighbourhoods in American Cities, Washington Federal Housing Administration, 1939.

Jacob, P.E. and Toscono, J., (eds.) The Integration of Political Communities, Philadelphia, Lippincott, 1964.

Johnson, N., How to Talk Back to Your T.V. Set, Bolton, Little, Brown, 1970.

Katz, E. and Larzensfeld, P., Personal Influence, New York, The Free Press, 1964.

Komarovsky, M., "The Voluntary Associations of Urban Dwellers", American Sociological Review, December, 1946.

Leahy, W.H., McKee, D.L. and Dean, R.D., Urban Economics, New York, The Free Press, 1970.

Lynch, K., The Image of the City, Cambridge, Mass., M.I.T. Press, 1960.

McLuhan, M., Understanding Media: The Extensions of Man, London, Nelson, 1964.

McElrath, D., Greer, S., Minor, D.W. and Orleans, P., (eds.) The New Urbanization, New York, St. Martens Press, 1968.

McLoughlin, B., Urban and Regional Planning: A Systems Approach, London, Faber and Faber, 1969.

McMarten, B.G., Communication and Political Behaviour in the International System: Explorations into Theory, Method, and Substance, M.A. thesis, U.B.C., 1965.

Meier, R.L., A Communication Theory of Urban Growth, Cambridge, Mass., M.I.T. Press, 1962.

Meier, R.L., "The Metropolis as a Transaction Maximizing System", Daedalus, 97, 1968.

Memmot, F.W., "The Substitutability of Communication for Transportation", Traffic Engineering, 1963.

Nygaard, J., "An Integrated Telephone Traffic Forecasting Tool for use in Planning I", Teleteknik, 14, 1970.

Nystuen, J.D. and Davey, M.F., "A Graph Theory Interpretation of Nodal Regions", Papers and Proceedings of the Regional Science Association, Vol. 7, 1961.

Orleans, P., "On the Changing Conditions of Communal Life in the Contemporary City", American Sociological Association, August, 1968.

Olsson, G., Distance and Human Interaction: A Review and Bibliography, Philadelphia: Regional Science Research Institute, 1965.

Pepinsky, H.B., (ed.) People and Information, New York, Pergamon, 1970.

Peucker, T.K. and Rose, W.D., "A Factorial Ecology of Greater Vancouver" in Contemporary Geography: Western Viewpoints, Leigh, R. (ed.), Vancouver, Tantalus Research, 1971.

Pierce, J.R., Symbols Signals and Noise, London, Hutchinson, 1962.

Pred, A., Long Distance Flow of Information Through Pre-Electronic U.S. Newspapers Economic Geography, 1970.

Robson, B.T., Urban Analysis, Cambridge, University Press, 1969.

Rogers, E.M., Diffusion of Innovations, New York Free Press, 1962.

Shannon, C.E. and Weaver, W., The Mathematical Theory of Communication, Urbana, University of Illinois Press, 1949.

Schramm, W., Mass Media and National Development, Stanford, Stanford Press, 1964.

Shevky, E., and Bell, W., Social Area Analysis, Stanford, Stanford University Press, 1955.

Simmons, J.W., "An Urban Information Field", Ontario Geographic Review, 2, 1968.

Simmons, J., "Interaction Patterns", Urban Affairs Quarterly, December, 1970.

Soja, E.Q., "Telephone Communication and Territorial Integration in East Africa: an Introduction to Transactional Flow Analysis", Ekistics, 28, 1969.

Soja, E.W., The Political Organization of Space, Commission on College Geography, Resource Paper 8, Washington, Association of American Geographers, 1971.

Tarnquist, G., "Flows of Information and the Location of Economic Activities", Geografiska Annaler, 50 B, 1968.

Tarnquist, G., "Contact Systems and Regional Development", Land Studies in Geography, Series B, Human Geography, 35, 1970.

Watzlowich, P., Helmick, J. and Jackson, D., Progmatics of Human Communication, New York, Horton & Co., 1967.

Weiner, N., Cybernetics, New York, John Wiley and Sons, 1948.

Webber, M., "Order in Diversity: Community Without Propinquity", Cities and Space: The Future Use of Urban Land, Wiugo, L., (ed.) Baltimore, Johns Hopkins University Press, 1963.

Webber, M., "The Urban Place and the Non-Place Urban Realm", Explorations into Urban Structure, Webber and others, (eds.) Philadelphia, Pennsylvania Press, 1964.

Webber, M., "The Post-City Age", Daedalus, 97, 1968.

Wheeler, J.O., "Social Interaction and Urban Space", Journal of Geography, Vol. LXX, April, 1971.

Wise, A., "The Impact of Electronic Communication on Metropolitan Form", Ekistics, 32, 1971.

Willmoth, D., Communication and Urban Structure, Discussion paper, Dept. of Town and Regional Planning, University of Sydney, 1971.

Wolforth, J.R., Residential Location and the Place of Work, B.C. Geographical Series, Number 4, 1965.

Wright, C. and Hyman, H., "Voluntary Association Membership of American Adults", American Sociological Review, 23, June 1958.