HELIPORTS: THEIR LOCATION IN THE CENTRAL BUSINESS DISTRICT

by

VERNER JACOB WIELER

REPORT ON A PROJECT SUBMITTED IN LIEU OF A THESIS IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

in the Department of

COMMUNITY AND REGIONAL PLANNING

We accept this report as conforming to the standard required from candidates for the degree of MASTER OF SCIENCE

Members of the Department of Community and Regional Planning.

THE UNIVERSITY OF BRITISH COLUMBIA

April, 1958.
ABSTRACT

The helicopter represents a revolutionary approach to flight. Its most important characteristic is its flexibility; it climbs and descends vertically, it hovers in mid-air, and it travels at relatively slow and fast speeds. Therefore, it presents a vehicle which has great potential in operating within or directly above the physically dense central business district, carrying passenger and freight traffic.

Helicopter transportation is now taking root in several large metropolitan cities, and more cities are considering the installation of such a service. It appears that the helicopter will become a strong member of the urban transportation system in the near future, and therefore steps should be taken in advance of its advent to insure a proper location of the heliport, as well as an efficient route pattern within the metropolitan city. It is felt that the helicopter will be most restricted in its operation within the central business district, and at the same time will carry its greatest payload in and out of the central business district. Therefore, the location of one or a pattern of heliports within the central business district, becomes a fundamental issue to helicopter transportation.

Several studies have been undertaken which considered the heliport location in light of the technical requirements of
the helicopter, and to some degree the potential traffic which the helicopter might bear. The heliport location criteria which evolved reflected this more general approach, particularly to traffic generating areas. The studies did not consider individual land uses which might directly or indirectly cause the failure of a heliport because the particular characteristics of the land uses could not support helicopter transportation.

Using former studies, therefore, as a basis for further research, this study has attempted to analyze traffic generating areas as they affect helicopter transportation. In this respect, the land uses of the central business district and the traffic that such land uses create have become the focal point of the study.

The study draws certain conclusions with respect to heliport locations in the central business district. First, it recognizes the overlapping effects of specific land uses and the technical limitations of the helicopter on the choice of location. Although it is felt the land use factors are essentially determining over a period of time, the technical limitations create problems which must be dealt with, with equal urgency, and in some cases might initially control location. However, in all cases, the land use factors should receive precedence in the establishment of location criteria. It is the land use criteria that will determine the long-range success of the helicopter service.
Secondly; the heliport should be located in the "auto-oriented" areas of the central business district, but should be closely associated with the "walking" area of the specific types of central business district workers who may be expected to be the major users of helicopter transportation. Thirdly; the technical characteristics of the helicopter require that the heliport have an area of approximately four acres. In addition, it should have a bi-directional approach route with an obstruction profile ratio minimum of 1:8, with allowance for emergency landings outward to the critical point in the take-off pattern.

The problem of noise associated with the helicopter in flight have been mentioned only in passing, this involves a detailed study of the mechanical parts of the helicopter which the author could not discuss with authority. However, the noise will have its affect on adjacent land uses to a considerable degree. The onus is on the helicopter manufacturer to attempt to reduce the noise to a compatible level.

The location of a heliport on a water-front site seems particularly advantageous with respect to the lower cost of land and an obstruction-free landing and departure route. However, if the water-front location cannot satisfy the land use criteria which have been developed, and which generate the traffic potential, then such a location would prove to be inadequate. Furthermore, harbour regulations pertaining to shipping in the area may result
in the negation of the values of a particular water-front location from the standpoint of the land use criteria.

The study was limited in obtaining sufficient data on land use in relation to the movement of central business district workers. Such research is now underway but only to a limited degree,

It is felt that the contribution of this study lies in its attempt to point out the influence of land uses on the generation of traffic, and the helicopter service developing on the basis of what traffic the specific land uses are generating.

Approved
In presenting this thesis in partial fulfilment of the requirements for an advanced degree at the University of British Columbia, I agree that the Library shall make it freely available for reference and study. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by the Head of my Department or by his representative. It is understood that copying or publication of this thesis for financial gain shall not be allowed without my written permission.

Department of Community & Regional Planning

The University of British Columbia, Vancouver 8, Canada.

Date 9th May, 1958.
The purpose of this Thesis is to develop criteria or general principles for guiding city planners in their selection of appropriate locations for major heliports within the central business districts of major metropolitan centres. This objective is achieved by means of an analysis, on the one hand of the land use pattern and establishments within central business districts and the changes in these factors, and on the other hand, of those physical and technical factors of the helicopter and the heliport that are likely to influence the location of heliports.

The study is not concerned with a whole network of heliports for a metropolitan region - that is a regional study of helicopter transportation. The author views the central heliport as the focal heliport in the region, and therefore its location is the most significant one and also the most complex. A separate investigation of the central heliport was felt to be important.

The British Columbia Lower Mainland Regional Planning Board, in its study of *Airports for the Lower Mainland*, emphasized the importance of recognizing the helicopter as a new and practical means of transportation, and that helicopter operations should be visualized as an integral unit in the total regional transportation framework. The author recognizes the regional approach as a requisite to setting the stage for more detailed investigation. This study attempts to
provide more of the detailed investigation of one significant portion of the regional helicopter transportation pattern.

The author encountered difficulty in obtaining information, especially with regard to linkages between establishments, and the movement of various types of persons within the CBD. These problems supply rich fields for further research, and their analysis would throw much light on the subject of heliport locations, as well as aid in the re-shaping of the whole transportation system to allow it to operate at a functional maximum from one control centre.

The studies by R.H. Mitchell and C. Rapkin in Urban Traffic, and of John Rannells in The Core of the City, have been invaluable to this study and have been referred to extensively.

It is hoped that the study has aroused a greater interest in heliport location within the Central Business District, and has shed more light on the problems which must be considered in properly locating the heliport.

This study is indebted to the advice and material offered by many persons and organizations concerned with the Central Business District, and with helicopter transportation. Of particular mention are:

Mr. Ira M. Robinson, A.B., M.A.,
Assistant Professor of Planning,
University of British Columbia,
Vancouver, B.C.
Mr. J. R. Iyall, P.Eng.,
Technical Assistant to the City Engineer,
City of Vancouver,
Vancouver, B.C.

Mr. W. L. Inglis, P.Eng., M.E.I.C.,
Airport Manager,
Vancouver International Airport,
Vancouver, B.C.
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A - THE HELICOPTER:

According to the Oxford Dictionary the helicopter is a "flying machine deriving both its lift and its propulsive power from horizontally revolving blades or rotors, and capable of ascending and descending vertically". This study considers the helicopter as a vehicle, not just as a flying machine, and that it can hover and fly sideways and backwards in addition to ascending and descending vertically.

What has created greatest enthusiasm in the field of helicopter transportation is this 'vehicles' uncanny flying characteristics which enables it to land and take-off within a confined area. This is the versatility any airborne machine must have to operate within a built-up area. The helicopter can fly among tall buildings, can land and take-off from a sufficiently strong roof, and can land and take-off from the ground immediately adjacent to a ground transportation system or a pedestrian walk-way.

Helicopters vary greatly as to size. The capacity of commercial helicopters now operating, range from two to twelve passengers. On November 2nd, 1957, Russia claimed a record-breaking flight by a twin turbo-prop MI - 6 helicopter to an
altitude of 7,500 feet with a load of 24,000 pounds. Eleven days later, on November 13th, Fairey Aviation of England announced the successful test flight of the "world's first vertical take-off airliner" - the Rotodyne. The Rotodyne has a capacity of 48 passengers and a speed of 185 miles per hour.

Dr. Igor I. Sikorsky considers the transport helicopter, being developed in the immediate future, as following two distinct lines of design.

"The first would correspond and be similar to the airliner or transport airplane. The second would be a freight and cargo carrier and would be a craft in its own class with virtually no parallel in any other aircraft or even in any other vehicle of travel.

The first type would need very little description because it would essentially be the further development of the modern helicopter as currently used. It means an aircraft with a body-fuselage with interior arrangements essentially similar to what is used in corresponding military transports or airliners. In the helicopter it would be desirable to use larger entrance doors or more of them in order to expedite the loading and unloading of the aircraft in the case of short-range flights. Furthermore, it would be desirable to use larger windows because, in the majority of cases, the helicopter offers much more interesting scenery than could be viewed from the airplane.

The second and very interesting type whose appearance may be confidently expected in the near future, would be a special freight-cargo helicopter which would be specifically designed to lift any type of object or load, including large and bulky ones, and to carry them on the outside, suspended below the body of the aircraft.3

1 - The Vancouver Sun, (November 2nd, 1957)
2 - The Vancouver Sun, (November 13th, 1957)
The problem that faces helicopter manufacturers is the development of multi-engine helicopters which will provide greater efficiency, economy, safety and carrying capacity - a technical problem; the problem that faces the heliport operator is the acceptance of the helicopter by the general public as a means of transportation which they will use with confidence and not shun in fear and doubt - an acceptance problem.

It is beyond the scope of this study to consider helicopter transportation of a military nature, or for exploration and survey purposes in uninhabited or sparsely populated rural areas. The emphasis is on the use of the helicopter in the densely built-up areas of the central business district within the urban setting.

B - STATUS OF THE HELICOPTER IN THE URBAN TRANSPORTATION SCENE:

In North America metropolitan helicopter transportation began with the mail service in the Los Angeles metropolitan area in 1947. This initiated the period of experiment and development under way today to improve the flying characteristics of the machine itself, and to create enthusiasm and confidence in the mind of the public who must ultimately accept or reject the helicopter as a means of transportation.

The recent stage of helicopter transportation development appears to be something like that of airline service in the late
1920's, when mail was the principle item carried and passengers were few. However, this picture is rapidly changing and today there are a score of helicopter operators in North America and in Europe carrying large numbers of passengers and goods, and the market is continually expanding. To cite one example, New York Airways, Inc., Flushing, N.Y., was inaugurated on 8th July, 1953, and became the first regularly scheduled helicopter passenger service in the world. In 1956, it carried the following traffic:

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<td>Passengers</td>
<td>42,972</td>
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<tr>
<td>Mail</td>
<td>1,159,704 pounds</td>
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<tr>
<td>Freight</td>
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This can be considered a significant volume of traffic for the third year of operation of the firm.

Although there are many commercial helicopter firms in operation today, the following firms are operating within metropolitan areas across North America:

- New York Airways, Flushing, N.Y.
- Port of New York Authority, New York, N.Y.
- Los Angeles Airways, Los Angeles, Cal.
- Chicago Helicopter Airways, Chicago, Ill.
- Helicopter Air Services, Inc., Chicago, Ill.
- Cleveland Air Taxi Inc., Cleveland, Ohio.

5 - New York Airways Incorp. began carrying mail in 1952.
These firms are carrying passengers, mail and freight, although some carry only one or more of these three.

There are some eighty commercial helicopter charter operators in the United States and Canada, using a total of some 400 helicopters.6

Canadian helicopter firms have been inaugurated and expanded at a significant rate over the past few years. Of the approximate dozen firms operating in Canada by far the largest firm is Okanagan Helicopters Limited, based at Sea Island - within the Vancouver metropolitan area. The Canadian helicopter firms have been engaged principally in construction work in remote areas, power line inspections, mountain and water rescue, air surveys, and transporting supplies and persons into remote areas, otherwise inaccessible. There is no actual metropolitan helicopter service in operation in Canada; however, Vancouver will no doubt have the first metropolitan helicopter service operating in Canada with the shuttling of mail between the Vancouver International Airport and the post office in downtown Vancouver. The newly completed post office is specifically designed to handle helicopters from its roof-top heliport. The helicopter service will handle mail freight only, the heliport not being designed for passengers. Therefore, if helicopter

6 - The American City, (August, 1957) p. 160
service is instituted in the Vancouver metropolitan area another location will have to be chosen within the CBD which will be capable of handling large numbers of passengers as well as freight.

The Port of New York Authority envisions helicopter service as taking three forms:

1. Aerocab or shuttle service
2. Inter-city service
3. Suburban service.

Elaborating on these three forms, the P.N.Y.A. go on to say that the largest market will eventually be found in the communication business, i.e., in competition with trains on a short-haul metropolitan area type of operation.

The second largest market will be inter-city service in competition with regular railway coaches.

The third largest market will be metropolitan area-to-airport, airport-to-airport within the same metropolitan area, and outlying area-to-airport. The traffic potential in this type of service is not nearly as great as in the first two, but it is a type of traffic that is willing to pay a high price for services rendered. The P.N.Y.A. feel that the current high cost of helicopter travel can be met by this type of traffic because it is not particularly interested in whether it is paying 4 cents per mile or 24 cents.

7 - The P.N.Y.A. Study, although speaking in general terms, is referring to the New York Metropolitan area regarding the forms of helicopter services envisioned and the market for the service.
per mile, but simply a question of whether getting there in 15 minutes is worth $5.00.  

In regard to the order in which helicopter services are likely to be introduced into the air transport industry, the P.N.Y.A. view was that it would be in the exact reverse to that in which they are listed above; that is:

1 - Metropolitan Area-to-airport, airport-to-airport within the same metropolitan area, and outlying area to airport.

2 - Inter-city service.

3 - Short-haul commutation service.

It is evident that perhaps the most spectacular contribution to the field of transportation in this age of technical development is to be seen in the versatile helicopter. Its possibilities afford unlimited opportunities to those persons concerned with providing a better means of public transportation. In addition, the very presence of the helicopter service as a member of the urban transportation system may not only tend to re-distribute the functions of the other transportation facilities, but may also ease the load on those facilities, de-

8 - However, helicopter fares may be competitive with other forms of transportation under certain circumstances.

crease vehicular congestion, and finally it may cause adjust­ments of the land uses in certain areas, especially within the central commercial area, to a more desirable arrangement in the interest of the community as a whole.

The helicopter must be visualized as a public trans­portation vehicle for its role within a metropolitan centre. It is expected to carry passengers predominantly, and such freight which it finds economical to carry.

Some indication of the future potentialities of the helicopter was given in a recent study by the Port of New York Authority. Its major conclusions were:

(a) The helicopter is a brand new air vehicle with entirely new potentialities.

(b) It will expand air travel in the short-haul field, a vastly greater market than the long-haul field, so success­fully invaded by fixed-wing aircraft.

(c) The Korean War has advanced the day of the heli­copter as a common carrier by five to ten years.

(d) Within the next few years, a ten-place helicopter will be used in common carrier service.

(e) By 1958, 30-place helicopters will be available for common carrier commercial operations.

10 - Helicopter Transportation, Port of New York Authority, (New York, 1952)
(f) It will not be possible to land these newer helicopters on any and every roof-top, nor to permit them to fly at random through the air over cities. Despite its versatility, the helicopter will require a carefully located, specifically designed airstop facility.

(g) The helicopter will require the allotment of its own air channels, landing and take-off procedures suited to its special capacities, and standards of service tailored to the markets it can expect to serve.

(h) The potentialities of the helicopter cannot be realized within the time periods discussed unless the Federal Government (U.S.A.) is prepared to include this new aircraft in its hitherto liberal policy of aid to commercial air transport and to include helicopter airstops in its airport aid programs.

(i) While the earliest common carrier use began as an airport shuttle service in 1953, it has even greater potentialities in the field of short-range inter-city travel and in the expanding area of commutation service.

The B.C. Lower Mainland Regional Planning Board, in its study of airports, suggests certain probable effects of the large-scale use of helicopters in the Lower Mainland. What was felt most important was a "speedier intercourse" between Greater Vancouver and other urban areas within a radius of some 200 miles.
The idea of direct flights from one downtown to another would eliminate the necessity for airport-to-downtown journeys, assuming that the passenger would have otherwise travelled in a scheduled fixed-wing aircraft. The centres which would be most affected by such a service, in relation to the Vancouver Metropolitan, would be Victoria, Nanaimo, Seattle, Bellingham, Chilliwack, and Mission.

Helicopters could also cause accelerated industrial development of the underdeveloped areas north of Vancouver. They might also open up certain recreational areas, such as Garibaldi Park, which are relatively inaccessible by ground transport.

The suggestion was also put forward that the helicopter could supply a commutation service between urban centres and a major international airport established some distance out from the concentrated and populous urban areas. This large airport would be the terminal for long-distance fixed-wing commercial air carriers. (With the introduction of the Bristol-Britannia turbo-propeller aircraft into regular passenger service in 1950, and the Comet and Boeing 707 jet airliners by 1959-60, the necessity for constructing large airports some distance away from large metropolitan centres will become virtually inevitable to aid in the efficient and adequate development of long-range fixed-wing air transport operations.  

11 - Crerar, A.D., Airports for the Lower Mainland, Lower Mainland Regional Planning Board, (Newwestminster, B.C., Sept. 1953) pp. 11-12.
C - THE NEED FOR THE METROPOLITAN REGION TO CONSIDER SPECIFIC LOCATIONS FOR HELIPORTS WITHIN THE CENTRAL BUSINESS DISTRICT

Clearly, then, the day of wide-spread inter-city helicopter transportation is not far off. The municipal planners who, a few short years ago were debating as to whether to build an airport are now facing the question of how many airports the community needs. The heliport presents basically the same problem to the planner. An attempt must be made to anticipate the need in advance of demand in order to maintain a greater control over development of heliports, not as a separate entity, but as a functional part of the dynamic central business district. This means that thought must be given now to the most appropriate locations for heliport sites within the CBD. As the final conclusion of the aforementioned study of the Port of New York Authority, it stated:

(j) None of these potentialities of the helicopter as a common carrier can be realized unless attention is given promptly to the study of actual sites, not only in the Northern New Jersey/New York Metropolitan area but in a region within a 175 mile radius, and to the design and development of airstop facilities fitted to the needs of the common carrier helicopter and the traffic it will be ready to serve. 12

12 - Helicopter Transportation, p. v.
The question could be logically raised: Why should the metropolitan city consider the heliport as a functional part of the dynamic central business district, requiring a detailed location study? The following points are suggested as significant answers to this question:

First, the fundamental consideration is that helicopter transportation is put into effect when there is a sufficient demand for its service; that is, when the establishments and the land uses of the CBD create a demand for helicopter service just as the demand for street cars and trolleys, railways, and private cars has developed over the past years. The helicopter will fit into the urban transportation pattern by supplying a transport service for a particular clientele which the urban area, especially the central business district, generates.

Secondly, the total helicopter operation, including the heliport and the helicopter flight pattern, must fit into the overall plan for the urban area, particularly the plan for the central business district. Within this broad category such considerations as an integrated urban transportation system, protection of land uses adjacent to the heliport, adequate terminal facilities, especially for ground traffic such as private passenger cars, and specific helicopter routes in and out of the CBD must receive critical analysis.
Finally, the study would allow the public authorities to choose certain advantageous sites for the heliport before the demand for heliports has created an inflated price for those sites, or, it would allow them to retain sites while they are still available and specifically meet the requirements of the heliport operation.

