THE CANADIAN CONTRIBUTION TO THE
GEOGRAPHY OF AIR TRANSPORT

AIR TRANSPORT & ECONOMIC DEVELOPMENT:
THE CASE OF NORTHERN CANADA
THE CANADIAN CONTRIBUTION TO THE GEOGRAPHY
OF AIR TRANSPORT

by

John Eric Fairfield
B.Sc.(Hons.), Queen's University, Belfast, 1967

AN EXTENDED ESSAY SUBMITTED IN PARTIAL FULFILMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF ARTS
in the Department
of
Geography

© JOHN ERIC FAIRFIELD
SIMON FRASER UNIVERSITY
November 1972
APPROVAL

Name: John Eric Fairfield
Degree: Master of Arts
Title of Extended Essay: The Canadian Contribution to the Geography of Air Transport

Examine Committee:

M.E. Eliot Hurst
Senior Supervisor

R.C. Brown

G.P.F. Steed

J.M. Munro

Date Approved: November 22, 1972
ABSTRACT

One result of the increased attention being devoted to the Canadian North is an increase in transportation studies relating to the country as a whole. Air Transport, in particular, is well suited to the country's needs and it is pertinent at this point to consider the Canadian contribution to air transport geography. The purpose of this paper is to identify the areas of that field to which Canadian writings relate and to consider the importance of the Canadian contribution.

The carrying out of this objective is facilitated by a review of the spatial aspects of the literature on air transport in Canada, a task that centres on the work of one individual, K.W. Studnicki-Gizbert. This work is related to the mainstream of air transport writings in order to establish the value of the former in the context of the latter. In particular, a summary of the application of quantitative models to air traffic patterns is undertaken as this is not available elsewhere.

The most important spatial components of Canadian air transport writings are a consideration of the structure and history of the industry, the application of statistical models to the same, and an analysis of 'frontier aviation'. The main literature on the structure and history of Canadian air transport draws heavily on statistics and Studnicki-Gizbert's knowledge of this makes his contribution especially valuable, and unique.

Quantitative models have been used extensively in air transport studies elsewhere and the application of these to the Canadian scene is weak and inconclusive, adding little to the main body of writings on the
subject. On the other hand, little has been done elsewhere on frontier aviation so the Canadian contribution to that field has been considerable and is a major step forward, Studnicki-Gizbert's analysis of the same going into considerable depth.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Sub sections</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>The Canadian Contribution</td>
<td>2</td>
</tr>
<tr>
<td>Conclusion</td>
<td>28</td>
</tr>
<tr>
<td>List of References</td>
<td>31</td>
</tr>
<tr>
<td>Bibliography</td>
<td>34</td>
</tr>
</tbody>
</table>
INTRODUCTION

A trend has emerged in recent years that is focusing an increasing amount of attention on the Canadian North, a trend which has been characterized by projects and proposals such as the Road to Resources programme, the Mid-Canada Corridor concept and the Great Plains Project. This attention has attracted studies of transportation within the country as a whole because of the importance of the subject to the North in particular. Air transport has shared in this since it is so well suited to the North, and because its role in society is still expanding at a very fast rate and is changing with time. The geographical implications of this are obvious and it is perhaps pertinent at this time to consider the role of air transportation within the main body of geographic literature and to discuss the Canadian contribution to the same. The purpose of this paper, therefore, is to evaluate the Canadian contribution to air transport geography.

Most work on transportation geography has been done outside Canada - especially in the United States. In light of this fact, the purpose of this evaluation is to identify the areas of that field to which Canadian writings relate, and to consider the importance of the Canadian contribution.

Air transportation is here defined as commercial air transport, both scheduled and unscheduled, and including freight as well as passenger traffic. Military activities are ignored except where they directly influence commercial aviation, as in the case of airfield and airways construction in remote places. Furthermore, this aeronautical activity
is restricted to the area within the national boundaries of Canada and excludes international movements on the grounds that studies of the latter would not reveal anything specifically 'Canadian', but would rather reflect the influence of a dominant neighbour.

A final constraint is to limit the literature to analytical works, thereby excluding a wide range of books and articles that describe the air transport pattern without attempting to explain it. Nevertheless, within this constraint the subject matter of this paper will, of necessity, range beyond the immediate topic of Canadian literature in order to develop the background to the same and judge its value. An example of this is the attention given to development of quantitative techniques in other countries (relating to air transport), a review which has not been done before.

Finally, the bibliography, while by no means exhaustive, brings together a wide variety of items that bear upon the subject. In particular, that section of the bibliography that is listed under 'Air transport - theory' lists in one place most of the literature that covers the application of quantitative techniques to geographical problems of air transport. To the best of the writer's knowledge, this is the most complete list of this type.

THE CANADIAN CONTRIBUTION

One immediate result of reviewing the literature of Canadian air transport is that the portion of it that relates to spatial problems is very scanty indeed. So much so that the essential thrust of that literature is contained in the work of one individual, Konrad W. Studnicki-
Gizbert. This paper is largely devoted to the work of this one individual because his is the only major contribution to the topic in question. Furthermore, his work neatly summarizes the Canadian air transport scene from an economic and historical as well as a geographic viewpoint, and provides a useful meeting point for a consideration of many ideas that have influenced literature on the geography of air transport elsewhere.

Primarily an economist, Studnicki-Gizbert analyzes the Canadian air transport industry from a more formal economic viewpoint than a geographer might, but the nature of the subject is such that it has very strong spatial implications. Although Studnicki-Gizbert's work on locational analysis and frontier aviation is of particular interest to geographers, it should be remembered that all of his work has geographic implications, and provides useful background knowledge of the type that is fundamental to an understanding of geographical problems. At the core of all Studnicki-Gizbert's writings is a knowledge of the economic structure of the air transport industry, a knowledge that in turn permits a degree of understanding of the processes at work within the industry that are shaping it and the pattern it presents on the landscape.

Further to his consideration of the economic structure, Studnicki-Gizbert devotes a considerable amount of attention to the history of the industry and the manner in which it has developed, thereby adding to the degree of understanding he affords of the industry. He seeks to account for the phenomenon of Canadian air transport within the constraints imposed by historical growth and the socio-economic and political frameworks affecting
the industry through time. It is his consideration of the economic mechanics of the industry that allows him to identify the dualism of the Canadian air transport scene in a more rigorous form than any of his predecessors - a dualism involving what he terms 'mainline' and 'frontier' aviation.

It is important to remember that Studnicki-Gizbert is referring to the 'economic' aspect of the air transport industry's structure and not to every aspect of the same, a task that would involve a consideration of the whole environment, both physical and human, in which the industry operates. The basis for this consideration is essentially the Dominion Bureau of Statistics data bank and a collection of historical facts, statistics being fundamental to all his work. Although Studnicki-Gizbert specifically brings out the importance of developments in the rest of the Canadian economy and in the world at large, both economic and technological, as well as the role of various decision making bodies, an undercurrent of economic determinism flows through his work.

He considers a number of external factors that have had both direct and indirect influence on the structure and growth of air transport. Direct external influences are (in this paper) factors that are external to commercial air transport but relate directly to it and that involve deliberately made decisions that affect it specifically. The role of government bodies is especially prominent in this regard, notably that of boards directly responsible for licensing air carriers. The Board of Transport Commissioners, which was responsible for issuing licences in the early days had a great influence on the growth of the industry, although
how important these decisions were in the spatial sense remains to be researched.

"The Board was authorized to license all routes on the basis of public convenience and necessity, and was given control over rates and schedules. The granting of the first licenses appeared to have been made according to the doctrine of 'grand-fathers' rights', and introduction of competitive services was virtually halted. As a result of the Board's activity, competition was all but eliminated over the northern routes. Although the establishment of initial tariffs was left to the carriers, the Board exercised strict supervision of tariff filings and changes."

"An interesting aspect is the ratio of licenses issued to the license refused, since it indicates the degree of protection which the Board decided to give the industry against new entrants (the assumption here, is, of course, that virtually all refusals were made on competitive grounds)."

Likewise a fairly liberal licensing policy on the part of the Air Transport Board was noted by Studnicki-Gizbert as being one of the factors contributing to the healthy growth of charter operations after the second World War.

Another important external factor, this one with strong spatial implications, is the development of airports and airways. There are two main phases of airport construction, one pre-war and the other during wartime. Pre-war airport construction was affected by other factors, such as the depression and subsequent make-work programmes by the government, and this did not always result in the most efficient use of the investments from the viewpoint of aviation. Studnicki-Gizbert quotes an example of a 'make-work' programme that was effected during the winter of 1932-33 to build airways. Since much of the planning for this had already been done, the programme proceeded without an undue waiting period and involved little
waste. Although this looks like an admirable plan on paper it turned out to be somewhat less than successful in practise, for the installation of lighting and radio-equipment, and the provision of meteorological services lagged behind the labour-intensive airport construction work.

The airway construction programme across Canada began in earnest before the 30's because of the need to develop an independent Canadian route to combat the similar moves in the U.S.A. This, of course, affected the mainline routes of the South more than frontier aviation of the North, where greater use was made of lakes, both frozen and unfrozen, for landing spaces.

The extensive development of new airports in Canada during the war can be attributed to the British Commonwealth Air Training Plan, anti-submarine warfare bases on both coasts and the ferry systems to Alaska and to Europe. The air ferry route system to Europe was important because the choice of airports at Torbay, Gander, and Goose Bay and many intermediate fields determined the development of post-war Trans-Atlantic routes to a considerable degree.

Other government policies that affected the industry in wartime involved contracts to individual airlines that put them in a strong position after the war. Examples of this were Trans Canada Airlines' contract to operate Trans-Atlantic services in 1943-45 that had a bearing on that carrier's services later on, and Canadian Pacific Airlines' (C.P.A.L.) contracts to provide service facilities.
Studnicki-Gizbert notes some other ways that the government has exercised control over aviation. Prior to 1945 the manipulation of postal rates was a favourite ploy, but this was never as important in Canada as it was in the U.S.A., where the airline industry was force-fed by such techniques. After 1945 airmail in Canada was put on a more commercial footing, which in theory should have affected the pattern of services, although research to establish this is still lacking. Of more importance since the war has been the control the government wields over the largest of the 'bush' operators, such as Pacific Western Airlines, Wardair, and, formerly, C.P.A.L. This control is achieved by dividing the work available in the North into sections and giving these sections to specific airlines, and in so doing exercise a certain amount of restriction on the growth of these airlines. Mainline services in the South are protected by this manoeuver too.

