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SIGHT LINE ANALYSIS AS A MEASURE OF HUMAN ORIENTATION
IN TRANSPORTATION TERMINALS

W.J. Cook, B.Sc. (Eng.)

A thesis submitted to the Faculty of Graduate Studies
in partial fulfilment of the requirements for the degree of
Master of Engineering

Faculty of Engineering
Carleton University
Ottawa, Ontario

September 1978

c 1978 Wallis Jordan Cook

The undersigned recommend to the Faculty of Graduate
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"SIGHT LINE ANALYSIS AS A MEASURE OF HUMAN ORIENTATION
IN TRANSPORTATION TERMINALS"

- submitted by W. J. Cook, B.Sc., in partial fulfilment
of the requirements for the degree of Master of Engineering.

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ABSTRACT

Existing methods of evaluating how a terminal facility and its signage system assists in user orientation in terminal facilities has not been adequately quantified in previous research. This thesis presents a method to measure user orientation through visual perception of an object-goal by the application of linear graph, network and matrix algebra theories. The method incorporates two data collection methods based on sight line measurements which are shown to be directly related to user orientation. These results can be validated by passenger or employee interviews with self-administered observation and camera surveys. The method was tested in ten terminal facilities of different types and sizes. Their quantified results were validated and a distinct relationship was found to exist between human orientation, building layout and terminal information systems.

In order to demonstrate its application to any terminal facility design, an existing facility was hypothetically structurally changed, quantified and any identified user orientation areas were reduced by the implementation of a signage information system. Both the new terminal and the existing signage system were again evaluated to further identify any areas where users were disorientated. It was further demonstrated that a more adequate signage system may be implemented to reduce any further disorientation problems. Though with limitations, the methodology developed offers valid insight into user orientation and its interaction between terminal layout and signage information systems.

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SIGHT LINE ANALYSIS AS A MEASURE OF HUMAN ORIENTATION
IN TRANSPORTATION TERMINALS

CHAPTER 1
INTRODUCTION

1.1 Transportation Terminals

A transportation terminal facility can be conceived as that part of the transportation system whose primary function is to provide for the transfer of people and goods. If we consider that the purpose of any transportation system is for the efficient movement of people and goods, then the transportation terminal plays an important part. A spatial concept of a transportation system can be visualized as a network comprised of links and nodes. The links are the routes over which traffic moves and the nodes are the terminals where routes may originate, terminate or pass through. The act of transferring, accessing or egressing the transport system within the nodes is carried out at transportation terminal facilities. Braaksma, (1) in his work on airport terminals also discusses this network concept of a transportation system;

"In its abstract form the transportation system consists of a network of links and nodes. The links represent the routes for each mode of transport, for example streets and highways, rail lines, sea lanes and air routes. The nodes represent the junctions of the links, either of the same mode as in street intersections and highway interchanges, or of different modes such as bus terminals, railroad stations, harbours and airports. The latter are transfer points."

In summary, terminal facilities serve as transfer points or nodes between various transportation systems either of the

same mode or of different modes. They are complex systems themselves and may be comprised of many related subsystems which also can be conceived as a network of nodes and links. For example, public rail transit stations may consist of a series such as parking lots, terminal buildings and platforms, all of which are connected by links or routes. These facilities may serve as transfer points between the road mode and the rail mode. The user who wishes to transfer between the two different modes travels, in most cases, as a pedestrian on the links through the facilities. A schematic representation of a transportation network is shown in figure 1.1:

1.2 Passengers and Pedestrians

A passenger in the terminal facility is only one particular type of pedestrian or terminal user. There are other users classified as visitors, employees, well-wishers, greeters, and special users, such as the handicapped. It is these terminal users who have only just recently been recognized by planners and designers in relation to their effect on passenger movement within transportation terminals. In the research report by Johnson (2) it was found that of the total number of pedestrians surveyed in the Voyageur Colonial Bus Terminal, nearly 25 percent were visitors (those other than passengers) (see Table 1.1).

Another study (3) indicated that there are a large number of transferring passengers, or those who transferred from one mode to another mode, in transportation terminals.

FIGURE 1.1
THE TRANSPORTATION AND
TERMINAL NETWORK SYSTEM

TABLE 1.1

WEIGHTED AVERAGE WALKING DISTANCE*

	Terminal User			
	Outbound Passenger	Inbound Passenger	Visitor	Total
No. of Card-Carriers	616	290	293	1,199
Total Distance Walked (person-ft.)	150,471	54,113	52,006	256,590
Weighted Ave. Distance Walked (ft.)	244.3	186.4	177.5	214.0
Standard Dev. of Dist. Walked	49.2	64.3	57.2	55.6
Ave. No. of "Trips" per Person	2.4	1.6	1.7	2.1
Ave. "Trip" Length (ft.)	100.2	113.6	102.4	101.9

*SOURCE: Reference (2)

As shown in tables 1.2 and 1.3, the percentage of transfers at some of the United States airports were found to be as high as 72 percent and at Canadian airports, as high as 32 percent. These facets of pedestrian and passenger movement were not considered in the early designs and concepts of terminals.

Hoel⁽⁴⁾ expresses the need for planners and designers to quantify terminal operations with emphasis on passenger activities when he states;

..."it is at these nodal points that the traveller transfers between nodes and it is well known that travellers assign a much higher disability to the time spent transferring than the time spent in the vehicle (up to 2.5 to 1)."

1.2.1 Research Deficiencies and Need

Transportation specialists are now beginning to recognize the importance of passenger and goods movement within the terminal facility in the total operation of the transportation system and the lack of research in the field. This recognition has been mainly due to the fact that improvements to the link or route portion of the trip can only be realized if the node or terminal facility performs adequately. Wortman⁽⁵⁾ emphasizes the lack of attention paid to terminal facility planning and design when he states;

"The transportation terminal represents an element of the transport system that has been neglected in considering the total transportation needs of an area. The State of Knowledge concerning transportation terminals has progressed very little when compared to the advances in technology of the remainder of the system. In spite of the importance of the terminal in providing for the movement of people and goods, little attention has been given to the planning and construction of terminal facilities . . . Transportation planning

TABLE 1.2

PERCENT TRANSFERS AT U.S. AIRPORTS IN 1971

AIRPORT	PERCENT TRANSFERS
Atlanta	72
Dallas	53
Chicago	46
Philadelphia	39
Denver	36
New Orleans	32
Kansas City	32
San Francisco	31
Los Angeles	30
Miami	29
Minneapolis-St. Paul	27
Detroit	19
Boston	15
New York	15

SOURCE: Reference (3)

TABLE 1.3

PERCENT TRANSFERS AT CANADIAN AIRPORTS IN 1974

AIRPORT	PERCENT TRANSFERS
Montreal	32
Halifax	31
Winnipeg	29
Toronto	28
Vancouver	27
Calgary	20
Edmonton	15
Saskatoon	13
Ottawa	5
Quebec City	2

SOURCE: Transport Canada

studies while recognizing the significance of terminals have included the terminal in a very superficial way."

Hoel (4) et al, also recognizes the important role that the terminal plays in the levels of service offered by transportation terminal systems;

"Abrupt transition and delays at interface facilities can offset service advantages offered by high speeds, frequent service obtained through close vehicular headways and other advances in line - haul technology and operations. With inadequate interface facilities, line haul improvements will not reach their full potential impact in meeting the transportation objectives for which they were designed."

Consequently, research, with the objective of establishing quantifiable methodologies to aid in decisions pertaining to the planning, design and construction of terminal facilities is greatly needed.

1.3 Terminal Design Objectives

When considering terminal buildings, the activities within and immediately around the building can be compared to the previously discussed transportation network. The links in the terminal complex, between various process points, or origins and destinations, are the routes over which the terminal user may flow; and the origins or destinations which a user may need to flow to or from are, the nodes or junctions of the network. A schematic diagram of a terminal facility network is shown in figure 1.2.

In order to meet the demands required by a terminal system

FIGURE 1.2
TERMINAL NETWORK SYSTEM

user, an exact statement of how the system performs or what it should do, should be detailed. When considering the user, a major goal which terminal facility design should attain is to provide an economical, safe, comfortable and convenient transfer between different or among the same modes of transport.* On behalf of the owner/operator, a facility design goal should be to provide a maximum level of service within established budgetary constraints, namely, reduced costs and maximized revenues.

1.4 Level of Service Concepts and Orientation

The Highway Capacity Manual⁽⁶⁾, has developed level of service standards for six levels of design which were based on service volumes, operating speeds and a qualitative evaluation of driver convenience. This report also listed six objectives, which should be incorporated in evaluating the level of service of a highway facility;

1. Speed and travel times
2. Traffic interruptions and restrictions
3. Freedom to manoeuvre
4. Safety
5. Driving comfort and convenience
6. Economy

John Fruin⁽⁷⁾, in his work on pedestrian planning and design, adopted these level of service concepts in order to measure pedestrian flows, based on pedestrian volumes and

* Other physiological and psychological characteristics which affect user performance should also be considered.

qualitative evaluations and recommends their evaluation when designing pedestrian spaces. The following, therefore, are seven objectives listed by Fruin which he recommends should be evaluated in order to obtain an adequate pedestrian design level of service.

1. Safety
2. Security
3. Convenience
4. Continuity
5. Comfort
6. System coherence
7. Attractiveness

He points out that all goals and objectives are inter-related and overlapping with an improvement in one objective generally resulting in opportunities for improvement in the others. Also, when he discusses the system coherence objective and its important need for evaluation he states;

"A confused pedestrian searching for orientation has limited receptivity to secondary visual inputs such as aesthetics When the pedestrian is assured of his primary concern of orientation and direction, his level of receptivity to sensory gradients, such as changes of colour, light, ground slope, smells, sounds and textures, is increased, System coherence is also an important element in building design particularly for transportation terminals. An incoherent passenger terminal configuration multiplies the number of directional signs needed, thus decreasing individual sign effectiveness. Directional signing will not satisfactorily alleviate incoherence in building design. Signs should be considered as a supplementary message to confirm the visual statements expressed by the legibility of the building design itself."

A pedestrian therefore relies on visual inputs received in the terminal space, such as building configuration and its information systems, in order to be orientated around or through the facility. Since system coherence and orientation are two objectives to be evaluated in terminal facility design as stated above by Hoel et al and Fruin, and these two factors should be considered in evaluating terminal level of service, it would therefore be desirable to quantify visual perception and orientation relative to a terminal user.

1.5 Problem Statement

There are few quantitative measures to evaluate terminal system performance and a corresponding level of service, except by qualitative measurement and subjective judgements. Hoel⁽⁴⁾ emphasized this when he stated:

"the methodology for planning and designing urban transport interface facilities has been based primarily on "rule of thumb" techniques"

Therefore, to adequately evaluate design objectives, quantitative measures should be established or are at least desirable.

Within the terminal system is its user, who is directly affected by the facility's performance and offered levels of service. It is this user who is subjected to any lack of consideration given to terminal design goals and objectives.

A terminal user is basically making a transfer, and in order to do so effectively, he must have a visual perception of a desired goal, orientate in its direction and finally motivate to actually obtain it. This can only be accomplished by providing visual

contact, through a direct sight line, to the desired goal. Visual contact is made through the sight line by observation and recognition of the node, either by its physical structure and composition, or by a sign identifying it, or by a sign directing the terminal user to it. Once this visual contact is made, a user attempts to follow this sight line to obtain the desired goal. Any problems encountered by a user in attempting to carry out these actions can be directly related to terminal facility design and the existing signage information system.

At present there are few methods which provide explicit information or quantification on terminal user performance, that is, a measure of a user's ability to perceive and move through or around a terminal facility, or the terminal's ability to assist the user in this way. This should be available to the terminal designer who is planning and designing a new facility or making major improvements to an existing terminal. It should also be available to the owner/operator who wishes to assess the existing terminal performance in order to make or request necessary adjustments to improve the performance, and offer to a user a better level of service.

1.6 Purpose and Scope of Study

The primary purpose of this research is to develop a quantitative measure of human orientation in a transportation terminal. To do this an adequate survey technique will have to be devised. A secondary purpose of this research is to find

a relationship between human orientation, building layout and terminal information systems.

The scope of this research is limited to:

1. inter-city passenger terminal facilities,
2. the terminal user flows within and in close proximity of the terminal building,
3. physical planning of the internal and limited (namely curb and platform or boarding/deboarding areas) external components of the terminal building, and
4. information systems pertaining to the visual aspects only (audio information systems are excluded).

1.7 Thesis Organization

Chapter 2 outlines a complete literature survey discussing current work on terminal design, human orientation and information systems and how they pertain to the user in the transportation terminal facility environment. As well, it proposes a theory for measuring terminal user orientation relative to visual perception and the presence of sight lines based on linear graph theory and matrix algebra.

Chapter 3 outlines how sight line data is measured and compiled into visibility matrices. The terminals from which this data was collected and a method demonstrating how these terminals may be compared is also discussed.

Chapter 4 demonstrates how various terminal system, subsystem and component visibility indices are calculated from the compiled matrices and how they are related to user orientation.

A computer program developed to reduce repetitive calculations of the indices is also discussed, as well as the indices results from all the terminals studied.

Chapter 5 validates the calculated visibility indices of the studied terminals and demonstrates in detail how sight line analysis may be applied to a particular terminal in order to evaluate existing orientation problem areas. How the sight line analysis method may be applied to evaluate the impact to user orientation of any terminal structural changes, or information signage application is also discussed.

Chapter 6 summarizes the research carried out, the results obtained and the benefit of using orientation theory in the design and evaluation of transportation terminal facilities. Concluding remarks with respect to the research undertaken in this thesis is also listed. Recommendations are listed for carrying out further research in the area of terminal user orientation with brief details of how this may be done and the results expected.

CHAPTER 2

A THEORY FOR MEASURING ORIENTATION

2.1 Current Work on Orientation

Literature related to human orientation and transportation terminals can be found in the sciences of architecture, physiology, psychology, biology, physics, neurology, education, space medicine, art and philosophy. The reading of these texts, journals and research papers revealed that human orientation is directly related to visual perception. Detailed scientific theories on visual perception, orientation, and motivation were found mainly in the disciplines of psychology, physiology and physics, and although the author is familiar with such relevant theories, their explanations and definitions are outside the scope of this study. However, their comprehension was necessary in order to quantify human orientation in transportation terminals.

Studies on visual perception related to transportation and traffic were largely found in the highway and traffic engineering disciplines⁽⁸⁾⁽⁹⁾⁽¹⁰⁾⁽¹¹⁾. In addition, the journal on *Architectural Psychology* and other related visual perception studies by architects and psychologists on space and the environment discuss visual perception with some references to human orientation⁽¹²⁾⁽¹³⁾. However, only two papers and a text were found to specifically relate to human orientation, visual perception and transportation terminals, with only one of these papers semi-quantifying the variables.