The question is raised: What factors are likely to affect the location of heliports in a CBD. To date, most studies on this question have emphasized either the volume of traffic, or the technical considerations, as dictating the siting of heliports. But, while these factors are important - and indeed, will be discussed in this report, the most dynamic considerations are the land use factors affecting the generation of passengers for helicopter transportation within the CBD; this aspect, however, is given only passing reference in the studies hitherto.

The central business district shows within itself a wide variety of intricate land uses and distinctive clusters of particular types of businesses. This variety of land uses in turn generates traffic in the form of particular types of people who represent either shoppers, persons on business, sight-seers, holidayers, or some combination of these. Goods are also transported to and from the various business establishments and are destined for certain areas depending on the type they are. Somewhere within the central business district there is an area,

13 - See for example, Ibid. p. 5 and Port of New York Authority, Helicopter Location and Design, p. 9
or areas, which would be most convenient to a particular group of persons or goods, who would travel by helicopter to some area outside of the central business district, if such a service became available.

This study will endeavour to locate such areas by means of an analysis of the functional and locational characteristics of the various land uses within central business districts, the changing trends in these characteristics, and the movement of persons in the CBD. Chapters 2 through 5 are devoted to this analysis.

In addition, it is recognized that physical and technical factors, for example, height of the heliport above ground level or maximum approach angles of the helicopter, will also affect the location of heliport sites. Chapter 6 considers some of the more important factors here. On the basis of these analyses, criteria are developed, in Chapter 7, for selecting appropriate locations within the CBD for heliports.

Finally, Chapter 8 discusses some of the zoning and administrative considerations in implementing a heliport program once the decision as to location is determined, and emphasizes the major differences in setting up a heliport in Canada.

14 - This approach to the study of helicopter transportation owes much to the pioneering work of Robert Mitchell and Chester Rapkin in *Urban Traffic*, as well as the accompanying analysis of John Rannell in *The Core of the City*. 
A - THE CENTRAL BUSINESS DISTRICT

The central business district is the "heart" of the city. In a sense, it can be considered a geographical region in itself and it, therefore, displays the three dominating characteristics of a planning region:

First, it has a "core" area. Here is located the peak land value intersection. This peak land value area has originated and has been maintained as such by the two crucial factors of:

1. Maximum pedestrian flow, and
2. Maximum vehicular flow.

Within this core area three functions have the greatest concentration. These are:

1. Retail establishments.
2. Offices.
3. Financial establishments.

Secondly, as in the case of a planning region, the boundaries of the CBD are zonal. That is, there is a "zone of transition" from the concentrated centre outwards. This zone of transition is generally considered as the boundary of the central business district.

Thirdly, the CBD has also regional variation within itself, this often being referred to as horizontal zones. The zones
which develop are generally considered as:

- retailing area
- hotel area
- cinema area
- night club area
- wholesale area
- office and financial area.

A vertical zoning of functions is also found in the CBD. This is, certain types and qualities of establishments rent on specific floors of specific types of higher buildings.

It must be seen initially that no two CBD's will be identical in terms of their location. Each has had a unique history of development in which local conditions have dictated particular locations for the CBD. Therefore, the CBD of a large city which is a seaport will dictate an altogether different location than the CBD of a prairie city which has developed as a hub for rural activities that stretch out from it in all directions. The exact location of the CBD within different cities will vary greatly, but within each CBD itself there is found an amazing similarity of types of establishments and ways in which these establishments locate in relation to each other and in relation to other "centres" which the CBD creates.
A great deal of pioneering research was carried out in the field of land uses by Dr. R. M. Haig, in his studies of the New York area. Haig believed that the aim of the modern master plan was to maximize the efficiency of the urban area through an arrangement of land uses which would minimize the "costs of friction". The two elements which Haig considered made up the costs of friction were transportation costs and site rentals. The underlying economic forces which mold the urban land use pattern, he felt, were often working imperfectly toward the same end. The imperfections, lags, and obstacles to the free operation of the forces of adaptation were the origins of urban problems which limited the efficiency of the land use structure as an economic mechanism. To Haig, accessibility meant ease of contact, that is, contact with relatively little friction; and ultimately, this referred to ease of contact at low cost.

R.U. Ratcliff, in another study of land uses, stated that among land use types there is a hierarchy of "convenience-desirability". Consumers vote by the amount and frequency of their purchases to establish the retail structure in a pattern

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#15 - See R.M. Haig, Major Economic Factors in Metropolitan Growth and Arrangement (New York, 1927).

#16 - See R.U. Ratcliff, The Madison Central Area (Madison; Bureau of Business Research & Service of the University of Wisconsin, 1953).
which maximizes their convenience. This creates the phenomenon of clustering, thereby minimizing the costs of friction.

Another study of land uses was that of R.E.Murphy and J. E. Vance.\(^{17}\) The study considered nine (9) United States cities ranging in population from 150,000 to 200,000 persons. It was decided not to use cities over this population size to avoid the special character of very large cities. "Land use" was considered to be the most practical approach to delimiting the central business district. Some of the conclusions of the study are presented here to emphasize certain generally accepted phenomena regarding the CBD, and also to bring to light certain significant facts which are valuable in the search for heliport locations. The applicable conclusions are these:

1. The land uses typical of the CBD, the ones which are truly "central business" in character, are offices and retail outlets for goods and services.

2. The CBD, more than any other business area of the city, serves the entire community rather than any one part of the city or any one ethnic group.

3. The current demand for office space in CBD's is focused upon new, high office buildings. (This was especially noticed in the new cities of Tulsa, Oklahoma, and Phoenix).

4. There seems to be a type of new Western City, built essentially on a single plane, but having a few peaks of tall buildings for offices, hotels and department stores.  

#18 - If Vancouver, B.C. is considered as one of these newer Western cities, then Murphy's assumption does not hold entirely true. For, although there are relatively few "tall" buildings, the majority of the buildings in the CBD are not on a single plane, but are more "intermediate" in height. The average height being somewhere between two and four stories. Therefore, Vancouver could be considered as having a distribution of tall, medium and single-storey buildings clustered in relatively close proximity. It is interesting to note, however, that of the three new and tallest buildings erected in Vancouver in the past three years, two are exclusive office buildings and the third is the administration centre of one large utility corporation. All three buildings are located some distance from the peak land value intersection, the one being two blocks away, the others several blocks further away, but all three in the area west of the intersection.
5. The CBD has ceased to be entirely a "walking zone". It has acquired outer sections that are, in part, "automobile orientated zones".

6. In most cities the position of the peak land value intersection has shifted at one time or another, but where it corresponds to a particularly well developed route focus the peak point may remain stable for a long time.

Reviewing the land uses that have been considered in this section, certain fundamental facts are evident and pertain to the investigation of land use as it affects the generation of traffic.

The central district functions serve the whole metropolitan area, consequently they attract persons from all parts of the metropolitan. These persons have come to this area for particular reasons, and have a certain number of destinations which they intend to or will visit. They arrive in the central district by private auto or public transit after connecting onto major thorough routes which converge in the central business district. Therefore, the CBD is the focal point of transportation routes, its centre or certain areas close to it experiencing the heaviest density of passengers and vehicles seen in any area of its size within the whole metropolitan area. Within this central district is found an area where persons principally walk between establishments they wish to visit. The trend toward a few high buildings in the
CBD, for purposes of business offices and department stores, should be noted. It is of interest to note that the 3 new "tall" buildings in the Vancouver CBD are located more in the outlying auto-orientated area. Although Murphy's study claims the new Western city is more a two-size physical variation - high buildings and single-storey buildings, Vancouver displays a significant array of medium-storey buildings within the core area. Economics seem to indicate the necessity for the construction of higher buildings in this extremely high land value area. The fourth building, newly opened in the midst of the Vancouver Core Area, is a five-storey building housing a bank on the main floor and devoting the four upper floors to administrative offices.

The "walking zone" generally contains retail sales and service establishments, offices, financial institutions and public entertainment facilities. The area immediately next to this close walking zone but still a significant part of the central business district is orientated more toward the automobile and other transport vehicles and can be considered a transition zone which is auto-orientated. The walking and auto-oriented zones are discussed further on page 99.

19- Murphy & Vance felt that the area beyond a distance of 400 yards from the peak land value intersection ended the walking zone, and was oriented towards the auto.
and the establishments located here do not necessarily cater to
the pedestrian. The zone of transition contains large numbers
of wholesalers (with and without stocks), manufacturers and in-
dustries. These firms are generally located in the older, multi-
storied buildings.

Before considering the changing trends in land use and
the movement of the central business district, it is necessary
to consider the establishments that exist there in more detail,
in order to arrive at a more significant conception of the CBD.

C - ESTABLISHMENTS IN THE CENTRAL BUSINESS DISTRICT

In considering establishments in more detail it is neces-
ary first to define the terms "establishment" and "land use", so
that they are considered separately, or at least as intégral parts
of the total central business district. For the purposes of this
study, the definitions will be those used by Rannells.20

Establishment: Individuals or groups using a
definite location as a recognizable place of business, residence, government,
or assembly.

Land use: Repeated activities of individuals
and establishments as they relate to
the use of space at fixed locations and among
these locations.

20 - J. Rannells, The Core of the City
(Columbia University Press, New
York, 1956) p. 11.
In the progressive approach to the understanding of land use within the central district the establishments it contains must be observed. The following ten characteristics apply to establishments found in the CBD's of practically every metropolitan city in North America.

1. The establishments are of all ages.

2. Old and new establishments are found side by side.

3. New buildings with the most up-to-date services and advantages of location naturally command the highest rents, and the very appearance of the more successful of these buildings becomes a symbol of their desirable qualities.

4. Well-located older buildings can maintain fairly high rents by modernizing their services and altering their appearance to accord with what is expected of them.

5. In outmoded locations the same kind of older buildings continue to serve a less demanding group of establishments at rentals which their operators can support.
6. In a general way the quantity and quality and cost of accommodations provided by the stock of buildings in an established business district all go on adjusting to the requirements of the entire array of establishments that use them.

7. The "front-and-fixture" alterations of establishments in the central district have been significant. This means of keeping up with their symbols is most generally applied to "frontage" establishments, thus highlighting the enormous differences between ground space, accessible from the street, and upper floor space. These differences are so marked that there may be little or no connection between the ground-floor and upper-floor establishments. (For example, hotels, office buildings, apartment houses, - these all have much the same assortment of retail shops and small service establishments at the ground level.)

8. Old residential structures are always present in the centre of any city, and provide a
reservoir of space which can be adapted to the needs of the more volatile elements of central activities.

9. The differentiation of activities carried on by present-day urban establishments has been brought about largely by technological advances—
in production, communication and transportation.

(a) Improved production:
- This affects the internal space requirements of manufacturing establishments.
- It forces some types of manufacturing out of the central business district.

(b) Improved communication:
- This has largely released the same activities from the necessity of locating near each other for the exchange of information.
- Business organizations are now more free to locate each of their separate activities in a place suited to its particular needs.
(c) Improved transportation:
- Especially in trucking.
- This figures largely in the changes taking place in the location patterns of activities which are isolated to each other.

10. In addition to the technological advantages, changes taking place in the very organization or the activities themselves are potent factors in the re-alignment of establishments and linkages among them. 21

Although the central district contains a great profusion of establishments, this study will deal exclusively with particular classifications of establishments. By considering groups of establishments it becomes easier to relate their locations to significant areas of the CBD, and to note the spatial relationships and linkages which exist between them. If groups of establishments and their relationships with one another are observed, and the type of traffic generated by such groups is superimposed over this pattern, it may be possible to choose certain sites for heliports which intimately connect certain major interchange areas.

21 - Ibid. Chap. V, "Land Use in Central Business Districts." The ten characteristics include various factors presented in this chapter.
Various classifications of central business district establishments have been made. The following are representative and will be considered for this study:

1. **Standard Industrial Classification Manual**: 22
   
   (a) Manufacturing.
   (b) Wholesale trade.
   (c) Retail trade.
   (d) Business services.
       - including finance, insurance,
       real estate.
   (e) Personal services.
   (f) Transportation, communication and
       other public utilities.

2. The classification for the CBD established by the Philadelphia City Planning Commission, Philadelphia, Pa., for their studies of 1934 and 1949. 23


23 - Ibid. p. 125.
(a) Manufacturing.
(b) Wholesaling.
(c) Business services.
(d) Consumer services.
(e) Retailing.

3. The classification of establishments in the CBD has been broadly divided into three sections in the study by Murphy and Vance. These are:

(a) Establishments present and apparently typical:
- restaurants
- women's clothing
- men's clothing
- furniture (high & medium class)
- hardware & appliances
- banks
- insurance and real estate
- personal services (barbers, beauticians, etc.)
- clothing service.
- department stores
- 5¢ and 10¢ stores
- drug stores
- jewellery & gift stores
- amusement establishments
- general offices
- commercial parking
- hotels & other transient lodging.

24 - See R.E. Murphy & J.E. Vance, op.cit., pp.189-222.
(b) Establishments rare enough to be absent, or essentially so, from one or more of the central business districts:

- supermarkets
- auto sales
- service stations
- accessory, tire and battery sales
- newspaper publishing

- railroad stations
- bus stations
- residences
- industrial
- wholesale
- headquarters offices

(c) Establishments occupying substantial space in all C.B.D.'s, but not typical central business land use:

- public land and buildings
- organizational and charitable institutions

- vacant building or lot space.

Although Murphy's study has value in its classification of types of establishments, it is limited to the extent that the criteria used were: "that the only establishments that are truly 'central business' in character are offices and retail outlets for goods and services". However, the establishments that are listed under the three headings could actually be rearranged to give consumer service, business service, and retailing groups, and also office and financial groups. Therefore Murphy's study
proves its value to this study in citing those typical establishments found in the core of the CBD, as well as other types occasionally found, and those types considered as being non-central business in function.

For the purpose of this study the following classification of groups of establishments will be used in order to simplify the approach as much as possible, and in recognition of the fact that the CBD is a number of clusters of certain types of establishments. The groups are:

1. Retailing.
2. Consumer services.
3. Business services.
5. Manufacturing.

Having considered land uses and establishments in the central business district, as observed by various researchers, we now turn to the more dynamic aspects of the central district; that is, the trends of development in certain areas, the centralization and decentralization of establishments, new types of structures and values, and the physical movement of the peak land value within this central district.
CHAPTER III

CHANGING TRENDS IN THE CENTRAL BUSINESS DISTRICT

The Central business district is a dynamic area in which the most stable elements are the buildings, the streets and the utility services present. The establishments present are constantly changing in their internal operations and in their actual locations. Movement of the peak land value point in the central business district is generally seen as following three directions:

1. It may move along the same street.
2. It may turn up another street.
3. It may jump over to a new location some distance away from its origin, but still well within the recognizable central business district.

The "residue area" left behind by the movement of the centre of the central business district progressively reduces in quality and is generally considered a poor quality area, especially for retail sales. However, the stigma of a poor quality area, though it may apply to retail sales establishments, does not necessarily apply to the many other types of establishments that make up the total functions present. The residue area, because it still has buildings it formerly had, experiences different tenants. The firms

25 - The "Peak Land Value Point" or "Intersection" is generally considered as the point of highest land assessment for local taxation purposes, and therefore is also the highest priced land.
observed in this area are cheaper quality retail outlets, retail services, manufacturers, industrial firms, business services, cheap hotels, night clubs and entertainment spots. There are very few new buildings constructed in this area.

The old CBD area contains a large residential settlement and some new residents are attracted. Many former business buildings are converted into dwellings, and, because of the poor condition of the buildings, low rents are asked; consequently, persons of low income who cannot afford to live elsewhere are attracted to it. It also becomes an area of social problems. Alcoholics, drug addicts, old age pensioners, new immigrants, and well-established immigrant groups are present. The area becomes a conflict area, not only by its high incidence of crime, but also because friction appears between the different groups present, in particular where immigrant groups of vastly different cultural and social backgrounds are grouped side-by-side.

The new centre of the CBD created by the movement of the peak land value point, generally contains the establishments of the "best quality" in the CBD. The buildings are new, the designs contemporary, and there is the vitality of the area which attracts those firms who can pay the high rents and land costs that are demanded. Many inter-related factors, however, determine the types of establishments that are found in this new area, and they are
discussed in more detail further on. This area, assumed to be the centre of retail sales establishments, attracts the heaviest density of pedestrian traffic as well as vehicular traffic. Consequently, a cluster of certain types of smaller retail and service stores appear, each catering to a specialty as a rule, and together reaping the benefits created by the dense movement of pedestrians among the large stores. The area has in its immediate vicinity better quality hotels and entertainment establishments.

The movement of the CBD is said to move in various directions for certain reasons: For example, Murphy states that the CBD moves towards high class residential areas as a repulsion to the deteriorated conditions that exist in the old CBD area. Bogue states that the CBD is attracted in the direction of the homes of the City’s leading business executives. These explanations are all plausible, although no study has yet shown conclusively that any of these factors are determining. It is not sufficient to consider only local factors as being totally responsible for the catalytic effect. Of equal importance is the effect of the total national economy, as well as the international economy, and also the haphazard action and fatuity of the real estate institution itself.

Traffic congestion in particular has a significant influence on the movement of the CBD, for nowhere in the balance of the city is there so much vehicular and pedestrian traffic compacted into so small an area throughout the day and well into the night. As vehicular traffic increases, certain business establishments will experience either a loss or a change in the type of customer they attract. The inconvenience of having to drive some distance further to pull into a pay-park area may influence the would-be shopper to shop elsewhere, where it is more convenient.

Encircling the retail establishments that cluster about the peak land value point of the C.B.D. are a maze of establishments representing many different types of activities. These mainly consist of wholesalers, manufacturers, service-to-industry firms, and public establishments of various kinds. They form the almost unseen portion of the C.B.D., but they create two traffic generating conditions which affect the whole of the C.B.D.

1. They generate dense vehicular traffic, particularly truck traffic.

2. They generate a large labour force which streams into the central area in the early morning and disperses out again in the late afternoon. In addition, throughout the day, persons on some form of business either walk or drive within the C.B.D.
The result of these two conditions is heavy traffic, mostly private autos, between 7 A.M. and 9 A.M., followed by relatively heavy truck and auto traffic throughout the day, and ending with the heavy flow of private auto traffic heading home between 4 P.M. and 6 P.M. To add to these traffic conditions, certain other forms of vehicular traffic exist over this time period:

1. Public transit vehicles.
2. Shoppers and sight-seers autos.
3. Autos driven by persons on some form of business.
4. Vehicles passing through the CBD destined to various points in the greater metropolitan area.