Indirect external influences to which Studnicki-Gizbert draws attention are those factors that are not directly related to air transport, but whose effects are so far reaching that their influence is strong. Such a factor would be the Second World War, which in turn generated the direct external influences related above (i.e., government policies to air transport in response to wartime conditions). Such phenomena as the great depression were, of course, very important too, for the stock markets have a strong controlling influence over aviation, especially that at the 'frontiers of development'. Studnicki-Gizbert notes the spatial implications of this by drawing attention to the influence on aviation of fluctuating mining stock. Since aviation is characterized by small traffic volumes in 'frontier' regions, it is obviously highly unstable, especially
when it can be subjected to wild variations of demand. When mining stock is riding high, a mere rumour is sufficient to increase the demand for air transport by a few hundred per cent, and the opposite is true if the price of certain key minerals is very low. Furthermore, air transport at the 'frontier' has no control over this situation and can take no action to prevent a slump. Rate concessions are meaningless in this context. Particularly referring to the Toronto 'penny stock' market, Studnicki-Gizbert points out that in times of 'boom', a great flurry of aeronautical activity occurs, even if the purpose of much of it is only to generate publicity. When the market is 'dead', however, not only do these publicity flights cease, but so too does much of the legitimate exploration activity.

Generally speaking, however, external factors are recorded in Studnicki-Gizbert's work as phenomena that affect aviation, but do not necessarily help the quality of explanation, i.e. in what way do governmental policies on airport construction affect people's motivations to travel? Likewise, why does the stock market, so far away, affect traffic the way it does? Studnicki-Gizbert, on a couple of occasions, displays a glimmer of what was to come in spatial studies, especially when referring to decision making. For example, referring to the growth of traffic in the 1950's, he says,

"It appears that the growth of mainline traffic, as illustrated by T.C.A.'s (now Air Canada) development was due more to the acceptance of air travel, and the improvements of services than to economic influences external to the industry."3
The services which he perceives to be relevant include availability of capacity in relation to traffic (i.e. load factors), frequency of schedules and the quality of the equipment in use; factors whose importance he sees as varying with time and the 'market'. Even in this case, however, statements are caged in broad generalities, such as 'acceptance of air travel', and people are treated as large aggregates. Statistically this is sound (if it conforms to facts) but the quality of explanation offered is limited.

Likewise, decision making bodies are stripped of specific peculiarities such as their perception of the problem as opposed to the real situation. A notable exception to this in Studnicki-Gizbert's work is the way the government was influenced by the idea that the airline industry was highly unstable in the thirties. Although there is insufficient data to confirm or refute this, the idea led to strict control on competition. Studnicki-Gizbert therefore, borders on some of the behavioural aspects of spatial problems, but does not go into them at any length or with any deliberation. Although specific politics are not brought out, it is unlikely that they were totally absent or irrelevant in the case of aviation. When the Canadian Pacific Railway was built, for example, there was a great deal of political manoeuvering and there is no reason to suppose that the Canadian political scene has changed radically since then. The role of decision making bodies is considered, rather than the processes by which they do their work.

Since so much of his work on the structure and history (and by implication, the geography) of the Canadian air transport scene is based
on statistics, the value of these is crucial to an appreciation of the importance of Studnicki-Gizbert. Unfortunately, the data available is weak. Two particular shortcomings that Studnicki-Gizbert bewails are the lack of statistics to present a historical series of the geographical distribution of air transport in Canada and the lack of differentiation in the data banks between transport and other air services, such as police work. Furthermore, statistics do not separate northern aviation from southern and include flying club activities of non-transport organizations. Nevertheless, the air transport industry's development has been well documented relative to other segments of the transportation industry, especially in the more recent period.

In spite of these grave limitations, Studnicki-Gizbert is optimistic about the future, for the statistics gathered in 1960 and subsequent years are of a higher calibre than previously. In 1960 new reporting procedures resulted in the collection of data that were more meaningful in light of the growing interest in applied statistics, and in air transport statistics in particular, than the information collected in the past during the early days of the industry. Studnicki-Gizbert's optimism may be premature, for the statistics that are considered 'meaningful' today may not be so tomorrow, in the same fashion that the scanty data of years past is not suitable for today's socio-economic models.

The value of this work to geography must therefore be limited, being more descriptive than analytical, but it does provide very useful background information. In view of the shortcomings of the documentary evidence about the past, however, it is unlikely that anyone else is
about to contribute significantly more than Studnicki-Gizbert to a history of the structure of the industry, although the memoirs of some of those who have helped the industry grow since its infancy will no doubt help if, and when, they are published.

It is within this framework of deterministic considerations that Studnicki-Gizbert analyzes frontier aviation and the spatial pattern of Canadian air transport, two facets of his work that are especially of interest to geographers. The treatment given the spatial pattern is so heavily oriented to what has been done in the United States that a digression is in order here to establish the background against which to evaluate the Canadian contribution.

The beginnings of the movement to quantify description of air travel patterns find their origin in the work of the United States Civil Aeronautics Administration (hereafter the C.A.A.) in 1946-47. Approaching the problem of the importance of factors other than population and distance on air travel, the C.A.A. assumed economic factors to be important and accordingly set out to study the 'economic character' of communities. This study,

"... was undertaken to determine if airport planning could base aeronautical demand entirely on the size of a community or whether the 'character' of the community had to receive consideration. In this application, the manner in which people of a community earned their living - their 'economic lives' - was viewed as forming the community's character."

"This study established the necessity, in airport planning, of using more than the mere population of a community as the basis. It showed the need for knowledge of the extent to which the movement of things and people entered into everyday life, the amount of earnings, the way earnings were spent, and other such factors."
The C.A.A. study indicates that purchasing power was important in generating air traffic and in that aspect Marketing Centres and Institutional Centres were superior to 'Balanced' and Industrial Centres. Market and Institutional Centres had a higher per capita index of airline passengers than the other two types. It should be noted, however, that the work of the C.A.A. concentrates on the North-Eastern part of the United States, which is a highly developed area in the traditional commercial sense, and in such areas, variables may be significant that are insignificant in other parts of the world. The assumption that economic variables are important in explaining air traffic patterns is a straightforward one in view of the relatively high cost of flying in the past, and in many ways the work of the C.A.A. was to prove the obvious.

The Port of New York Authority took an interest in the C.A.A. work and its early market research took a similar approach to the selection of variables related to air transport. Its interest was entirely on economic information, passengers, wages, salaries, etc. and as such it is limited although it does provide useful information on what type of people flew if not why those same people actually did so. Amongst the responsibilities of the Port of New York Authority is the planning of airports to meet the needs of the future as well as an "obligation in developing and serving the untapped potential market for air transportation". Not surprisingly the U.S. domestic airlines assisted in the surveys. Basically, the philosophy of the Port Authority was as follows:

"One of the ways to foresee the nature and volume of air traffic in the future, as it will affect the terminals
and airlines serving the New York - Northern New Jersey Metropolitan area, is to analyze the changing composition and characteristics of the people who use the airlines serving this area today, and periodically conduct similar surveys in the future and determine and project the changing nature of the air travel market. Since most of the information considered relevant to the analysis can be supplied most readily, or exclusively, by travelers themselves, a questionnaire technique was used in this survey.¹

Thus the New York work leans heavily on pragmatic market analysis, although it earlier made use of more direct statistical methods. The value of this is obvious, for the area it examined is a highly populated, highly developed market (commercially speaking) with a fair degree of homogeneity. Great expense is involved in using questionnaire type surveys but this is offset somewhat in the New York area by the fact that access to a large population can readily be effected. The expense of such a survey on a national scale would be enormous. Manufacturers, such as McDonnell-Douglas and Boeing for example, could never hope to cover their market area, all of the non-communist world, with the same detail and accuracy that the New York Port Authority potentially can in its market area, and furthermore, the New York surveys were assisted by a large number of airlines. Weaknesses of the New York work lie in the nature of the questions subjectively chosen for the questionnaire and the small % sample surveyed, the latter being the result of the very large numbers of passengers passing through the city each day, and despite the fact that the survey was carried out on a large scale.

Related to these pursuits of variables associated with air transport was a developing interest in econometric models that could be applied to use the same. D'Arcy Harvey was one of the first to apply the 'gravity' concept to air transport when, in 1951, he attempted to explain
(in the statistical sense) the airline passenger traffic pattern in the United States. Although D'Arcy Harvey states categorically,

"This article sets forth the factors determining the airline passenger traffic pattern within the continental United States."^6

it is important to remember that the model does not explain socio-economic phenomena, but merely allows mathematical relationships to be illustrated. A statistical relationship between sets of phenomena does not require that there be a causal relationship also, although it may imply such. Using the unmodified formula \( \frac{P_1 \times P_2}{D} \), Harvey obtained reasonable correlations between the ordinal values (i.e. ranking) of predicted and actual traffic on various routes. Harvey sees population and distance as primary factors affecting the traffic flow between any two communities, while the economic character of each community is an important secondary factor together with the 'density of communities' in a given area. Since population and distance can be measured accurately he holds the economic character and area density constant for the purpose of his model. He acknowledges,

"Like all economic formulae, this one \( \frac{P_1 \times P_2}{D} \) is a guide and an indicator. Its application requires a fundamental knowledge of economic geography and air transportation."^7

Using Chicago as his example, D'Arcy Harvey uses the gravity model to predict the ordinal values of traffic flows to and from other cities. His work (together with that of others in the C.A.A.) was used as the economic basis for the National Airport Plan, as a decisive element in the installation of navigational and landing aids, as a guide for deciding the need for new airline routes and as an important consideration in the consolidation of airlines. The impact of this work was far reaching
so much so that when Mayhill subjected D'Arcy Harvey's work to critical examination on account of its importance and far reaching effects, he concentrated on the details of the technique rather than on the technique itself. His main criticisms concern the choice of cities for use in the model (D'Arcy Harvey obtained very favourable results by omitting a number of cities that were anomalous to the general pattern), the hinterland problem and the meaning of 'distance'. Mayhill compares the actual traffic figures with forecasts based on the \( \frac{P_1 \times P_2}{d} \) model, losing sight of the fact that D'Arcy Harvey used the model primarily to obtain the ranking of the air traffic of various city-pairs. By concentrating on D'Arcy Harvey's inputs, Mayhill misses one obvious weakness of the gravity model - that it is analogous rather than explanatory. D'Arcy Harvey's contribution, however, although not very relevant today, was in its time a step in the right direction.