FIGURE 2.1
VISUAL DESIGN*

* SOURCE: REFERENCE (4)

Hoel et al (4) states:

"Passenger orientation is the principal criteria for the effectiveness of information systems and the design process should be based on providing a continuous path of graphic directions between the transit vehicle and the street."

They go further on this aspect and list in a table all known possible criteria for evaluating station design. They suggest that passenger orientation may be quantified by considering the connectivity of a node-link network, with performance measures by network analysis.

In summary, little of the research material found detailed and/or demonstrated quantifiable methodologies which may be considered or possibly used in terminal planning and design, particularly when attempting to achieve the goal of minimizing terminal user disorientation.

2.2 Human Orientation Defined

When travelling and performing the act of a pedestrian inside a terminal building, an expression often repeated by others, or possibly thought to oneself is, "I must find my way to... (destination)", or when asking information from others, "Could you please tell me how I can find my way to...?" or "How can I get to...?" A more correct version of this thought or statement would be, "In which direction must I orientate myself to reach...?" or, when asking another, "Could you please orientate me in the right direction so that I may reach...?" In other words, a passenger in a terminal complex attempts to orientate or seek orientation when he wishes to reach a particular destination such as a ticket counter, a restaurant, or an exit.

A basic dictionary definition (Oxford) of "orient" is "the action of ascertaining, or fact of knowing the relative position of anything or oneself" or "the positive arrangement of a natural object or formation relative to points of the compass or other points of the same structure." To "orient oneself" the dictionary states is "to put oneself in the right position or relation, also, to ascertain one's bearings."

Howard and Templeton⁽¹⁶⁾, in their text on human spatial orientation, refer to the term "geographical orientation" as:

"A way that a person is facing with respect to the objects on the earth's surface.

The phrase a person's orientation is sometimes used to refer, not to the actual orientation he may have but the ability to behave according to his actual orientation. If that behavior is correct we say the person is well orientated; if not, he is said to be disorientated. Then again, the term orientation is sometimes used to describe the actual movements made in setting the body in a particular direction.

Geographical orientation involves a skill in the ability of a person to maintain a sense of direction when moving about."

From the above it can be summarized that, when referring to terminal user orientation, we mean those tasks which involve the ability of a user to be well orientated and maintain a sense of direction when moving about a terminal. If the terminal user's behavior in his movements and in choosing a direction is correct, he is orientated; if not, he is disorientated.

Vision, or visual perception of the environment has been clearly expressed as man's most important modality for orientation,

for this has been borne out by studies (Guldborg, 1897; Szymanski, 1913; Blumenthal, 1928; Lund, 1930, etc.). They show that animals and men, when deprived of visual communication with their environment, are unable to walk in a straight line and tend to circle. These studies further show that most people veer to the right rather than the left, and that females veer to a greater extent than males. Another study showed that the majority of subjects observed descended by the right staircase of a twin symmetrical stairway, in other words, orientating themselves to the right in their direction of movement.

These individual differences appear to be due to physical asymmetries of the body (Abderhalden, 1919; Guldbert, 1897; Lund, 1930). There is no evidence that man possesses any special sense for direction and the popular belief that primitive people and children possess an innate sense of direction appears to be a myth. In the light of this evidence, it must be assumed that man can orient himself in a direction only when he can see some familiar landmark or sign. Gibson⁽¹⁷⁾ in his work on the perception of the visual world discusses the three variables - visual perception, orientation, and locomotion:

"the simplest kind of study (to define orientated locomotion) would probably be the act of going to a visible object or place - the goal. Locomotion of this sort is orientated directly toward the goal. The body movement is a function of optical stimulation which yields the perception of a visual world with the goal - object in it. Body movement is modified only by the necessity of avoiding obstacles or directing the movement into the field of safe travel.

Another contribution to terminal user orientation was undertaken by Bronzaft et al (21), who measured New York City subway users' orientational or directional problems in the system. Basically it was a study of the subway users' ability to use guide maps to determine their location and decide on correct patterns of action necessary to carry themselves through the total system to their required destination.

Two other related works were a paper by Fruin and Cantelli (14), and Fruin's book on *Pedestrian Planning and Design* (7). The paper by Fruin and Cantelli on information systems in transportation terminals emphasizes the importance of these systems to human orientation. The authors discuss that because the terminal building is a complex system and the passenger is concentrating on seeking a destination, both building space and information systems must be well planned, adequately designed and properly located. If not, they point out, a passenger may become confused and disorientated and undergo a sense of anxiety and insecurity. Fruin reinforces this idea in his text, and as shown in Figure 2.1, when he states that a designer must consider a terminal building in terms of visual design. Poor design statements will give the user a confused visual field and hence create disorientation. He goes on to state that a simplified visual field where visual design elements have been carefully considered will minimize user disorientation and confusion.

In a paper by Hoel et al (15), the authors emphasize correct application of passenger information and graphics:

A more advance form of locomotion would be the act of going to an object or place beyond the range of vision. This may be called the destination. "Being orientated" in the popular sense of the term, refers to this ability. In common sense terms, one must know both where he is going and where he is now. It requires over and above the visual world, a frame of reference or a topographical schema. Orientation is inseparable from locomotion for, only because an observer gets a different visual field at a different standpoint, does he perceive a single integrated world."

If a terminal user does become disorientated in the terminal system or network he may be

- a safety risk in that he is concentrating every effort on orientating himself and not on the avoidance of other users and objects,
- a critical factor in the terminal processing function, reducing terminal employees' work effort and concentration by the constant interruptions responding to disorientated users' requests for directions and assistance, and
- a future transportation system non-user, recalling the frustration and possible costs associated with not making a scheduled departure due to not finding the departure area or platform.

In considering the above quotations and discussions, as well as those of Chapter 1, Section 1.5, it can now be understood that a terminal user, when moving in a terminal network, must become orientated geographically by the visual perception

of the next goal or destination through a direct sight line. He must then direct himself by locomotion of his body along the correct and simplest path, namely the sight line, (in order not to be disorientated psychologically) so that he may arrive at his desired destination.

2.3 Human Orientation and Networks

A network basically consists of two or more distinct points, called nodes, with lines joining pairs of these nodes called arcs. As discussed in Chapter 1 these nodes or points may be conceived as processing points or concessions in a terminal facility and the arcs or lines connecting them as a series of sight lines. For the purpose of quantification of a network, certain methods have been developed which can be used to describe, in mathematical terms, the nature of such systems. One such method is linear graph theory.

A complete description of linear graph theory and networks can be found in the following section. The equations relative to these linear graphs and network quantifications which will be used throughout this research, are displayed and explained, including a numerical example. Representation of these results using matrix algebra theories with the related computations are also detailed and discussed.

2.4 Linear Graphs and Networks

A simple linear graph is basically a collection of edges or arc segments (lines) and points or vertices (nodes), Figure

2.2, a and b. Collections or sets of linear graphs (networks) may either be finite or infinite depending upon the number of elements that they contain. For the purpose of this work, finite network graphs are considered.

Linear graphs can be broken down into different classifications such as non-orientated, orientated or planar, non-planar. The difference between orientated and non-orientated graphs is the fact that the lines of orientated graphs are incident upon two nodes and that a sense of direction is implied from one node to the other (Figure 2.2b) (orientated = directed, non-orientated = non-directed).

A planar graph is a graph which can be mapped on a plane such that no two lines have a point in common, that is, not a vertex (Figure 2.3 b and c).

If the number of lines incident to a node may be counted, this number is known as the degree (Figure 2.3a).

A chain or path is a series of nodes where at each node the degree of each intermediate node is two and the degree of each terminal node is one. In Figure 2.2a, (1,2) (2,3) (3,4) (4,2) (4,5) is a chain or path with the terminal nodes (1) and (5). In figure 2.3c, (1,4) (4,3) (3,2) is a chain or path with (1) and (2) being terminal nodes.

A circuit or loop is a closed chain or path where all nodes are of degree two or where a chain or path actually connects

FIGURE 2.2(a)
NON-ORIENTED
GRAPH

FIGURE 2.2(b)
ORIENTED
GRAPH

FIGURE 2.3(a)
NON-PLANAR
GRAPH

FIGURE 2.3(b)
PLANAR
GRAPH

FIGURE 2.3(c)
TREE
GRAPH

a node to itself. Figures 2.2b and 2.3a and b, have closed chains or paths (2,3) (3,4) (4,2) forming such a circuit or loop. Figure 2.3c does not.

A connected graph forms a basic network and is considered connected if there is a chain or path connecting any pair of nodes. All diagrams in Figure 2.2 and 2.3 are connected.

A tree can be defined as a connected subgraph of a connected network which basically contains no loops. Only diagram (c) of Figure 2.3 is a tree, for all other diagrams contain loops.

A text book definition⁽²²⁾ of a tree is: if and only if there exists exactly one path between any two nodes, or consecutive nodes, constitutes a tree.

2.4.1 Network Quantification

A measure of the connectivity of graphs and networks can be obtained by making use of some of the concepts of linear graph theory. If ℓ = the number of links (arcs) of a network and n = its number of stations (nodes) then the maximum number of connections or links a non-directed graph or network (Figure 2.3a) can have is:

$$\ell_{\max} = \frac{n(n-1)}{2} \quad \dots \dots \dots (1)$$

where:

$\ell_{\max}$ = the maximum number of links a network can have,

n = the number of nodes in the system.

This equation holds true when considering a directed system of one-way links, that is, there nodes are connected by one directed link. For example, when considering the directed network of Figure 2.5a, with each node connected by one-way directed links, the maximum number of links, $\ell_{\max}$, the system can have is:

$$\ell_{\max} = \frac{n(n-1)}{2} = \frac{4(4-1)}{2} = 6$$

If it is desired to know the degree of each node in the system, that is the one-way links radiating from or being received by a node, as demonstrated in Figure 2.5a, they are found by using the equation:

$$\ell = n-1 = 4-1 = 3$$

Node 1 in the diagrams is of degree 3.

For a directed network having two-way directed links, the maximum number of two-way connections the network can have is calculated by using the equation:

$$\ell_{\max} = n(n-1) \dots \dots \dots (2)$$

This is shown in the two-way directed graph in Figure 2.4a and 2.6a and the maximum connections it has is:

$$\ell_{\max} = n(n-1) = 4(4-1) = 12.$$

If the number of two-way connections radiating from and received by a particular node or the degree of the node is required, the application of equation (1) will yield for the network in Figure 2.6a:

$$l_{\max} = \frac{n(n-1)}{2}$$

Therefore, the degree of node 1 in Figure 2.4a or 2.6a will be:

$$l_{\max} = \frac{4(4-1)}{2}$$

$$= 2(4-1)$$

$$= 6$$

Counting the links of node 1 in these two figures will prove this to be true.

If the number of directed links a node radiates to (one-way directed, away from) another node or nodes is needed, the equation to calculate this is:

$$l_t = n-1 \quad \dots \dots \dots (3)$$

which is the same for calculating the number of directed links which are received by a node (one-way, directed to) from another node or nodes which in turn can be designated by l_f .

Application of linear graph theory can also yield a node connectivity index which quantifies either a node and its connectivity to the rest of the system or the system connectivity to a node. In other words, based on the number of links a node radiates to the other nodes in a network, the following equation gives an index (in %) of how connective or linked to the network is that node. Similarly, based on the number of links a node receives from the other nodes in a network, the same equation gives an index (in %) of how connective or linked the node is from the rest of the network. The equation is:

$$CO = CA = \frac{(l_t \text{ or } l_f)}{n-1} \times 100\% \quad (4)$$

where

CO = the connectivity of a node relative to the rest of a network

CA = the connectivity of the rest of the network to the node

l_t = the sum of the links of a node radiating to the rest of the nodes in a network

l_f = the sum of the links of a node received from the rest of the nodes in a network

n = the total nodes in a network

This equation was developed to show that due to the directiveness of links in a system, a node may radiate more or less links than it actually receives. This is demonstrated with the following example. In Figure 2.6a, node 2 has radiating from it three directed links to nodes 1, 3 and 4, and it receives three directed links from nodes 1, 3 and 4. Therefore the connectivity of the node to the rest of the system is:

$$CO = \frac{l_t}{n-1} \times 100\%$$

$$= \frac{3}{4-1} \times 100\%$$

$$CO = 100\%$$

This is true since counting the links radiating from node 2 reveals three links present and the degree of node 2, or the one-way directed links it should have totals 3. Also, the connectivity of node 2 from the rest of the network is:

$$CA = \frac{\ell_f}{(n-1)} \times 100\%$$

$$= \frac{3}{4-1} \times 100\%$$

$$CA = 100\%$$

This value of 100% is correct since the degree of node 3 is three i.e., the total one-way directed links it should have. This can be verified by counting the directed links in Figure 2.6a that are received by node 2.

An average node connectivity index which quantifies the links radiating both from and to a particular node in a network, or rather, the connectivity of a node is simply

$$CT = \frac{\ell_T}{2(n-1)} \times 100\% \quad \dots \dots \dots (5)$$

where

C_n = the connectivity index for a node in a network containing n nodes and ℓ links expressed in %

ℓ_T = the sum of the links radiating to or received by a particular node ($\ell_t + \ell_f$) in the network

n = the total number of nodes in the network.

Therefore adding all the links radiating from and received by node 2 which is 3 and 3 respectively and substituting it into equation (6), reveals that the connectivity of node 2 is:

$$\begin{aligned}
 CT &= \frac{\ell_T}{2(n-1)} \times 100\% \\
 &= \frac{(\ell_t + \ell_f)}{2(n-1)} \times 100\% \\
 &= \frac{3 + 3}{2(4-1)} \times 100\% \\
 &= \frac{6}{6} \times 100\% \\
 &= 100\%
 \end{aligned}$$

The above demonstrates how to quantify the main components of a network, namely the links and nodes. The following describes how to quantify the network itself and any number of identified subsystems in the network.

Again, application of linear graph theory can give a connectivity index for any two-way directed network by the equation:

$$C = \frac{\ell}{n(n-1)} \times 100\% \quad \dots \dots \dots (6)$$

where

C = the connectivity index for a network containing n nodes and ℓ links expressed in %

ℓ = the sum of the actual number of links counted or measured in the network

n = the actual number of nodes counted or measured in the network.

A maximum connectivity index of a network can be found when $\ell = \ell_{\max}$. This is to say that the theoretical or ideal connectivity of a system can be defined as:

$$C_{\max} = \frac{\ell_{\max}}{n(n-1)} \times 100\% \quad (7)$$

where

$C_{\max}$ = the maximum connectivity index a system can have of ℓ links and n nodes expressed in %

$\ell_{\max}$ = the sum of the maximum number of two-way directed links a system can have

n = the actual number of nodes counted or measured in the network.