Because of the dense vehicular movement present, it imposes a negative effect on the retail area of the CBD. The vehicular movement comes in conflict with pedestrian movement. The traffic conflict tends to change the shopping pattern and in many cases it causes would-be downtown shoppers to by-pass the CBD in favour of the outlying modern shopping centres. However, recent studies indicate that the CBD still attracts the majority of shoppers purchasing major household appliances and family needs, and that the outlying areas are favoured for supplying the everyday needs.28

There has been a great deal of interest lately in the possibility of introducing a monorail transit system which would carry

28 - See Pages 47-54.
29 - Vancouver Province, (Vancouver, B.C., Sept.13, 1957, p.17.)
commuters into the CBD from the surrounding metropolitan area. The monorail is not a new idea but only a variation of the electric trolley, electric street car, overhead railway, and the electric subway railway. However, the fact that it may be suspended above the street gives the monorail some decided advantages in that it does not conflict with ground vehicular traffic to any large degree. But, as many cities are experiencing today, an increase in public transit facilities does not increase the proportion of persons using those facilities, and, in fact, the private auto is appearing in greater numbers each year. Whether changing levels of prosperity in the country as a whole will change this phenomenon is not known, nor is it possible to assess accurately the systems of values of persons which appear in part in the purchase of automobiles. The private auto has become a desirable possession to the individual and any vehicular traffic planning, especially within the CBD, must consider the increasing number of private autos and their affect on that area.

The foregoing is an attempt to picture in a broad way changing trends observed within the central district. It is necessary now to examine in greater detail the actual changes in land use and establishments. The changing trends of establishments and the move-

29 - Vancouver Province, (Vancouver, B.C., Sept. 13, 1957, p. 17
30 - See Wilfred Owen, The Metropolitan Transportation Problem.
 ment of the CBD are probably the most important elements in the consideration of potential traffic for helicopters, and the locating of heliports. If a pattern of change can be observed, it may be possible to choose certain locations for a heliport which are most compatible in the dynamic picture. Such Heliport locations should not be obsolete in the foreseeable future, in relation to their surroundings.

A - **CHANGING TRENDS IN LAND USE:**

In considering this question, it is necessary to assume that it is possible to guide changes in land use and traffic. Certain techniques have been available to the planner and he has been able to put them into effect with a certain degree of success. As private development is the major form of change in land use in the CBD, public action and control can influence its nature, timing, and location. This public action and control can be realized through the use of the following techniques, either independently or in combination:

- zoning
- building regulations
- redevelopment of blighted areas
- construction of highways and transit lines
- provision of industrial facilities
- provision of services and utilities.
The city may achieve greatest success in its attempt to create a desired land use pattern by the careful planning of its internal highway system and transit system; however, other possibilities may be equally successful. What is of value to not for this study is that public action and control is able to influence land use to a considerable extent, and therefore, as sound planning legislation becomes adopted into city policy, immediately a measure of control over land use has been created. It indicates further, that future land use can be controlled and directed by the system of public control, still allowing sufficient freedom for the operation of private enterprise.

In attempting to describe the change in patterns of land use in the C.B.D., it is necessary to note the process of urban land utilization. In *Urban Traffic*, Mitchell and Rapkin suggest that a parcel of land must experience three major improvements before its physical utilization is complete:

1. The parcel must be improved to the needs of the anticipated user.
   - by improved services and facilities.
   - by demolition, if this is necessary.

2. The parcel is further improved by construction or alteration.
   - this constitutes a unit of real estate, but it is not yet "land use".
3. The occupancy of the land and the building space.

- the physical utilization of the parcel is complete.
- the occupants may change from time to time without further alteration of the space required. 31

Throughout the entire three steps of improvement the complex process of land utilization is subject to competition for specific locations among the would-be users. And the whole process is subject to the delaying effect of prior rights held on the land. Without owner approval the parcel remains as it was, unless local government action or some other force compels the improvement. Therefore, the change in land use of a specific parcel is mainly the result of the conscious decision of its owner, which may be influenced directly or indirectly by the actions of the real estate market. For future planning purposes, then, it would seem impossible to forecast changes in the land use of a parcel of land unless some direct public action is foreseen.

Changes in the available supply of space through the construction of new buildings causes a change in land use. Mitchell and Rapkin make these observations:

31 - Urban Traffic, p. 15
"One of the most dramatic and readily observable factors in land use change is to be found in the construction of new buildings. As a rule, the new building is put to a different use than the structures that previously occupied the site. Occasionally the general category of use is the same, but there are differences in quality. A new building has the following effects: (Additional space seems to facilitate the working out of other forces in process).

1. Additional space is made available for the firms present and for new firms coming in.

2. Often the building provides a more strategic location for existing firms and for the estimated movement requirements of new establishments.

3. A "one-establishment" building has generally had a choice of location according to its movement requirements.

4. Establishments attracted into the new buildings (often by the quality and prestige associated with it) may form new foci of activities previously located elsewhere.

5. Establishments directly or indirectly linked will be attracted to the new concentrations. (Often buildings are built with suitable facilities for the linked uses. For example, variety service shops on the main floor of an office building who require walk-in customers).32

Rannells considers buildings and the accommodations supplied by the addition of buildings in the following way:

"The most permanent things in the C.B.D. are the buildings themselves. Buildings are constructed, as a rule, in

response to demand for accommodations beyond those available in the existing structures.

"New buildings reflect well-established activities of their prospective users. These are usually activities such as are current in the older buildings.

"Commercial buildings, by far the greatest bulk of C.B.D. construction, are most frequently built in the midst of an existing concentration in order to capitalize on the advantages of a location proved to be successful. ....New and used buildings are thus in competition for tenants, although not entirely for the same ones. New buildings supply the needs of those best able to lease new (and expensive) space, while similar older buildings find themselves, in time, with tenants of "lower type" than the buildings were designed for. Meanwhile, new assortments of tenants are always being formed by the continually changing ways of doing business which are characteristic of commercial enterprises."33

What becomes apparent in the observations of Mitchell and Rapkin is that new buildings tend to attract firms of higher quality than may have previously been found on or near the particular site. Also, it is seen that these new establishments generally stand to gain in their new location; and as a by-product of their influx, attract into the area certain establishments which may be linked to them in some manner. The new location may also give the establishment a better orientation to the types of establishments it caters to. Of course, here again, many exceptions exist. What is evident, however, is that the new

33 - The Core of the City, pp. 41-2
building which is to cater to a particular group of establishments
has the effect of re-arranging the land use in the immediate area
to a condition which is compatible to the new establishments which
occupy the buildings. Also significant is the observation that
new buildings are most frequently built in the midst of an existing
concentration of buildings; this indicates the degree of stability
the CBD enjoys. However, new buildings are often built in the
residential areas immediately adjacent to the concentrated CBD,
and this abnormality significantly changes the land use trend of
particular establishments.

In considering the construction of a building for establish­
ments and the effect that this building has on its surroundings,
Rannells observes that: "Old buildings are re-altered and new
buildings are built as individual projects, and there is little
to no consideration of the effects such buildings might have on
the former situation that this particular area had enjoyed." Some
of the problems that arise are:

1. If a new building is set-up, there is no
   concern for the vacancies or loss in land
   value that might result to the area from
   which the new tenants came.

2. The overall efficiency of a local area may
   be upset by dislocation of its service est­
   ablishments which cannot afford the higher
   rents brought about by new construction.
3. The harmful effects of traffic congestion resulting from overbuilding".34

All three problems cited here bear significantly on the change in land use which an area might experience. What appears as the major problem is that the new construction or re-alteration of buildings is not controlled or restricted by any legislative power which is considering the effect that such changes might have on the other functions which together comprise the CBD. However, here it may be argued that it would be impossible to control private development beyond the control imposed by standard zoning for certain purposes. Within these "zoned" areas establishments have the right, and are required, to continually adjust their activities in order to remain competitive in their business operation.

Summarizing the changing trends in land use, certain features are outstanding:

1. Land use can be significantly influenced by various forms of public action and control.

2. The owner of a parcel of land and the buildings thereon, largely controls what future land use his property could have. However, various external factors could actually control the

34 - Ibid. p. 41.
type of land use his property is experiencing at present.

3. New buildings give establishments a definite location and accommodation advantage.

4. Buildings are relatively permanent and fixed; establishments are continually changing through the process of adjustment.

5. New and altered buildings can seriously disturb the land use pattern which has developed in a particular area, as well as in the area from which the tenants came.

B - The Changing Trends of Establishments

It is necessary now to consider the establishments which make the physical utilization of buildings and the parcels of land on which they stand complete. The establishments represent the land use of an area, and therefore they are of basic interest to this study. It is the establishment that creates the generation of persons and goods movement, and will determine where a heliport might be placed to serve it most usefully and conveniently. As it is a highly mobile and vulnerable being, the establishment evades any possibility of being a static form of land use, and therefore presents the planner with the problem of attempting to forecast its movements - or its adjustments.
Elaborating on the physical setting of establishments, Rannells states:

"Patterns of buildings and streets and other improvements on land are relatively permanent in comparison with the groupings of establishments which they accommodate. The groupings appear and change as requirements for different kinds of activities are modified and as establishments are formed and dissolved. A great deal of shifting of activities among existing accommodations goes on continually, while a relatively small proportion of establishments are set up in newly constructed buildings in any given period. Additions to the public works or public facilities: plant in any one period are also fractional modifications of existing facilities. The predominant situation is that of new activities adjusting to the physical accommodations as they exist."35

In analyzing establishments in action, their requirements for space and location are determined by both internal and external activities, that is, by the activities carried on within each establishment and by its relationships and interactions with others. Rannells considers internal and external activities in the following manner:

1. The internal activities of establishments;

   Space requirements brought about by activities carried on within the establishment are met by:
   - frontage, or shipping facilities
   - office, factory and display space.

   These are generally fulfilled by the city's present supply of buildings.

35 - Ibid. p. 50
2. The external activities of establishments;

Location requirements are met by:
- physical setting in which the building is placed.
- the services available.
- the combination of activities engaged in by near-by establishments.\textsuperscript{36}
- nearness to transportation or to markets.
- linkages to various establishments nearby or distant.
- whether they are suppliers or competitors or customers.
- the presumed value of prestige of a good address.

It is inevitable that the requirements change more rapidly than the great bulk of the accommodations can be adapted, and it frequently happens that one set of requirements is better satisfied than another. Therefore, the patterns, on the land use map, taken by different categories of establishments are largely influenced by their external activities. This often produces the deviation from the normal distribution of establishments observed when a group of establishments moves away from accommodations which are entirely suitable for their internal activities. There-

\textsuperscript{36} - Ibid. p. 39
fore, it becomes apparent that the location requirements of an establishment, its external-activity area, causes its movement, and consequently, the dynamic nature of the central business district.

Considering the changes in land use caused by the activities of establishments at a given location, Mitchell and Rapkin suggest that two prominent changes are significant:

1. Land use change comes about through changes that occur internally in an establishment that remains established at a given site. (For example, retail stores have responded to a shift in composition of traffic passing the establishments.)

2. The subdivision of functions and the removal of one or more of the functions to other locations more suited to their movement requirements. The locational change of certain functions may be necessary because:
   - the land uses may be incompatible.
   - the pattern of linkages may have changed.

What might have been a manufacturing area at one time may now be an administrative district occupied by the main offices of the manufacturing firms.

Summarizing the changing trends of establishments, four factors carry considerable weight:

37 - Urban Traffic, p. 122
1. New establishments must adjust to the physical accommodations as they exist. That is, the "concentrated" nature of the C.B.D. remains, in effect, in perpetuity. Dispersion of the establishments from this concentration is very limited.

2. The locational requirements of an establishment are most important to it. This can change the land use of a given area most significantly. It may cause a group of establishments to move out of an area suitable to them in their internal operations, but unsuitable location-wise.

3. The amount of pedestrian and vehicular traffic passing a given establishment may cause a change in the establishments' internal activities; that is, an internal adjustment to external uncontrollable events.

4. The removal of the incompatible and inadequately linked functions of an establishment out of the C.B.D, leaving behind those functions which benefit most by this location; that is, mainly the administrative and control sections of industrial and manufacturing establishments.
C - Attempts to Revive the Central Business District:

This section may have equally been captioned "the war against the outlying shopping centre".

In a study of "The Downtown Area", Business Week views the CBD in this way: "...the very things that make the downtown what it is, help to destroy it in the end - namely, people and traffic." This is the problem the merchants of the CBD, and the local government face. If the CBD is to remain the "centre" of the city, positive action must be taken to perpetuate its esteemed position. The merchants of the CBD, seriously aware of their predicament, have rallied behind the "revival" banner in full force in order to retain the area as the distribution centre, and as a centre of activity, as well as to guarantee their existence and investments.

The "campaigners", attempting to attract people into the CBD, have used the following tactics:

- One-way streets.
- Off-street parking.
- Merchant-sponsored parking corporations.

Free bus transport for shoppers on special days.

- "Face-lifting" programs.
- Multi-million dollar city-centre shopping areas. For example, Pittsburg's "Golden Triangle".
- Slum clearance.
- Civic improvement.
- Fringe parking.

Each technique is an attempt to assure convenience and accessibility to the person coming into the CBD.

Referring further to the observations of Business Week, suggested four possible approaches which might be followed to produce an adequate urban renewal system for the C.B.D.:

1. Get people in and out quickly. By,
   - improved accessibility.
   - improved street system.
   - skirting expressways.

2. Give the city back to the people:
   - create "foot-traffic" areas exclusive from auto-traffic areas. (For example, Lijnbaan Shopping Centre in downtown Rotterdam).

3. Use the land properly:
   - a difficult approach.
   - involves land use, zoning, etc.
   - the idea is to use each part for the purpose it is best suited for.
4. Rebuild the slums that constrict the centre of town.
   - but, ... get away from the idea of 'Ghettos'
   for the financially underprivileged". 39

The situation that might evolve in the C.B.D. is that downtown facilities may increasingly serve specialized needs, and the servicing of more frequent and common needs may be in the process of transfer to peripheral areas. But one thing seems to fight against the "specialization" idea for C.B.D.'s; it is this question - can the large major functions exist with a decrease in the mass of people in the C.B.D? Will this "specialization", to a more extreme point, cause the C.B.D. to rot away?

In defense of the CBD remaining the focal point of commercial activity in the metropolitan city, three studies are presented as argument.

The first study is that of D.L. Foley, "The Daily Movement of Population Into the Central Business District". 40

The value in observing the persons entering the CBD lies

39 - H.L. Marx, Community Planning, p. 44
not only in indicating the perpetuity or future existence of the CBD, but, more significantly, to show the proportion of the total metropolitan population which regularly or frequently enters the CBD for any of a number of reasons. In this way a certain concentration of persons can be attributed to a CBD according to the day and time in the week, and according to the population of the metropolitan city itself.

Foley's study concerned itself exclusively with the daytime population of the CBD in middle-sized, and large American cities. Traffic surveys were used as the major source of information. Sixty-three (63) cities were examined, all but ten (10) of which had a 1940 metropolitan population of 100,000 persons or over.

The guiding question of this study was: What proportion of a metropolitan population enters and accumulates in the CBD each week day. Along with this, two related questions were: How do these entry and accumulation proportions vary by city size, and, how have these proportions varied with time? Three main indices were used to measure typical week-day population movement. (See Table, p. 54B).

Unfortunately, because of the lack of sufficient information regarding the cities studied, Foley was forced to rely on averages from groupings of cities, impeding direct and conclusive interpretations as to time-series trends.
### STANDARDIZED MEASURES OF DAILY POPULATION MOVEMENT INTO CENTRAL BUSINESS DISTRICTS  
**BY CITY SIZE GROUPS**

<table>
<thead>
<tr>
<th>Metropolitan District Population (in 1,000's)</th>
<th>Mean Number of Persons Per 1000 Metro. Population</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Entering CBD 7 a.m. - 7 p.m.</td>
</tr>
<tr>
<td>100 - 249</td>
<td>665</td>
</tr>
<tr>
<td>250 - 499</td>
<td>558</td>
</tr>
<tr>
<td>500 - 999</td>
<td>481</td>
</tr>
<tr>
<td>1,000 - 1,999</td>
<td>274</td>
</tr>
<tr>
<td>2,000 - 2,999</td>
<td>213</td>
</tr>
<tr>
<td>3,000 and over</td>
<td>201</td>
</tr>
<tr>
<td>GROUP AVERAGES:</td>
<td>399</td>
</tr>
</tbody>
</table>


**Note:** Traffic surveys for the years 1936-40, and 1946-50 were used as representative, contemporary, and reasonably normal conditions. The war years 1941-5, were excluded since their ratios tended to be abnormally low. All ratios have been standardized, (1) adjusting for CBD acreage and (2) excluding pedestrian entrants.
DAILY POPULATION MOVEMENT INTO CENTRAL BUSINESS DISTRICTS, BY CITY SIZE.

Figure 1. (Diagramatic Representation of Table 1, p. 54-A)
Some extremely interesting findings are brought forward in this study. The variations in the ratios by city size indicated broadly: (See Table p. 54A and Diagram 54B).

(a) That the number of persons entering the CBD between 7 a.m. and 7 p.m. varies inversely with city size.

(b) The destination ratio also varies inversely with city size, but not to the extent that the entrance ratio varies.

(c) Considering accumulation ratios, the maximum accumulation of persons within the CBD amounts to between 9% and 12% of the metropolitan population.

(d) In general, the ratio of person entering the CBD: to persons with destinations in the CBD: to maximum accumulation of persons at anytime during the day is about 4:2:1. This ratio holds most true for cities having from one-half to one million population, and varies somewhat for cities smaller or larger than this.

(e) A careful examination of the incomplete data, regarding year to year trends, has suggested the following cyclical, short range variations in the entrance ratio (the only ratio for which the most
information on a historical basis is available) during the past 30 years: (See Table 56A).

i. - The entrance ratio dropped during the lowest years of the depression in the early 1930's.

ii. - After climbing back in the period 1936-41, the ratio again dropped during World War II. This drop was apparently related to transportation curbs, heavy war industry employment with long hours, and shortages of consumer goods for sale.

iii - The ratio climbed sharply following the War, hitting a peak in the period 1946-48. It has since dropped slightly. This marked rise following the War seems to reflect the high level of employment, shopping and other business activity, both within the CBD, with its consequent drawing effect, and throughout the city, with the result that more persons move through the CBD en route to other destinations.