Following this pioneering work, the gravity model was taken up by others studying air transport and subjected to various refinements and adjustments. Richmond, for example, introduced refinements to the population factor, using the number of people from one community registered in the hotels of another as the alternative to raw population figures for a measure of interaction. Ikle claimed that the effect of distance on air travel may be somewhat complex. He has shown,

"... that the frequency of plane trips between cities in the United States (per pair of people) increases for the first 150 to 200 miles and then decreases approximately with the first power of the intervening distance."\(^{10}\)

Richmond states that,

"... air travel comes into its own only when the intervening distance is above a certain minimum and that, as distance
increases above the minimum, the influence of distance on the number of air trips is, as measured by certain criteria, nil."\(^{11}\)

Such modifications, however, only allow higher correlation coefficients to be obtained for a model that is local in application. They do not convert the model into one that can be applied to other areas of the world. Doganis pointed this out by applying D'Arcy Harvey's work to European air transport and obtaining a rank coefficient of 0.24. Even by allowing for the economic character of the communities in question, he only obtained a rank coefficient of 0.26, concluding that,

"It seems that even when making allowance for the economic character of communities the gravitational concept of human interaction as formalized by D'Arcy Harvey does not, in general, account closely enough for the pattern of air passenger movement in Europe."\(^{12}\)

Although Doganis was interested primarily in traffic forecasting, his work is of interest to geographers because it produces a simple model that, with a minimum of variation, can be applied to many areas of the world. It cannot be construed as a general model, however, but rather as an advanced development of the gravity model, having simplicity and flexibility as its major assets. Doganis modified the interaction formula by using the total air traffic of a city for the population variable. This at once disposes of the hinterland problem and reflects the economic character of the population, the quality of air services provided and the competition from neighbouring airports, as well as from other forms of transportation. Furthermore, this statistic is normally readily available. The immediate criticism of this variable is that it does not allow a study of traffic potential from a community if air services to that community
do not already exist. However, since there are few communities of any size that do not have access to air transport, the point is not a serious one, besides, the aim of the exercise is to find ordinal values. If it were being used to find cardinal values the criticism would be serious. Doganis's use of total air traffic figures resulted in a rank coefficient of 0.74, a marked improvement over that obtained using raw population data.

Although Taaffe had tested the view that the relationship between air traffic and distance would be an inverse square one, no one had related this work to Europe. Doganis's suggestion was to vary the exponent of distance to arrive at the optimum for the area in question. This turned out to be between 1 and 1.5 in Europe, the final model giving a rank coefficient of 0.74. He acknowledged that the exponent itself might be a variable, but much more work should be done before this could be ascertained. The logic behind the search for the best exponent is a bit woolly, being more akin to the 'shot-gun' approach, trying a lot of different values and picking the best fit for the model.

Carrothers\textsuperscript{13} has examined the development of the gravity model from the work of Henry Carey\textsuperscript{14}, Ravenstein\textsuperscript{15} and Lill\textsuperscript{16}, to that of Stewart\textsuperscript{17} and Zipf\textsuperscript{18}, and has commented on some of the adaptions made to it. Within the field of air transport the model has found many applications because of the simplicity and availability of the inputs it requires and the ease with which it can be used. However, despite its general weakness of being unable to explain in an analytical sense, it has been used by Belmont\textsuperscript{19} on interstation airline traffic, Hammer and Ikle\textsuperscript{20}
on intercity telephone and airline traffic interaction, and by Long on city characteristics and air travel demand. Its value in these contexts must be limited in view of the fact that interaction between parts of the model is not clearly understood.

Simple regression analysis is another model that has found widespread use in the field of air transport, but its value as an analytical tool can be restricted by the use of the 'shot-gun' approach to the selection of variables. Airlines using the model for prediction are particularly prone to this fault, for airline forecasters are more interested in what variables relate to air travel than they are in explaining the rationale behind each. Information on this kind of action usually does not appear with the final results, but the practice goes on amongst the largest of the Canadian airlines. Data on a large collection of variables that somehow might influence air traffic may be tested to see if many correlate closely with air traffic figures. Some do and some don't, and the reasons why this should be so are of little consequence to the forecaster. At the same time, it should be admitted that some close correlations are obtained in this manner.

The main criticisms of the simple regression analysis are common to most statistical models. The model is only as good as the variables subjectively chosen for it and it demonstrates a statistical and not necessarily a causal relationship. In the case of air passenger traffic, the simple regression model is limited in that it does not deal with what is essentially a multivariate situation. Nevertheless, simple correlation analysis is very useful in analyzing air traffic in relatively small areas.
E.g. a province, especially when it can be shown by other means that air traffic depends on one of a number of very important variables, e.g. population. Where a number of variables are important the multiple regression approach may be more useful.

Multiple regression analysis has already been used in a number of disciplines because multiple regression is one of the very few numerical methods which can be used to evaluate simultaneously the effect of several causative factors.

With regards to air transport, a number of factors act simultaneously to affect the flow of passengers to or from a given point, and those same factors interact with each other. In an uncontrolled experiment based on transport data, causative factors cannot be held constant, so an attempt must be made to evaluate the influence of those same factors on experimental results. This can be attempted using the multiple regression model. Richmond has applied this technique to air passenger forecasting for Denver (Colorado, U.S.A.), using two independent variables, namely the number of hotel registrants in Denver from other cities and the number of intermediate stops in the best service from Denver to 65 other communities. The weakness in his work lies in his choice of variables, not his technique. The reasoning behind the choice of hotel registrants from other cities as an important variable is not clear, although it apparently gives better results than raw population data. Nevertheless, it cannot be used in a general model for the relevance of the variable to other places has not been demonstrated. Criticism can be levelled at almost every work of this type on the sole grounds that the choice of variables is likely to
be subjective.

The level of sophistication and mathematical abstraction to be found in models relating to air travel patterns increases beyond the simple and multiple regression models. Schmidt, of the Douglas division of the McDonnell Douglas Corporation, and thus an insider of the airline world, has developed a fairly complex mathematical model for forecasting air passenger demand, based on econometric data. A more extreme example of this tendency towards abstract mathematical models is the work of Elle in Sweden, who considers the "socio-economic, geographic and technical aspects of the development of air travel". In an appendix to his work, Elle describes a geographical model for domestic airline networks in Sweden, using only population data for the regions in question (each with a hypothetical airport), technical and economic data of the aircraft used on Swedish domestic flights, data on route structure and data on fare levels. It is interesting to note that the conventional socio-economic variables of income, social class (or occupation), family size, etc., are missing and Elle's work appears to be an exercise in geometry, for he is interested in predicting the Swedish air network. He succeeds in doing so to a considerable degree, and to date his is the only available general model for any country's air traffic pattern.

A more pragmatic trend was contemporary with the development of spatial models, a trend that was epitomized by the market analysis approach of the large aircraft manufacturers, the Boeing Company of Seattle being prominent in this regard. This approach was not limited to large commercial companies, however, there being workers like Zimmer,
who sought to identify factors relating to air travel in the Detroit metropolitan area by carrying out surveys. Likewise the Survey Research Centre of the University of Michigan, which cooperated with the Port of New York Authority's surveys earlier, concentrated on large surveys, using the information it gathered in the application of various statistical techniques and models. Examples of this are Lansing and Blood's use of multiple regression analysis to explain non-business air travel, and Lansing, Liu and Suit's statistical models in an analysis of inter-urban air travel.

Boeing's work in this regard does not break new ground but rather emphasizes statistical models that use readily available data. Indeed, since speed is important when Boeing is eager to obtain information for its sales teams, mathematical techniques are preferred over questionnaire type surveys. Some simple models have resulted from this approach including Moore's work on a forecasting model for Iran Air which involved inputs readily available in a good reference library. Boeing's contribution to the literature, therefore has been practical rather than theoretical, but has some useful geographic applications, mainly by providing a number of simple models that can be applied to spatial problems in many parts of the world.

The Canadian contribution to this part of geographic literature has been small in the light of what has been done elsewhere. Analyzing mainline aviation, for example, Studnicki-Gizbert attributed the traffic pattern to the existing communities of interest and the relative advantages of air transport over surface media, listing under 'communities of interest'
such variables as population, distance, national and provincial centres. He drew heavily on the type of work done by the C.A.A., the Port of New York Authority, the University of Michigan, and the Boeing Company, and noted the value to market analysis, of relating the potential traffic of a settlement with some other phenomena which is more easily measured. This, he said, could be used to identify those places whose traffic is under-exploited, allowing the necessary stimuli to be applied to rectify the situation as well as facilitating planning where no air services have previously existed.

Considering population to be the phenomena most closely related to the generation of air traffic from a centre, Studnicki-Gizbert applied some statistical tools to the Canadian situation but found no significant relationship between the two. Furthermore, the relationship between relative prosperity and air transport in Canada is not readily apparent. He quotes the examples of London (Ont.) and Lethbridge as generating less air traffic than Fredericton or Moncton in contravention of the expected positive correlation between wealth and air transport.

Reviewing the C.A.A. work on the economic character of communities, Studnicki-Gizbert tried applying this to Canada and concluded that the groups of cities in each category would be too small to be meaningful in a statistical sense. He went into a discussion of population/distance formula, reviewing the gravity model and considering some applications of the same to the Canadian experience by himself and others in the Canadian Air Transport Board, coming to the conclusion that the
model is very weak, but it is not without some merit as a tool that can be used in conjunction with other methods to examine a given situation. He pointed out that population distance formulae and trend analysis both have a role to play in studying air traffic potential, depending on the maturity of the system in question. If the system is mature there is little to be gained from refinement of the socio-economic variable, and if it is immature it is dangerous to rely on past trends.

By aligning itself so closely with what has been done elsewhere on spatial patterns, the Canadian literature on this aspect of air transport therefore mirrors the strengths and weaknesses of the same. Studnicki-Gizbert is critical of much of this, however, and whether deliberate or otherwise, the effect of his work is to draw attention to the weaknesses of many statistical models when applied to Canada. He does not go any further than these econometric models, and even from a philosophical viewpoint, is limited to these same approaches, emphasizing statistical relationships and predictions, rather than true explanation. He does not, for example, consider any aspects of human decision making and does not go beyond the 'state of the art' regarding air transport patterns. At the same time his work is the only one on air transport at a national scale that considers the variation in spatial patterns of movement.

Studnicki-Gizbert's work on 'frontier' or 'bush' aviation is, by comparison, a major contribution to that section of the literature. He adopts the term "frontier aviation" in order to avoid geographical connotations.
"... 'bush flying' develops when a frontier of the economic development is pushed in space, and when the frontier of operational development of air transport is also pushed. These 'double frontiers' - regional development and operational development frontiers - are interrelated. This interrelationship will be considered later, for the time being, assuming that it necessarily exists, and trying to develop a name which would free us from geographical connotations, we can introduce a new term to describe the stage of air transport development in frontier conditions as 'frontier aviation'."30

The only other contributions to this topic are from Kenneth Sealy31, J. Mercier32, and some unpublished reports on New Guinea that tend to confirm Studnicki-Gizbert's generalizations about air transport in all underdeveloped regions. Sealy's contribution was to categorize the types of underdeveloped areas (transport wise) that he perceived and, choosing a suitable category that included Canada (low population density and high national and per capita income) in which order was most discernable, to outline three steps through which a hypothetical air transport industry would progress as 'development' takes place.33 These steps are: a "pioneer phase" when aircraft are used for anything and everything; a phase when road and rail routes are being established and aircraft play a mixed role between passengers and freight; and a "final phase" or 'normal' air transport when passenger traffic is dominant, and only specialized freight is carried. These views were the product of general observations.