If we consider figure 2.4a, the connectivity index of this orientated two-way directed network would be:

$$C_{\max} = \frac{\ell}{n(n-1)} \times 100\% = \frac{12 \times 100}{4(4-1)} = \frac{1200}{12} = 100\%$$

Similarly, if a particular subsystem need be identified in the total directed network and its connectivity alone is desired, then this can be represented by the following equation:

$$CS = \frac{\ell_s}{n_s (n_s - 1)} \times 100\% \quad (8)$$

where

CS = the connectivity index of a chosen subsystem of ℓ_s links and n_s nodes expressed in %

ℓ_s = the number of directed links counted or measured in the subsystem within a system

n_s = the actual number of nodes in the subsystem.

The connectivity of a particular subsystem to the remainder of the system, that is, how connective the nodes in the subsystem are to the other nodes in the network, can also be quantified. In other words, based on the number of links a subsystem of n nodes radiates to all other nodes, the following equation will give an index (in %) of how connective the subsystem is to the network. Conversely, based on the number of links a subsystem of n nodes receives from every other node in the network, the same equation will give an index (in %) of how connective or linked, is the network to the subsystem:

$$CSO = CSA = \frac{(\ell_{so} \text{ or } \ell_{sa})}{n_s (n - n_s)} \times 100\% \quad (9)$$

where:

CSO = the connectivity index of a subsystem relative to the rest of the network

FIGURE 2.4(a)

DIRECTED NETWORK

Columns

i \ j	1	2	3	4
1	1	1	1	1
2	1	1	1	1
3	1	1	1	1
4	1	1	1	1

Rows

$X = (a_{ij}) =$

a_{ij}

FIGURE 2.4(b)

ADJACENCY MATRIX

FIGURE 2.5(a)

ONE-WAY DIRECTED
NETWORK

$X = x_{ij} =$

i \ j	1	2	3	4
1	1	1	0	0
2	0	1	1	0
3	1	0	1	1
4	1	1	0	1

FIGURE 2.5(b)

ADJACENCY MATRIX

CSA = the connectivity of the rest of the network to the subsystem

l_{so} = the sum of the links a subsystem radiates to the rest of the network

l_{sa} = the sum of the links a subsystem receives from the rest of the network

n_s = the number of nodes in the subsystem

n = the number of nodes in the network.

Also, if the connectivity of this subsystem relative to the total system is required, this may be represented by the equation

$$CTS = \frac{l_{st}}{2n_s(n - n_s)} \times 100\% \quad (10)$$

where

CTS = the connectivity index of a subsystem with l_{st} , the sum of the total two-way links ($l_{so} + l_{sa}$) between n_s nodes of the subsystem and n nodes of the system expressed in %, relative to the total network

l_{ts} = the sum of the measured or orientated two-way directed links between the subsystem nodes ($l_{so} + l_{sa}$) and all other nodes in the network

FIGURE 2.6 (a)
TWO-WAY DIRECTED
NETWORK

$$S = s_{ij} =$$

i \ j	1	2	3	4
1		1	1	1
2	1		1	1
3	1	1		1
4	1	1	1	

FIGURE 2.6 (b)
ADJACENCY MATRIX

FIGURE 2.7(a)
COMBINED DIRECTED
NETWORK

$$T = t_{ij} =$$

i \ j	1	2	3	4
1		0	0	0
2	1		1	1
3	0	1		1
4	0	1	1	

FIGURE 2.7(b)
ADJACENCY MATRIX

n_s = the total nodes in the subsystem

n = the total nodes in the network.

Examples applying equations (8), (9) and (10) above are better demonstrated when quantifying an actual terminal layout and this is done in Section 2.5.

2.4.2 Matrix Algebra

Most authors of mathematical texts or papers using linear graph theory show their results when presenting various relationships of diagrams or graph forms by using matrix algebra. Garrison et al⁽²²⁾ call the matrix used in network analysis a "connection matrix" and if a network has "n" nodes, the connection matrix is generally square or an "n x n" with each row and column corresponding to a specific node. The elements of the matrix are usually one or zero depending on the existence or non-existence of the line connecting the two nodes. The following is the mathematical formulation of linear graph theory by matrix algebra and pertains to connected planar graphs or networks.

The adjacency matrix depicted in Figure 2.4b has the numbers or functions (X) displayed in its array (a_{ij}) which are generally called its elements. The row and column elements entered are from the connected network of Figure 2.4a, namely the four connected nodes of a directed non-planar graph arrayed as

a square matrix (4 x 4). A matrix of links of this type can be displayed with its elements a_{ij} as follows:

$$a_{ij} = \begin{cases} 1 & \text{if and only if, there exists a link between} \\ & \text{node } i \text{ and } j \\ 0 & \text{if no link exists between node } i \text{ and } j \end{cases}$$

Prihar (23) in a paper on the connectivity of communication systems discusses this concept related to directed networks found in radio and television broadcasting and he defines such networks as:

A matrix of antimetries (one-way links). Figure 2.5b is formed by the following x_{ij} entries

$$x_{ij} = \begin{cases} 1 & \text{if, and only if, there exists a link between} \\ & \text{node } i \text{ and } j \\ 0 & \text{if no link exists between } i \text{ and } j \end{cases}$$

and

A matrix of symmetries (two-way links). Figure 2.6b is formed by the following s_{ij} entries

$$s_{ij} = \begin{cases} 1 & \text{if, and only if, there exists a two-way} \\ & \text{link between } i \text{ and } j \\ 0 & \text{if no link exists between node } i \text{ and } j \\ s_{ij} = s_{ji} \end{cases}$$

But not all networks are just one-way directed or just two-way directed, but may contain a combination of antimetries and symmetries, as shown in Figure 2.2b. A matrix of this type follows the standard as described above, namely the one-way directed network but with consideration given to the direction and number of links present. Gordon () in his text defines this

type of matrix as an adjacency matrix. This combination or adjacency matrix, a matrix of one-way links and two-way links is formed with the following t_{ij} entries:

$$t_{ij} = \begin{cases} 1 & \text{if, and only if, there exists a directed link between node } i \text{ and } j \\ 0 & \text{if no directed link exists between node } i \text{ and } j \\ t_{ij} = t_{ji} \end{cases}$$

A network and its corresponding matrix of this type is shown in Figure 2.7a and b. The sum of the elements across any row (to the right of the matrix) shows at a glance the total number of nodes a particular node is connected with (node 3 radiates two directed links to two other nodes); the sum of the elements down a particular column shows the number of directed links a particular node receives from other nodes (for example, node 1 receives 1 directed link from other nodes).

2.5 Graphs, Networks, Sight Lines and Terminals

As described in Chapter I, section 1.3 and as depicted in Figure 1.2 of Chapter I, the transportation terminal facility, which in this research is considered as the building and its immediate surroundings, is compared to a network consisting of nodes and links. The following discussion relates this network to linear graph theory orientation, visual perception and transportation terminals in order to derive an applicable methodology to quantify terminal user orientation.

The directed graph and adjacency matrix of Figure 2.8a and b, can be compared to a hypothetical transportation terminal

FIGURE 2.8(a)
HYPOTHETICAL
TERMINAL NETWORK

FIGURE 2.8(b)
VISIBILITY MATRIX
(HYPOTHETICAL TERMINAL NETWORK)

WHERE:

L_{mc} = THE TOTAL THEORETICAL SIGHT LINKS WHICH SHOULD EXIST FROM ANY PARTICULAR NODE TO ALL NODES IN THE SYSTEM (ROW TOTALS), OR THE TOTAL THEORETICAL SIGHT LINKS TO ANY NODE FROM ALL THE NODES IN THE SYSTEM (COLUMN TOTALS).

L_t = THE TOTAL ACTUAL MEASURED SIGHT LINKS FROM ANY PARTICULAR NODE TO ALL NODES IN THE SYSTEM (ROW TOTALS).

L_f = THE TOTAL ACTUAL MEASURED SIGHT LINKS TO ANY PARTICULAR NODE FROM ALL NODES IN THE SYSTEM (COLUMN TOTALS).

L_s = THE TOTAL ACTUAL MEASURED SIGHT LINKS FROM ANY PARTICULAR IDENTIFIED SUBSYSTEM NODE TO ALL OTHER NODES IN THE SAME SUBSYSTEM (ROW TOTALS), OR THE TOTAL ACTUAL MEASURED SIGHT LINKS TO ANY PARTICULAR IDENTIFIED SUBSYSTEM NODE FROM ALL OTHER NODES IN THE SAME SUBSYSTEM (COLUMN TOTALS).

L_{so} = THE TOTAL ACTUAL MEASURED SIGHT LINKS FROM ANY PARTICULAR IDENTIFIED SUBSYSTEM NODE TO ALL OTHER NODES IN THE SYSTEM.

L_{sa} = THE TOTAL ACTUAL MEASURED SIGHT LINKS TO THE SYSTEM FROM ANY PARTICULAR IDENTIFIED SUBSYSTEM NODE.

FIGURE 2.8 (b) (CONT'D)

network consisting of nodes and links. The nodes in this network can be classified as a combination of mandatory nodes which a passenger must flow through in order to complete a trip and optional nodes which the passenger may require depending on individual needs. In any terminal these nodes are easily quantified since in each terminal facility all mandatory and optional nodes can be identified. In many cases they are typical of the facility type and need only be numbered and labelled. Therefore, from Figure 2.8a the nodes of this hypothetical terminal network may be labelled as

- Node 1 - main entrance to terminal;
- Node 2 - ticket counter;
- Node 3 - hold room, wait area, or platform; and
- Node 4 - baggage claim.

It is also possible to quantify the links of a terminal network if consideration is given to the spatial or geographical orientation and visual perception theories. As discussed previously, vision was pointed out as the main modality of man which assists in both psychological and physical orientation, stimulating final directed locomotion to an object, goal (node). The links connecting the mandatory nodes and all other optional nodes necessitated by the terminal network system for its users, could therefore be represented by sight lines. These sight lines can also be considered as the depicted directed links in the hypothetical example, diagram 2.8a, based on the fact that a terminal user can stand at one node (origin) or for that matter any node and see a required node (destination) or any number of nodes, and therefore a two-way directed sight line

should exist. That is, from the node to the rest of the nodes or from the rest of the nodes back to the node. However, as demonstrated in diagram 2.8a (dotted lines) and which was observed in the field observations (discussed later), all the visual links between a node desired, or all other nodes in the terminal network, may not exist. Therefore, the visual ability or orientation of the terminal user is decreased. Similarly, when quantifying the total network and cumulating all existing sight links, it may be found that relative to the theoretical sight lines which should exist in a terminal network, that many of the links are non-existent. Therefore the visibility of the total system, or the network, is either poor or good depending on the number of links which are, or are not, present. As demonstrated in diagram 2.8a, possibly due to the size of a node, an obstruction, or the layout of the facility, a terminal user standing at node 1, the main entrance, may find that node 3, the waiting room or platform, cannot be seen (dashed link). Standing at node 4, the baggage claim, and looking for the main entrance, node 1, the user may find that ~~it~~ cannot be observed (dashed link), even though this is the node which may be the next one he desires or is required to be processed through. Entering these existent (recorded as 1, solid links) or non-existent (recorded as 0 dashed links) sight lines in the adjacency matrix, which for this example, is now termed the visibility matrix (Figure 2.8b) and applying the previously discussed graph and matrix algebra theories, the visibility of a node, a subsystem, or the total system, can be quantified, and as previously discussed, can be directly related to the orientation of a terminal user.

From section 2.4.1, and applying equation (2) for a two-way directed graph, the maximum number of visual links which should exist in Figure 2.8a, the hypothetical terminal facility, should be:

$$\ell_{\max} = n (n-1) = 4 (4-1) = 12$$

This is shown in the visibility matrix in Figure 2.8b, in the end row and column, titled "(1) m" where the total of the links which should be radiating from or received by each node is 3 with their sum being 12. Therefore, since we are considering the links as sight lines, the theoretical visibility index of a terminal network, as a surrogate of the theoretical connectivity of the network, is found by using equation (7), section 2.4.1 and is

$$V_{\max} = \frac{\ell_m}{n (n-1)} \times 100\%$$

$$= \frac{12}{4 (4-1)} \times 100\%$$

$$V_{\max} = 100\%$$

where:

$V_{\max}$ is the maximum visibility which a terminal network can have.

The actual number of sight lines which exist in the hypothetical terminal is shown in the end row and column with the heading "(1) t" or "(1) l", and has the sum of 7. Calculating the actual visibility of the terminal network can be done by applying equation (4), section 2.4.1.

$$\begin{aligned}
 V &= \frac{(\ell_t \text{ or } \ell_f)}{n(n-1)} \times 100\% \\
 &= \frac{7}{4(4-1)} \times 100\% \\
 &= 58.3\%
 \end{aligned}$$

where:

V = the actual visibility a terminal network has.

This basically means that only 58.3% of all the possible two-way directed links exist in this terminal network example. Theoretically, the ideal may be 100% when all 12 links are present.

To identify exactly which visual links do or do not exist between the nodes (i.e., to and from), individual node analysis is required, as discussed in the following paragraphs.

To evaluate the visibility of any particular node in the terminal network (either how visible is the rest of the terminal from the node, or how visible is the node from the rest of the terminal) is given by the application of equation 4, section

2.4.1 giving the direction of the links or sight lines. ℓ_t or ℓ_f .

For the purpose of this research, the visibility of a terminal network from a particular node in the network is termed "node orientation" and the actual calculated value is found using this equation (4), section 2.4.1 and may be termed its "node orientation index" (V_o). From the example, the orientation index for node 2 is the row link total entered under the "(2) ℓ_t " column and substituting into equation (4) is:

* A more realistic objective is to strive for something less than 100%.

$$V_o = \frac{l_o}{n-1} \times 100\% \quad t = o$$

$$= \frac{3}{4-1} \times 100\%$$

$$V_o = 100\%$$

Conversely, the visibility of a particular node in the network from the rest of the terminal network is termed "node accessibility" and the actual calculated value is found again using the equation (4), section 2.4.1 and can be termed its "node accessibility index" (V_a). From the example, the accessibility index for node 2 is the column link total entered under the "2 l_f " row and, substituting this into equation (4) is:

$$V_a = \frac{l_a}{n-1} \times 100\%$$

$$= \frac{2}{4-1} \times 100\%$$

$$= 66.7\%$$

$$l_t = l_a$$

Combining the two results from above and terming it "node visibility" (V_T) that is, the average visibility of a node in the terminal is given by equation (5), section 2.4.1 Substituting the link value totals from the example, the visibility of node 2 is (sum of the row and column totals for node 2 being $3 + 2 = 5$):

$$V_T = \frac{l_T}{2(n-1)} \times 100\%$$

$$= \frac{5}{2(4-1)} \times 100\%$$

$$= \frac{5}{6} \times 100\%$$

$$= 83.3\%$$

If, in this hypothetical example, a subsystem of a terminal user type is identified, such as that of an arriving passenger, the visibility of this subsystem itself, i.e., the orientation of a user in the subsystem and terming it "subsystem visibility" (V_s) can be calculated by using equation (8), section 2.4.1:

$$V_s = \frac{l_s}{n_s(n_s-1)} \times 100\%$$

Basically, this equation calculates how visible all the nodes in the subsystem are to the user, thereby quantifying his orientation in the subsystem as he moves through it.