In the discussion of the findings the study produced, Foley concludes with five major observations:

(a) The findings support the fact that the CBD holds a position of vital functional importance.
<table>
<thead>
<tr>
<th>Time Periods</th>
<th>Persons entering CBD 7 a.m. - 7 p.m.</th>
<th>Maximum Accumulation in CBD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Less than 1 Million Metro. Pop.</td>
<td>1 Million Pop.</td>
</tr>
<tr>
<td>1926-30</td>
<td>411</td>
<td>264</td>
</tr>
<tr>
<td>1931-35</td>
<td>-</td>
<td>223</td>
</tr>
<tr>
<td>1936-40</td>
<td>514</td>
<td>224</td>
</tr>
<tr>
<td>1941-45</td>
<td>394</td>
<td>201</td>
</tr>
<tr>
<td>1946-50</td>
<td>622</td>
<td>235</td>
</tr>
<tr>
<td><strong>GROUP AVERAGES</strong></td>
<td>485</td>
<td>229</td>
</tr>
</tbody>
</table>

(b) Broadly, 1 person in 5 metropolitan residents has at least one destination in the CBD during each week-day. And 1 person in 10 residents will be found in the CBD in the early afternoon at peak accumulation. These figures best suit a metropolitan of approximately one million population; as cities get larger the ratios tend to drop; for smaller cities the ratios tend to increase considerably.

(c) Regarding the notion that the CBD is dispersing, this study, although its findings are tentative, indicates that the CBD's of the largest cities (that is, one million and over) are holding their own as measured by the entrance and accumulation ratios used as indices, and that the CBD's of medium-sized cities (100,000 to one million) are gaining.

(d) Although residential areas, some shopping facilities, and certain employment centres have indeed been dispersed, the CBD, today, seems to draw more persons per 1,000 metropolitan population than it did 20 years ago (in the 1930's).

(e) The higher entrance ratios for the smaller cities apparently indicate a relatively greater concentration of functions in the CBD of the smaller cities.
The second study introduced here and vital to the consideration of the "centralized" nature of the major CBD, is that of Jonassen, in his comparison of the downtown area to the outlying shopping centre.

"Jonassen observed these features. "....in all three cities the most important disadvantage of the central business district was difficult parking; next in importance for all cities was too crowded; and third, traffic congestion. Respondents from all three cities agreed that the advantages of downtown shopping were, ....first, large selections of goods; second, can do several errands at one time; and third, cheaper prices. Opinions concerning suburban shopping centres were less uniform in second and third choices, but respondents in the three cities agreed that closeness to home was the chief attraction.....the number and weight of downtown advantages seem to minimize the disadvantages of parking and traffic difficulties".

The third study concerned the attraction of the Vancouver city CBD for purchases of various goods and services. A sample survey of shopping habits was carried out by the Richmond Town Planning Department. 42 (See accompanying Table on p. 58A).

Richmond is a municipality of some 30,000 population, located within the Vancouver Metropolitan area, and separated from it by the North Arm of the Fraser River. Three bridges connect Richmond with the Vancouver-Burnaby-New Westminster areas. The sur-

41 - C.T. Jonassen, The Shopping Centre Versus Downtown, (Columbus, Ohio, 1955) pp.90-1
### DESTINATION OF RICHMOND SHOPPERS FOR THE THREE MAJOR TYPES OF HOUSEHOLD COMMODITIES

<table>
<thead>
<tr>
<th>Item</th>
<th>Vancouver City (Large CBD)</th>
<th>Richmond Mun. (Suburban)</th>
<th>Burnaby (Suburban)</th>
<th>New Westminster (CBD)</th>
<th>Other Areas (Suburban)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Family Groceries</td>
<td>12.5%</td>
<td>80.3%</td>
<td>1.7%</td>
<td>5.5%</td>
<td>0%</td>
</tr>
<tr>
<td>2. Family Clothing</td>
<td>73.2%</td>
<td>12.5%</td>
<td>3.6%</td>
<td>10.1%</td>
<td>0.6%</td>
</tr>
<tr>
<td>3. Large Household Appliances</td>
<td>69.6%</td>
<td>16.0%</td>
<td>3.0%</td>
<td>10.7%</td>
<td>0.7%</td>
</tr>
</tbody>
</table>

**SOURCE:** Richmond Town Planning Department, "Customer Shopping Survey" (Richmond, B.C., July, 1957.)
The results show the degree of attraction that the large CBD has; only family groceries (that is, "convenience goods") were purchased locally in large amounts. The amount of shopping done in other municipalities is also indicated, again emphasizing the attraction of the large CBD for major purchases. The most significant reasons expressed by the majority of Richmond shoppers as to why they preferred buying in the Vancouver CBD were these:

1. It has large department stores.
2. It has the best variety in goods, quality, and prices. (That is, the large CBD satisfies more tastes and pocket books than any other area.)
3. It has sales and bargains every business day of the year.
4. There is convenient transit service into the CBD from most points in Richmond.
5. It has many second-hand stores.

As a concluding part to the discussion of changing trends in the CBD, it is of importance to consider defense measures. In this age of atom bombs and intercontinental missiles it is only natural to assume that should hostility break out between nations the major attack areas would be military installations and cities—especially the central area which in effect controls the functions of the whole metropolitan region. To plan for atomic warfare may
seem a futile approach. However, some general comments can be made.

D - DEFENSE CONSIDERATIONS - A CASE FOR DECENTRALIZATION:

It is said that to the extent that cities are vulnerable to enemy attack, the nation is vulnerable. New weapons can suddenly wipe out large urban areas. This leaves one shuddering at the sight of a densely built-up central business district which is, in many instances, the regional centre of operations. If the CBD was suddenly demolished, chaos would result. The concern is brought forward in the Bulletin of the Atomic Scientists in which is stated:

"There must be some balanced size of a city (and particularly the CBD) to provide an optimum combination of immunity to damage from airborne weapons, and efficiency and economy in producing the goods and services, and amenities of modern urban living". 43

It is evident from this article that the U.S. Government will establish governmental firms in extra-central district locations, to avoid the vulnerability of attack on one densely built-up area where all the facilities exist.

The American Society of Planning Officials has urged the U.S. Federal Government to "provide strong and continuing leadership in this field, and to recognize reduction of vulnerability as a prime consideration in all construction and development projects which it undertakes, or for which it provides financial or

43 - Reprinted in Community Planning, p. 57
This could mean an exodus of certain establishments from the CBD, and could cause a serious disruption in the land use pattern set-up and functioning there. However, the exodus of government "orientated" establishments which may be affected by a policy of dispersion may not disrupt the land use of the CBD in a negative way, but may only require another adjustment phase by the establishments remaining. However, what must be remembered is that a real threat of attack by nuclear weapons could cause an hysterical exodus of CBD establishments, with the resulting paralysis of central distribution and service functions.

Having considered land use and establishments, and their ability to adjust to the different circumstances created by the central business district, it is now necessary to consider the relationships that exist between establishments. This introduces the concept of linkages. In the following chapter we will consider linkage as it is applied to nucleations of establishments, and the spatial relationships between these nucleations.

44 - Ibid. p. 58
Historically, the central business district, the earlier "market centre", has contained two particular types of establishments:

1. The sellers or traders of produce.
2. The money lenders and other credit instruments needed in the trade of stock.

The aim of the ancient city was to "promote trade". In retrospect, the major functions of the central district have not changed at all, except that many refinements and subdivisions of these primary functions have developed. It is quite conceivable, then, that a system of linkages, or inter-relationships or inter-dependencies, could have developed in those early years of trading, and that today we see linkage as the 1958 refinement of that primitive form; and, that any future date will show a variation of the existing conditions of today. However, no matter what refinements occur, what seems to persist consistently are the same major functions today referred to as the:

1. Major retail sales and service centre.
2. Financial and administrative centre.
A - THEORY OF LINKAGES

The CBD can be viewed as a maze of establishments, each with its particular functions, and each dependent on a certain number of other establishments for particular things which allow this establishment to continue to function. The relationships that exist between establishments are called linkages. It is the form of the linkage that determines how establishments are physically related to each other, and this in turn produces the concept of nucleations, or clusters, of certain types of establishments, and also the spatial separation between the different clusters. Linkage is also seen as more than the physical relationship between establishments - the physical groupings are merely the end result. The condition of linkage is dynamic in form, with ever-changing relationships occurring as establishments relocate, expand or decline, subdivide particular internal activities, or for other reasons where a change alters the pattern of linkages.

Each establishment has its own pattern of distribution, and related combinations of them tend to congregate in more or less distinct centres, each a somewhat different area but always overlapped by others. The consequent mixture at any one location, say within one block, will be characterized, as much by the variety of unrelated activities as by the type of businesses for which that district is noted.
The generally accepted definition of linkage is that it is a relationship between establishments characterized by interactions which require movement of persons or of goods or the exchange of information.

In *The Core of the City*, four types of linkage are distinguished:

(a) **Competitive Linkage:**

Each establishment strives to hold or increase its own share of the same market, for goods or services, dealing either with a generalized "public", with groups of establishments, or with a single establishment. Competition is so all-pervasive that examples are legion, from newstands to publishers, from pedlers to department stores.

(b) **Complementary Linkage:**

Both establishments supply the same market or a single customer-establishment with goods or services which are interrelated. The products of both establishments may be mutually interdependent; or the product of one establishment may supplement the product of the other. Examples of both kinds abound among establishments

supplying the "bits and pieces" and subassemblies of manufactured goods of all sorts to the "prime" manufacturing establishments, from men's clothing to motor cars.

Both competitive and complimentary linkages have much in common, especially among closely related establishments which comprise a specialized "market". The close proximity of these groups, often a mixture of manufacturing, wholesaling, and service establishments, encourages flexibility in the business operations, since it provides conveniently a wide range of linkages.

(c) **Commensal Linkage:**

Both establishments use the same facilities or depend upon the same supplier or the same market. There may be no direct business relationship between establishments commensally linked.

(d) **Ancillary Linkage:**

Services supplied by one establishment to the members of another. Examples are specially common in major business centres where cafeterias, cigar stores, and various "consumer service" establishments serve the working population.

Commensal and Ancillary Linkages are also considered as having much in common. The relationships tend to be indirect but they may exert a powerful effect in attracting different kinds of establishments to a given location.
The four types of linkages may each be seen, depending on the form of the relationships that exist between establishments, in the following arrangement:

i. **As Paired Linkage:**

Participation by two establishments only, without the introduction of an intermediate establishment. There is a direct movement from one to the other. For example, the transaction between a supplier and a customer.

ii. **As Chain Linkage:**

Participation by two establishments in joint activity which includes one or more intermediate establishments in the course of its accomplishment. However, each link in the chain is a paired linkage. For example, suppliers office - suppliers warehouse - shipper - wholesaler - customer (four paired linkages).

iii. **As Systematic Linkage:**

Participation by groups of related establishments engaged in a common system of activities.

The Paired, Chained, and Systematic Linkages are more or less direct, simple relationships. The shorter the linkage chain that is considered the easier it is to visualize the linkage. If linkages are viewed in an all-inclusive manner, they lose their significance in the multitude of linkages which are actually in effect, and it becomes
impossible to arrive at any conclusion regarding any particular linkage arrangement.

Perhaps one of the most notable contributions to the concept of linkage was expressed by Robert M. Haig when he described an establishment (s) as a "packet of functions". The complete operation of the packet of functions produces the end product or service which determines the success of the establishment. Haig felt that in some cases the packet of functions is loosely tied and in other cases tightly tied - and that difficulties of coordination and control increase as the disintegration of the packet progresses. The scale of operation is, however, an important factor.

In addition, there may be a tendency, because of the increased costs of management through subdivision, to resist the separation of functions which derive advantages from close physical proximity.

Haig's formulation leads to a possible clue in observing the types of establishments that do persist in the central business district. The small businesses are forced, by cold economic fact, to either remain in one location or vacate completely to another location more suitable to their operation - and perhaps completely disrupting the network of linkages it had developed in its relation to other establishments. The large industry may subdivide its functions, retaining the head office and administration sections in the central business district, thus maintaining the linkage pattern developed there, while other parts of its operation (or

46 - Haig, R.M. Major Economic Factors in Metropolitan Growth and Arrangement, p. 37
parts of its packet of functions) may be relocated in areas where the operation could be carried on as efficiently and perhaps more economically. In the former case, a whole re-orientation of linkages may be necessary; in the latter case, the "external" linkages are retained and the major addition is that the "internal" linkage has been extended physically, creating perhaps a more successful operation.

Haig also predicated that certain advantages flow from a cohesion of functions in a given district, and the result is a number of specialized centres with definite unities of interest, rather than a single diversified centre. The two types of districts described had these distinct characteristics: 47

(a) The financial district:

- The efficiency of the firms depend on close proximity.
- It contains only those retail shops and services as supply the immediate conveniences to the workers in that district. The general central business district shopper does not buy here, nor are there the facilities for him here.

(b) The retail area:

- Its outstanding characteristic advantage is that it is a consolidated area of shops within walking distance of each other.
- Only such financial firms which service the immedi-

47 - Ibid. pp. 38-39
ate shops and their customers are present. (That is, banks, brokers, finance companies, etc.). Haig considered that the same characteristic factors apply also to the wholesale areas and the factory areas. However, linkage does not always create neat and well-defined nucleations of establishments which are closely related to each other in some distinct manner. There appear many variations to the rule. In many instances the linkage only appears after an establishment has moved to a particular location, and for reasons other than that of strengthening the ties of the linkage. However, becoming a "using" member of the linkage appears vital.

R.U. Ratcliff has stated that "no matter why people want to be near something or somebody, their preference is expressed in terms of value and becomes an economic force". 48

Ratcliff considered further that space relationships were the primary factors in the existence of urban organization, and in the location of urban centres. Cost, an economic factor, particularly the minimization of cost, was the controlling force. In his article which is concerned with relating efficiency to location, Ratcliff emphasized certain measures of urban efficiency.

These measures were of two forms:

(a) The cost, or disutility, of distance;

The cost was an economic one rather than a physical one, and,
That it was a space relationship evaluated in view of its importance to those individuals and firms concerned.

(b) The equitable distribution of the burden of locational costs in accordance with benefits received and in proportion to the responsibility for their creation; the equitable distribution serves as the basis of market transactions; as well as being a social test - the underlying criterion being the welfare of the community.

The first measure seems to include all the four common types of linkage previously discussed; namely, competitive, complementary, commensal, and ancillary. The location of the establishment in its relation to certain other establishments dictates the cost to be absorbed by location at that spot; and, that in order to become a member of the necessary web of linkages present in that area, the establishment must be able to bear the initial cost of establishing there; while, simultaneously, it is attempting in the long run to achieve a minimization of costs by its membership in the linkage pattern.
In considering the second measure, introduced by Ratcliff, it may be surmised that the locational costs of an area have been created by the particular web of linkages present there, and if the linkage pattern is seriously disrupted the locational costs are immediately affected. This may point out the extremely high locational costs a retail establishment must absorb to establish in the recognized retail area of the central business district; and because the "packet of functions" of a retail establishment operates most efficiently in one location, the firm depends heavily on the stability of the existing retail area linkage pattern for its survival, and hence, there is a resistance to movement created by the web of linkage except for that relocation taking place within this closely-knit pattern. The retail establishments not able to meet the locational costs demanded are extricated from the vital linkage pattern and relocate in the outlying areas of the central business district, or in other outlying areas, or they close down. Ratcliff\(^9\) points out that the "history of the Madison Central Business District is one of a constant replacement of less intensive uses by more intensive uses"; furthermore, he conjectures that "decentralization is a symptom of degeneration and decay only if it leaves a vacuum behind, -- much of the outward movement of certain urban functions occurs as they are pushed out of the centre rather than as they respond to a pull toward outlying locations".

49 - Ibid. pp. 132, 137.
P.S. Florence, in another contribution to the aforementioned volume, assumed that the high prices, or rents, for land (locational cost) give priority for uses of land that profit most from a central site or access to the central site. They drive out uses which find this centrality less profitable. He felt that what might exist is a hierarchy of possible uses of a piece of land descending from the most to the least profitable. Without any deliberate city planning, the restrictions of the land factor by the price mechanism ecologically will produce some kind of logical pattern. He observed further that land use maps for large cities in all countries brought out clearly the central sites of professional specialists, of financial and commercial houses, and of public administration, entertainment facilities, and specialty stores. The land use maps also indicated the radiating star pattern of more general stores, and the grouping of factories and homes, usually separately, in the sections between the radii. Factories processing heavy goods tended to group around rivers, canals, railways, and other means of transporting their materials and products.

Florence's assumptions regarding priority of land use and the ensuing locational costs compare, in essence, with Ratcliff's cost, or disutility, of distance; each study emphasizes the tendency of establishments to nucleate in some manner in order to benefit from the linkage pattern present therein; and, that continuity of

the establishment is a "survival of the fittest" business, - those surviving benefiting most from the particular advantages of the linkage which has created the nucleation within the central business district.

It may be postulated that the central business district is, in fact, a series of webs of linkages (creating the nucleations) involving establishments of distinct types; and, more important, that linkage chains of particular groups of establishments may range from most profitable webs-of-linkage to least profitable webs-of-linkage. Further, it is suggested that the most profitable webs-of-linkage groups represent the foci of the central business district and are the only makers of stability attributable to the conglomeration of establishments which actually exist there. See diagram, page 74-A).

Although patterns of linkage have been observed among establishments, the tendency is therefore, to type the central business district functions accordingly. However, typing webs-of-linkage may be sufficiently adequate for today, but, we must also recognize the startling effects of technological change, and its disorganizing as well as organizing capability.

Jessie Bernard observed that "less spectacular than war,

51 - NOTE: Profitability refers here to the extent of success a particular establishment may have by locating in a particular area and thus becoming a part of the existing web of linkages.
but perhaps fundamentally more conducive to nonconformity and therefore disorganizing to community life, are new inventions or technological changes". However inevitable technological change is, Bernard felt that because the scientific method has played such a large role in technology, it is far ahead of all other aspects of community life. He further remarks that technological change may destroy whole communities by taking away their "economic underpinnings". If technologies do not change too rapidly a community becomes adjusted to them, but the more rapid the change the less adjustment time is allowed, and disorganization and dissociation occur.

Considering then the postulate expressed earlier, in respect to the picture of the central business district as the area in which least-profitable webs-of-linkage groups could represent the foci of central business district activities; it may be further postulated that technological change can alter these linkage patterns significantly, changing the whole concept of nucleations which have been developed. (See diagram page 74-A). This may be simply illustrated by the advent of the television set offering particular retail establishments the opportunity of employing mass communication of a revolutionary means to sell their products. The effect might be an

THEORETICAL WEBS-OF-LINKAGE IN
THE CENTRAL BUSINESS DISTRICT.