Mercier's contribution, on the other hand, was to formalize the problems of air transportation in underdeveloped countries and in so doing attracted Studnicki-Gizbert's attention to the similarity between such problems in underdeveloped countries and in Northern Canada. These
problems, which Mercier recognized in the air transport of what he terms 'Black Africa', are discussed by him under the following headings;

- Very marked inadequacy of infrastructure and material means.
- Uneven and fragmentary facility and network coverage.
- Over-preoccupation with immediate results.
- High costs of transportation in general.
- Low traffic volumes.

He goes on to stress that the infrastructure of air transport can sometimes be cheaper than surface infrastructure, especially where population density is low and settlements are separated by great distances. His 'reflections' are in themselves a good descriptive summary of what exists and are in turn used by Studnicki-Gizbert in a more rigorous economic form.

Studnicki-Gizbert's analysis of frontier aviation takes the form of an examination of the structure of that segment of the industry relative to the structure of mainline aviation. A digest of this work, therefore, has the appearance of a compare and contrast exercise through time. One such contrast is that of the importance of the route to mainline aviation as opposed to the base of frontier aviation. In more populated areas a route (between A and B, for example) is very important because of the traffic that moves along it; on an important route this could be considerable and would be looked upon as a 'plum' by the carriers. Where population is low and not capable of generating a constant flow of traffic the base from which a carrier operates becomes important. Since the cumulative effect of the traffic generated by small settlements
(i.e. the individual routes from the base to the respective settlements) could be large enough to justify air services, the importance of the base becomes apparent.

A consideration of an element of structure such as that above, at once brings in many other associated contrasts between mainline and frontier aviation. It is apparent, for example that mainline aviation flourishes where population is heaviest and frontier aviation where it is relatively sparse. Likewise, this population difference determines the type of airline service an area receives, either chartered or scheduled. The frontier, with its lower population is dominated, by and large, by charter flying, whereas the South, the most populated, is relatively well endowed with scheduled mainline services. Furthermore, the average fare levels of the frontier are higher than for the mainline because of the lower traffic on the numerous routes as opposed to the fewer mainline routes. In a sense, mainline aviation enjoys economies of scale.

The stability of the two parts of the industry also varies, the more developed mainline services being relatively stable. Frontier aviation, on the other hand, is susceptible to a 'boom and bust' economy that is brought about by a few major projects, such as the iron ore developments at Knob Lake and defense work on the DEW line and the Mid-Canada line, whose influence is very great where normal traffic levels are low. Nevertheless, the aviation on the frontier is relatively self-sufficient, at least in its early stages, because it is a response to an economic need. The more elaborate mainline services are subsidized to a much greater extent, either by direct post office help or by the
provision of services, such as airways.

The recognition of 'bush' aviation has been made by virtually all who have examined the Canadian aviation scene, but Studnicki-Gizbert is the first to systematically examine the structure of the air transport industry as a whole and to define the role of the two types of aviation within that whole. He states that the Canadian spatial pattern is different from that which is normal for other countries, which usually tend to have either of the two types of aviation, but not both. The reasons for this, according to Studnicki-Gizbert, lie in the early growth of the industry, when frontier aviation prospered (especially during the depression when there was a concentration of activity in resource exploration) and mainline development was weak. The state of technology was the prime reason for the fact that pre-war air transport in Canada was dominated by frontier aviation. Although he concedes that a more stimulating government policy towards aviation could have helped mainline services before the Second World War, the state of technology was such that it would have been late in the thirties before equipment of a suitable type would have allowed such services to have been economically self-sufficient. (This was a familiar situation all the world over at that time until the Douglas DC-3 put air services on a sound financial footing.) With the somewhat restrictive attitude of the Canadian government towards aviation the only area where the industry could succeed was the 'frontier' where competition from surface modes was at best weak, if at all existant.

The role of air cargo in frontier aviation is also significantly
different from the 'norm' elsewhere, being relatively greater in importance on frontier rather than mainline routes. In drawing attention to this, Studnicki-Gizbert mirrors yet contradicts Sealy by pointing out that the growth of frontier aviation in Canada before the war was a reversal of the pattern of development in other countries where a progression from air mail, air mail and passenger, passengers, and finally passengers and some freight is observable. Since the war, the pattern has been shifting to give overwhelming predominance to mainline aviation, a phenomenon that Studnicki-Gizbert attributes to rapid economic development, population growth, and equipment availability.

This analysis of frontier aviation, based on economic structure and historical developments is the only one of its kind, even if it is heavily weighted towards economic reasoning, and is valuable on the grounds of uniqueness alone. Noting that frontier aviation accounts for most of the country's chartered aircraft movements and is responsible for much support work in the opening up of the North, Studnicki-Gizbert justifies his analysis on the grounds that the frontier is of interest to transportation economists, who can study the interaction of transport and economic development in "almost ideal 'laboratory conditions'", and also allows the simultaneous study of different stages of air transport developments.

CONCLUSION

The main contribution of Canadian writings to the literature on the geography of air transport is centered on the work of one individual, K.W. Studnicki-Gizbert, who provides much useful background information
to spatial problems and specifically considers the structure and growth of the industry, the spatial pattern of air transport and frontier aviation. His account of the structure and growth of the industry is only as good as the data he draws upon and is therefore limited in value in a geographic sense. Nevertheless, he presents a great deal of useful information in one place.

When considering spatial patterns, Studnicki-Gizbert borrows some of what has been done elsewhere without contributing to that section of the literature. His work on frontier aviation, on the other hand, surpasses anything that has been done anywhere else, as he goes beyond the listings of Sealy and the problems of Mercier to explain the structural identity of aviation in frontier regions. It is of passing interest at this stage to note that the Canadian contribution to aircraft manufacturing parallels this and Canada's greatest contribution to the aeronautical world is a series of aircraft designed and built for underdeveloped and developing regions.

Studnicki-Gizbert has established the 'state of the art' as was up to the 1960's, with emphasis on predictive models and with an element of economic determinism underlying his work. It is unfortunate that nothing of a behavioural nature had been written about air transport before Studnicki-Gizbert did his work, because an acknowledgement of this aspect of the air transport scene would have added to the degree of explanation he affords. Although nothing relating to the Canadian scene has been written from this angle, a step forward has been taken in the U.S.A. by Borgstrom, whose work may open the way for a similar approach
in Canada. Borgstrom considers the

"... spatial implications of perceived physical, temporal, economic and socio-cultural distance by examining the system of passenger air transportation between the mainland, i.e. contiguous, United States and Hawaii."34

He concentrates on an examination of principles by which the development of passenger transportation systems may be understood and restates the problem as follows,

"For what purposes has a system of passenger air transportation developed between the mainland United States and Hawaii?"

"Considering this problem behaviourally, an important implication is the question: Have the motivations of those travelling that route been influenced for the generation of traffic and possible economic or neo-colonial advantage? Or has traffic developed along that route simply because transportation services were demanded to connect two spatial entities?"35

The need now is for Canadian literature to broaden the approach it has taken in the past by bringing in a consideration of why individual people make the decision to use air transportation, while at the same time refining the statistical techniques which have been so useful in the past.
LIST OF REFERENCES

1. This writer's other extended essay (No. 2)


3. Ibid., p. 262.


7. Ibid., p. 157


11. Richmond, p. 66.


22. Based on personal conversation at Vancouver Airport, with officials of two large Canadian airlines.


33. A more complete discussion of Sealy's work is included in this writer's other Extended Essay. (No.2)

35. Ibid., p. 3-4.
BIBLIOGRAPHY

AIR TRANSPORT IN CANADA


__Transportation of Minerals in Northern Canada.__ Ottawa: Queen's Printer, Ottawa, Canada. 1961.


__The Economics of Canadian Air Transport Industry, Ph.D. Thesis, McGill University. 1964.__

__Canadian Frontier Aviation. Institut du Transport Aerien, Paris, France. 1964.__
The Regional Air Carriers Problems. Ottawa: Queen's Printer, September, 1966


AIR TRANSPORTATION THEORY


Belmont, D.M. A Pattern of Interstation Air Travel, Transactions, American Soc. of Civil Engineers, (1957)


Cherington, P.W. & Schneider, L.M. *Transportation and Logistics Education in Graduate Schools of Business Administration*. Harvard University. 1967.


"City Characteristics and the Demand for Interurban Air Travel," Land Economics. 44, (1968), 197-204.

Distance, Intervening Opportunities, and Air Travel. Paper presented at the Annual Meeting of the Western Science Regional Association, Newport Beach, California. February 6-9, 1969.


AIR TRANSPORT - GENERAL


The Impact of Mail Programs and Policies on United States Air Carriers. Seattle: Graduate School Business Administration, University of Washington, 1967.


Frederick, J.H., Some Problems of Selling Air Travel., Journal of Marketing, 9 (October 1944) 144-150.


Harris, R.F. The Economic Efficiency of Regional Air Carriers in the National Transportation System. Winnipeg, Manitoba: Centre for Transportation Studies, University of Manitoba, Research Report No. 3, January 1969.


Holloway, R.J., Which Cities (in Minnesota) can support Airline Service., Journal of Marketing, (18 October 1953) 177-178.


Travel Research Institute, Vacation Travel Attitude Study, June 1967.


MISCELLANEOUS


Thomas, E.N. Maps of Residuals from Regression: Their Characteristics and Uses in Geographic Research. Iowa City: State University of Iowa, Dept. of Geography, Monograph Series No. 2, 1960.

AIR TRANSPORT AND ECONOMIC DEVELOPMENT:

THE CASE OF NORTHERN CANADA

by

John Eric Fairfield

B.Sc.(Hons.), Queen's University, Belfast, 1967

AN EXTENDED ESSAY SUBMITTED IN PARTIAL FULFILMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS

in the Department

of

Geography

© JOHN ERIC FAIRFIELD

SIMON FRASER UNIVERSITY

November 1972
APPROVAL

Name: John Eric Fairfield

Degree: Master of Arts

Title of Extended Essay: Air Transport and Economic Development: The Case of Northern Canada

Examining Committee:

M. E. Eliot Hurst
Senior Supervisor

K. C. Brown

G. P. F. Steed

J. M. Munro

Date Approved: November 22, 1972
ABSTRACT

The purpose of this paper is to examine the role of air transportation in Northern Canada today and describe a potential role for it in the future development of the area. This is achieved by reviewing the literature available on the subject (or relating to it) and stating some likely developments for the future.