If nodes 1, 3 and 4 are the subsystem of Figure 2.8a, then from Figure 2.8b, the visibility matrix, the row entry for node 1 to node 3 and 4 is $0+0=0$, as shown in column "(3) l_s ". The row entries for node 3 to node 1 and 4 are $0+1=1$, and the row entries from node 4 to 1 and 3 are $0+1=1$ giving a total $0+1+1=2$. Therefore the visibility of this subsystem is:

$$V_s = \frac{l_s}{n_s(n_s-1)} \times 100\%$$

$$= \frac{2}{3(3-1)} \times 100\%$$

$$= \frac{2}{6} \times 100\%$$

$$V_s = 33.3\%$$

Similar to the node accessibility and orientation indices, if a user of a particular subsystem wishes to see any node or nodes in the remaining terminal network, it can be termed "subsystem orientation" with the actual calculated value termed the "subsystem orientation index" (V_{so}).

Therefore, reading across the rows of the matrix in Figure 2.8b corresponding to nodes 1, 3 and 4 (the subsystems) and under the node 2 column, which in this case is the network, gives entries of 0, 1 and 1. They are entered in the end column with the heading "(4) $_{so}$ " with a total of 2. Substituting this into equation (9) of section 2.4.1 reveals a subsystem orientation index of:

$$V_{so} = \frac{so}{n_s (n_s - 1)} \times 100\%$$

$$= \frac{2}{3(4-3)} \times 100\%$$

$$V_{so} = 66.7\%$$

This value shows that the network is not visible by the nodes in the subsystem. Similarly, for an arriving passenger who is in the network, and wishes to return to the subsystem, reading down

the columns of the matrix corresponding to nodes 1, 3 and 4 (the subsystem) and in the node 2 row (the network); gives entries 1, 1, and 1. They are also entered in the bottom row with the heading "(4) ℓ_{sa} " with a sum of 3. Again substituting this into equation (9) gives a subsystem accessibility index of:

$$V_{sa} = \frac{\ell_{sa}}{n_s (n - n_s)} \times 100\%$$

$$= \frac{3}{3 (4-3)} \times 100\%$$

$$V_{sa} = 100.0\%$$

Combining these two results from the above and terming this "total subsystem visibility", which is the visibility of the subsystem relative to the network (total two-way directed sight lines between them), is given by equation (10), section 2.4.1 and, for this example, is:

$$V_{ts} = \frac{\ell_{ts} = (\ell_{so} + \ell_{sa})}{2 n_s (n - n_s)} \times 100\%$$

$$= \frac{2+3}{2 (3) (4-3)} \times 100\%$$

$$V_{ts} = 83.3\%$$

A second hypothetical terminal example will further demonstrate the application of the previously discussed mathematical and visual theories and the impact of terminal layout, directional signs and their placement has to terminal user

orientation. Figure 2.9a may be considered as a simple terminal layout (physical) with 4 nodes as designated. This was designed and can be evaluated exactly the same as the first hypothetical example and the existence of visual links due to the physical observation and recognition of the nodes are recorded in Figure 2.9 b:

Directional signage, that is signs with a node name and an arrow pointing in the direction of the actual location of the node in the terminal, were drawn in the Figure 2.9a layout, and shown in Figure 2.10a in order to demonstrate a hypothetical sign system which may exist in a terminal network. These signs were located to improve the visibility of a terminal user, hence, improve his orientation. This is done by considering the identified non-visible nodes as recorded in the physical visibility matrix of Figure 2.9b as well as considering the possible two-way flows (arriving-departing) of terminal users through the system. For the example, and as recorded in Figure 2.9b, a user entering the front main entrance, node A, may not be able to see and recognize node B due to the angle at which it is situated and the fact that it is recessed into the terminal wall. This is then recorded in the physical visibility matrix as zero (0). The visibility of the node, and therefore the ability of a terminal user to find it, can be improved by placing a directional sign at 90° to the user, and therefore the node can be considered as being seen, providing it is within viewing distance.

FIGURE 2.9(a)
NODE PHYSICAL LAYOUT

FIGURE 2.9(b)
VISIBILITY MATRIX
(NODE - PHYSICAL ONLY)

WHERE:

L_m = THE TOTAL THEORETICAL SIGHT LINKS WHICH SHOULD EXIST FROM ANY PARTICULAR NODE TO ALL NODES IN THE SYSTEM (ROW TOTALS), OR THE TOTAL THEORETICAL SIGHT LINKS TO ANY NODE FROM ALL THE NODES IN THE SYSTEM (COLUMN TOTALS).

L_t = THE TOTAL ACTUAL MEASURED SIGHT LINKS FROM ANY PARTICULAR NODE TO ALL NODES IN THE SYSTEM (ROW TOTALS).

L_c = THE TOTAL ACTUAL MEASURED SIGHT LINKS TO ANY PARTICULAR NODE FROM ALL NODES IN THE SYSTEM (COLUMN TOTALS).

L_s = THE TOTAL ACTUAL MEASURED SIGHT LINKS FROM ANY PARTICULAR IDENTIFIED SUBSYSTEM NODE TO ALL OTHER NODES IN THE SAME SUBSYSTEM (ROW TOTALS), OR THE TOTAL ACTUAL MEASURED SIGHT LINKS TO ANY PARTICULAR IDENTIFIED SUBSYSTEM NODE FROM ALL OTHER NODES IN THE SAME SUBSYSTEM (COLUMN TOTALS).

L_{so} = THE TOTAL ACTUAL MEASURED SIGHT LINKS FROM ANY PARTICULAR IDENTIFIED SUBSYSTEM NODE TO ALL OTHER NODES IN THE SYSTEM.

L_{sa} = THE TOTAL ACTUAL MEASURED SIGHT LINKS TO THE SYSTEM FROM ANY PARTICULAR IDENTIFIED SUBSYSTEM NODE.

FIGURE 2.9 (b) (CONT'D)

The recordings in the visibility matrix of Figure 2.10b were done by considering that a terminal user stands at any node and wishes to see a particular node, or all other nodes, but is only doing so through directional signage.

Observation of a node through a directional sign is recorded in the visibility matrix, Figure 2.10b, and if a node is not observed through a sign, it is recorded as zero (0). If it is observed through a sign, it is recorded as a slash (/). If two different directional signs are observed from one node, and they identify two different nodes, C and D, then one slash is entered under C and one under D. Also, if standing at B, in this case, and only one node, node C, is visible through two different directional signs (that is, one sign in one location and another in a different location), then entry under C is two slashes (/). The above two examples are shown in the visibility matrix of Figure 2.10b.

Quantifying the combination of the visibility of a user of a terminal network by the physical presence of the node and through a directional sign, or both, are recorded in the terminal visibility matrix in Figure 2.11. This example is simply the analysis of whether a node is recognized and identified by the visual perception due to its physical presence and/or through a directional sign. Since the directional signs were installed in the example terminal layout of Figure 2.10a, to try and improve the visibility of the terminal user by the analysis of the

FIGURE 2.10(a)
NODE SIGNAGE LAYOUT

VISIBILITY MATRIX		NODES				ROW TOTALS			
		(A) ENT. EXIT	(B) TICK COUN	(C) HOLD PLAT	(D) BAG CLAIM	(1) l_m	(2) l_t	(3) l_s	(4) l_{so}
N O D E S	(A) ENT. EXIT					3	3	2	1
	(B) TICK COUN	1				3	3		
	(C) HOLD PLAT				0	3	2	1	1
	(D) BAG CLAIM					3	3	2	1
		TOTALS				TOTALS			
C O L T O T A L	(1) l_m	3	3	3	3	12			
	(2) l_t	2	3	4	2		11		
	(3) l_s	2		2	1			5	
	(4) l_{so}	0		2	1			5	3
		TOTALS				TOTALS			

FIGURE 2.10 (b)
VISIBILITY MATRIX
(NODE - SIGNAGE ONLY)

WHERE:

L_m = THE TOTAL THEORETICAL SIGHT LINKS WHICH SHOULD EXIST FROM ANY PARTICULAR NODE TO ALL NODES IN THE SYSTEM (ROW TOTALS), OR THE TOTAL THEORETICAL SIGHT LINKS TO ANY NODE FROM ALL THE NODES IN THE SYSTEM (COLUMN TOTALS).

L_t = THE TOTAL ACTUAL MEASURED SIGHT LINKS FROM ANY PARTICULAR NODE TO ALL NODES IN THE SYSTEM (ROW TOTALS).

L_f = THE TOTAL ACTUAL MEASURED SIGHT LINKS TO ANY PARTICULAR NODE FROM ALL NODES IN THE SYSTEM (COLUMN TOTALS).

L_s = THE TOTAL ACTUAL MEASURED SIGHT LINKS FROM ANY PARTICULAR IDENTIFIED SUBSYSTEM NODE TO ALL OTHER NODES IN THE SAME SUBSYSTEM (ROW TOTALS), OR THE TOTAL ACTUAL MEASURED SIGHT LINKS TO ANY PARTICULAR IDENTIFIED SUBSYSTEM NODE FROM ALL OTHER NODES IN THE SAME SUBSYSTEM (COLUMN TOTALS).

L_{so} = THE TOTAL ACTUAL MEASURED SIGHT LINKS FROM ANY PARTICULAR IDENTIFIED SUBSYSTEM NODE TO ALL OTHER NODES IN THE SYSTEM.

L_{sa} = THE TOTAL ACTUAL MEASURED SIGHT LINKS TO THE SYSTEM FROM ANY PARTICULAR IDENTIFIED SUBSYSTEM NODE.

FIGURE 2.10 (b) (CONT'D)

visibility matrix entries, the results of their quantification (see Table 2.) should be close to ideal, i.e. the terminal user, using this network, should be adequately orientated.

The recordings in the visibility matrix of Figure 2.11 are made when considering that a user may stand at any particular node in the network and desires to perceive any other node, either physically or through a directional sign. If it is seen by its physical presence only, the entry into the visibility matrix is one (1) and if not, the matrix entry is zero (0). If the node (or nodes) desired are seen both physically and through a directional sign, there is an entry of both and one and slash (1 /). If there is no physical perception but a node is observed through a directional sign, the entry is zero, slash (0 /). Conversely, if there is physical perception, but no observation through a directional sign, the matrix entry is one, zero (1 0). If a node is observed through 1,n, directional signs, with or without node physical perception, the entry is one or zero, due to the node physical perception, with 1,n, slashes for directional signage observation. Using Diagram 2.10a as the hypothetical terminal, Figure 2.11 is the matrix compiled by the combined quantification of node visibility, with entries corresponding to observation, either through a directional sign and/or by its physical presence, as discussed above.

Row and column sums in the lower right corner of the matrix of Figure 2.11 are the visibility link sums corresponding to the networks, subsystems or components being analyzed. Sub-

FIGURE 2.11
VISIBILITY MATRIX
 (NODE-COMBINED SIGNAGE
 AND PHYSICAL ONLY)

WHERE:

L_m = THE TOTAL THEORETICAL SIGHT LINKS WHICH SHOULD EXIST FROM ANY PARTICULAR NODE TO ALL NODES IN THE SYSTEM (ROW TOTALS), OR THE TOTAL THEORETICAL SIGHT LINKS TO ANY NODE FROM ALL THE NODES IN THE SYSTEM (COLUMN TOTALS).

L_t = THE TOTAL ACTUAL MEASURED SIGHT LINKS FROM ANY PARTICULAR NODE TO ALL NODES IN THE SYSTEM (ROW TOTALS).

L_f = THE TOTAL ACTUAL MEASURED SIGHT LINKS TO ANY PARTICULAR NODE FROM ALL NODES IN THE SYSTEM (COLUMN TOTALS).

L_s = THE TOTAL ACTUAL MEASURED SIGHT LINKS FROM ANY PARTICULAR IDENTIFIED SUBSYSTEM NODE TO ALL OTHER NODES IN THE SAME SUBSYSTEM (ROW TOTALS), OR THE TOTAL ACTUAL MEASURED SIGHT LINKS TO ANY PARTICULAR IDENTIFIED SUBSYSTEM NODE FROM ALL OTHER NODES IN THE SAME SUBSYSTEM (COLUMN TOTALS).

L_{so} = THE TOTAL ACTUAL MEASURED SIGHT LINKS FROM ANY PARTICULAR IDENTIFIED SUBSYSTEM NODE TO ALL OTHER NODES IN THE SYSTEM.

L_{sa} = THE TOTAL ACTUAL MEASURED SIGHT LINKS TO THE SYSTEM FROM ANY PARTICULAR IDENTIFIED SUBSYSTEM NODE.

FIGURE 2.11(b) (CONT'D)

stituting these link sums into the appropriate equation to complete the quantification of the orientation of a terminal user for all three procedures discussed above are summarized and discussed in the following section.

2.6 Transportation Terminal Users and Components

2.6.1 Basic Definitions

As discussed previously, the primary function of a terminal system is to provide for the transfer of people and goods. This system may consist of a series of subsystems, such as an airport terminal system where there exists an airside subsystem, an interface subsystem, and a landside subsystem⁽³⁾. In all cases of terminal systems the interface is the terminal building and includes the facilities for passenger and baggage processing.

The users of the interface system, and in particular the passengers, can be broadly classified into groups according to their usage. However, before doing so, the terminal building itself must be identified as to what main transportation mode it serves. For example, both a bus terminal building and an airport terminal building were planned, designed and built to process the intended user of the bus and air modes respectively. Hence, the main, or primary, modes are the bus and air transport systems. The access, egress system can be considered as the secondary mode. When the main terminal system function is established, users of the system should be identified and some typical classifications are:

- Employees: persons working for or with the owner/operator of the terminal, the owner/operator of a concession or the owner/operator of the relevant transportation system
- Well Wishers: persons in the terminal who are there to bid farewell to a departing passenger
- Greeters: persons in the terminal who are there to meet or greet an arriving passenger
- Visitors: persons in the terminal who are there to visit an employee or who wish to do business with the owner/operator of the terminal, the concessions or the transport system
- Passengers: persons in the terminal who are there to undertake a transfer between different transportation modes or between the same mode
- Special Users: persons in the terminal who may be all of the above user types who are either children, handicapped or aged.

For the purpose of this work, the passenger is the main concern and this includes the special user, where special users are considered as usually being assisted by a normal individual. Therefore this work pertains to the normal passenger (moves by himself or with other passengers) and the assistants of the special user.. Passengers can also be classified according to their flow within the terminal either from or to the primary or secondary modes (inter-modal transfer) or between the same modes (intra-modal transfer). These are:

Originating Passengers: passengers to begin their trip or portion of it in the primary mode. They undergo an inter-modal transfer through the terminal and are sometimes referred to as departing passengers.