POSTULATE 1

DISORGANIZING
FORCE

TECHNOLOGICAL
CHANGE

ORGANIZING
FORCE

LEAST PROFITABLE
WEBS-OF-LINKAGE

MOST PROFITABLE
WEBS-OF-LINKAGE
elimination of these types of establishments from the central business district to outlying areas, the business being conducted solely by means of, for example, a television-phone, and delivered by some rapid vehicular means.

It is important now to look at the types of nucleations that have traditionally been a part of the central business district, as well as the establishments, so that some picture may be developed indicating the result of the linkages and their spatial relationships within the central business district.

B - WHAT HAVE BEEN, AND ARE TODAY, THE MOST PERMANENT NUCLEATIONS OF ESTABLISHMENTS IN THE CENTRAL BUSINESS DISTRICT?

- Market Places and Fairs of the Past -

In order to fully appreciate the significance of the nucleations of establishments that constitute the central business district it is important to look back into earlier periods of civilization. What is suggested is that the central business district of ancient times contained principally the traders and sellers of goods, and the money lenders and money changers; and, that these two main participants of commerce have always maintained the market place, and have created the great trading cities of the past. Today, the central business district shows the 1958 refinement of these two dominating forces of trade - seen now as the centre of retail sales and services, and the financial and administrative centre. It is suggested that the central
business district was created because of those two forces, and as long as the central business district remains in existence they will continue to play the leading roles, and, will be the visual and economic expression of the success of the economy of the region the city serves.

The City of Babylon, possibly as early as 3,000 B.C. was a market place to which precious metals were brought from all directions. Later, records show that by 1,600 B.C. well-developed trade routes existed, over which the Arabs conducted caravans transporting silks, spices, wine, gold and other commodities from the Red Saa district, from Phoenicia, and even from Asia to Egypt, where they were exchanged chiefly for grain and linen. Excavations in Egypt have revealed certain vases which seem to have been brought from the Island of Crete as early as the year 2,000 B.C.53

The Bible refers to the nation of Tyrus and its trading centres in this way:

"12. Tarshish was thy merchant by reason of the multitude of all kind of riches; with silver, iron, tin, and lead, they traded in thy fairs.
13. Javan, Tubal, and Meshach, they were thy merchants; they traded the persons of men and vessels of brass in thy market.

14. They of the house of Togarmah traded in thy fairs with horses, and horsemen, and mules.

17. Judah, and the land of Israel, they were thy merchants: they traded in thy market wheat of minnith and Pannag, and honey, and oil, and balm.\(^5\)

In fact, this whole chapter (Chapter 27) which is concerned with the riches of Tyrus, contains references to the "trading" or "market" centres where commerce was carried on. It is only natural to think that wherever there was a group of people a market place, of some fashion or other, was needed to supply the needs of the people.

Medieval commerce seemed to take one step in reverse. "During the dark ages that followed the fall of Rome, commerce was almost entirely in the hands of the Mohammedans, with centres at Bagdad, Damascus, Cairo, Alexandria, and the Moorish cities in Spain. Western and Northern Europe became divided under the feudal system into thousands of tiny units, each attempting to be complete within itself, and entirely independent of all external sources of supply. Roads were totally neglected; strangers were regarded with suspicion; robbery was a common practice; and commerce, under such conditions, was quite naturally almost non-existent."\(^5\)

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54 - The Bible, Ezekiel 27: 12, 13, 14, 17
55 - The Lincoln Library of Essential Knowledge, p. 1200
Many studies of the central business district have been carried out in recent years, each attempting to establish some characteristic found present, and noting the types of establishments and their characteristic pattern of grouping. Although studies of linkage have merely scratched at the surface of this elusive superstructure, linkage perhaps shows promise of being the controlling factor in determining groupings of establishments, as long as technological developments are foreseen as great influencing factors, and perhaps in extreme cases, - disorganizing factors.

Ratcliff suggests there are two basic reasons why central locations are advantageous to various activities and functions. These are:

1. The central location minimizes transportation costs:
   - That convenience is the prime factor.
   - He felt that central area businesses may be roughly divided into four groups on the basis of the geographical location of their clientele:
     (a) No local clients group;
     i - their contacts are largely outside the community. For example - mail order, and some types of industries and manufactures.
     ii - Centrality is not important for customers

56 - In The Metropolis In Modern Life, op. cit. pp.138-9
may be for employee convenience.

iii- They could locate outside of the C.B.D.

(b) Community-wide clientele group:

i- serve the entire community and the hinterland.
For example, a department store.

ii- The central location is important for client and employee convenience.

iii- The maximizing of public convenience is vital to their success.

(c) Neighbourhood Clientele Group:

i- They supply those persons living on the periphery of the C.B.D. who find it most convenient to shop for daily needs and services in the C.B.D. For example, grocery stores, drug stores, dry cleaners, located on the fringe of the commercial core.

ii- They must be present to supply the need.

(d) Central Area Clientele Group:

i- They find their clientele among the businesses located in the central commercial area.

ii- A central area location is inevitable because of the nature of their business. For example, cafes, business services.

iii- They could locate outside of the C.B.D., but face-to-face contacts are an important part of the business, making a central business district most desirable.
2. Haig's assumptions regarding the "packet of functions" concept, where an enterprise's proper location is determined by the proportion of the components of the packet; the cohesion or clustering of establishments is witnessed here. In Ratcliffe's Madison Central Area Study, he noted that "As the city grows--the more intensive types of retail outlets tend to dominate the central area. Because the cohesion of central area functions is so strong, disintegration is most unlikely in the foreseeable future. The strength of the central area lies in its unmatched variety or availability. Even the newest, most elaborate one-stop regional centre provides only a fraction of the activities and combinations of services which are available in the downtown destination area." 57

- Nucleations of Establishments observed in the Central Business District -

The following observations are presented as representative of the studies which have been undertaken with respect to Nucleations:

1. R. U. Ratcliffe, "Efficiency and the location of urban activities." 58

57 - Ibid. pp. 146
58 - Ibid. pp. 138-9
<table>
<thead>
<tr>
<th>MAJOR FUNCTION</th>
<th>FUNCTIONS CLUSTERING ABOUT IT</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Department and variety stores</td>
<td>- dress shops</td>
</tr>
<tr>
<td>(b) Outlets serving men</td>
<td>- shoe stores</td>
</tr>
<tr>
<td>(c) Restaurants plus theatres plus flower shops</td>
<td>- hat shops</td>
</tr>
<tr>
<td>(d) Financial district</td>
<td>- hosiery stores</td>
</tr>
<tr>
<td>(e) Warehouse district</td>
<td>- other women's specialty shops</td>
</tr>
<tr>
<td>(f) Manufacturing district</td>
<td>- banks</td>
</tr>
<tr>
<td>(g) Processing district</td>
<td>- investment houses</td>
</tr>
<tr>
<td>(Industrial district)</td>
<td>- business services</td>
</tr>
<tr>
<td>(This group has generally deserted the CBD)</td>
<td>- lawyers</td>
</tr>
<tr>
<td></td>
<td>- accountants</td>
</tr>
<tr>
<td></td>
<td>- insurance companies</td>
</tr>
<tr>
<td></td>
<td>- loft houses</td>
</tr>
<tr>
<td></td>
<td>- loft-type industry</td>
</tr>
<tr>
<td></td>
<td>- transport terminals</td>
</tr>
</tbody>
</table>
Of these nucleations, Ratcliff writes: "Thus the central area (however delimited) is a galaxy of constellations formed of activities which appear to have a locational affinity one for the other, and are related in some degree to other clusters in the area. -- These constellations are related land use types which generally are confined in extent to a ground area which can be comfortably covered on foot." 59

A rapid observation of the functions described narrows the establishments into 4 major groupings:

(a) Retail sales and services
(b) Entertainment and related services
(c) Financial and administrative services
(d) Industrial services

2. E. W. Burgess, Concentric Zone Theory: 60

Burgess recognized the following districts, with their particular functions:

Zone I - The Central Business District Zone:
(a) Retail shopping district:
   - where shoppers seek the largest assortment of goods and services.
(b) Financial district:
   - performs special functions
   - need not cater to the convenience of a large number of persons.

- is close to the Retail Shopping District.

**(c) Wholesale district**
- may lie next to the Financial District or may be nearer the Shopping Centre.

**(d) Light Manufacturing Establishments:**
- a few may be interspersed among old residences and delapitated structures.

**Zone II - The Zone in Transition:**
- Burgess described this area as being immediately adjacent to the central business district.
- Is slowly invaded by expanding business and light industry.
- The zone contains the following types of establishments:
  - light industries
  - warehouses
  - stores
  - manufacturing plants
  - gambling houses
  - vice "dens"
  - saloons

(all may exist within the same block).

Although Burgess' Theory has been criticized for many inadequacies, what is of interest for this study, and quite applicable, is the classification of functions in the more inclusive cen-
central business district - which includes his zone in transition area.

3. John Rannells, *The Core of the City*, (Study of Philadelphia:

The six major business groups recognized in this study were:

(a) Retailing
(b) Consumer services
(c) Business services
(d) Wholesaling without stocks
(e) Wholesaling with stocks
(f) Manufacturing

Data for this study was comprised of the number of establishments per block, and the floor area. Observations of the nucleations vary from generally scattered establishments to fairly coherent areas.

Although each of the three studies show variations, the obvious conformity is that these appear recognizable nucleations or districts, and that, considering broadly all cities, these nucleations are present and characteristic. There is always a retail district, a financial and office district, a wholesale-industrial-manufacturing district, and an entertainment district.

What are the most predominant spatial relationships that exist between different nucleations of establishments?

Although some work has been done in spatial relationships
between nucleations of establishments, and between establishments themselves, perhaps the most intensive analysis has been that which appears in *The Core of the City*, a study of Philadelphia city. In this section the author will consider only the spatial relationships expressed by Rannell's study, as it is felt to be adequate for the heliport study at this stage.

The study of 1949 reveals some generally scattered as well as some fairly coherent establishments in the central business district. The following groups of establishments are distinguished (within the "reference core of 59 blocks"):

1 - Most coherent establishments:
   (a) Manufacturing
   (b) Wholesaling without stocks

2 - Similarities of location between nucleations of establishments:
   (a) Manufacturing and wholesaling with stocks occupy much the same area.
   (b) Business Services and consumer services occupy much the same area.
   (c) Wholesaling without stocks seems to fall almost entirely within both the business services and consumer services groups.  

3 - Diagramatic locational relationships between nucleations.

The following table (Table XI in *The Core of the City*)

---

61 - *The Core of the City*, p. 122-3, Table XI.
indicates the relative proximity of pairs of business groups or establishments. The table is also shown diagramatically on the following pages.

<table>
<thead>
<tr>
<th></th>
<th>W</th>
<th>B</th>
<th>C</th>
<th>R</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>13%</td>
<td>9</td>
<td>8</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Wholesaling</td>
<td></td>
<td>1</td>
<td>1</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Business services</td>
<td></td>
<td>11</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumer services</td>
<td></td>
<td>17</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table XI shows the following interesting and significant relationships:

(a) The **strongest** locational tie between groups is that of manufacturing and wholesaling. (13% of all combinations).

(b) The ties between wholesaling and the services are **insignificant**.

(c) **Strong** locational ties exist between retailing and manufacturing, and retailing and consumer services. (See Diagram on page 86-B)

(d) The five remaining pairs are all about average - (around 10%).

From Figure 37, (See Diagram on page 85B) the following assumptions are made by Rannells:

(a) Only manufacturing and retailing have significant ties with all the other groups.

(b) The consumer services and business services each relate to two other groups.
Similarity Of Location Of Nucleations Of Establishments.

(Overlapping Locations)

- Manufacturing
- Wholesaling (with stocks)

- Business Services
  - Wholesaling (without stocks)
  - Consumer Services

Source: The Core Of The City, p.122

Note: Percentage represents proximity of pairs of activities. Distance between symbols are to represent reciprocals of these numbers.

Source: The Core of the City, p.138, Figure 37
(c) Wholesaling relates to only two other groups.

(It is important to note, however, that the separate parties in each of these paired relationships differ considerably in their degree of participation).

Figure 38 (in Rannells, page 138) diagramatically shows the consistency of relationships among the five major business groups. (Only the results are noted here). The diagram is the same as Figure 37 except that the data is taken from two other tables; a different method of attempting to get comparable results. The results of this table, expressed by Rannell's, were:

(a) Business services are the most combined group. (That is, located in closest proximity to each other.)

(b) Manufacturing was the next most combined group.

(c) Retailing was the most uniformly distributed among the other groups.

(d) Manufacturing was the next most uniformly distributed group among the other groups.

(e) Consumer services were the most isolated group.

(f) Wholesaling is the least uniformly distributed.

(g) When pairs are examined the most balanced relationship is manufacturing-retail. (That is, each of these shares

63 - Note: The six major functions were reduced in the study to five, retaining Wholesalers with stocks, and combining wholesalers without stocks with business services, as they were located almost entirely within the business services concentration of blocks and their functions seem to coincide.
about the same proportion of its combinations with the other, or nearly a 1 : 1 ratio).

(h) Almost as equally balanced as (g) is the relationship between business-consumer services.

(i) Those groups in which wholesaling participates (M-W, W-R) are least balanced, each in roughly a 2:1 ratio.

The patterns of business groups that have been presented are no more than general approximations showing relative locations of the groups. They are based mainly on the "combined core" which is a type of a merger of blocks in which both floor space and number of establishments take part. Unfortunately, more refined data on patterns is not available, and until such time, any reference made to nucleations of establishments is only an approximation, and much is yet to be learned. However, some fundamental issues are brought to light, and on these facts a tentative conclusion will be drawn for purposes of considering the location of heliports.
C - CONCLUSION

1. - The former "market place", today's "central business district", has always been the place of major trading and major financial transactions.

2. - What all large central business districts seem to have in common is some form of:
   - retail district
   - financial and office district
   - wholesale-industrial-manufacturing district
   - entertainment district.

3. - Considering Ratcliff's four major groups in the C.B.D.:

   Each of the groups could quite conceivably be located outside the C.B.D. The groups requiring a central location most may be listed in this order:

   First - Community wide clientele group
   Second - Central area clientele group
   Third - Neighborhood clientele group
   Fourth - No local clientele group.

4. - The nucleations of the C.B.D. can be observed as webs-of-linkage; and, that there might be different levels of webs-of-linkage determined on the ability of that web to provide a fair margin of profit to its member establishments. And, further, that the most profitable of these webs of linkage may be the major dominating nucleations present in the C.B.D. One dampening factor, however,
could occur where too rapid technological changes disorganize one or more of the linkage chains which have developed.

5 - Referring to the Philadelphia studies, only manufacturing and retailing have significant ties with all of the other four groups present. The relative proximity of the four other groups to retailing and wholesaling groups is roughly equal, the proximity appearing in this way:

To Retailing: Closest - consumer services (17%)  
- manufacturing (16%)  
- business services (10%)  
Farthest - wholesaling (8%)

To Manufacturing: Closest - wholesaling (19%)  
- retailing (16%)  
- business services (9%)  
Farthest - consumer services (8%)

Since both retailing and manufacturing share approximately the same proportions of their combinations between all the other four groups, it may be assumed that at some point between the major retail nucleation and the major manufacturing nucleation there may appear a suitable location for a downtown heliport. However, the following problems appear:

(a) Retailing firms are the most evenly spread among the other four groups. No distinct retail grouping is observed.

(b) Manufacturing firms are also fairly well spread among
the other four groups.

From these two conditions it appears that both retailing and manufacturing nucleations are the most dispersed nucleations; and, this might be accounted for by the first postulate of the helicopter study (page A) which considers different webs of linkage of particular nucleations, varying from least profitable to most profitable linkage groups.

(c) Wholesale groups and business service groups seem to be the two groups which locate closest together as a group, that is, they are the least dispersed among the other groups.

In conclusion, it may be proposed that both the wholesale and the business service groups may be considered as "land marks" in the CBD. (See diagram on p. 91A). This suggests a possible heliport site somewhere between the wholesaling nucleation and the business service nucleation, if cohesion of the establishments of a nucleation is considered as a useful criteria in assessing locations for a heliport.
Cohesion or Dispersion of the Establishments of the Five Major Business Groups.

Indicates Cohesion of Establishments of the Nucleation: (Solid Line)
Indicates Tendency of Establishments to Disperse into Other Nucleations: (Broken Line)

Possible Heliport Location

Source: The Core of the City, Assumptions from pp. 138, and pp. 71-73 (of this study).
Webster's Dictionary defines accessibility as something "capable of being approached". In this section the establishments of the central business district will be viewed according to their approachability by the persons who find themselves in the CBD for any of a variety of reasons. The CBD is the area subject to the greatest demand for accessibility; the establishments located there attempt to create the conditions which allow for the greatest possible degree of accessibility.

Primarily, an attempt will be made to picture significant movements of persons among the various establishments. If it is possible to portray such movements, and if these movements appear to be generally standard, it may be possible to visualize areas within the CBD which are orientated towards persons walking between destination-establishments, and persons using a vehicular means to arrive at destination-establishments within the CBD. Thus, two areas within the CBD can be observed; that is, a pedestrian-oriented area, and a vehicle-oriented area. The definition and limitations of these two areas of the CBD are important to a study considering the location of a major downtown heliport, or system of heliports, if it is necessary to fit the heliport into the most efficient location, determined by the establishments responsible for the most significant generation of persons traffic.
A primary assumption advanced at this point is that a downtown heliport should be so located that it may be reached by foot by as many persons as possible. This suggests a heliport location intimately tied to the pedestrian-orientated area of the CBD, and serving a particular clientele who are most readily adaptable to transit by helicopter.

1. General Considerations of Persons-Movement within the Central Business District

Convenience of movement in the CBD:

The CBD provides a common locational advantage at the focus of transportation, and a mutual advantage in proximity among the central land uses. That is, it offers the unique convenience of accessibility and availability.

The accessibility of the CBD is geographical as well as man-made in the converging transportation facilities. Ratcliff states that its availability is a product of the unmatched variety of services and activities, the wide range of choice within each service, and the relatedness, direct and indirect, of most of the central activities. These dimensions of availability give the central area a tremendous potential advantage in convenience over any other spot in the community. The greater the number of possible combinations of errands which can be run within a destination area, the greater the aggregate potential saving in transportation costs. 64

The Street Pattern:

The street exerts an influence on the pattern of land uses by establishing the basic avenues of accessibility. The street provides for the movement of persons, the transportation of commodities, it furnishes light and air and access, and all or many of the utility services above and below the ground. In these terms, then, the street appears to be one of the most permanent elements in the entire array of man-made structures which represent the CBD. The changing movement requirements are the direct long-run cause for changes in the street system, and in some of the other channels of movement.