Background information that must be considered includes a survey of the physical environment, a review of transportation developments in the North and the meaning of economic development in the North. In particular, the aims and objectives (both stated and apparent) of the federal government are considered and a metropolis/hinterland situation is considered to exist between Southern and Northern Canada. Some possibilities for future development are entertained and it is concluded that, regardless of the course of any such activities in the future, it is unlikely that population distribution patterns will change. Therefore transportation needs will remain constant for some time, being for transport media to serve a skeletal system as is the case today.

The role of transport in the North is considered in the light of conventional thinking, as typified by Sealy's framework for air transport in underdeveloped areas. Technological change, and a number of trends associated with it are looked at in light of the work of Cartaino, and it is apparent that the dominance of surface transport in regions where the transportation system is skeletal can no longer be taken for granted.

In light of this, Sealy's original framework is modified to allow a stage of highly developed air transportation to be present in an area that is itself not highly industrialized. Finally, a consideration of recent developments in air transport geography writings reveals that
attention is being paid to behavioural phenomena, and it is suggested that the future course of the literature in Canada could include this direction to balance the present emphasis on economics.

The conclusion is that aviation can meet all the needs for transportation in large parts of the North, if this is required, without any surface transport but this will depend upon the attitude of the government to the same area.
<table>
<thead>
<tr>
<th>Sub-sections</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Background</td>
<td>3</td>
</tr>
<tr>
<td>Economic Development in the North</td>
<td>6</td>
</tr>
<tr>
<td>Air Transport in the North:</td>
<td></td>
</tr>
<tr>
<td>A Possible Role</td>
<td>14</td>
</tr>
<tr>
<td>Conclusion</td>
<td>29</td>
</tr>
<tr>
<td>List of References</td>
<td>32</td>
</tr>
<tr>
<td>Bibliography</td>
<td>35</td>
</tr>
</tbody>
</table>
LIST OF MAPS

Northern Canada: Transportation

and Settlement . . . . . . Page 2
INTRODUCTION:

The purpose of this paper is to examine the role of air transportation in Northern Canada today and describe a potential role for it in the future development of the area. Such considerations will automatically involve brief descriptions of the physical environment and the role of economic development in the area. Although both of these fields of enquiry could occupy the prominent position in large volumes, it is intended here to consider them only in as much as they affect the role of air transport in the North.

The region that is the subject of this paper is the area of Canada, north of the continuously settled area. The actual southern border of this area can be defined in a number of ways (see Gajda ¹) depending on the criteria by which one measures settlement, but there is general agreement that the area exists. This area has been called by various names such as the 'Middle North' or the 'Mid-Canada Corridor' and normally excludes the polar regions of the very far North. Since the amount of air transport in the very far North is negligible, this paper ignores a definition of the Northern boundary to the region referred to hereafter as the 'North'.

'Air transportation' is limited to domestic commercial airline flying, both scheduled and charter except where other (e.g. military) influences become important. These limitations are imposed here because civil aviation reflects stages of development more readily than military aviation, and in Northern Canada the former is represented mainly by domestic commercial aviation.

It is within the constraints outlined above concerning the 'region' and 'air transport' that the order, that is the topic of this paper, can be discerned.
BACKGROUND

The region here called the 'North' extends over a large area across central Canada, being wider than it is long. Comprehensive geographical surveys of the area are available from a number of sources, (e.g. Warkentin ²) and it is proposed here to draw attention to some of the most relevant factors affecting the air traffic pattern. In particular, the combination of sparse resources and low population density scattered over a vast area is a very significant generator of specific transport needs. The land is not particularly mountainous in most places and were other factors favourable, is not in itself a major barrier to movement. Climatic conditions are severe but their strongest influences on transportation are more indirect than direct. Some of the side effects of climate are important, especially the shortness of the growing season, which affects the strength of the agricultural economic base. Limited possibilities for agriculture in the traditional sense and a very slow rate of tree growth restrict the possibilities of permanent settlement living off the land. Permafrost is very important in that it affects surface transportation to a great degree and also restricts some types of mining operations, such as being a retarding influence on the Knob Lake iron ore development. ³ Furthermore, roads, railways, and airports are more expensive to construct in regions of permafrost than in other places, as are settlements. ⁴ The physical environment itself is more fragile than in warmer regions because the various ecological processes are slower and nature takes so much longer to recover from any changes thrust upon it. The capacity for supporting man in large numbers is therefore limited. The minerals of the North are many when looked at in total but this does not take into account the vast area
over which they are spread. When this is done, the area does not appear to be as richly endowed as it was at first sight. Likewise abundant water becomes less significant when the ecological cost of exploitation is considered. Tourism is relatively underdeveloped in the North up to this time, so it becomes apparent that the economic base is weak.

Population is small and the overall density very low; furthermore, most of this population lives in small settlements rather than isolated dwellings, so transportation links are between a number of small towns, villages or hamlets that are separated by very great distances. This pattern is becoming apparently stronger as the population that at one time occupied the intervening space (usually the indigenous population) is moving to the small settlements and adding to them. The net effect of this is to give the transportation system a "ferry" character, namely that the origins and destinations are dominant in affecting the travel pattern and intervening opportunities are few, in much the same fashion that a ferry derives no revenue from points other than its origin and destination. In many ways, the railway in the Canadian Shield to the North of Lake Superior is a type of ferry system. The significance of this type of system is that the traffic from the origin of the trip must cover the costs of the total trip to the destination, and little revenue can be derived from traffic that only goes part of the total journey as is normal in more densely settled areas. Thus one of surface transport's advantages over aviation is substantially reduced in the North.

Early transportation in the North was centered on a number of trails used by the indigenous population and goods transported were small high-value items. Today's traffic pattern is not unlike that of old and the actual route system that centres on Whitehorse today bears
a remarkable similarity to the former trails of the indigenous peoples in that the main direction of movement remains the same. The goods being carried today, however, include bulky items such as mineral concentrates. This reflects a change in the technology of transportation in the North since the non-indigenous population began to settle and exploit the area. The first means of transport to be used by non-indigenous peoples was water and this is still important in some places, especially the extreme North-west, in the Mackenzie Valley region. Although water is one of the cheapest means of transport, the shortness of the season forces operators to spread the cost of their investment over a very short period of each year and this raises the cost of water travel above that of other modes, except in a very few cases. Before the advent of large-scale operations, when capital investment was low, this did not matter a great deal, but in modern times, technological improvements to transport systems demands that those systems be utilized at a very high rate. Thus road and rail transport have an edge over water in the North, even for bulky items.

Railways run North-South and are used on a strictly colonial basis (see Taaffe, Morril & Gould 5) to carry raw materials out. Economically, railways are used where large volumes of bulky, relatively cheap goods are to be moved, and most are associated with mining developments, the Hudson Bay Railway to Churchill being a notable exception, although it now supports mining activity at Thompson, Manitoba, also. Roads operate on a similar economic basis to railways, in that they serve the traffic requirements between specific points and derive little business from the intervening spaces. It is not always obvious that the traffic justifies the existence of such surface links.
Aircraft usage developed rapidly during the inter-war years, due mainly to the ability of the aircraft to cover large areas during exploration for minerals and at low cost and also due to the lack of alternatives. Capital investment is low and this more than offsets the high running costs of the mode, so much so that at least one mine north of Yellowknife relies solely on aircraft as a means of transport. Lately some trunk routes have developed in the North, from the larger centres to the South, but charter work is very important. Lateral links within the North are still weak, as anyone wishing to travel from Whitehorse to Yellowknife is aware.

In summary, the low population density concentrated in clusters separated by large distances results in very high transportation costs for total trips taken. This has produced a skeletal transportation system which has grown up piece-meal to serve specific interests, such as mining developments.

ECONOMIC DEVELOPMENT IN THE NORTH

Economic development is not as readily apparent a concept as was once thought and over-simplification of it has resulted in a lack of understanding of the processes it involves and of the real impact that it makes. It is beyond the scope of this paper to analyse the processes and end-product of economic development, it suffices here to state a number of assumptions that are being made concerning the process and concentrate on the role of air transport within such constraints.

Ambiguity surrounds the aims of 'economic development', but most commentators assume that it involves an increase in living standards. However, 'living standards' themselves are by no means absolute as Usher points out:
"The Bankslanders need not worry about the basic necessities of life, and indeed enjoy a very comfortable standard of living. Such judgements are relative of course. Compared with other native northerners, the living standards of Sachs Harbour people are very high. Comparisons with other peoples and places in Canada are more difficult because the spending priorities are different, as well as the necessity of considering intangible values concerning the 'good life'."

Furthermore, if one settles for a definition involving an increase in the exchange of goods and services, one may come across a number of serious side-effects, especially in a cross-cultural context. An example of this was the supplying of guns to indigenous peoples of Southampton Island by visiting whalers. This allowed the natives to vastly increase their hunting efficiency the following winter thus, presumably, affording some degree of "economic development". The long term result, however, was the overkilling of game stock and the eventual perishing of the natives due to starvation. Definitions of "economic development" therefore involve long term viewpoints.

To get around cyclic fluctuations and uneven spread of 'development', terms such as 'national' or 'regional aggregates' are frequently used in this type of definition. The unfortunate fact about aggregate increases is that they ignore local decreases, i.e. in the context of Northern Canada, areas of 'real' poverty could be developing alongside areas of increase in per capita income and the aggregate would still be favourable. Doubt exists about the value of an indicator of economic development that yields positive results even when poverty is increasing.

While no totally satisfactory definition of 'economic development' exists, it is possible to get around many of the difficulties outlined above if the phenomenon is taken to mean any long period increase in
aggregate regional and per capita incomes in real terms. The later reference to 'real' terms avoids problems of monetary inflation.

The role of transportation in economic development is, in this paper, assumed to be that of a passive concomitant, a view which has been adequately expounded elsewhere. Thus air transportation in the North is seen as developing with the region, but not "force-feeding" economic development in that region. The construction and improvement of airways will not of itself call forth economic growth.

In light of the foregoing discussion, it is relevant to consider what is taking place in the North, and the attitudes of those most responsible, namely the government. The most significant objectives mentioned in the speeches of high ranking government officials, namely the Honourable Jean Chrétien, Minister of Indian Affairs and Northern Development, and by John A. McDonald, the former Deputy Minister of Indian Affairs, have been summarized as follows:

1) To provide a rising standard of living and quality of life for northern residents, particularly the indigenous peoples, by methods compatible with their own preference and aspirations.