Terminating Passengers: passengers who end their trip or portion of it on the primary mode. They undergo an inter-modal transfer through the terminal and are sometimes referred to as arriving passengers.

Connecting Passengers: passengers who begin or end a portion of their trip and undergo an intr-model transfer on the primary or secondary modes. This transfer usually takes place in the terminal.

It is realized by the author that passengers are either originating, terminating or connecting, and may participate in what is considered a supplementary mode of transportation in the terminal system itself such as vertical transportation (elevators, escalators, etc.) or horizontal transportation (moving walkways, electric carts, etc.). For the purpose of this research they are considered only as public circulation systems taking place in public circulation areas.

As discussed earlier, and adapted from Braaksma⁽¹⁾, the main function of the terminal system is composed of a set of mandatory activities in which a passenger must partake in order to complete or continue a trip. The secondary function of the terminal system is to provide concessions or amenities for the passenger (defined below) which may be considered as optional activities and which are used by choice of the passenger. If these mandatory or optional activities are located at various activity centers or nodes throughout the terminal building and these nodes or centers are connected by sight lines, discussed previously, which in this study are assumed to be desired routes or paths which will be followed by the passenger, then the terminal system may be identified as a network. These nodes and links of the network may be considered as components of the terminal system and are defined as follows:

Nodes: are activity centers in the terminal system which a passenger flows through in order to satisfy a personal or required processing need. They may be identified by the function they perform or by signage. They may further be classified as follows:

- a) Mandatory Nodes: activity centers in the terminal system which a passenger must flow through in order to satisfy a processing requirement. They are identified by the function they perform or by signage.
- b) Optional Nodes: activity centers in the terminal system which a passenger may flow through in order to satisfy a personal need. They are identified by the function they perform or by signage. They can be further classified as follows:
 - i) Amenities: an activity center which increases physical or material comfort of the passenger (or user). They are not basically considered as non-revenue producing for the owner/operator. (washrooms)
 - ii) Concessions: activity centers which increases physical or material comfort of the passenger (or user). They are basically considered as revenue producing for the owner/operator. (car rentals)

Links: are visual sight lines between nodes which a passenger sights along to see required nodes. They consist of straight lines from any portion of the nodes to any portion of the required nodes and a sight line is said to exist if and only if the required nodes are easily identified or recognized either by function or by signage.

Pseudo Nodes: are points in the terminal which assist and/or direct a passenger to other nodes. These points are generally signs or clusters of signs and form part of the link portion of the network. They, for the purpose of this study, are not considered as actual nodes (hence term pseudo). They become surrogate for the real activity center and can be further classified as follows:

- a) Directional Signs: are signs or clusters of signs which assist in directing a passenger to a required node. They usually consist of word letters or symbols and are accompanied by a directional arrow.
- b) Identification Signs: are signs or clusters of signs which are located or attached to, or are in extremely close proximity of a required node. They may consist of word letters or symbols and are not accompanied by directional signs.

- c) Advertisement Signs: are generally signs or clusters of signs of certain size and character distributed throughout the terminal and serve only the purpose of advertising for its owner and a source of revenue for the owner/operator of the terminal.

It is also recognized that the terminal may have a complex information system consisting of visual (sight), and aural (sound) or tactile (touch) methods for dispensing information. However, only those systems which assist the passenger visually in the recognition of a node (origin or destination) are considered in this research work.

The previous list of passengers classified according to their flow patterns may be further classified according to their flow type. It is important to note that these "flow types" may be conceived as a subsystem within the main terminal system and their flow patterns form individual networks in the terminal consisting of links and nodes.

For intercity trips on bus, rail, air or marine modes, originating, connecting or terminating passengers of the primary or secondary modes may have as a portion of their trip, a certain trip type such as domestic, transborder or international and may be classified accordingly. Transborder or international passengers usually are required at their point of origin, termination or connection to be processed through government facilities (customs and immigration). Domestic passengers usually are not (depending on government requirements) and trip types as these may be within a country, state, province, region or city. A list of these subsystems, their flow types and combinations which may be

found within the terminal system, are as follows:

Each a passenger terminal subsystem	{	originating - domestic	}	Each a network of links and nodes
		originating - transborder		
		originating - international		
		terminating - domestic		
		terminating - transborder		
		terminating - international		
		connecting - domestic to/from domestic		
		connecting - domestic to/from transborder		
		connecting - domestic to/from int'l		
		connecting - transborder to/from int'l		

The passenger types listed above form individual passenger subsystems which may be considered as networks comprised of nodes and links. Their links are the visual sight lines and their nodes, the mandatory processing requirements (and all optional nodes). Those mandatory nodes may be listed as follows considering the passenger flow type as depicted in Table 2.1.

2.6.2 Discussion of Results

The designed terminal node layout in the second example shown in Figure 2.9a is exactly the same as the first hypothetical terminal network shown in Figure 2.8a. Therefore, the visibility matrix entries of Figure 2.9b for the terminal are exactly the same as the entries for the hypothetical terminal network, Figure 2.8b. This is verified with the first two row entries (1 and 2) in Table 2.2, displaying equal visibility indices for the same node, subsystem and network or terminal system.

The quantification of the matrix entries of the total terminal network in Figure 2.9b, only, due to their observation by their physical presence only, can be found in row 3 of Table 2.2.

The results show in the actual visibility column (V) that this network has only 58.3% of the theoretically possible visual links present. In order to identify where the remaining 41.7% of the links are deficient, individual node analysis is required. This is done by first calculating the visibility of each node in the system. Using the matrix entries in Figure 2.9b and applying equation (5) from the previous section 2.4.1 yields:

$$\text{Node A: } V_{nA} = 16.7\%$$

$$\text{Node B: } V_{nB} = 83.3\%$$

$$\text{Node C: } V_{nC} = 66.7\%$$

$$\text{Node D: } V_{nD} = 66.7\%$$

These calculations reveal that all nodes in the terminal have link deficiencies, with node B the least deficient. To further pinpoint exactly where these node links are deficient, the application of equation (4) to calculate the orientation (links from a node to the rest of the network) and accessibility (links from the rest of the system to a node) yields:

(Orientation)		(Accessibility)	
V_{OA}	= 0.0%	V_{aA}	= 33.3%
V_{OB}	= 100.0%	V_{aB}	= 66.7%
V_{OC}	= 66.7%	V_{aC}	= 66.7%
V_{OD}	= 66.7%	V_{aD}	= 66.7%

From the above, it can be seen that the orientation index for node B is ideal. Therefore, a user standing at node B and wishing to observe one or all other nodes in the system will be able to do so since all the one-way visual links to the system are present. Node A is the least visible, that is, all the

MANDATORY NODES*	OPTIONAL NODES*	
	AMENITIES	CONCESSIONS
1. TICKET FARE COLLECTION COUNTERS OR BOOTHS; ALSO BAG CHECK-IN	1. WASHROOMS	1. RESTAURANTS, BARS
2. PUBLIC CIRCULATION AREAS (STAIRS, ESCALATORS, ELEVATORS, DOORS - EXIT, ENTRANCE - VERTICAL AND HORIZONTAL TRANSPORTATION SYSTEMS)	2. TELEPHONES	2. CAR RENTALS
3. FEDERAL INSPECTION AREAS CUSTOMS AND IMMIGRATION	3. INFORMATION CENTRES: - MONITORS - BOOTHS - TIMETABLE BOARD	3. LOCKERS
4. DEPARTURE AREA OR LOUNGE, WAIT ROOM, HOLD ROOM, WAIT AREA	4. FIRST AID	4. SHOPS - GIFT, BOOK, SMOKE (ALL RETAIL STORES)
5. PASSENGER BOARDING DEVICE (IF NECESSARY) STAIRS, STEPS, MOBILE LOUNGE, CURB (PAVEMENT) GANTRY	5. NURSERY	5. INSURANCE COUNTERS
6. BAGGAGE CLAIM AREA	6. POST BOX, STAMPS	6. CURRENCY EXCHANGE COUNTERS
7. BOARDING AREA; PLAT- FORM, APRON, DOCK		7. GROUND TRANS- PORT INFO. BOOTHS - TAXI, BUS, ETC.
8. CURB AREA; SECONDARY TRANSPORTATION BOARD- DEBOARD AREA AND DEVICES		8. HOTEL PHONES

* ALL OR SOME ARE PRESENT AT TERMINALS DEPENDING ON MODES SERVED AND SIZE OF TERMINAL.

TABLE 2.1
NODE CLASSIFICATION

visual links radiating from A are absent, and some of the links received by A are also absent. This can be further justified by the application of equation (4) which will quantify the visibility value of a node if one or any number of its one-way links are absent. For example:

For any node: $N = 4$.

$$\text{All links present } V=3 \quad V = \frac{3}{4-1} \times 100\% = \frac{3}{4-1} \times 100\% = 100\%$$

$$\text{One link absent } V=2 \quad V = \frac{2}{4-1} \times 100\% = \frac{2}{3} \times 100\% = 66.7\%$$

$$\text{Two links absent } V=1 \quad V = \frac{1}{4-1} \times 100\% = \frac{1}{3} \times 100\% = 33.3\%$$

$$\text{All links absent } V=0 \quad V = \frac{0}{4-1} \times 100\% = \frac{0}{3} \times 100\% = 0\%$$

From the previous calculations, nodes C and D (V_{OC} , V_{OD}) are each missing one link radiating from them, for a sum of two links. Nodes B, C and D (V_{aB} , V_{aC} , V_{aD}) are each missing one received links, respectively for a sum of three, giving an overall total of five links. Node A receives one link (V_{aA}), possibly from node B, yet it is missing two links, which may be those radiated from C and D (V_{OC} , V_{OD}). Also, node A (V_{OA}) does not radiate any links, which are probably those not received by nodes B, C and D (V_{aB} , V_{aC} , and V_{aD}). This gives a total for node A of five missing links. Hence, it is obvious that since the two missing link sums are equal, node A is the problem node in the system.

This deficient node may also justify the low visibility values in the quantification of the total system ("V" column 3 in Table 2.2) and in the visibility results for the chosen subsystem (V_s , V_{so} , V_{sa} columns in Table 2.2). Row and column entries for node A in the visibility matrix, Figure 2.9b will further justify the lack of links radiating and received by the node.

Although identifying deficiencies of links in matrix rows and columns appears rather simple, (particularly in this case since it is such a small terminal with a well defined layout), complex terminal layouts with large visibility matrices will prove to be extremely difficult when attempting to identify particular problems. As will be shown later, the analyst must rely totally on the quantification equations.

In order to correct the problem of poor visibility, that is, the disorientation which a terminal user may undergo, three options are available to the terminal designer. They are:

- i) to relocate the node so that it is visible to and from the rest of the nodes in the system,
- ii) to remove the obstruction, which in this case is a wall, or
- iii) to install an adequate information system, namely, an appropriate directional or identification signage system.

When considering the costs associated with the above design alternatives, particularly if it is an existing facility, it is obvious that those associated with construction and the

possible disruption to user service are in excess of the costs associated with the quantification and installation of adequate signage.

If a proposed signage information system is to be installed in a new or existing facility, it would be ideal if it could be quantified for effectiveness prior to installation in order to establish its correct location and number. This would maximize user orientation and reduce costs incurred with the installation of unnecessary signs. An example of how this may be done is shown in Figure 2.10a by the plotting of a signage system on the existing terminal layout, adopted from Figure 2.9a. Visibility links between the terminal system, subsystem and its individual nodes attributed only to the directional signage identifying them, are then entered into the visibility matrix as shown in Figure 2.10b. These entries are then summed and substituted into the appropriate equation to quantify the effect of the proposed signage system and hence, its contribution to user orientation.

Since node A was identified as the problem node in the physical visibility analysis, sign layout design effort should be concentrated on this node, making it more visible to the system, or the rest of the system being more visible from the node. Once accomplished, additional signage may be added to improve any other deficiencies (if identified and needed).

To show poor design effort and the effect of signs on user orientation, a sample sign system was drawn on the same

terminal layout of Figure 2.9a and is displayed in Figure 2.10a. This particular signage system, although it does consider the problem of the node A deficiency, was drawn to demonstrate how the lack of correct quantification procedures (such as placing signs where intuition and rule of thumb techniques govern) may lead to unnecessary costs by the placement of too many signs and which might also contribute to the disorientation of a user in the terminal system.

Two directional signage installations were drawn on the layout, with the existent or non-existent visual links entered in Table 2.2 (third row). Compared to the previous visibility calculations, such as 58.3% for the actual visibility (V) of the terminal system due to physical presence analysis, the signage system alone has increased the terminal system visibility to 91.7%. Also, the accessibility of node P in the physical node analysis was only 66.7% visible, but due to the signage alone, the node is now 100% visible. The subsystem identified as nodes A, C and D has also been improved with an increase from 33.3% to 83.3%. Its orientation index has similarly increased from 66.7% to 100%.

The only problems identified, shown in the signage visibility matrix of Figure 2.10b, are: node C does not see node D through a sign (0 entry) and node B observes node C through two signs (2 entry). Although the total links radiating from B show there are three links present (0, 1, 1 column - heavy square) it does not mean that all links are visible to the nodes, i.e. radiating to C, P and A.

The combined quantification of the visibility of the example terminal system, its subsystem and individual nodes due to the visual perception by the physical presence of nodes and the signage system, can be found in row 4 of Table 2.2. Link entries due to the possible visual observation of the nodes are entered in the combined visibility matrix (see Figure 2.11).

Since ideal visibility, that is, where all nodes are visible both ways, is indicative by an index result of 100%,* it can be realized that if from one node, another node or all nodes can be observed by their physical presence and a sign (or through other signs), an index could exist which is much greater than the ideal. Since a node cannot be physically observed more than once from any other node, that is, two links exist between nodes (one one way and one the other way, as explained in section 2.4.1) an index greater than the ideal can only be indicative of an over signage problem. That is, the node is observed by itself and through a sign or many signs. This is also true if a node is not physically visible, but is observed through more than one sign.

If an over signage problem is identified, then two constraints should be considered by the designer:

- 1) that the presence of the sign or signs, identified as creating a problem for a particular node or nodes, may be justified since they may serve as verification to a user travelling on a particular subsystem or between two nodes far removed from each other, that he is indeed travelling in the right direction; or that a node may not be immediately recognized to a user and that may also serve as verification that he is indeed at his required destination;

- ii) that the removal of a sign may be justified for one particular node where there is an identified visual problem. However, consideration must be given to the fact that its removal may decrease the visibility of that node from another node, or nodes in the terminal.

These constraints point out again the fact that individual node analysis and quantification is required. For example, in Figure 2.11, node B (row entries) physically sees all the other nodes, A, C and D (2 entries), yet the addition of signs has increased their visibility (/ entries) above the required ideal index (3 ideal versus 6). It would therefore be indicative to remove the sign or signs associated with this over signage problem. In doing so, however, this would reduce the visibility of node A. This is because from node B, nodes C and D are observed both physically and through a sign (two signs for node C = 2 // 's). But, standing at node A, nodes C and D are only visible through one of the sign sets which may be removed, when removing the over signage problem for node B.