The friction of space in relation to persons movement:

Dr. Haig believed that the aim of the modern master plan was to maximize the efficiency of the urban area through an arrangement of land uses which would minimize the cost of friction. To Haig, accessibility meant contact with relatively little friction.65

In Urban Traffic, Mitchell and Rapkin accept Haig's concept of the friction of space, and go on to expand this concept as it applies to movement:

"Space, on the one hand, may be considered as an input factor that enters into the cost relationships in terms of rent, transportation, time (labor cost) etc. On the other hand, space can also be considered in terms of output; that is, a firm not only sells goods and services but also convenience. In this sense, alternative locations will have different influences on the level of the demand curve, with more accessible locations tending to lower it. Here too, the strategic factor is movement expressed in transportation cost. The cost, however, is not incurred by the establishment but by the persons who visit it. Cost to the visitor must include such elements as time, convenience, and pleasantness, as well as dollar

On the whole, the relative importance of these input and output factors in the operation of specific kinds of enterprises constitutes a significant factor in the locational distribution of activities in an urban area. It should be noted that in most cases where location is related to cost, the establishment's principal activity, in terms of movement, is as a base of operations. In those cases where location is related to demand, the principal activity centres around the establishment as a destination of one type or another."66

Linked establishments will be characterized by movements among each other, while the non-linked but proximate establishments will not have movement among each other. Establishments located close to each other, both linked and non-linked, provide a basis for analyzing the structure of movement. The locational pattern of establishments and the relative ease of travel between establishments determine the grouping, the degree of interaction, and the frequency of movement between establishments.

Types of mass movement:

Wilfred Owen describes congestion, caused by mass movement within the CBD, in this inimical manner:

"We have the assurance, that the problem of congestion in urban areas has been precipitated by the automobile, on the contrary, has been our escape from congestion; that the automobile and mass transportation are both guilty of promoting congestion; and finally, that neither is the primary culprit, but rather a host of other factors that have resulted, thanks to modern technology, in the successful attempt to crowd too many people and too much economic activity into too little space. And of the city itself, we are told that preservation of the vast investment of urban America will assure both economic salvation and atomic annihilation".67

66 - Urban Traffic, pp. 109-110
67 - W. Owen, The Metropolitan Transportation Problem.
Owen feels that the following factors must be respected in properly viewing the roles of public and private transportation:

(a) It appears travel requirements and consumer choice will continue to favor the automobile. (Present statistics strongly back this observation.)

(b) Revision of public policy to give equal treatment to all forms of transportation will not appreciably alter the patterns of movement that have developed to date.

(c) The competitive aspects of auto and transit have been over-emphasized; their roles to a large extent are complimentary.

(d) The advantages and disadvantages of public carrier and auto transportation vary according to these differing circumstances:

I - In the CBD:
   - Land use is so intensive that the attempt to accommodate private transportation under all circumstances is not feasible.
   - In peak hours at least the emphasis must continue to be on some form of mass transport.

68 - Ibid. p. 162-4
ii - In less-dense areas:
   - Residential and commercial uses must be
     accommodated by a combination of private
     and public transportation, with increasing
     reliance on the auto as incomes and auto
     ownership increase.

iii - In low-density suburban areas:
   - Public transit is least able to meet the
     local needs of a scattered population.
   - There is nearly complete dependence on the
     car.

iv - In addition to the geographic factors, the
     urban transportation problem varies with the
     time and purpose of travel.

It may be candidly observed that the future of the CBD
will be greatly enhanced by the preservation of this area as one
which allows, primarily, convenient access among establishments
by large masses of persons travelling among their destinations
on foot.

Mitchell and Rapkin observe movement as being organized
spatially and temporally. 69

69 - Urban Traffic, pp. 22-3
Both characteristics are significant for this study:

(a) **Spatial characteristics of mass movement:**

The three forms recognized here are considered to be the key categories in the organization of the structure of movement:

i - **Assembling movement:**

A converging on points or areas of assembly.

ii - **Dispersive movement:**

Persons (or goods) are dispersed from points or areas of assembly throughout related areas of dispersal.

iii - **Random movement:**

Where persons (or goods) travel among dispersed locations.

Most persons - movement (including an interbase trip such as a trip to and from work), has the nature of a round-trip. (Most goods - flow, to the contrary, is one-directional).

(b) **Temporal characteristics of mass movement:**

It is through the dimensions of time, in a variety of applications, that some of the most critical relationships of movement and the land use pattern are expressed. Individual movements display a "rythmic pattern"; mass movements also display this rythmic pattern, and the phenomenon creates the "traffic peaks".

The components of a structure of movement at a given time
are individual movements of persons, goods, or vehicles, and various classes of these movements, and the systems of movement into which individual movements are grouped. Mitchell and Rapkin describe individual movements as they relate to establishments and their members, and the varieties and characteristics of trips:  

(a) **Establishments and their members:**

Each establishment has one or more members, for each of whom the establishment is a base of operations. A base of operations for an individual is any establishment of which he is a member. The two main bases of operations are home and work.

(b) **Trips: their varieties and characteristics:**

It is readily observed that bases of operations are focal points in persons-movement patterns, and appear more frequently than any other location as points of origin or destination in individual movement. The locations of the bases strongly influence the locus of all movement. Two general kinds of personal movement are distinguished:

i - **Interbase movement:**

Travel of an individual between two bases. This is the most routinized form of movement, and of particular significance to this study in that it denotes the pattern

of the frequency of visits. It becomes the most predictable form of movement in the CBD.

ii - Round-trip movement;

Travel from a base to one or more intermediate destinations and then returning to the base of origin. This type of movement is the least predictable.

II - Destinations of Persons within the Central Business District.

The movement of persons within the CBD can be observed most fruitfully as movement to, from, and among establishments as bases of operations and as destinations, in any evaluation of the relationship between land use and movement.

Much is yet to be discovered regarding the movement of persons in the CBD. To the present time, the largest contributions to an understanding of these movements have been those of:

R. Mitchell and C. Rapkin in Urban Traffic,
J. Rannells, in The Core of the City, and,
W. Owen, in The Metropolitan Transportation Problem.

The observations of persons-movement, as put forward in these three studies, are presented here along with several other studies which bear on particular aspects of this type of movement;

The survey was carried out by interviewing persons visiting four representative CBD establishments; a theatre, a specialty shop, a department store, and a small service establishment. The object of the survey was to observe the number and nature of associated destinations which may be visited by an individual on a single trip.

Results of the survey:

i - Mode of transportation and travel to the department store: (See Table on p. 101-A)

The significant observations here are:

- Approximately 25% of the visitors travelled by foot from their last base of operations.
- Over 50% of the visitors arrived by using some form of mass transportation.
- Persons who walked from a base of operations required approximately 10 minutes.

ii - Type of trip and number of stops:

- The distribution of trips sheds some light on linkages of establishments.
- It indicates the varying dependence of differ-
### Mode of Transportation Used and Average Time Required to Arrive at Destination from Last Base, by Callers at a Department Store

<table>
<thead>
<tr>
<th>Mode of Transportation</th>
<th>% of Total Visitors</th>
<th>Average Travel Time in Minutes From Last Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automobile</td>
<td>9.2%</td>
<td>39.9 minutes</td>
</tr>
<tr>
<td>Public Transit</td>
<td>55.3%</td>
<td>33.7</td>
</tr>
<tr>
<td>Walking</td>
<td>7.4%</td>
<td>10.7</td>
</tr>
<tr>
<td>Railroad</td>
<td>7.4%</td>
<td>47.0</td>
</tr>
<tr>
<td>Other and Undetermined</td>
<td>0.5%</td>
<td>-</td>
</tr>
<tr>
<td><strong>ALL MODES:</strong></td>
<td><strong>100.0%</strong></td>
<td><strong>28.3 minutes</strong></td>
</tr>
</tbody>
</table>

**SOURCE:** Interview Survey, Philadelphia, 1950.  
Urban Traffic, p.42, Table 1 (Part 0f)

(N.B. Mode of transportation refers to that used in travelling from last base, i.e., home-work-or school. Actual arrival at department store may have been by walking from an intermediate destination. Data shown in table are expansions of sample to total traffic count, hour by hour. Sample size for the department store was 251 persons.)
ent kinds of retail or service establishments on the working population of the area. The small service establishment is largely dependent on the working population, and such service establishments must be within a short walking distance of the clientele they serve.

The department store and the retail specialty shop are not orientated to the CBD working population, but serve the general metropolitan population. This, as previously considered, is the function of both of these activities which offer the greatest number of persons variety and accessibility within relatively short walking distances. However, because of their functions, these two types of establishments also serve whatever working population do shop there during the course of a week day. (See Table on p. 102-A, and Diagram on p. 102-B).

In the selection of sites for heliports, one is not so much concerned with the shopper from the residential area (home-to-home, round-trip movement) as he is with the person employed by an establishment in the CBD, who is moving or is required to move about the CBD. Therefore, what is of greatest interest here is the link between CBD employees from a variety of establishments
### DISTRIBUTION OF TRIPS BY TYPE, PERCENT OF NUMBER OF TOTAL TRIPS, AND BY AVERAGE NUMBER OF STOPS PER TRIP.

<table>
<thead>
<tr>
<th>Type of Trip</th>
<th>DEPARTMENT STORE</th>
<th>THEATRE</th>
<th>RETAIL SPECIALTY</th>
<th>SMALL SERVICE ESTABLISHMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% of Total Trips</td>
<td>Average Stops Per Trip</td>
<td>% of Total Trips</td>
<td>Average Stops Per Trip</td>
</tr>
<tr>
<td>Home to Home</td>
<td>57.0%</td>
<td>2.6</td>
<td>58.7%</td>
<td>2.0</td>
</tr>
<tr>
<td>Work-to Work</td>
<td>21.0%</td>
<td>2.0</td>
<td>2.5%</td>
<td>1.5</td>
</tr>
<tr>
<td>Home to Work &amp; Work to Home</td>
<td>13.7%</td>
<td>1.6</td>
<td>26.3%</td>
<td>2.0</td>
</tr>
<tr>
<td>Other Combinations</td>
<td>8.3%</td>
<td>2.0</td>
<td>12.5%</td>
<td>1.9</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100.0%</td>
<td>2.3</td>
<td>100.0%</td>
<td>1.9</td>
</tr>
</tbody>
</table>

**SOURCE:** Interview Survey, Philadelphia, 1950. Urban Traffic, p.49. Table 2 (Part of.)
DISTRIBUTION OF TRIPS TO FOUR ESTABLISHMENTS FROM WORK BASES AND RESIDENTIAL AREAS.

(PERCENT OF PERSONS CALLING AT THE ESTABLISHMENT.)

Persons to or from a work-base near by.

71% Small Service Shop 29%

27% Retail Specialty Shop 73%

34% Department Store 57%

29% Theatre 58%

Persons from residential areas.

SOURCE: URBAN TRAFFIC, p.44, FROM TABLE 2, INTERVIEW SURVEY, PHILADELPHIA, 1950
Movement Of Workers Within The CBD.

Postulate - 2

CBD

Employees

Consumer (CBD Worker) Services.

Walking Area

Retail Sales

Business Services

Financial & Administration

Area in which destination can be reached within approximately 10-minutes walking time.
and consumer service establishments - one relying heavily on the other. This then, mainly concerns the interbase movement of the CBD working population. (See Diagram on p. 102-C).


- Observations of the study:

In observing the generation of traffic by land uses it is fairly easy to note those establishments or groups of establishments, which play the dominant role in attracting persons; or, those establishments which require a large flow of person traffic in order to function successfully. Certain groups of establishments operate quite well by some other means of communication other than by the movement of persons, and these will also become apparent.

Some significant observations can be noted: (See Table on p.103-A, and Diagram on pp. 103-B and 103-C).

i - In all distance zones, as might be expected, commercial uses are the greatest traffic generators.

ii - Consider the "Core of the City" (Ring-0)

Commercial establishments are the major sources of traffic generation. Therefore, the largest amount of persons movement is restricted to move-

---

73 - Considering Ring 0 and 1 as being one zone.
74 - Unfortunately it was not possible to determine what constituted the commercial and industrial establishments. It is assumed commercial use also included business services, and industrial use included wholesale, manufacturing, and other forms of industry.
## Generation of Traffic by Land Uses in Detroit

<table>
<thead>
<tr>
<th>Ring</th>
<th>Description</th>
<th>Residential</th>
<th>Commercial</th>
<th>Industrial</th>
<th>Public Open Space</th>
<th>Public Buildings</th>
<th>Total Land in Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Core of CBD</td>
<td>733</td>
<td>1,797</td>
<td>153</td>
<td>-</td>
<td>945</td>
<td>1,522</td>
</tr>
<tr>
<td>1</td>
<td>Remainder of CBD</td>
<td>186</td>
<td>207</td>
<td>209</td>
<td>29</td>
<td>362</td>
<td>222</td>
</tr>
<tr>
<td>2</td>
<td>Remainder to 3 Miles</td>
<td>65</td>
<td>194</td>
<td>92</td>
<td>10</td>
<td>89</td>
<td>74</td>
</tr>
<tr>
<td>3</td>
<td>3-6 Miles</td>
<td>56</td>
<td>218</td>
<td>48</td>
<td>3</td>
<td>26</td>
<td>58</td>
</tr>
<tr>
<td>4</td>
<td>6-9 Miles</td>
<td>42</td>
<td>280</td>
<td>38</td>
<td>8</td>
<td>46</td>
<td>50</td>
</tr>
<tr>
<td>5</td>
<td>9-12 Miles</td>
<td>26</td>
<td>325</td>
<td>36</td>
<td>3</td>
<td>33</td>
<td>32</td>
</tr>
<tr>
<td>6</td>
<td>Over 12 Miles</td>
<td>14</td>
<td>182</td>
<td>8</td>
<td>2</td>
<td>17</td>
<td>15</td>
</tr>
<tr>
<td>TOTAL STUDY AREA:</td>
<td></td>
<td>29</td>
<td>269</td>
<td>37</td>
<td>3</td>
<td>33</td>
<td>36</td>
</tr>
</tbody>
</table>

**Source:** Detroit Metropolitan Area Traffic Study, Pt.1, (July 1955) p.41. Metropolitan Transportation Problem, p.225.

1 Excluding streets, alleys, and railway rights-of-way.
GENERATION OF TRAFFIC BY LAND USES IN DETROIT.

Source: Metropolitan Transportation Problem, p. 225.
Generation of Traffic by Land Uses in Detroit.

Source: *Metropolitan Transportation Problem, Detroit Metropolitan Area Traffic Study*, (Refer to Previous Diagram), p. 225.
ment between commercial establishments. Industrial establishments do not generate any considerable movement of persons in this area.

75 - In this respect Mitchell & Rapkin state: "If the establishments that serve as origins and destinations are confined to a small area, then accessibility can be achieved through proximity." This may be assumed as a usable observation in this case. Mitchell & Rapkin recognize certain characteristics of the commercial establishments in the CBD:

- The retailing and consumer services group.
  - They are held together primarily by consumer traffic.
  - While they are usually found together, they are not found in balanced proportions. **Urban Traffic**, p. 104, 115.

77 - Ibid. p. 115, Mitchell & Rapkin observe that the manufacturing and wholesaling with stocks group, have a major subdivision:

1. Those establishments which deal with the downtown department stores and other types of retail shops, and are found on the periphery of the concentrated portions of the retail shopping area. This could quite conceivably be the group referred to in the Detroit study and present in the "core".
2. Those manufacturing & wholesaling groups that supply markets outside of the CBD, and tend to locate at truck and rail terminals and along river fronts.

The business services and wholesaling without stocks group also display interesting characteristics:

1. They deal with business firms, not with consumers.
2. Both typically require, and can afford, accessibility in location.
3. Their space needs are mainly for office space.
The only other group that is notable for our purposes is the public buildings group. As most public buildings are located in the CBD and because of their proximity to the business establishments present, persons are able to walk or drive to these establishments en route to other destinations within the CBD. It may be postulated that the walking area of the CBD is the "core" of the CBD (as far as concentration and amount of persons-movement is concerned), and that the core includes the following establishments: Commercial establishments - the greatest proportion. Public establishments - a lesser proportion. Industrial establishments - only a small proportion of persons-movement.

iii - "Remainder of the CBD":

What is immediately outstanding is the sharp drop in commercial generation of persons-movement. That is, this is not the area of commercial establishments, and those that are present serve either the downtown business establishments or the residents living here. Public Buildings persons-movement generation has also dropped by one-third, but remains a significant generator of traffic. It is understandable
that public buildings are found in this area because of the high land value locations of the "core" which are avoided for practical reasons; and also, it could denote former positions of the "core" of the CBD - since having relocated farther away.

**Industrial establishments** generate more traffic in this area than in the "core". (i.e. 209 as to 153). This is a very significant observation, and may point out a close relationship between these firms and those of the core of the CBD, especially to the "core" industrial establishments and certain of the commercial establishments. (As has been observed in the Philadelphia study, the relationship to the small service establishment especially) and to business services.

(c) R.E. Murphy and J.E. Vance, "Delimiting the Central Business District".

Although the study concerned itself primarily with determining the spatial limitations of the central business district by land use and floor space, it included an important portion related to this heliport study. We are mainly concerned with Murphy's

"walking distance zones" here. In order to evaluate the intensity of land use within the CBD Murphy took the peak land value intersection and ruled out walking distance zones, as follows:

- a 200 yard zone,
- a 400 yard zone (he considered this zone to be the maximum walking distance).

The observations in the walking zones were as follows:

I - High quality variety stores and clothing stores fall within the 100 yard zone.

ii - Professional and business offices were found normally within the 200 - 400 yard zone.

iii - Theatres and hotels were found within the 200 - 400 yard zone.

iv - Heavy household goods firms and automobile firms were within the 300 - 400 yard zone.

Murphy found that the nine cities studied were only beginning to develop specialized zones (the population of the cities studied ranged from 150,000 to 200,000), he felt that definite "clustering" of establishments was not observable until a population reached 300,000 to 400,000 persons. (See Diagram on p. 107A).
WALKING DISTANCE AND LAND USES
AS MEASURED FROM THE PEAK LAND
VALUE INTERSECTION IN NINE CITIES
RANGING FROM 150,000 TO 200,000 PERSONS.