2) To encourage viable economic development in the north so as to realize its potential contribution to the national economy.

3) To maintain and enhance the northern environment with due consideration to social and economic development.

4) To maintain Canadian sovereignty and security in the North.

In themselves these objectives are acceptable but, as Usher points out:

"These objectives are surely supported by the great majority of Canadians as well as by northerners themselves. Yet their attainment poses a serious problem for the Canadian government and particularly for the Department of Indian Affairs. Any particular programme must be assessed in terms of its conformity
to these objectives. In doing so, it may be found that these objectives are sometimes incompatible and that one must be sacrificed for another." 9

In reality, a metropolis/hinterland situation exists between South and North, a situation that in theory is seen as being reciprocal or symbiotic, in that the division of functions between the two parts within the whole is seen as being beneficial to both sides. Usher points out that although the growth of metropolis centres and the competition between them for control of various hinterland areas has been well documented (Zaslow 10 and Burghardt 11),

"... Rather less attention has been given to the impact of this dominance on the hinterland itself, and particularly to the question of whether the relationship is indeed a symbiotic one between equals or a parasitic one more characteristic of imperialism." 12

Usher tends to feel that the latter of these two views is the more realistic and draws attention to the work of Watkins 13 and Levitt 14 viewing the problem on an international scale and to the work of Archibald 15 who applies Frank's 16 model of underdevelopment in Latin America to the Maritimes. It is in light of this situation that the stated objectives of the government must be viewed.

"Numerous developments in Canada suggest that, at least in the context of current Canadian political and economic organization, the relationship between metropolis and hinterland is not one of reciprocity between equals. The tendency toward metropolitan dominance has accelerated, especially during the post-war years and we are coming to accept unquestioningly predictions that by the end of the century, the great majority of Canadians will live in and around Montreal, Toronto, and Vancouver. What is less appreciated is the increasing limitation on the autonomy and opportunity of those who do not reside in these centres. The growth of metropolitan Canada is largely dependent on the extraction of resources and labour (and, some would argue, surplus capital) from the hinterland. Consciously or not, metropolitan Canada is now in a position to dictate the terms on
which the hinterland population will live.

Numerous programmes have been devised in recent years to 'rationalize' rural economies, generally involving the depopulation of the regions in which they are based. The profitability of economic activity in the hinterland is established by the metropolis, which almost alone has the power to make significant decisions with regard to pricing, marketing, capital investment and manpower policies. The injection of labour and capital into the hinterland is determined primarily by the rate of return on such investments to metropolitan institutions, rather than the net benefit in economic, let alone social terms, to the hinterland itself. Thus, where the hinterland population is engaged in activities profitable to the metropolis, it is encouraged or at least permitted to continue doing so. Where this is not the case, as in many parts of the Maritimes, the prairies and the North, rationalization, re-organization and depopulation are brought about, usually on terms established by the metropolis yet having profound social as well as economic consequences for the hinterland."

The next effect of this situation is that any "economic development" that has taken place in the past has been as viewed from the Southern economic centres and not from within the place where it is supposed to have taken place. A consideration of the impact of so called development can be used to illustrate the value of this, and sufficient information has been supplied relative to Banks Island to allow this. In order to help achieve governmental objectives exploration for oil was allowed to take place on Banks Island. The benefit to the indigenous population was to come through increased employment and business opportunities but the concentration of attention on the advantages of this development detracted from the disadvantages, namely that the current occupations of those people would be sacrificed - or at least curtailed somewhat, in order to make room for the new. The advantages of this on a balance sheet must be doubtful, as it makes the natives dependent on
circumstances over which they have no control and may eventually leave them economically stranded. Furthermore, the truly important jobs in such an economy are held outside the region - namely in the metropolis, so the oil and gas developments on Banks Island are merely an extension of the metropolis/hinterland structure to the far North. This is borne out by the attitude involved in a confrontation between the Banks-landers and the "outsiders" over seismic explorations that they feared might disrupt their traditional trapping economy. On the one hand it seemed logical to the Banks-landers that work would stop if their way of life was threatened. On the other side the view was that a few people should not stand in the way of progress for a whole nation. This in turn brings in questions about who in turn controls the metropolis that dominates the hinterland. Usher summarizes the problem,

"The question has been asked by some, 'Why should a hundred people on Banks Island stand in the way of twenty-million Canadians?' Perhaps the real question is whether the majority of Canadians truly feel their need for the immediate development of oil and gas resources in the Arctic justifies the potential damage to both the northern environment and the interests of those who rely on it for a living." 18

"The public must therefore understand the implications of northern development, see the potential conflicts and decide where their true interests lie. These are not simple economic questions but moral and political ones as well. On their answer hinges the quality of life which Canada builds for all its citizens, in the north and in the south. Inevitably, the Banks-landers, and ultimately all northerners, depend on the public's attitude to these questions, for without outside support, they will not likely alter the course of northern development in any beneficial way." 19

Implied in the above is the idea that the living standards of the indigenous peoples can only be improved by changing their economy to an industrial basis. Usher sees this weaning of the natives from trapping and hunting, rather than improving the methods and organization of these
pursuits, as a mistake. However, even if the traditional economy is 'developed', the impact can be detrimental in terms of social values. For example, if the catch of the hunter is increased by improved technology (ski-doo) without a corresponding increase in the stock of wildlife, it can only be at the expense of another trapper. This, in a society accustomed to sharing and downplaying the rights of private property, results in the breaking down of the trust holding the society together.

Even a local project, such as a defense base or a school, can disrupt the economic life of a small community. Thus any development should be sustained over a long period, for activity that provides work for one man over five years is socially and economically more desirable than that which gives work to sixty men for one month, even if the total investment in man hours is the same. The key, to Northern development is the attitude of mind of those 'doing' the developing, or at least controlling how it might take place.

"Recommendations, and indeed existing programmes, will fail in their intent if they are not implemented in spirit as well as letter. One may argue that government, on the basis of stated policy, is already committed to essentially the same goals and even many of the same methods recommended above. The case of Banks Island suggests that, on the contrary, government is committed to very different goals and methods."20

Since there is nothing to suggest that Banks Island is especially unique in the North, Usher's summaries can be taken as generalizations for most of the region. Other projects, such as the Road to Resources programme, the Mid-Canada Corridor concept, the Mackenzie Valley highway and the Great Plains project reflect the metropolitan attitude of those to the South, that the North is a vast storehouse of 'goodies' for it to take when it so chooses.
The problem remains of what type of development should take place in the North to sustain long term growth of aggregate regional income. Some forms of exports must be found - many of them invisible. Possibilities include industrialization, mining, the development of traditional occupations, tourism, depopulation and subsidies. Industrialization is not feasible in the North, at least not on a large scale, due to a fragile environment and costly transportation to distant markets. Mining could support a population for a number of centuries, but only at a few large-scale operations and on a planned basis. Small operations would be uneconomical, so would have to be ignored, as they couldn't compete with facilities closer to the main markets. Traditional occupations may be capable of some enlargement but it is doubtful if these could be the economic basis of a population enjoying the way of life to which the Northerners attain today. Tourism offers great potential for the North but, since it would be predicated on wildlife and on the fact that the environment be left as unspoiled as possible, it is doubtful if a heavy population could be supported by it. Furthermore, the luxuries that visitors would expect (even in remote areas) can best be provided at large centers, so settlement would be in clusters. Depopulation is a real possibility, but should only be considered as a last resort if all else fails, and the provision of subsidies to provide growth cannot be considered on a permanent basis as it is a wasteful use of resources. In the short run, however, it could be a very useful tool.

Although these are not the only possibilities for economic growth in the North, some generalities can be drawn from the above. Relevant to this paper is the fact that population is not likely to be large in total numbers and that population would not be scattered homogeneously through-
out the land but would be concentrated in a number of clusters that would
usually be separated from each other by long distances. Thus surface
transport would be relatively expensive and air transport would be able
to contribute to the total transportation needs in a very significant
fashion.

AIR TRANSPORT IN THE NORTH: A POSSIBLE ROLE

Since, in light of the foregoing, there is a good possibility that
the distribution of population in the North will not change dramatically
in the immediate future, it is possible to consider the role of air
transport in the northern milieu today and to draw certain conclusions
about what future developments of the same might be. The assumption that
transport is a passive concomitant to economic development has already
been made and it remains to describe what the actual day-to-day activities
of air transport might be. Relative to other forms of transport, aviation
is characterized by low capital costs and high running costs and is
particularly well suited to satisfy the needs of a skeletal transportation
system (as in the North) at a relatively low cost. Surface transport is
categorized by low running costs and very high capital costs, but normally
enjoys extra traffic from 'intervening opportunities' between termini
that aviation does not. Volume of traffic is a key component in the equa-
tion between running and capital costs. If traffic is low, the low capital
costs of aviation are more important than the low running costs of surface
transport; on the other hand, a large volume of traffic gives surface
transport a big advantage.

Kenneth Sealy\textsuperscript{21} is one of the few who have considered the role of
air transport in economic development and his framework for this is the
only one of its kind. In fact Studnicki-Gizbert\textsuperscript{22}, Mercier\textsuperscript{23} and some
unpublished papers about New Guinea are the only others to significantly contribute to the literature of air transport in underdeveloped regions. Sealy's work is of most interest here because he outlines steps through which a hypothetical aviation industry in a region such as Northern Canada ought to progress as development occurs. This being so, it is of value to examine this hypothetical framework and evaluate it in the light of the foregoing comments concerning development. Furthermore, recent technological changes and trends have changed the potential of air transport in underdeveloped lands and this should be applied to Sealy's framework to up-date it, bearing in mind it was first published in 1957 when no commercial jet liners were in service in North America.

Sealy recognizes three categories of underdeveloped territories:

1) Low population density and high national and per capita income countries. (e.g. Canada)

2) Low population density and low national and per capita incomes. (e.g. some African countries, Central American Republics)

3) High population density and low national and per capita incomes. (e.g. India, Indonesia and China)

Since the greatest advances are to be found in the first category, he concentrates on the countries that it covers in order to see how aviation fits into the development process. He claims that it is in this category that order is most discernible for development is variable within the other two. Note is taken of the fact that air transport flourishes most in highly industrialized communities where the urban population is greatest, passenger traffic forming the chief source of revenue. In underdeveloped regions these characteristics are not exhibited, yet air transport is important and its role changes as development occurs.
Sealy defines three phases to describe the process from pioneer to sophisticated aviation or, more properly from frontier to aviation.