An over signage problem which can be removed is the sign in front of node C. Considering the two constraints discussed above (and that it does not verify a user's route, and that the node can be recognized as it stands from all other nodes) the removal of the sign, since node C can be recognized physically from D and B, is justified. A single slash in the matrix for nodes B and D under the C column can therefore be removed (see Figure 2.10). Similarly, the B sign portion of the AB sign set on the central signage cluster can be removed, since node B is considered as visible physically from nodes D and C. Since

node B sees both nodes C and D physically, as well as through the CD sign set on the central cluster, the removal of this over signage problem can be accomplished by relocating the cluster directly in front of node B. Here, the sign set displaying A is still visible to nodes C and D, and the sign cluster displaying CD and B is still visible to node A. Node B need not observe any of the signs displayed since it can, as indicated previously, see nodes A, C and D physically, and therefore the sign cluster is located at 180° to the node.

Although the above has been quantified by the observation of the individual node entries in the matrix of Figure 2.11, the identification of signage problems at each node can also be done by the application of the appropriate equation as detailed in section 2.4.1.

The improvements to the proposed signage system are displayed in Figure 2.12a with corresponding visual link measurements in Figure 2.12b. Quantification of the visibility of this new combined system is displayed in row 5 of Table 2.2. Observation of these results reveal that the terminal system, its subsystem and its components have attained the ideal, which indicates that a normal user of the terminal should undergo little or no disorientation problems.

In conclusion, the orientation of a terminal user is dependent on the design and layout of the terminal facility. Although terminal planners and designers attempt to achieve the objective where the final design allows for total system visibility,

VISIBILITY CALCULATIONS HYPOTHETICAL EXAMPLE	L_{max} THEORETICAL LINKS (SYSTEM)	V_{max} THEORETICAL VISIBILITY (SYSTEM)	V ACTUAL VISIBILITY (SYSTEM)	$\mathcal{U}_O$ ORIENTATION INDEX (NODE 2)	$\mathcal{U}_a$ ACCESSIBILITY INDEX (NODE 2) (NODE B)	V_m NODE VISIBILITY (NODE 2) (NODE B)	V_s SUB- SYSTEM VISIBILITY (NODES 1,3,4) (NODE A,C,D)	V_{SO} SUB- SYSTEM ORIENTATION INDEX (NODES 1,3,4) (NODE A,C,D)	V_{SO} SUB- SYSTEM ACCESSIBILITY INDEX (NODES 1,3,4)
1 NETWORK FIGURE 2.8(a,b)	12	100	58.3	100	66.7	83.3	33.3	66.7	100
2 TERMINAL LAYOUT (NODES ONLY) FIGURE 2.9(a,b)	12	100	58.3	100	66.7	83.3	33.3	66.7	100
3 TERMINAL LAYOUT (SIGNS ONLY) FIGURE 2.10(a,b)	12	100	91.7	100	100	100	83.3	100	100
4 TERMINAL LAYOUT (COMBINED) FIGURE 2.11	12	100	150	200	166.7	183.3	100.0	83.3	100
5 TERMINAL LAYOUT (IMPROVED-COMBINED) FIGURE 2.12(a,b)	12	100	100	100	100	100	100	100	100

TABLE 2.2
SUMMARY OF VISIBILITY INDEX CALCULATIONS

FIGURE 2.12(a)
IMPROVED SIGNAGE

FIGURE 2.12(b)
VISIBILITY MATRIX
(IMPROVED SIGNAGE AND PHYSICAL)

WHERE:

L_m = THE TOTAL THEORETICAL SIGHT LINKS WHICH SHOULD EXIST FROM ANY PARTICULAR NODE TO ALL NODES IN THE SYSTEM (ROW TOTALS), OR THE TOTAL THEORETICAL SIGHT LINKS TO ANY NODE FROM ALL THE NODES IN THE SYSTEM (COLUMN TOTALS).

L_t = THE TOTAL ACTUAL MEASURED SIGHT LINKS FROM ANY PARTICULAR NODE TO ALL NODES IN THE SYSTEM (ROW TOTALS).

L_f = THE TOTAL ACTUAL MEASURED SIGHT LINKS TO ANY PARTICULAR NODE FROM ALL NODES IN THE SYSTEM (COLUMN TOTALS).

L_s = THE TOTAL ACTUAL MEASURED SIGHT LINKS FROM ANY PARTICULAR IDENTIFIED SUBSYSTEM NODE TO ALL OTHER NODES IN THE SAME SUBSYSTEM (ROW TOTALS), OR THE TOTAL ACTUAL MEASURED SIGHT LINKS TO ANY PARTICULAR IDENTIFIED SUBSYSTEM NODE FROM ALL OTHER NODES IN THE SAME SUBSYSTEM (COLUMN TOTALS).

L_{so} = THE TOTAL ACTUAL MEASURED SIGHT LINKS FROM ANY PARTICULAR IDENTIFIED SUBSYSTEM NODE TO ALL OTHER NODES IN THE SYSTEM.

L_{sa} = THE TOTAL ACTUAL MEASURED SIGHT LINKS TO THE SYSTEM FROM ANY PARTICULAR IDENTIFIED SUBSYSTEM NODE.

FIGURE 2.12(b) (CONT'D)

there is no quantification technique which will indicate how adequately the design meets this objective. To reach the objective, terminal designers, in conjunction with graphic designers, install signage systems after the facility design is complete, and in many cases when the terminal is actually operating, so that any design deficiencies related to user orientation can be reduced. However, if the layout design was quantified by visual considerations and measurements prior to construction (with user orientation as one of the main criteria for design) the quantification technique described in this section may provide the designer with an optimum user orientation condition, combining both the physical visibility of the system and the most adequate signage information system.

2.7 Summary and Conclusions

A statement of the original objective which this research is proposing to attain or quantify is necessary at this time in order to understand the relationship of the previous sections of this chapter. A major design objective in terminal facility planning, as was stressed previously, is to minimize passenger disorientation with the proposed specific criteria for evaluating this objective, being network analysis. A performance measure of this criteria may be carried out by the application of linear graph theory with matrix algebra applications. In order to do this, the terminal system needs to be defined and its subsystems and components identified. Once this is accomplished, the system can be represented as a network with its

components being the individual nodes such as processors and concessions and the links being sight lines and paths, with its subsystems pertaining to identified passenger types and their related flow patterns. A matrix of the components is arrayed and linear algebra applied to quantify the connectivity of the system, its subsystem and components. Further algebraic analysis will quantify other components and subsystems of the terminal system, such as the adequacy of the location of its components and signage information systems.

In conclusion, the results obtained can be directly related to orientation, since a high connectivity or visibility index of the system, its subsystem and components will mean that there exists a high degree of visual perception through sight lines, which has been stressed as the prime factor for terminal user orientation and motivation.

CHAPTER 3

DATA COLLECTION

3.1 Obtaining Sight Line Data

The data base used to calculate the terminal visibility indices and required for sight line analysis may be obtained from a floor plan or site survey. Floor plan data collection involves the procurement of a set of up-to-date floor plans of a terminal and then counting the links between the terminal's nodes. This method is quite similar to the method used in the previous chapter with the sight line analysis of the hypothetical example. On the other hand, site survey data collection is taken by field surveyors in the field and is the measurement of the sight lines between nodes in an existing terminal. Four observations are required to be undertaken in the site survey which are described in detail in Section 3.3. Table 3.1 lists the advantages and disadvantages of the two data collection methods.

The following sections contain a brief description of the collection methods and how the compiled data might be used to calculate terminal visibility indices. A few basic guidelines are also recommended which should be considered in the methodology application. Chapter 6 gives a complete description of how the data is used in the sight line analysis measurement of human orientation.

FLOOR PLAN DATA COLLECTION

Advantages

- can be applied to both existing and new terminal facilities
- simple to carry out
- individual subsystems and their components can be easily identified
- less disruption to existing terminal operations since it is "office orientated"
- less expensive (one man, one set of drawings)
- provides a method to apply an optimal layout for new terminal design with fully visible nodes and signage system
- can be used as a check on design objectives
- allows for adequate information system layout (signage)

Disadvantages

- does not account for physically placed barriers in existing or new terminals
- involves more computational effort and data manipulation with transfers (floor plans to three matrices)
- does not consider operational problems (peak-hour volumes, existing levels of service)
- visual perception ability/ distance not accurately accounted for during the peak hours

Table 3.1

DATA COLLECTION

(Floor Plans)

SITE SURVEY DATA COLLECTION

Advantages

- accounts for physical barriers or objects obstructing vision
- accounts for operational problems (peak hour volumes, levels of service)
- less computational efforts (data collection procedures - 1 matrix to 2 matrices)
- simple to carry out
- joint camera survey gives permanent record of existing conditions
- visual perception abilities/distances accurately accounted for
- allows for qualitative evaluation of the terminal (observation survey)
- can be used to check on design objectives
- evaluates existing information system installation
- non-disruptive to terminal operations

Disadvantages

- can only be used for existing facility analysis
- relatively expensive (2 surveyors plus associated trip expenses)
- more personnel required for both data collection and analysis

Table 3.1 (cont'd)

DATA COLLECTION

(Site Surveys)

3.2 Floor Plan Data Collection

Floor plan data compilation is basically the quantification of the visibility of the nodes in a terminal due only to the physical presence of identified and classified nodes drawn on a floor plan. This method is particularly useful when evaluating proposed terminal designs and signage systems, and their effect on user orientation. It is also useful in evaluating existing terminal designs and signage systems. When combining its quantified results with visual site survey results, an overall methodology is provided for the accurate quantification of user orientation.

The data collection for the floor plans involves the identification and classification of all nodes which are found drafted to scale on a terminal floor plan. Each node is identified as to what it is, and classified according to its function, that is, whether it is a mandatory or optional node. Table 2.1 is a node classification list and may serve as a guideline for this stage. These nodes are then entered in a visibility matrix, described in the previous chapter (Figures 2.9b, 2.10b, 2.11, and 2.12b). Sight lines are established, but not necessarily drawn on the layout, by the use of a straight edge joining the origin node (the node considered at the time) to all other nodes (destination nodes). A problem exists in the establishment of what a terminal user can actually see and at what distance. It must therefore be determined where a user at a node positions himself in order to visually orientate. The following sections

detail guidelines which have been established from the research of others, and by the author's observations, which should be considered when evaluating whether a sight line on a floor plan does, in fact, exist.

3.2.1 Floor Plans and Distance

From a previous definition, a node must be seen and identified for a sight line to exist and therefore its existence is dependent on the size of the node, its location and the user service volume expected to function in the terminal.

Large or medium areas designated as nodes such as shops (restaurant, coffee, bar, retail), ticket counter areas, platforms, gates, wait areas, exits or entrances, and stairs or escalators, or those areas bounded between the ceiling and terminal floor, can be considered to be seen and identified at a distance of 300 metres. This was established from psychological and visual perception research (17), research in traffic engineering on the visual acuity (8)* of vehicle drivers and by personal observations in the field by the author and his assistants. The application of this distance to floor plans also assumes that:

- i) most individuals have normal or near normal visual acuity,
- ii) both frequent and infrequent terminal users are able to recognize these areas.

* Visual acuity may be defined as an individual's ability to detect separation between two points, or the ability to detect a figure from its background or to detect the border of a stimulus (Ref. 8).

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- iii) all components of the terminal are to operate or are operating at service volumes corresponding to levels of service of C or greater as designated by Frain(7);
- iv) the nodes are not obscured by aesthetic or physically placed facades such as partitions, plants, curtains or posters;
- v) a node's enclosure, walls, or counters, or its identification sign or its actual physical situation falls within a horizontal viewing angle of sixty degrees (60°) from a line drawn perpendicular to the line of sight as shown below in Figure 3.1,

FIGURE 3.1
PERCEPTION ANGLE
(FLOOR PLAN ANALYSIS)

- vi) there is adequate lighting with minimum reflection and maximum background contrast;
- vii) in most cases there are present large (0.6 meters or greater), recognizable overhead identification symbols or signs such as Air Canada, Rent-a-Car, Tickets, gate number, exit or entrance, etc. (in the appropriate languages);

Medium or small areas with physical heights less than seven feet (booths, counters, seats, lockers, low baggage tracks, phones, doors, elevators, etc.), can be considered as seen and identified at a distance of 100 metres and it is assumed that:

- i) all the above points i), ii), iii), iv), v), vi), except vii) for the large areas are considered,
- ii) some sort of identification symbol or sign (0.25 m to 0.6 m in height) is present in most cases and is in close proximity (overhead, beside or attached to) the node considered.

As user volumes increase and approach capacity, there exists a point (different to many) where terminal users begin to depend mainly on visual information systems to orientate themselves through the terminal to a particular destination or destinations. Considering this visual dependency, it is therefore essential that any proposed signage system for a new terminal be evaluated in order to provide the user with the ability to attain maximum orientation. This also applies to existing signage systems in terminals already constructed.

In order to evaluate the effect of signage information systems, the following Transport Canada guidelines, developed for interior airport terminal signage installations and found in their sign manual (18), should be followed:

1. "Mounting height ideally should be 8' - 0" (2.44 m) from the bottom of the sign to the floor. This places the image at the optimum level for the normal field of view.
2. The size of sign required is related to:
 - a) space availability in the building,
 - b) viewing distance possible in the building,
 - c) viewing distance limitations of the passengers.
3. The first two items obviously cannot be covered by a standard as they relate to specific building features. As a general guide, the following rules for viewing distances have been found to be applicable.

<u>Type of Sign</u>	<u>Size</u>	<u>Av. Viewing Dist. in Ft.</u>
Pictograph	18 ins. (0.5 m)	180 (55 m)
Pictograph	12 ins. (0.3 m)	120 (31 m)
Written message	12 in. letter (0.3 m)	300 (91 m)
Written message	8 in. letter (0.23 m)	200 (61 m)
Written message	5 in. letter (0.13 m)	125 (38 m)

It is extremely difficult to tell exactly what level of service a terminal is to operate at, or is operating at, and for what periods of time. Similarly, it is also difficult to quantify at what particular level of service the average user begins to depend on the signage system since, as the level of service decreases, user inter-spatial separation decreases, which in turn causes visual perception of the lower nodes (less than 2.0 metres in size) to also decrease. Measurement to include these two factors in this research would involve a totally different research effort, that is, level of service quantification by the possible application of Fruin's⁽⁷⁾ criterion for level of service evaluation, as well as some sort of psychological survey to determine the average user's dependency on signs, at what level of service this dependency increases and to what degree. Therefore, user service volumes were not considered in floor plan data collection as contributing to the decrease of visual perception of the nodes. Yet, the author cautions that when collecting data from a floor plan, service volumes and their corresponding levels of service should be considered and the guidelines outlined above, particularly those related to perception distance.