Source: R.E. Murphy and J.E. Vance, "Delimiting
The Central Business District," in Economic Geography, Vol. 30, No. 3,
1954, pp. 189-222
CHAPTER VI

THE PHYSICAL AND TECHNICAL REQUIREMENTS OF THE HELICOPTER AND THE HELIPORT WITHIN THE CENTRAL BUSINESS DISTRICT

In the preceding chapters the emphasis has been on the land uses in the central business district. Certain basic characteristics have evolved along with other assumptions which require further research to judge adequately. Once a realistic approach to these land uses has been achieved, then the attention must focus back again on the helicopter itself and the heliport. The technical limitations of the machine along with its projected future capabilities must now be considered, along with the physical structure which harbors the helicopter when not in flight. This chapter attempts to focus the peculiarities of the helicopter in its flight condition, and in addition presents the basic arguments for rooftop and ground-level heliports. It must be emphasized that land use, and technical and physical factors must be visualized as one problem requiring an overall solution.

The actual dimensions of the heliport and the required approach clearances needed depend entirely on the type of heliport we talk about. The requirements of an airport, a suburban heliport, or a heliport in a densely built-up area such as the central business district, vary markedly. Many factors need to be reckoned with, such as: size of helicopters, function of the heliport (for public transport use, for private use, or for a mixed public and private
use), surrounding land use obstructions, density of helicopter traffic, and so on. Since this study limits itself to happenings within the CBD, the heliport requirements dealt with are those peculiar to helicopter operations into and out of a densely built-up area, where the site, approach clearance minimums, and the nuisance from aircraft noise as well as safety, become prime factors of consideration. In this respect, this chapter will deal with three general aspects; the broad requirements of the helicopter, the ground area required for efficient operation, and the flight paths best suited for helicopters entering built-up urban areas.

The noise problem is not discussed in any detail; it is assumed that the manufacturers will be required to decrease helicopter noise through technological improvements or the day of helicopter acceptance into the urban transportation scene will be unnecessarily delayed. In any case, the ambient noise level should be considered in site selection. The study primarily discusses the multi-engined helicopter, as it is the only form of helicopter which could be used in the CBD if economy, efficiency, and safety are the criteria.

A single heliport in the centre of a city is not the logical solution to the heliport problem. In many cases the traffic potential will be such that a number of somewhat smaller heliports will be required at various strategic locations within
the CBD. By a "smaller" heliport this does not mean a reduction of the approximate 200 ft. x 400 ft. take-off and landing area, but a reduction in the additional area required for parking, loading, and unloading, and so on.

A - THE BROAD REQUIREMENTS OF THE HELICOPTER

The broad requirements which a multi-engined helicopter should meet for operation over and into built-up areas are: 79

1. The helicopter should be able to maintain height after engine failure with the remaining engine(s) operating within their continuous rating (i.e. maximum continuous cruising power) by a margin of power to allow for manoeuvres, rough air, and deterioration.

2. The helicopter should be able to follow a normal approach path after engine failure with the remaining engine(s) operating within the take-off rating.

3. The helicopter should be able to make a safe touchdown on a restricted area in the hands of a competent pilot after engine failure.

4. The helicopter should be able to exercise a take-off manoeuvre such that, after engine failure at any stage, it can return safely to a restricted take-off point or fly to a less restricted landing area.

1. Roof-top Versus Ground Level Heliports:

The elevation chosen for construction of the landing and take-off area should be arrived at only after many factors have been considered.

In defining the two levels of heliports, a roof-top (or elevated) heliport is one which is located on a structure several stories above the ground; a ground level heliport may be structural or non-structural.

(Locations which might require structural heliports at ground level would be piers, or other water-edge locations, marshy areas, and so on.)

Roof-top heliports: Their advantages and disadvantages:

The advantages of roof-top or elevated heliports are:

(a) In areas where land cost is at a premium, the use of a roof-top for a hiliport will reduce the land cost because the land is also being used for many other activities located below the heliport.

(b) It permits the location of a heliport in built-up areas - immediately accessible to the greatest concentration of persons in the CBD, and closely tied to converging public transportation facilities.

(c) It provides a means of obtaining approach protection
on an inexpensive basis because the height of
the heliport itself will give a reasonable de-
gree of protection.

(d) It offers the possibility of providing a heli-
copter hangar deck below the landing area with
elevator access. However, such an installation
seems practical only with small helicopters
weighing up to about 20,000 pounds.

(e) Flight in the vicinity of an elevated heliport
would generally experience less turbulence than
flight into a ground level site in the same lo-
cation. This would result because the landing
area would be above nearby obstructions to wind
flow.

(f) It may be possible to combine a downtown auto
parking structure with a heliport located on the
roof of the structure.

The disadvantages of roof-top heliports are:

(a) A costly structure is required to support the
weight of the helicopter. The newly completed
post office in Vancouver illustrates the structural
problems associated with a helicopter landing area.
Although the roof-top heliport is designed princi-
pally to facilitate helicopters carrying mail, the
roof of the building required this design:
(In addition to the roof design requirements, the total building structure and foundation must have additional strength to carry the weight of the roof and the operations on it.)
(b) It is difficult to supply the necessary space required for a heliport on the roof.

(c) Fueling facilities must be brought to the roof level, increasing the cost of equipment required. Also, local fire insurance regulations and restrictions may not permit roof-top fueling.

(d) Insurance rates are considerably higher.

(e) The provision for handling emergencies is made more difficult. Removing disabled aircraft may require some type of lowering down the side of the building by means of a crane arrangement.

(f) Considerable space on the floors below the heliport will have to be devoted to heliport uses such as; exclusive elevators, moving stairways or other means of access, lobby and processing areas for passengers, freight, and baggage handling and passenger auto parking. Perhaps one of the major problems in developing a roof-top heliport would be the supplying of sufficient parking space for private passenger cars where passengers are utilizing helicopter service. Such cars would require parking for a longer period of time than the average person takes who is engaged in some form of activity in the CBD. The cost of land and the volume of building space required for passenger cars and the financial returns from
the parking service may not justify the use of one building as a composite major heliport. On the other hand, where multi-storied parking structures are already in existence in the CBD, or which are being considered for future development, it is quite feasible to consider such structures for a heliport. However, the location of such a parking structure would be subject to the land use considerations referred to in earlier chapters.

(g) It requires a higher cloud base (than the ground level heliport) to provide the same operating safety. The more elevated the heliport is the lower in proportion the cloud ceiling becomes.

(h) The support of the "ground cushion" is not available at roof-top elevations, with the result that a roof-top site must provide sufficient length to permit the helicopter to reach a minimum forward speed (currently about 40 M.P.H. for a transport type helicopter) for adequate control before leaving the edge of the platform.

(i) The heliport builder is required to commit himself now to the design of a heliport from a long-range standpoint. Because there is so much to be
learned about helicopter operations and heliport design requirements, it seems undesirable to create a rigid design until greater refinements are achieved.

Ground Level Heliports: Their Advantages and Disadvantages.

The advantages of ground-level heliports are:

(a) Low level operations in the approach and departure zones permit greater flexibility in both minimum speed and greater maneuverability, since the helicopter can hover on one engine in the "ground cushion" formed by the downdraft from the rotor blades, within 10 to 15 feet of the surface.

(b) The construction costs are lower as structural support of the heliport would usually be unnecessary, or, at least achieved at minimum cost.

(c) The ground level site should more conveniently provide the large space required for the heliport landing and take-off areas with its associated parking areas, for both helicopters and passenger autos.

(d) It would permit helicopters to make full use of the airspace between the ground and the cloud ceiling, and so would be closed less often because of "below minimum" weather.
(e) Fueling facilities should be provided at a major heliport, and these can be provided at minimum cost in a ground level heliport, using standard fuel handling techniques. In addition, the insurance costs would be considerably less in a ground level operation.

(f) The ground level heliport provides the minimum of pedestrian travel from the street or public transportation facility to the helicopter. It is a "saving of time" to the customer, and in this respect an important convenience factor.

(g) The ground level heliport could handle a disabled helicopter without excessive difficulty, either for repair purposes or by providing means to transport it from the heliport to some other facility.

(h) It could more readily be equipped to handle emergencies resulting from fueling or flight operations. Although the heliport should have its own emergency equipment, it could easily draw on other municipal emergency equipment.

(i) The initial ground-level structure could be simple and easily altered if it was found that the location or structure was not adequate.
The Port of New York Authority has decided that downtown heliports should preferably be located on waterfront property to clear over-water approaches. Waterfront offers additional advantages in that adjoining land use is normally commercial or industrial, and the heliport can be expanded as necessary by building out into the water rather than using additional costly land area. Also, fuel can be delivered by barge which is the most economical method.

The disadvantages of ground-level heliports are mainly that it would be extremely difficult to locate a heliport within the built-up CBD because of the obstruction clearance profile required for take-offs and landings, in addition to the high cost of a substantial piece of land for the services which must be located there.

2. **Design of the Heliport:**

The Port of New York Authority has established design criteria based on the estimated traffic volumes and on the operational capabilities and requirements of helicopter design. The area required for landing and take-off is an operational requirement dependent upon the flight characteristics of future helicopters. On the other hand, the amount of space and number of gate positions needed for loading and unloading is a function of both:

80 - See P.N.Y.A., Aviation Dept., Transportation by Helicopter, 1955-1975, pp. 61-75
(a) Volume of traffic, and,

(b) The size and ground handling characteristics of the helicopter.

Once traffic volumes to be handled by the heliport are arrived at, the problem of design criteria becomes one of determining what physical areas and facilities will be necessary to safely accommodate helicopters of the size and flight characteristics which these machines are expected to have. Although the volume of traffic to be handled is in one sense a controlling factor, the efficiency of terminal operations and the aerodynamic characteristics of the helicopter during landing and take-off are considerably more important in determining the total area required.

The heliport design criteria developed by the Port of New York Authority are shown on the chart on page 118-A.

It appears that an area in the neighbourhood of 200 feet by 400 feet maximum is necessary for a major downtown heliport, and depending on whether it is a ground-level or elevated structure, other related facilities must also be provided for. (See chart on page 118-B).

The Second Helicopter Meeting of the International
HELIPORT DESIGN CRITERIA

SPACE - WEIGHT CRITERIA:

1 - Landing - Take-Off Area  200 ft. x 250 ft. - One Landing & One Take-Off Platform.
2 - Wheel Loading 19,000 lbs.
3 - Loading - Unloading Area  30 ft. x 90 ft. - 8-17 Loading Positions
4 - Weight to be Carried by Each Loading  25,000 lbs.

OBSTRUCTION CRITERIA:

(Major and Secondary Heliport)

1 - Desired Maximum Elevation of Operational Area Above Street Level 100 ft.
2 - Minimum Lateral Obstruction Clearance 100 ft.
3 - Minimum Approach Obstruction Clearance 35°
4 - Desired Minimum Width of Approach and Departure Path  500 ft. 2

1 30-Place Helicopters Anticipated. This would have to be increased 50% when 40-place equipment becomes available.
2 Measured from end of platform plus 100 ft.

### HELIPORT AREA REQUIREMENTS

<table>
<thead>
<tr>
<th>REQUIREMENTS</th>
<th>1955</th>
<th>1960</th>
<th>1965</th>
<th>ULTIMATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - Size of Landing and Take-off Area.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major Heliport</td>
<td>100' x 100'</td>
<td>200' x 400'</td>
<td>200' x 400'</td>
<td>200' x 400'</td>
</tr>
<tr>
<td>2 - Number of Parking Positions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major Heliport</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3 - Parking Area</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major Heliport (a) If Helicopters Positioned Mechanically</td>
<td>-</td>
<td>85' x 135'</td>
<td>85' x 135'</td>
<td>85' x 135'</td>
</tr>
<tr>
<td>Major Heliport (b) If Helicopters are Taxied</td>
<td>80' x 125'</td>
<td>100' x 160'</td>
<td>100' x 160'</td>
<td>100' x 160'</td>
</tr>
</tbody>
</table>

1. If heliport elevation is such that loss of ground cushion occurs on take-off immediately after leaving heliport, size must be increased sufficiently to assure that operations can be safely conducted in compliance with the height-velocity diagrams for the helicopters using the heliport.

2. In addition, space should be provided for one disabled aircraft, or means should be provided for removing it from the landing area.

Air Transport Association, concluded, in regard to size of heliports, that in built-up districts a heliport area in excess of 200 feet by 400 feet would be extremely difficult to find - even for a major commercial heliport contemplated to serve the largest proposed helicopter. This area should therefore be understood as being the maximum area required from which to operate the helicopter at maximum gross weight.  

In addition to the actual dimensions of the site, orientation of the heliport in relation to prevailing winds must also be considered. Since the helicopter derives lift through airflow over its rotors, velocity affects performance. The operating area should be designed to permit operation into wind, to minimize crosswind operation, and to eliminate the need for downwind operation. This requires an analysis of local weather records to determine the direction of the prevailing winds, and this related to the type of helicopter which will fly into that particular heliport.


It appears, however, that if prevailing winds are not greater than 25 knots, the helicopter may take-off or land in any direction, thereby requiring, theoretically, only one approach and departure lane.\textsuperscript{83}

In general, it can be concluded that the heliport authorities must choose a certain dimension for the heliport, simply on the grounds of high land costs in the CBD. The operational aspects of helicopter operation will then have to be fitted into this framework. The helicopter manufacturer should be required to produce an aircraft to fit the operational requirements which the heliport dictates by its size and location within a densely built-up area, and also the obstruction profiles likely to be obtainable there.

3. The Heliport Obstruction Profile:

The major commercial heliport has as its basic objective the carrying of large loads, in the form of persons and goods. It becomes apparent, therefore, that the helicopter cannot be expected to make use of vertical take-offs and landings. The transport helicopter must use a relatively flat approach and take-off angle. The Port of New York authority states that in commercial use, the helicopter will have characteristics similar to conventional fixed-wing aircraft, though approach and take-off angles will be steeper and flight speeds

\textsuperscript{83} - \textit{Civil Engineering}, (Feb. 1955) p. 52
The Second Helicopter Meeting of I.A.T.A. brought to light the various problems the helicopter operation faces in respect to obstruction profiles. Obstruction profiles must be determined on the basis of:

(a) Current helicopter performance criteria.

(b) Future multi-engine performance characteristics with one engine inoperative.

(c) Instrument approach requirements.

(d) City planning considerations.

It is desirable, therefore, that the obstruction profile be such that it provides for the above factors in all stages of helicopter development. However, it may not be possible to provide a slope flat enough to accommodate the one-engine-out operation of early multi-engine helicopters. If this is true, it becomes necessary for this first stage operation to have take-off and approach routes which include sufficient emergency landing areas.

Consideration has been given to various take-off procedures with multi-engined helicopters which make provision for an engine failure at any point in the take-off flight path, without requiring an excessively

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flat slope in the take-off zone. Where flat slopes cannot be achieved it appears, at this time, that a reasonable procedure would be one in which the helicopter takes-off substantially upwards (that is, with small or zero horizontal velocity) to a minimum altitude over the heliport. At some point a decision must be made either to proceed with or abandon the take-off. If the take-off is to be continued, the helicopter must achieve such a combination of height and forward speed that all obstructions in the flight path can be cleared by a suitable margin. If the take-off is abandoned, the helicopter will be landed and brought to rest within the boundary of the heliport. The profile slope of 1:8 was conservatively chosen, at the meeting, in view of the lack of experience with multi-engined helicopters. With experience, it may be found practicable to increase approach gradients and make zoning less restrictive. In any case, it was felt unwise at that time to entirely reject any site which does not meet the 1:8 obstruction gradient requirement.

The profile slope that is established, and the width of the take-off and landing area together constitute the balance of space required for a heliport operation, and these also become the fundamental issues in
applying some form of restriction, such as zoning. I.A.T.A. feels that the width of the landing and take-off area should be not less than twice the rotor diameter of the largest helicopter liable to use the heliport. The rotor diameter of some helicopters under development is of the order of 100 feet which suggests that a 200 foot width will be adequate in most cases. The take-off area should be at least bi-directional; that is, normally with approaches 180° apart, and so orientated as to permit general into-wind operations a great percentage of the time.

The publication Civil Engineering, in its considerations of obstruction clearance, visualizes a forward take-off profile in which a 400 foot over-run area has been included to allow for an emergency landing directly after take-off, before one-engine-out flight can be achieved. (See Diagram on page 123A). Within the over-run area the take-off ratio has been doubled to 1:4 (as compared to the I.A.T.A. suggestion of a ratio of 1:8) giving the helicopter a height of 100 feet above a ground level heliport at a horizontal distance of 400 feet out from the heliport. However, it appears difficult to visualize the purchase of a strip of land 400 feet wide and 800 feet long (approximately 2 full

85 - Ibid. p. 18
86 - Civil Engineering, (February 1955) p. 52
OBSTRUCTION CLEARANCE - HELIPORTS

PROPOSED OBSTRUCTION CLEARANCE PLANES FOR AN URBAN GROUND HELIPORT ARE SHOWN IN PLAN AND ELEVATION.

FIG. 1

SCALE 1" = 400'

SOURCE: Civil Engineering, Feb. 1955, p. 52
city blocks) in the built-up CBD area. However, if the heli-
port is so located that take-offs would be over water, or some
other form of open space, then this does become a feasible approach.

R.H. Whitby,87 has contributed a great deal in his study
of linear dimensions and costs per acre of heliports as affected
by approach angle, as well as the three generally accepted forms
of take-offs, and their effect on site dimensions.

R.H. Whitby's Findings were as follows:

(a) The limitations imposed on site size by landing:

(See Diagram on p. 124-A)

i - The graph suggests a relation between approach
angle and site length. The clearances of half
an aircraft length ahead, and no approach nearer
than an aircraft length to an obstacle behind
the touch-down point are arbitrary; in practice,
the approach path may not be a straight line but
curved so that the lateral part is substantially
vertical, but this will tend to make clearances
greater when operating into a site of given size.

ii - To accommodate large helicopters operating near
high buildings much larger space is needed for
the landing.

87 - R.H. Whitby, "Operational Problems of Transport
Linear Dimensions of a Heliport as Affected by Approach Angle.

Source: Royal Aeronautical Society Journal, R.H. Whitby, "Operational Problems of Public Transport Helicopters," Vol. 55, 1951, p. 38, Figure 8
iii- As the angle of approach increases the site length gets smaller, and gets down to quite manageable dimensions of 400 to 500 feet between buildings by the time it has reached 35°. The reason for choosing 35° as a planning limit is that in the absence of wind and at the rates of descent visualized, the helicopter is likely to be operating in the vortex ring condition at angles of descent relative to the air in excess of 45°. In its milder form, this results in roughness and, in its extreme form, may lead to temporary loss of control.