"a) Pioneer phase: Use of aircraft for surveys of all kinds, e.g. topographical, forest or mineral surveys. If development of the resources seems justified, aircraft are used to establish the first camps and to aid in the construction of surface links.

b) Establishment of primary road or rail routes. Beginning of exploitation on a large scale. Aircraft still play a vital role as both passenger and freight machines.

c) Final phase: Growth of industry and settlement may follow if conditions are suitable. Air transport assumes a more 'normal' role, deriving most of its revenue from passenger, mail and specialized freight operations."  

He goes on to explain that:

This plan is particularly applicable to countries we have classified as category (1), for here we are dealing with almost uninhabited areas adjacent to more populous zones enjoying a high standard of living. The key to the situation is normally difficult physical conditions, particularly climatic ones. Indeed, as we shall see, conditions may be such that development may never proceed to stage (c) above."  

There are two basic weaknesses in Sealy's work, one being the assumption that the 'normal' order of things is for a region to develop until it reaches a stage of full-scale industrialization, and the second is to assume that the role of air transport must always be subsidiary to surface transport in an optimally developed state. He assumes that a 'developed' air transport system is one that exists in a 'developed' area and does not appear to have considered that a region that is permanently underdeveloped in an industrial sense (e.g. Northern Canada) might have a highly developed air transport system, employing efficient up-to-date machinery and the latest flying aids. A consideration of the changing technology of frontier aviation is thus in order here.

According to Chisholm, there are three ways in which technology can
cheapen transport costs.

"1) The substitution of improved means of transport for more rudimentary methods;

2) Improvements within individual transport media;

3) The greater degree of processing undergone by products and changes in the type of product towards the more valuable ones." 

Taking this a stage further, Soberman has pointed out that improvements in transport technology follow an established pattern involving

1. higher capital investment,
2. higher capacity for goods,
3. cheaper costs of moving each unit and,
4. requiring very high utilization rates

At this point the problem of oversophistication may arise. Owen comments:

"The view is often expressed that the latest in transport technology cannot be used to advantage in newly developing economies. This viewpoint often stems from an erroneous picture of the underdeveloped countries as being wholly immersed in the earliest stages of primitive transport. Actually, most underdeveloped countries are experiencing a mixture of all transport stages at once. Rural areas may be almost completely isolated, while the major cities and their connecting routes may reflect the most advanced stages of mechanization, motorization, and the air age. A single country may be partly victim of the same immobility that constrained the primitive societies of early history, and partly the beneficiary of the most recent forward push of twentieth century technology." 

The above is indicative of the fact that unlike those nations which were in the vanguard of the industrial revolution, contemporary developing regions can take advantage of the experience of others. As Owen puts
"Underdeveloped areas have two major advantages over the underdeveloped areas of the nineteenth century. The most important is the availability of advanced technical knowledge and the means for its effective application.

Along with today's scientific and technological accomplishments, a second and related advantage for underdeveloped areas is their growing capacity for exercising a wise choice of what technology has to offer. The establishment of national goals and the beginnings of planning on a country-wide scale make it possible to use the fruits of technology wisely." 29

The effect of technology is different in separate countries for there is no such thing as a typical underdeveloped area. Nevertheless what Cartaino 30 refers to as the 'Specific Aircraft Environment' in underdeveloped regions displays certain well defined characteristics. These are as follows:

1. Low aircraft utilization,
2. Hard usage,
3. Low value of speed,
4. Diversity of missions,
5. Short and rough airfields,
6. High altitudes and extreme temperatures,
7. Inadequate ground support.

Utilization rates of aircraft in underdeveloped countries are only 1 - 3 hours per day, the latter being a high figure. Cartaino quotes an example of the DC-3 fleet of Ethiopian Airlines averaging 2 hours per day and, although this was ten years ago, the general trend is still the same today. Furthermore, Ethiopian is one of the better African airlines. Such low rates are due to a lack of adequate navigational aids (which limits operations to the daytime, visual flight rules, and to contact flying), short route segments, low traffic demand due to the thin
distribution of population and lack of capital, the seasonal and unbalanced nature of traffic flow, and inadequate maintenance and supply facilities.

Secondly, aircraft usage is very hard in underdeveloped areas, mainly due to operations from gravel or unprepared runways. This damages the landing gear and the abrasive affect of sand and rocks is severe on the aircraft structure. In many underdeveloped countries, much flying is done under 'high and hot' conditions, i.e. at high altitudes and high temperatures. This necessitates frequent operation at high engine ratings. Furthermore, maintenance tends to be poor and the aircraft are not hangared, thus subject to extreme weathering conditions.

Thirdly, the lack of transport alternatives gives speed a low value. Where surface communications are primitive,

"... though air transportation is anything but cheap, the cost of a competitive transportation system, be it road, rail or river, may be even higher and will often involve a greater initial capital outlay than does the installation of a developed airways network."

Thus speed, one the greatest advantages of aviation in a developed economy, is an unimportant factor where alternative modes of transport are poor if at all existant.

"For example, truck transportation from Addis Ababa to Gondar in Ethiopia takes two days; in a DC-3, the trip takes about 2 hours. Clearly, the air-travel time effected by even a large increase or decrease in aircraft speed would not be significant in comparison with the present surface transportation time."

The fourth characteristic of the Aircraft Environment in underdeveloped areas is the diversity of missions and cargoes one expects to find. This is linked to the lack of alternatives to aviation. Goods one normally expects to go by surface communications often go by air. One grocer in B.C. ships 1,000 pounds of groceries per week to logging camps out of Campbell River by air, because there is no other way of getting
Fifthly, airfields are short and rough. Some strips in Ethiopia, according to Nord-Aviation of France, are curved and on others a Jeep cannot exceed the speed of 12 miles per hour because of the roughness of the runway surface. One classic strip in Peru is on a mountainside and is extremely short. The aircraft has to land uphill and go downhill to take off, a feat that is not made any easier by the knowledge that there is a precipitous slope downhill from the airstrip. It is not surprising that seaplanes and float planes are used where possible.

The sixth characteristic is high altitudes and extreme temperatures. As Cartaino points out:

"If there is one feature common to most of the underdeveloped countries of the world, it is the presence in large numbers of mountain ranges and plateaux, some formidable, many extending completely across the whole expanse of the country. . . .

. . . the general rule for climate in the underdeveloped areas is one of extremes. Very few of these regions enjoy the blessings of an equitable climate."

Operations, therefore, are carried out under exceptionally harsh conditions.

Finally, ground support is inadequate. Navigational aids are often missing and airports do not compare with what is considered normal in the western world. In addition spares are difficult to obtain and trained personnel are a rare phenomenon.

Following on from this, Cartaino outlines some of the implied requirements for aircraft suitable for use in underdeveloped areas. These requirements, in general form, are as follows:

1. Low capital costs
2. Ruggedness and durability
3. Configuration versatility
4. Short take-off and landing capability
5. Good 'high and hot' performance capacity
6. Easy maintenance capability
7. Independence of group equipment
8. A number of lesser miscellaneous factors, concerning factors such as aircraft handling, passenger comfort and cargo handling.

The most important of these is that the initial cost should be low. It follows from what has been said above about low utilization rates that capital costs are more important than operating costs. Thus second-hand and military surplus aircraft are used in large numbers, although their appeal is low to newly independent prestige-conscious countries. These new countries want the latest equipment available, despite the relative unimportance of marginal improvements of performance, with the result that aviation is not used optimally.

Secondly, the ruggedness and durability of the aircraft should be of a very high standard. Although the average flying life of an aircraft is much lower than in developed areas, the total life expectancy is much greater mainly because obsolescence is of little significance. It is essential, therefore, that an aircraft should be able to stand up to the poor runways and extreme climates as outlined above, as well as the multitude of potentially corrosive cargoes carried, such as fish and livestock.

The third requirement which Cartaino considers is configuration versatility,

"because of the unbalanced flow and seasonal character of cargoes in the underdeveloped areas, the variety of missions, and the limited ability to acquire specialized aircraft for each task." 34
It is important that the cabin layout can be easily converted to carry passengers or freight, or a mixture of the two. Furthermore, it is advantageous if the external configuration of the aircraft can be altered by the interchangeability of skis, floats and wheels.

As essential requirement (the fourth) for aircraft operating under harsh conditions and from short runways is STOL (short take-off and landing) characteristics. Associated with this is 'high and hot' performance. It has been mentioned above that many underdeveloped countries have airfields at high altitudes and in areas of high temperatures. Such conditions impose requirements on aircraft involving high engine ratings and high lift wing devices.

Sixthly, the fact that maintenance is sub-standard in these underdeveloped regions should be tackled by manufacturing aircraft that can be inspected and maintained in the field with comparative ease.

It is essential that aircraft used in these regions be independent of ground support. This means that starting should be independent from ground equipment, and airconditioning and cargo handling equipment should be built into the aircraft. In a Western country it pays to have auxilliary ground units to do these jobs, but this presupposes that many different aircraft will use the same units in one day. Obviously this cannot be the case where traffic is very low.

Finally, there are a number of miscellaneous items which should be considered before designing an aircraft for use in underdeveloped areas. These are aircraft-handling characteristics to be taken into consideration; (the aircraft should be easy to fly and have good handling characteristics at all times), passenger comfort (this cannot be entirely ignored, especially where tourists and foreign investors make up a large proportion of the total traffic), cargo handling (sophisticated techniques should be
avoided, for they only become economical when the time spent on the
ground is an important aspect of airline economics as seen in underdevel-
opked areas is not the case), and spare-parts logistics (it should be
possible for an aircraft to carry any of its own spare parts, presumably
for use in another of its own kind.) From the Western viewpoint, the most
important fact to come out of the foregoing discussion is that speed is a
relatively unimportant requirement for aircraft in an underdeveloped area.