3.2.2 Floor Plans and Node Designation

An origin node may not be considered as existing on the floor plan as a single point, but rather a defined area around the actual physical area or point considered. It was found by observation, that when a passenger visually perceives in order

to orientate, he/she does so, in most cases in motion, at a slight distance away from the actual node. An observed, or destination node though, is only considered as viewed based on its actual physical composition and does not have a described orientation area around it.

The following guidelines should assist when establishing orientation areas of origin nodes.

- i) Entrances and exists of the terminal or its facilities have a radius of a semi-circle of one to two metres beyond the actual doorway. In Figure 3.2, node 1, an exit, serves as an example. Node 7, when considered as a destination node observed from the origin node 1, would, through observation, not have an orientation area and in this case cannot, therefore, be seen.
- II) Processing and wait areas of the terminal, or within its immediate surroundings, also radiates one or two metres beyond its actual physical composition or spatial configuration. An example in Figure 3.2 is the wait area, origin node 10 which has an orientation area as shaded. Similarly, node 19, the baggage claim area, has an orientation area as shaded. However, node 19, when considered as a destination node viewed from an origin node, consists only of the baggage race track itself. Also, node 10, the wait area, when considered as a destination node, consists only of the actual seat layout. In other words, if one can see the seats, and it is recognized and identified as a wait area, then node 3 is said to be seen and a sight line exists.
- iii) Curbs, Platforms and Signs - Curbs or platform areas, when considered as origin nodes, extend over their entire length or area as designed. Sign clusters suspended from ceilings, on posts, or attached to walls, may also have a one to two metre orientation area when considered as origin nodes.

Summarizing, each origin node has a P.O.M. area (perception, orientation, motivation) and usually radiates one to two metres around the node. A destination node does not, for it must be observed and recognized as it physically stands.

3.2.3 Floor Plans and Matrix Formulation

Once all nodes are coded, numbered or labelled, a matrix is drawn up with the nodes entered into corresponding columns and rows. One origin node is selected and from this node all destination nodes are "joined" by sight lines using a straight edge on the plan. Each destination node "seen" is entered in the matrix as one. If "seen" through a sign, entry is slash and if not, entry is a zero. This is repeated for all nodes in the terminal. An example of floor plan matrix entries is shown in Figure 3.3, which was compiled from the Moncton, New Brunswick international airport floor plan depicted in Figure 3.2.

3.3 Site Survey Data Collection

Visual site survey data collection involves the actual physical field measurement of a terminal node system by one or two surveyors. A visual survey of Moncton International took place on June 15, 1977 and its visibility matrix as recorded in the field, is shown in Figure 3.4. It should be noted that this matrix is a combination matrix which, as discussed in Chapter 2, includes the visibility of nodes due to their presence and through signs. From this matrix, as will be shown in Chapter 4,

FIGURE 3.2
MONCTON INTERNATIONAL AIRPORT (NTS)
 FLOOR PLAN / P.O.M. AREAS - SHADED

VISIBILITY MATRIX	1.	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
	ENT, EXIT - EAST	TICKET COUNTER AIR CANADA	TICKET COUNTER EPA	SCHEDULE	POST BOX	PHONES EAST	COFFEE, BOUT, BAR	SECURITY CHECK	HOLDROOM	WAIT AREA	PHONES	ARRIVALS - DOMESTIC	AIRSIDE	CURB	ENT, EXIT - CENTRAL	WASHROOMS	PHONES (BAG)	ENT, EXIT (BAG)	BAG CLAIM DEVICE	LOCKERS	CUSTOMS, IMMIG	CAR RENTALS	ARRIVALS - INT					
1 ENT, EXIT EAST	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
2 TICKET COUNTER AIR CAN	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
3 TICKET COUNTER EPA	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
4 SCHEDULE	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
5 POST BOX	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
6 PHONES (EAST)	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
7 COFFEE, BOUT, BAR	1	1	1	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0					
8 SECURITY CHECK	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0					
9 HOLDROOM	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0					
10 WAIT AREA	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0					
11 PHONES	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0					
12 ARRIVALS - DOMESTIC	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0					
13 AIRSIDE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
14 CURB	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
15 ENT, EXIT - CENTRAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
16 WASHROOMS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
17 PHONES (BAG)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
18 ENT, EXIT (BAG)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
19 BAG CLAIM DEVICE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
20 LOCKERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
21 CUSTOMS, IMMIG.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
22 CAR RENTALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
23 ARRIVALS - INT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
24																												
25																												
26																												
27																												
28																												

FIGURE 3.3
 MONCTON INTERNATIONAL AIRPORT
 (VISIBILITY MATRIX - FLOOR)

VISIBILITY MATRIX																												
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1 ENT, EXIT (EAST)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 TICKET COUNTER AIR CANADA	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 TICKET COUNTER EPA	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4 PHONES (LOCAL)	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 COFFEE, REST, BAR	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 WAIT ROOM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7 SECURITY CHECK	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8 AIRSIDE	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9 HOLDROOM	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 POST BOX	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 PHONES (LOCAL HOTEL)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 CAR RENTAL	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 ARRIVAL GATE	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 CUSTOMS, IMM AREA	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 LOCKERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
16 BAG CLAIM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
17 WASHROOMS 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
18 ENT, EXIT (CENTRAL)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
19 ENT, EXIT (BAG)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
20 CURB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
21 PHONES (BAG)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
22 BOUTIQUE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
23 SCHEDULE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

FIGURE 3.4
MONCTON INTERNATIONAL AIRPORT
(VISIBILITY MATRIX - SITE)

besides the full evaluation of the terminal's system, subsystem and components, the visual links due to the signage system can be extracted and evaluated in order to determine its adequacy relative to user orientation as well as the evaluation of the visibility of the nodes alone, due to their physical presence and adequacy of layout.

The following procedures with noted guidelines were derived from notes and experience gained from terminal site surveys and should be followed with the application of the site survey analysis technique.

3.3.1 Preliminary Site Survey

An initial "walk through" should be carried out to identify all nodes and signage carefully noting their physical location on a floor plan and establishing their function by name, code or number. The following "check list" may assist in doing this:

- i) locate on the floor plan a name, number or code for all major or mandatory processing nodes (see Table 2.1 for a guideline),
- ii) locate on the floor plan a name, number or code for all optional nodes (again see Table 2.1 for a guideline),
- iii) locate on the floor plan and name, number code and measure the size and letter height of all signs, establishing whether they are identification or directional signs types and whether they are word or symbol signs,
- iv) identify and record on a floor plan, with a word description or code if necessary, all problem areas such as reflection and refraction of glass partitions.
- v) locate all windows, curtains, plants and other possible sight line obstructions.

Once the above has been completed, it is necessary to ascertain from the owner/operator, or from a schedule, the peak hour or busy period so that the actual field measurement may be carried out during this time. If time permits prior to the busy period, a second "walk through" should be carried out with a camera. If time does not permit, this survey may follow the visual survey. The camera survey is important in that it provides a recording of major sight lines and problem areas. For an adequate representation of visually perceived areas, a 35 or 50 mm lens is recommended.

3.3.2 Actual Site Visual Survey and Matrix Formulation

Having recorded, numbered or coded all the nodes on a floor plan, they are then entered into a matrix with corresponding rows and columns. Figure 3.4 is an example. This matrix may then be carried by the surveyors with entries made as the nodes are visually perceived from an origin node. Standing at the origin node, the surveyor recording in the matrix need only call out the required node. The second surveyor can then determine whether it can or can not be perceived.

The following guidelines should be followed when carrying out the visual site terminal survey:

- i) A node must be both recognized and identified before it can be recorded as seen, and hence a visual sight line is said to exist. It is therefore recorded in the matrix with a one if it is seen, and a zero if it is not.

- ii) A node, if recognized and identified through aesthetic facades such as glass walls, partitions, curtains, etc. may be recorded as seen. Caution should be exercised here in that such nodes must be seen under existing lighting conditions and angles and it can be seen within the total origin node orientation area (P.O.M. area) and not only a small portion of it.
- iii) The observation position at the origin node follows the guidelines outlined previously (the P.O.M. area).
- iv) A node, if recognized and identified through a visually perceived identification or directional sign is considered as seen and it is recorded that a visual sight line exists to that node. If this is the case, the matrix recorder enters the matrix row and column intersection with a slash, recording that the node is seen through a sign. For each directional sign encountered for one particular node required, slashes are continuously entered. If a node is both visually perceived physically and also perceived through a sign, the entry is a one and a slash. For example, in Figure 3.2, considering the wait area as an origin node 3, the telephones may be recognized and identified both through a directional sign and by itself, and the matrix entry will be a slash and one. These guidelines are similar to those outlined for the hypothetical example in Chapter 2.

The survey is then carried out until all nodes have been considered and the matrix is complete.

3.4 Discussion

As discussed in Table 3.1 and as found by observation by the author, along with the results shown in Chapter 4, site survey data collections were found to be a more accurate and a simpler method to use, since, in addition to its simple data acquisition method, for example, terminal qualitative assessment for visual perception ability can also be accounted for. A typical example of this was noted at Quebec City airport, where although the terminal lighting was subdued to give a "living

room" atmosphere, it created difficulty in the perception of some of the identification signs where these signs "blended in" to its environment.

In summary, provided that most of the guidelines and the basic rules of vision are followed, and in particular that the surveyor or analyst negates that although he may be familiar with terminal operations and procedures, data collection from a floor plan and a site survey, as will be shown later, are equally adaptable for sight line analysis in order to measure passenger orientation in transportation terminals.

3.5 Types of Terminals

In order to test the validity of sight line analysis as a measure of human orientation and the previously discussed data collection methods to measure sight lines, the author felt it necessary to choose an appropriate terminal type to survey. In studying all passenger related transportation terminal facilities, and considering both time and cost constraints involved in data collection and evaluation, airport terminals in the range of small to intermediate sizes were recognized as being the most appropriate for the surveys because:

- i) there exists a full range of sizes in the Canadian airport system,
- ii) nearly all airports process or serve all passenger types (domestic, transborder, international - originating, terminating or connecting) as well as well wishers, greeters and visitors,

- iii) in most cases airport terminals have a large array of service and processing activities, and
- iv) floor plans and information are relatively easy to obtain through Transport Canada.

A cluster of small to intermediate airport terminals exists in eastern Canada and those surveyed were Fredericton, Moncton, Saint John and Edmundston in New Brunswick, Quebec City airport in Quebec and the Ottawa International Airport.

To further test the versatility of sight line analysis, the Ottawa rail terminal and Voyageur Colonial bus terminal were also surveyed. Since early analysis of the small and intermediate terminals demonstrated that the method worked and was easy to undertake, further verification of the analysis was later undertaken on two large major airport terminals - Mirabel and Dorval. These terminals were surveyed because:

- i) of their proximity to Ottawa,
- ii) of their similarity in design, size, concept and passenger movements,
- iii) they are all fairly busy terminals, and
- iv) they represented a "good mix" of new and old facility design considerations.

Both site surveys and floor plan measurements for each terminal were undertaken by the author and the following sections and subsections detail their application and the actual work involved.

3.5.1 Terminal Floor Plans

Floor plans of the terminals to be surveyed were obtained from the federal Ministry of Transport, Airport Facilities Branch, and the owners and operators of the bus and train terminals. The methods and guidelines to be used in floor plan data collection were followed, as described in Section 3.2, and floor plan visibility matrices were compiled for each terminal. Because the floor plans of the existing terminals did not detail their signage systems, they could not be considered in the floor plan visibility quantification. The results shown in the summary Table 5.2 and discussed here are from floor plans without any signage system considerations. Therefore the entries in the floor plan visibility matrix correspond only to the existence or non-existence of links between nodes due to their physical presence as measured on the floor plan. An example of the floor plan visibility matrix entries is shown in Figure 3.4 for the Moncton airport terminal.

In order to validate the effect a signage system has in assisting user orientation and how it can be quantified by floor plan analysis, the Moncton airport is again used as an example. The floor plan matrix entries pertaining to the terminal system, subsystems and components were evaluated by the application of the equations developed in Chapter 2. These were then compared to the visual field survey calculated results and the actual problem areas were finally listed. In order to try to reduce these orientation problems, an improved layout was drawn and an

improved signage system applied. These were then evaluated alone and in conjunction with each other and the results compared with the existing terminal layout to see to what degree improvements were made, i.e., the orientation problem areas were reduced.

A summary of results of the floor plan analysis calculations to all the terminals considered for this research can be found in Table 5.2. The table shows that the time required to undertake the floor plan data collection of each terminal is directly proportional to the number of nodes identified. This will be reflected in the costs associated with the evaluation of any particular existing terminal or terminals and, similarly, the costs associated with the planning and design of any new terminal facilities quantified to measure user orientation. Since only one person is required to do the data collection, using only a set of floor plans and a matrix sheet, manpower costs are minimal. Material costs are also minimal, provided up-to-date floor plans are available for existing terminals and planning has allowed for an extra set to be available for each proposed concept of the original floor plans in order to evaluate any new terminal facility design. The only other material costs are pencils, rulers, etc. to draft matrices and enter visual link values. As will be outlined in Chapter 4, a computer program has been developed, again to reduce manpower costs required in the computational effort necessary to calculate the visibility indices.

In summary, the floor plan data collection was relatively simple. Nodes were identified, labelled, numbered on the floor plans and then entered in the matrix row and column headings. Using a ruler and following the suggested methods and guidelines outlined in Section 3.2, the existence or non-existence of visual links between nodes were recorded in a corresponding visibility matrix. Completion of the entries in a visibility matrix for all terminals identified to be evaluated was basically all that is required for floor plan data collection.

3.6 Site Survey Data Collection

As stated in Section 3.1, the complete site survey of each terminal facility involved four observations. The first was a preliminary walkthrough of the terminal by two surveyors who located, numbered or coded all mandatory and optional nodes, as well as all directional and identification signs in a visibility matrix.

The second survey was the full visual survey undertaken by the same two surveyors who considered each node and signage, beginning at the first node (random choice) and attempting to observe all other nodes, moving to the next and again attempting to observe all other nodes and so on, working through each and every node. While doing this, the surveyors recorded in the visibility matrix all existing or non-existing sight lines between the nodes.

The third survey involved a permanent recording by camera of important nodes which were recognized as possibly creating problems in their individual visibility calculations.

Included in the third survey was a Field Observation form (Appendix A) filled out by one of the surveyors who recorded particular physical and psychological observations such as passenger flow patterns, terminal layout, visual problem areas, signage and other generalities such as lighting conditions, safety, barriers, peak hour effects, etc. The field observation form is to serve as an additional record of various problem areas and difficulties which, based on the surveyors' actual experience, may also be experienced by a passenger and which could be referred to as verification in visual node evaluation.