(b) Site areas required in relation to angle of approach:

(See Diagram on p. 125-A)

i - Since approaches are normally made into wind, these are based on the square of the length derived in the previous diagram on p. 124-A.

- an assumption that is somewhat pessimistic in the larger sizes.

ii - An urban site for a large multi-engined helicopter approaching at 35° would have to be about 4 acres in size. A site much smaller would not give sufficient room for ground installations and parking of other aircraft.
Area and Cost of a Heliport as Affected by Approach Angle.

Current Cost Per Acre Must Be Applied.

Source: Royal Aeronautical Society Journal, R.H. Whitby, "Operational Problems of Public Transport Helicopters," Vol. 55, 1951, p. 39, Fig. 9.
The effect of take-off on size of sites suitable for safe operation:

(See Diagram on p.127-A).

i - Consider the forward take-off:
The aircraft is accelerated and climbed to a height such that it can maintain height on one engine and be clear of surrounding obstructions. If an engine fails at this point, the pilot has the choice of continuing to climb or of returning to the airfield; a period of delay while he is making up his mind must be allowed. A rather large dimension of nearly half a mile results, and, if this is made up of two "runways" 150 yards wide, to allow for emergency landings into wind, about 50 acres are required.

ii - Consider a vertical take-off:
The take-off is vertical to the critical point so that if an engine failed the helicopter could either return to the landing field or pick up a sufficient forward speed (loosing height in the process) to maintain height on the remaining engine without danger of collision with ground obstructions. The pilot will not wish to descend from the rotor operating in the vortex-ring state, and furthermore, it will not be easy for him to see immediately below, therefore he will be driven
make his approach back on to the landing ground at a steep, but far from vertical, angle. The area of the site required for this technique would be about 20 acres.

iii - Consider the Backward Take-off:

Here it is assumed the helicopter takes-off backwards and at about 45° to the horizontal, keeping his take-off point in view and the aircraft nose into the wind. If the engine fails at the critical point, the pilot has sufficient height to fly away on one engine or to descend on to his take-off point, and this phase of take-off becomes identical with that of the normal approach. The area required, therefore, is the same as that suggested as meeting landing requirements, that is, about 4 acres. The ability to maintain control of the a/c when the engine fails and during the period while adjustments are being made to the throttle of the remaining engine and the collective pitch, will require to be demonstrated. Until such matters as this have received practical trial the requirements of space for heliports cannot be specified with too great a degree of confidence.
SAFE TAKE-OFF PROCEDURES AND EFFECT ON SITE DIMENSIONS

FORWARD TAKE-OFF
(50 Acres)

CRITICAL POINT

25 fps 50 75

100 fps

3 Secs. Delay

2400 Ft.

VERTICAL TAKE-OFF
(20 Acres)

3 Secs. Delay

CRITICAL POINT

25 50 75 fps

3 Secs. Delay

900

BACKWARD TAKE-OFF
(4 Acres)

3 Secs. Delay

CRITICAL POINT

25 50 75 fps

75 25 fps

100 fps

400

SOURCE: ROYAL AERONAUTICAL SOCIETY
JOURNAL, R.H. WHITBY, "OPERATIONAL PROBLEMS OF TRANSPORT HELICOPTERS," Vol. 55, 1951, p. 41, Fig. 12.
C - FLIGHT PATH OF HELICOPTERS OVER URBAN AREAS

In order for a helicopter operation to function, the helicopter must fly between terminal points for the expediting of persons and goods. Many factors must be taken into consideration, each requiring detailed investigation. The problems of route altitudes under VFR and IFR conditions, the coordination of helicopter and fixed wing traffic patterns, and many other problems must be agreed upon in order to set up a practical operation. This heliport study could not possibly include such information, although it is recognized that such information is invaluable to actually putting a helicopter service into operation.

The flight paths generally agreed upon as being best suited for helicopter flights are those over:

- water bodies
- parks
- golf courses
- uninhabited land
- railway rights-of-way
- auto freeways.

It is obvious that flights over these areas minimize the seriousness of forced landings because they provide relatively unobstructed landing areas, as well as absorbing much of the effects of rotor blast and direct-overhead noise.

If adequate flight paths over such desirable areas is not possible, routes will have to be chosen which offer the inhabitants
on the ground immediately below such flight paths a minimum of inconvenience in noise and a maximum assurance of safety from a falling aircraft, as well as offer to the occupants of the helicopter the greatest chances of survival should some factor cause the helicopter to make a forced landing.

D - CONCLUSION

Economy of operation and development points to the fact that a ground level site be used for a major CBD heliport. Such a heliport will require a ground area of somewhere near four acres. A simple, ground level structure can be used which has adequate space for touch-down, and aerial manoeuvre space, not necessarily surfaced, for the acceleration and climb-out path. Although a sizeable area will still be needed for a ground level heliport, the owners investment can be kept to a minimum and he can retain complete freedom of design for the large heliport which may be anticipated in the future.

The Port of New York Authority visualizes the future heliport as a part of a specially constructed structure on which the lower floor will be utilized for the parking of itinerant helicopters, and for vehicular parking in connection with the heliport.

A bi-directional take-off and landing area must be visualized, with an obstruction clearance profile ratio of 1:8, for purposes of zoning.
CHAPTER VII

CRITERIA FOR SELECTING A HELIPORT IN A MAJOR CENTRAL BUSINESS DISTRICT.

This study has been concerned with the factors likely to affect the location of a heliport in the CBD in relation to the other establishments present there. It must be realized that the helicopter will no doubt serve a particular clientele which originates or must operate among certain establishments in the CBD. It is also felt that the helicopter will not be a mass transportation vehicle at the outset as other ground transportation systems are. It appears that certain occupations require the use of fast means of vehicular transportation between various points, mainly for business purposes; this is the group which will benefit most from helicopter transportation. The study could not go into types of potential customers, but other studies, particularly of short-haul fixed-wing commercial carriers, indicate specific "types" of airline passengers, and it is felt the commercial helicopter passenger will no doubt be quite similar to the commercial fixed-wing aircraft passenger. 38 Underlying these considerations is the basic question of the demand for helicopter service as opposed to other forms of public transportation which might prove equally capable of handling such traffic.

In the preceding chapters the author has presented various

aspects of the complex field of land uses which includes groupings of establishments, and movements of persons within central business districts. In addition, the technical and physical requirements of helicopter operations were presented to indicate the minimum standards below which the helicopter could not operate successfully. With these basic considerations at hand certain criteria may be advanced which consider the heliport location from the city planning point of view.

It appears that either the land uses of the CBD or the physical and the technical requirements of the heliport operation could demand precedence in determining a heliport location, if only a superficial investigation is undertaken. However, there are certain fundamental considerations which will determine the success of the heliport over an extended period of time, and as an establishment which compliments other establishments to which it is related. These fundamental considerations are the basis of this study; that is, both the land uses and the heliport requirements must be seen as working partners.

The strongest partner in the relationship is the land uses, this determines the traffic potential which may be served. If the heliport cannot be located in relation to its traffic market, then it may be a serious disadvantage to the CBD, and particularly to the total urban transportation pattern.

The technical and physical limitations of the heliport
operation becomes the auxiliary partner of the combination. The limitations these present may reduce the potential of a heliport location which may be satisfactory from the land use standpoint, but these factors must still be considered as secondary in the choice of locations wherever long-range planning is in process.

As a result of the analysis of the land uses and the helicopter requirements, and the relationship seen between them, the heliport location criteria are presented as a two-stage selection process. The first stage of selection sets out the land use criteria which are fundamental to the whole selection process. The second stage sets out the heliport and helicopter requirements which completes the selection process and allows for the service to be operationally functional.

THE FIRST STAGE IN SELECTING A HELIPORT LOCATION: The Land Use Criteria.

The land use factors may determine the actual success of the helicopter operation. If the heliport location has not been intimately related to the traffic generation areas it serves then it has been misplaced and would suffer seriously in being functionally inadequate in its anticipated role.

If it is assumed that public action and control can influence the nature, timing, and location of private development, then, by locating a heliport and its accompanying obstruction profile, a
predetermined land use pattern may be achieved in a given number of years in the area adjacent to the heliport operation. That is, the heliport may be considered as a useful device in molding new land use patterns for particular parts of the CBD. For example, by height restrictions along the obstruction profile which might allow for the location of certain types of land uses such as open space, low buildings for specific commercial uses, and so on. In this respect the following criteria should be considered:

1. The heliport establishment must become the member of several distinct linkage groups, each most able to utilize helicopter service. If the heliport is considered in relation to the most permanent establishments of the CBD, it should be tied closely to the administration and financial area, and the retailing-service area. Of these four groups of establishments, the retailing area may prove to be the least favorable area for the location of the heliport, in relation to traffic generation. In addition, if affinity for clustering of like establishments is considered a valid criterion, then the heliport would best be situated between the wholesale-manufacturing area and the business services area.
2. The conflict between auto traffic and pedestrian traffic must be resolved. Such a criterion demands a reduction in detrimental congestion, and suggests definite "walking areas" and "auto-oriented areas" in the CBD. In addition, the whole metropolitan transportation system must be designed as an integrated unit, directed from one control centre, and not many different control centres.

3. The heliport should be located in the low and medium height building areas of the CBD. This suggests the concept of three building-height levels for the CBD, - low buildings, medium-height buildings, and tall buildings. Various portions of the CBD that are presently developed or are developing should be evaluated to determine if building-height zones or areas are feasible. And further study must also be made of the present concentrated building areas, as well as the relative permanency of buildings in relation to the establishments which occupy the buildings, in order to evaluate the effect of building heights that are scattered in random heights, or grouped according to specific heights. This is the field in which the
architect, the engineer, the sociologist and the economist could pool their knowledge to provide a starting point.

4. The heliport should be located in the "auto-oriented" area but catering to the "walking" area. That is, the heliport should be situated in the zone of transition between these two areas. In such a location the heliport may draw its customers from walking traffic equally well as from persons arriving at the heliport by some vehicular means. This suggested location area is also that area where CBD commercial parking facilities are currently being developed, and some spatial arrangement between down-town passenger car parking facilities and the heliport may be envisioned as a practical measure.

5. The heliport should be so located that it is within ten minutes walking time of the majority of persons and establishments it will serve. The ten minute limit appears to be the maximum distance a person desires to walk between destination establishments. The convenience and accessibility factors are important to this consideration. It must also be assumed that the helicopter will, for
some years to come, provide service to a particular working population within the CBD, and will not cater to the general retail consumer traffic in the CBD. However, additional research into the type of traffic the helicopter will generate must be carried out to give more validity to this conception. It appears that one vital field of research which must be made is that concerning the walking area of the CBD worker, and in particular, the type of CBD worker that will become an active user of helicopter transportation.

6. Finally, a heliport location may be considered in an area that does not satisfy the external locational requirements of other exclusive CBD establishments, such establishments may also supply traffic for the helicopter service.


1. The initial CBD heliport should be a simple, ground-level structure, which can be economically altered if its design or location prove to be inadequate or detrimental. The ground-level heliport, although it requires sufficient structural strength, does not involve the huge
expense of the added structural strength
a high building demands to supply the same
facility. In addition, it would be difficult
to provide one roof-top with a flight deck area
of some two to four acres. The problems of
accessibility to the roof-top, convenience,
repair and fueling facilities, and ground
cushion, all force the heliport to be as near
the ground as possible.

2. The heliport itself, exclusive of obstruction
profile requirements, will require an area of
approximately four acres. This area includes
that required for landings and take-offs, heli­
copter parking, helicopter loading, and servicing
and refueling areas.

3. Planners should consider as a working standard
an obstruction profile angle of 1:8. This profile
will probably be the greatest determining factor
in the heliport location in relation to the surround­
ing buildings. As better helicopters are produced
this ratio will be reduced, but the reduction may
not be too great. However, if certain areas are
just below the 1:8 minimum ratio they should not
be considered as unusable, but could be earmarked
for a possible future site, keeping in mind the
the potential technical development of
the helicopter.

4. A bi-directional (180° - opposite) approach
route should be considered, with into-wind
operation where possible or necessary. This
appears to be the minimum number of approach
routes that will be required.

5. Some form of emergency forced-landing area
must be provided between the point of takeoff and the reaching of the "critical point"
along the take-off route. This assumes that
the take-off will be a relatively flat, forward
take-off so that the helicopter may carry a
maximum load within an efficient engine power-
to-weight rating, in a manner that provides the
helicopter occupants with the greatest degree of
safety.

6. The detrimental affect of engine noise and rotor
blast must be taken into consideration. This
would be considered in conjunction with the
obstruction profile, and may force an increase
in profile ratio above 1:8, additionally restrict-
ing the maximum height of physical structures below
the approach and departure route. Although the
study has recognized the detrimental effects of engine and rotor noise, considerably more study must be undertaken to evaluate the noise as a nuisance factor to adjacent land uses and land uses along the flight path for some distance.

7. Adequate flight paths into and out of the CBD must be chosen. Such flight paths should be routed so that there is an emergency landing area at specific intervals along the flight route. The intervals to be so spaced as to allow an engine-out glide approach from the minimum en route altitude. The emergency landing area should be at ground level in an open space where there are a minimum number of people at any given time. Such areas include parks, golf courses, vacant land, railway rights-of-way, wide roads.

8. Finally, the heliport must provide adequate passenger car parking facilities for the passengers using the helicopter service. As the heliport seems best situated at ground-level, it appears that auto parking cannot be considered as an integral part of the one structure but must be considered as an auxiliary structure. This might mean an auto parking
structure within a short walking distance of the heliport itself.

In addition to the actual technical criteria, or, perhaps, as the result of considering these criteria, city planners might do well to determine what area the CBD can afford to give for the heliport operation and its accompanying obstruction clearance profile. The helicopter manufacturer should then be obliged to produce the machine to fit the maximum allowable dimensions. This appears to be a plausible approach when the focus is on the CBD as a whole and not just on the helicopter service itself.

In conclusion, it is felt that the cooperation of the commercial operators in the CBD could be anticipated in the attempt to create "walking" and "auto-oriented" areas in the CBD. Such areas would encourage the overall development of the land uses of the CBD in a positive manner, and would in addition automatically allow for the provision of an efficiently operating helicopter transportation system in an adequate location or pattern of locations.

It must be strongly emphasized that no private or public construction of a building with an adjoining helicopter landing area (smaller than a major heliport) should be permitted in the
CBD without first developing a plan of the total heliport facilities allowable and possible within the CBD, and following along the general line of principles set forward in this study.
CHAPTER VIII

CERTAIN PROBLEMS IN PLANNING FOR HELIPORT FACILITIES

The city planner faces particular problems in attempting to locate or simply consider a helicopter service. A major problem is the determination of the legal basis under which the heliport may be instituted within the general framework of zoning. That is, will the city zone particular sites exclusively for a heliport, or will the zone in which the heliport is located be the wholesaling - manufacturing zone or the financial - business services zone, and so on, with no further refinement of the concept of horizontal zoning by type of land use. In addition, another approach, that of various "zones" present in the CBD, may be considered, perhaps in conjunction with the conventional land use zones; that is, here may be considered high-building or medium-building or low-building zones, or some other concept which considers the vertical physical structure of the CBD in contrast with the land use and establishment approach. Los Angeles has considered various heliport zoning techniques and these are listed on the following page.\(^89\)

In Canada, cities face a somewhat different control

POSSIBLE TECHNIQUES OF LAND USE ZONING FOR HELIPORTS.

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Listed Use</td>
<td>Permitted in specified zones only.</td>
<td>Permits indiscriminate location within specified zones. Does not control number or spacing of heliports. Might lead to air traffic congestion and conflict. Might restrict heliports from areas where needed.</td>
</tr>
<tr>
<td>Listed and Conditional Use</td>
<td>Permitted in specified zones as matter of course and in other zones by specific conditional approval.</td>
<td>Permits indiscriminate location in specified zones but allows location, site, and use control in other zones. (This is current status of airports (including heliports) in Los Angeles City ordinance)</td>
</tr>
<tr>
<td>Conditional Use</td>
<td>Permitted only by specific conditional approval.</td>
<td>Allows specific location, site, and use control in all cases. Might be considered discriminatory unless applied on basis of sound plan and uniform standards.</td>
</tr>
<tr>
<td>Supplemental Use</td>
<td>Permitted only in specified districts superimposed on zoning plan.</td>
<td>If district is so small as to permit only one heliport, this might be considered to constitute spot zoning. If district is large enough to permit location of several heliports indiscriminately, air traffic problems might result.</td>
</tr>
</tbody>
</table>

Cont'd. . . . .
### Possible Techniques of Land Use Zoning for Helicopters

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controlled Supplemental Use</td>
<td>Permitted only in specified districts and subject to specific conditions.</td>
<td>Allows specific location, site, and use control within selected areas. Guarantees freedom of other areas from heliport uses.</td>
</tr>
<tr>
<td>Exclusive Use</td>
<td>Permitted in special zone which prohibits all other types of use.</td>
<td>Prevents appropriation of land for other uses. Reasonable application probably limited to fixing of heliport location in relation to other uses within large single ownership.</td>
</tr>
<tr>
<td>Variance</td>
<td>Permitted by specific conditional approval only if general conditions for variance are met.</td>
<td>Improper use of variance if ordinance makes any other provision for heliports. Meeting of necessary conditions for variances might prevent serving of public interest.</td>
</tr>
</tbody>
</table>

**Source:** City Planning Department, Los Angeles, Calif., Preliminary Report On Planning For Heliports, (Los Angeles, January, 1956) Chart 6.2 (following p.63).
over air transportation than is the case in American cities. In the United States, airports are owned either federally, by cities, or by private operators; in Canada, the Federal Government, through the Department of Transport, controls all airfields. It is felt that all heliports will also come under the control of the federal government, except that they may be administered by cities or municipalities. No private ownership of heliports is anticipated in Canada. In addition, the Department of Transport controls airport zoning which includes obstruction profile zoning. It is generally assumed that when Canadian commercial heliports are developed the federal government will also zone the area about the heliport to provide for public safety and aeronautical safety. This will require the utmost of cooperation between cities and the federal government, so that the zoning restrictions applied will benefit the whole metropolitan community, and not stand as an obstacle in the path of sound commercial development in the CBD. Although the Department of Transport, Air Services Division, has not as yet produced standard requirements for heliports, it is considering such standards as are being accepted by the International Civil Aviation Authority which represents many countries and operators throughout the world.

90 The standard approach clearance ratio for airports is 1:50.
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