It is necessary to consider the 'specific aircraft environment'
and 'requirements for aircraft in underdeveloped areas' because of the
changes that are taking place in the nature of air transport in developing
areas. While second-hand and military surplus aircraft are the most
economical, the usefulness to these regions of such aircraft today is
limited. The ubiquitous DC-3, of which there were many thousands available
in 1945, will someday be worn out (although it has, to date, shown a
remarkable tenacity to life) and replacements will be needed. Since there
are few older aircraft about to come in on the second-hand market to meet
the needs of frontier regions, it follows that new machines will have
to be designed and built. It is apparent from what has gone before that
the technology exists to solve the problem. As Cartaino summarizes,

"... solutions have been developed and are now being
employed which satisfy most of the requirements for
underdeveloped-area aircraft. Perhaps the overriding
consideration in most of these contemporary solutions
is to keep the design simple. Aircraft designers by
and large have heeded the adage 'simplicate and add
lightness' and indeed have realized that for successful
operation in less-developed environments, this adage can be
safely amended to 'simplicate even at some expense of
lightness'. It needs to be emphasized again and again
that the ultimate sophistication in design is simplicity." 35

Thus the answer to the problem depends on decisions taken in the
developed countries that manufacture aircraft, and the process has already
begun. Preoccupation with 'front-line' commercial jets and other
sophisticated equipment designed specifically for advanced urban industrial economies has resulted in the neglect of simple rugged aircraft for underdeveloped areas. It is significant that some of the best aircraft for use in frontier areas have come from Canada and not from the U.S.A. While Canadian aircraft have been designed specifically for 'bush' operations in remote areas of Northern Canada, they have found acceptance in other parts of the world because of the similar requirements in other underdeveloped areas. Despite the U.S.'s unchallenged leadership in the manufacture of commercial aircraft, that country has not done much for aviation in underdeveloped regions. Although Cessnas and Pipers can be used in frontier regions, these aircraft are basically for business and executive use and are not well suited to an underdeveloped environment. European countries are much more to the fore in this field, especially Britain and France. The involvement of these two countries in this is probably a reflection of their interests in their former colonial territories, through political and economic ties. As a result a number of aircraft are coming on the market that are suitable for use in underdeveloped areas. However, these aircraft are also designed for use in the feeder services in developed countries for no manufacturer wants to risk all on equipment that is useful only in a backward region. This is probably the best that underdeveloped areas can hope for in the immediate future.

The DC-3, according to many, has been in need of replacement for nearly twenty years. Designed in the 1930's, this aircraft has done much for aviation in general and is now being retired to the underdeveloped countries. Although it can perform well in tropical areas it is not suited to the far North. Some Canadian operators use DC-3's in the Arctic and Subarctic, but many problems are encountered for these aircraft were never designed for such an environment. Nevertheless, a replacement will
be a long time coming for a variety of reasons. The most prominent of these is the price of aircraft. Although, a DC-3 in good condition can be bought for $20,000 to $30,000, a similar new aircraft would cost $500,000. This is partially due to higher operating costs imposed by stricter safety regulations. The DC-3 does not meet current air worthiness criteria in the U.S.A. (such as take-off on one engine in the event of one engine failing) and is grossly underpowered. Nevertheless, it has been certified because it has thoroughly proved itself as one of the safest aircraft built. The importance of this today is that this makes a replacement to the DC-3 uneconomical while it can still fly.

Among recent developments are versatile, relatively large capacity, small aircraft such as the Short Skyvan. Although STOL characteristics are desirable, they incur a penalty in the form of less cargo capacity. Similarly, float planes carry less than their land based equivalents but are more versatile in that lakes provide ready made landing strips in many underdeveloped areas, e.g. Northern Canada and Chile. Even more versatility is obtained from amphibious aircraft, which can operate from either land or sea, but this versatility is expensive in terms of carrying capacity for wheels must be carried as well as floats. Figures for different configurations of the Dehavilland Turbo-Beaver are as follows:

<table>
<thead>
<tr>
<th>Type</th>
<th>Maximum Payload Pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land</td>
<td>1790</td>
</tr>
<tr>
<td>Ski/Wheels</td>
<td>1560</td>
</tr>
<tr>
<td>Sea</td>
<td>1440</td>
</tr>
<tr>
<td>Amphibious</td>
<td>980 from water</td>
</tr>
<tr>
<td></td>
<td>1080 from land</td>
</tr>
</tbody>
</table>

(Source: D.H. of Canada Ltd.)

Helicopters play a unique role in developing countries. Because of their high capital and operating costs they are most effective in areas
where per capita incomes are high. The helicopter is at its best on specific jobs over rough terrain, through which no surface communications penetrate. It is perhaps significant that British Columbia has one of the highest helicopter per capita ratings in the world. The role of the helicopter in economic development is changing due to advances in rotor technology and the application of small powerful turbine engines. It is apparent that it will find increasing use as a tool in the opening up of hitherto inaccessible areas.

"An evolutionary picture might be borne in mind: at the very beginning, a helicopter could be used to bring in a bulldozer to carve out a short strip suitable for STOL aircraft. Then, as time progresses, this strip could be improved so that eventually aircraft with more normal take-off performance could be phased into the operation."

Aside from the advances made in conventional equipment, new modes of transport have been developed which could affect the future of transport in underdeveloped countries. Of greatest significance to those interested in aviation is the hovercraft, (air cushion vehicle or ground effect machine) whose operating costs fall between those of the fixed wing aircraft and the more costly helicopter. Functionally, the hovercraft's advantage lies in the fact that while it can only operate over a smooth surface, the actual nature or load-bearing capacity of those surfaces is of no importance. It is thus especially suitable for operations in Arctic regions where muskeg abounds or where rivers are closed to conventional traffic for long periods due to freezing and thawing, and has the added advantage of being less damaging to the environment. Unfortunately it will not be suitable for many parts of the Yukon, due to rough terrain, but should find acceptance in the North West Territories. However, like the helicopter, it will be where there are few alternatives,
for its operating costs are high. It must be borne in mind that this mode of transport is in its infancy and it is too early to be dogmatic about its role in economic development. Many of its proponents are enthusiastic about the future and should they be proven correct, the hovercraft will be a very useful tool for underdeveloped regions. In the meantime it is perhaps safer to be conservative and equate the hovercraft with the helicopter as a specialized machine for a specific job. It will be useful, but exactly how useful it is too early to say.

In light of these trends and developments a modified version of Sealy's framework for Northern Canada can be outlined. The three stages would be as follows:

**Phase 1:** Pioneer stage. Aircraft are used for surveys of all kinds and for exploration. The equipment is used sporadically on a charter basis. Helicopters and hovercraft are complimentary; helicopters used at first and hovercrafts later to haul heavy supplied.

**Phase 2:** The beginning of large scale exploitation. It is probable that road or rail links will be established. In this case aircraft will begin to specialize on passengers and freight. However, it is possible that aviation may handle all the transport to some major points. In this case the very intense use of large aircraft is involved.

**Phase 3:** If the environment is suitable, the growth of industry and settlement will take place. This definitely requires surface transport. (If the environment is not suitable little progress will be made beyond phase 2,
but the role of aircraft may change somewhat.) Aircraft in this phase are used very intensively on a highly specialized basis.

On the surface this outline seems similar to Sealy's but its basis is different. Whereas Sealy describes stages of development with descriptions of what aircraft are doing, this framework concentrates on the characteristics of commercial aviation at different stages. Thus the key to the modified framework is the progression,

1. from low aircraft utilization to high,
2. from small aircraft to large,
3. from high unit costs of transport to low, and
4. from diversities of missions and cargoes to specialization.

Thus a frontier area (i.e. Northern Canada) can have a highly developed form of air transport without being in itself highly industrialized.

The trends which Soberman has outlined are readily apparent in the North and air transport is characterized by them as technological improvements are introduced. The effect of this is the emergence of air transport as a substitute, rather than a complement to surface transport.

As better equipment becomes available, the use of aviation as the total transportation system over many parts of the North will have to be considered. In a land where an airport costs the equivalent of 13 miles of highway, and distances are great, the wisdom of building large underused highways must be questioned. For some years a gold mine at Discovery, 50 miles north of Yellowknife, N.W.T., has been serviced by air, and as technological improvements are applied in the North, this treatment will be extended to other less valuable commodities. Pacific Western Airlines carries silver concentrate out of Camsell River, near Great Bear Lake, using a Lockheed
Hercules freighter, a four-engined turbo-prop machine,\textsuperscript{37} and this can be viewed as the beginning of a new era in the use of aircraft in the North.\textsuperscript{38} The main trend is the trend of change from surface to air transport that is working increasingly in favour of aviation. The proposal to use a giant freighter (the RC-1) to carry oil out of the North, in connection with the Great Plains Project, is an extension of this, although the project itself has many weaknesses.

Nevertheless, the reality today is that surface transport dominates thinking especially in high places. Sealy epitomises the popular feeling:

"We must emphasize the point that no large-scale development can take place without bulk surface carriers."\textsuperscript{39}

Viewpoints like this reflect the colonial attitude mentioned above, that the North is to be exploited, and to a confusion between 'development' and 'industrialization'. The transport needs are perceived by the metropolis; for facilities to carry out heavy raw materials, and the main routes all run North-South, whereas important East-West surface connections of the region's needs will result in the development of more intra-regional routes, a policy which would benefit aviation.

CONCLUSION

Technological changes in transportation result in a number of trends; trends that favour more advanced technology over primitive and established means of transport in terms of the per unit costs of moving individual items. Since overall traffic is low, one can expect terminal, or overhead, costs to be more important than running costs over a particular route. This favours air transportation and combines with that mode's
flexibility of route structure to give aircraft an advantage over other modes that it rarely enjoys in other more evenly populated parts of the world.

In strict economic terms therefore, one can foresee the North's transport needs being met by a large number of scattered airports, served by advanced technology aircraft affording low per ton-mile costs, together with some surface transport on trunk routes where the volume of traffic on a steady basis would justify it. This view, however, must be tempered by the knowledge that the North is not a closed system, and the economic system affecting it does not reflect the needs and aspirations of the people in that area, but rather, it reflects the economic pressure of the dominant South.

The key to what happens to transportation in the North is government policy and the attitude to the North, of the people in the more populated South. In the past, some attitudes have been discernible that indicate a very close relationship between development and surface transport, e.g. Diefenbaker's Roads to Resources and Trudeau's MacKenzie Valley Highway. Such attitudes are aligned more closely to ideas of resource exploitation than to the true needs of the North _per se_. There is a general trend in the world towards planning, both autocratic and democratic, and assuming that planning is based on a rational assessment of the choices to be made and on the implications of action, this could be advantageous to aviation in the North. If one of the roles of transportation is seen by the powers that be to reduce isolation within a region, it could be that aviation will develop along the lines mentioned above. However, if there is little change in attitude, the emphasis will continue to be placed on expensive surface links.
It is to be hoped that an evaluation of the aims and objectives of a total transportation system for the North is undertaken before an excessive amount is invested in expensive surface facilities that will not be fully utilized.
LIST OF REFERENCES


4. Ibid., Chapter 6


14. Levitt, K. Silent Surrender: the Multinational Corporation in Canada (Toronto), 1970


31. *Ibid.*, 4

32. *Ibid.*, 4

33. *Ibid.*, 6-7

34. *Ibid.*, 9

35. *Ibid.*, 30


39. Sealy, 179.


Harris, R.F. *The Economic Efficiency of Regional Air Carriers in the National Transportation System*. Winnipeg, Manitoba: Centre for Transportation Studies, Research Report No. 3, January, 1969.


---


---


---


The Regional Air Carriers Problem. Queen's Printer, Ottawa, Canada, September, 1966.