The final survey was a passenger interview with questionnaire (Appendix B). This involved a surveyor choosing and interviewing a passenger, at random, either at the departing curb area or in the waiting area. This survey followed the camera and field observational surveys, and was undertaken to validate the final quantification of user orientation. Once the terminal had been visually surveyed and its floor plans analyzed, the calculated visibility indicie results were compared to both the field observation forms and passenger interviews to see if the same nodes calculated to be poorly visible were, in fact, actually visible or not visible.

For the first three terminals surveyed - Fredericton, Moncton and Saint John airports, - the random choice of a terminal user to be interviewed was carried out. Each interview began with a brief explanation outlining the purpose of the survey. If the individual agreed to answer the questions, the survey continued (only one person out of the total 123 users approached refused to respond). Once the questioning was completed, it was only natural that some of those surveyed would follow up with queries regarding the purpose for the survey (even though explained at the outset). In nearly all cases, those interviewed continued in a friendly conversation, either approving or disapproving the reasons for the survey. In some instances, they actually discounted their answers to the questions, and in effect, eliminated their response. As discussed in section 3.5.7, the frequency of passengers recalling an area where they actually did have difficulty (brought forward after the survey took place) caused this survey method to be discontinued for the other airports. It was felt at this point that in order to continue using the passenger surveys that a larger sample and more thorough passenger questionnaire would be needed to ensure reliability. The next most logical person to survey, who perhaps unknowingly is directly involved in user orientation, was an employee of the terminal or its concessions. In the majority of cases, they receive most of the enquiries for directional assistance from terminal users. Due to the fact that they are asked directions on a regular basis, it seemed likely that their responses to a questionnaire on terminal user requirements would be more

predictable. Hence a new questionnaire was compiled to further validate the quantification techniques (Appendix C-1).

3.7 The Base Matrix

In order to compare the visibility indices of one terminal with those of another, the collected data for each terminal must be either transformed, weighed or reduced to a common base. The results of the quantification of the base data can then be used for terminal comparison purposes. Figure 3.5, from the International Air Transport Association's Airport Terminals Reference Manual⁽¹⁹⁾, shows 41 major passenger functional areas which are either essential or desirable areas required in a passenger terminal complex. These are listed in column 1 of Table 3.2. Similarly, the Transport Canada document on Terminal Capacity⁽²⁰⁾, lists 26 important areas in airport terminals, also listed in Table 3.2, column 2. From the field survey, based on frequency of occurrence, 26 essential or desirable areas are considered in this research as listed in Table 3.2, column 3. If these components are considered as necessary components which are to be included in all terminal designs, they can be considered as the components when combined to form a base terminal. Therefore, if all components in all terminals (no matter with what frequency they occur) can be reduced to a single node, then each terminal can be said to be of standard or base form. If the components of the base terminal can be ideally designed visually, or laid out so that they are totally visible, then all sight links (2-way)

FIGURE 3.5
I.A.T.A. TERMINAL AREAS
(AIRPORT MANUAL)

SOURCE: REFERENCE (19)

REQUIRED TERMINAL PROCESSING/FUNCTIONAL AREAS					
	I.A.T.T.A. MANUAL MAJOR FUNCTIONAL AREAS (FIG.1, REF.) (1)		TRANSPORT CANADA TERMINAL BUILDING OVERVIEW (PG. 8, REF.) (2)		SUMMARY FOR BASE MATRIX ANALYSIS (3)
	<u>DEPARTURES</u>		<u>PROCESSING</u>		<u>PROCESSING (MANDITORY)</u>
1	- CURBSIDE	1	- ARRIVALS AND DEPARTURE CURBS	1	- CURB (GROUNDSIDE)
2	- CURB BAG CHECK	2	- TICKET AND BAG CHECK-IN	2	- AIRSIDE (PLATFORM
3	- RESERVATIONS COUNTER	3	- SECURITY	3	- EXITS, ENTRANCES
4	- ENQUIRY COUNTER	4	- CUSTOMS, HEALTH IMMIGRATION	4	- TICKET, BAGGAGE CHECK-IN
5	- CHECK-IN COUNTER	5	- BAGGAGE CLAIM	5	- TICKET PURCHASE
6	- AIRLINE OFFICES BACK UP		<u>SUPPORT ACTIVITIES</u>	6	- WAIT AREA
7	- BAGGAGE SYSTEM	6	- CIRCULATION AREA	7	- SECURITY (GATE)
8	- BAGGAGE MAKE-UP AREA	7	- WAITING AREAS	8	- HOLD ROOM
9	- EMIGRATION CHECK		<u>AMENITIES</u>	9	- CUSTOMS & IMMI- GRATION AREA
10	- SECURITY CHECK	8	- WASHROOMS	10	- ARRIVALS GATE
11	- CUSTOMS CHECK	9	- PUBLIC PHONES	11	- BAG CLAIM
12	- DUTY FREE SHOP	10	- LOCKERS		<u>AMENITIES AND CONCESSIONS (OPTIONAL)</u>
13	- DEPARTURE LOUNGE	11	- NURSERIES	12	- TELEPHONE, LOCAL
14	- GATE HOLD ROOM	12	- FIRST AID ROOMS	13	- TELEPHONE, HOTEL
15	- GATE CHECK	13	- POST OFFICE		

TABLE 3.2
REQUIRED TERMINAL PROCESSING/FUNCTIONAL AREAS
(SUMMARY)

REQUIRED TERMINAL PROCESSING/FUNCTIONAL AREAS					
I.A.T.T.A. MANUAL MAJOR FUNCTIONAL AREAS (FIG.1, REF.) (1)		TRANSPORT CANADA TERMINAL BUILDING OVERVIEW (PG. 8, REF.) (2)		SUMMARY FOR BASE MATRIX ANALYSIS (3)	
16-	GATE CHECK	14	- HOTEL RESERVA- TIONS DESK	14	- RESTAURANT, COFEEE, BAR
17-	V.I.P. LOUNGE	15	- FLIGHT SCHEDULES	15	- RETAIL SHOPS
	<u>ARRIVALS</u>	16	- RESTAURANTS	16	- CAR RENTALS
18-	BAGGAGE BREAK- DOWN AREA	17	- SNACK BARS	17	- LOCKERS
19-	BAGGAGE SYSTEM	18	- BARS	18	- WASHROOMS (M)
20-	BAGGAGE CLAIM AREA	19	- AUTOMATIC FOOD DISPENSERS	19	- WASHROOMS (F)
21-	BAGGAGE STORE		<u>CONCESSIONS</u>	20	- SCHEDULE, MON- ITORS
22-	BAGGAGE TRANSFER SYSTEM	20	- NEWSSTANDS	21	- POST BOX, STAMPS
23-	BAGGAGE (LOCKERS, DEPOSIT)	21	- SHOPS	22	- INFO. BOOTH
24-	ARRIVAL CON- COURSE	22	- BANKS	23	- BANK, CURRENCY EXCHANGE
25-	HEALTH CHECK	23	- CAR RENTALS	24	- GRND. TRANSPORT INFO.
26-	IMMIGRATION CHECK	24	- INSURANCE	25	- FIRE EXITS
27-	DUTY FREE SHOPS	25	- DUTY FREE	26	- FIRST AID, POLICE LOST AND FOUND
28-	CUSTOMS CHECK	26	- OBSERVATION DECKS		

TABLE 3.2
REQUIRED TERMINAL PROCESSING/FUNCTIONAL AREAS
(SUMMARY CONT'D.)

REQUIRED TERMINAL PROCESSING/FUNCTIONAL AREAS					
	I.A.T.T.A. MANUAL MAJOR FUNCTIONAL AREAS (FIG.1, REF.) (1)		TRANSPORT CANADA TERMINAL BUILDING OVERVIEW (PG. 8, REF.) (2)		SUMMARY FOR BASE MATRIX ANALYSIS (3)
29-	VISITORS GREETER AREA				
30-	ENQUIRY COUNTER				
31-	CURBSIDE				
	CONCESSIONS AND AMENITIES				
32-	HOTEL RESERVA- TIONS				
33-	CAR RENTAL				
34-	POST BOX				
35-	BANKS				
36-	RESTAURANT, COFFEE, BAR				
37-	SHOPS				
38-	FLIGHT INSURANCE				
39-	GROUND TRANSPORT				
40-	LOST AND FOUND				
41-	NURSERY				
42-	PRESS				

TABLE 3.2
REQUIRED TERMINAL PROCESSING/FUNCTIONAL AREAS
(SUMMARY CONT'D.)

are present and quantifying the terminal will yield a visibility index of 100%. Hence, the transformed data of an existing terminal should also theoretically have a visibility index of 100% if it is optimally designed with consideration given to user orientation (signage included).

3.7.1 Data Transformation to the Base Matrix

The field visual survey evaluated the visibility of nodes due to their physical presence and the terminal's existing signage system. Therefore, the visibility matrix compiled from the survey would be the most appropriate data to consider for transformation into the base matrix. When doing so, the following guidelines should be used.

Guideline 1:

Consider: The following nodes as found in the terminal

FIGURE 3.6
HYPOTHETICAL NODE LAYOUT

Where: All B nodes are the same
 All A nodes are different, that is,
 $A_1 \neq A_2 \neq A_3 \neq A_4$

Since: A surveyor stood at any particular node type A¹
 (e.g. A₂ car rental - origin) and wished to observe
 one node type B (telephone) all of which were separate
 (not together) and in different locations in a ter-
 minal and that only one of B (B3) was observed physically
 and through a directional sign from said particular
 node A, then node B was recorded as being seen, due to
 its physical presence or through a sign as shown in
 the following example.

Example: The field survey visibility matrix will show the
 following recordings as observed in the field,

FIELD VISIBILITY MATRIX	PHONE ①	BAGGAGE CLAIM	PHONE ②	PHONE ③	TICKET COUNT	PHONE ④	HOLD ROOM	→
↓								
CAR RENTAL	(0)	1/	(0)	(1)	0	(0)	0/	
↓								

FIGURE 3.7
 SAMPLE VISIBILITY DATA

Then: Transferring this recording from the visibility matrix,
 it is recorded in the base matrix that the car rental
 sees a phone, through a sign and/or due to its physical
 presence, one, slash (1/).

Guideline 2:

Consider: The following nodes as found in the terminal.

FIGURE 3.8
HYPOTHETICAL NODE LAYOUT

Where: All B nodes are the same
All A nodes are different, that is
 $A_1 \neq A_2 \neq A_3 \neq A_4$

Since: A surveyor stood at any particular node type A
(e.g. A_2 car rental - origin node) and wished to observe one node type B (telephone) all of which are separate and in different locations in a terminal and that one of B or any number of node B was observed from said particular node A, then node B was recorded as being seen, either due to its physical presence or through a sign as shown in the following example.
For this case consider B_1 was seen physically, B_2 only through a directional sign, and B_3 and B_4 both physically and through a directional sign.

Example: . The field survey visibility matrix will show the following recordings as observed in the field

FIELD VISIBILITY MATRIX	PHONE ①	BAGGAGE CLAIM	PHONE ②	PHONE ③	TICKET COUNT	PHONE ④	HOLD ROOM	→
↓								
CAR RENTAL	(1)	1/	0	1/	0	0	0	
↓								

FIGURE 3.9
SAMPLE VISIBILITY DATA

Then: Transferring this recording from the visibility matrix, only one recording is made in the base matrix no matter how many times that particular node was observed and recorded in the visibility matrix, either through a sign or due to its physical presence. Hence, the recording in the base matrix for this case is only (1/) since it was observed at least once physically and through a sign.

Guideline 3:

Consider: The following nodes as found in the terminal.

FIGURE 3.10
HYPOTHETICAL NODE LAYOUT

Where: All the B nodes are the same

All the A nodes are the same

$$A_1 = A_2 = A_3 = A_4$$

Since: A surveyor stood at one node A (e.g. front door) and wished to observe one node B (telephone) all of which are separate and in different locations in a terminal and that one of B or any number of node B was observed from node A (another front door) and that one of node B or any number of Node B was observed from node A, and so on, then node B was recorded as being seen, either due to its physical presence, or through a sign, as recorded in the following example.

Example: The field survey visibility matrix will show the following recordings as observed in the field

	PHONE ①	BAGGAGE CLAIM	PHONE ②	PHONE ③	TICKET COUNT	PHONE ④	HOLD ROOM
↓							
ENT, EXIT, FRONT ①	1	0	0/	0	1	1	0/
↓							
ENT, EXIT, FRONT ②	1	0	0	0	0	1	0/
ENT, EXIT, FRONT ③	0		1	1		0	
↓							
ENT, EXIT, FRONT ④	0	1/	1	1	1/	0	
↓							

FIGURE 3.11
SAMPLE VISIBILITY DATA

Then: Transferring this recording from the visibility matrix to the base matrix, the following rules should be followed:

let N = the number of origin nodes which are the same. For this example, node A. above, $N=4$

let X_{sp} = the number of sight lines counted in the visibility field survey matrix between the origin nodes (A) and the other required nodes (B) due to their physical presence

let X_{ss} = the number of sight lines counted in the visibility field matrix between the origin nodes (A) and the other required nodes (B) through a sign, or signs

then if: $\left. \begin{matrix} X_{sp} \\ X_{ss} \end{matrix} \right\} \geq N/2, (X_{sp}, X_{ss} \geq 1)$

Then the visibility of Node B is transferred to the base matrix as being seen

and if: $\left. \begin{matrix} X_{sp} \\ X_{ss} \end{matrix} \right\} < N/2, (X_{sp}, X_{ss} \geq 1)$

Then the visibility of node B is transferred to the base matrix as not being seen.

In the example above, $N=4$ and X_{sp} can be counted to equal 8, and therefore:

$X_{sp} = 8 \geq 4/2$ therefore node B is transferred as being seen physically.

Also X_{ss} can be counted to be equal to 1 and therefore

$X_{ss} = 1 < 4/2$ therefore node B is transferred as not being seen through a sign.

Hence, the final recording in the base matrix of a terminal user's ability to see a phone from the front entrance and exit is (10).

Also, where a node is listed in the base matrix, and was not found in the terminal field survey, the node entries in the base matrix are zero.

Following the guidelines and points outlined above, all the data entered in the field survey visibility matrix can now be transferred to a base matrix. The data from these base matrices for each terminal, once quantified, can now be compared and any particular terminal system, its subsystems and components, may either be more, or less visible than any other terminal system, subsystems or components.

3.8 Terminal Site Surveys

The following subsections are detailed accounts of the findings in the ten terminals which were visually site surveyed. Each terminal discussed has an accompanying floor plan. Field observational forms and passenger interview questionnaires can be found in Appendices A and B respectively. Due to space limitations, only the Moncton airport has an example of its visibility matrix which was compiled in the field.

The floor plan accompanying each terminal discussed in the following sections has node numbering relative to floor plan data collection and not site survey coding. Again, due to space limitations, only the Moncton airport has an example of its matrix with entries from its floor plan analysis, and site survey analysis (Figures 3.3 and 3.4). The actual compilation of the data collected in the field and from the floor plans, a description of visibility index calculations, how each terminal's visibility results can be compared, a description of the computer program used to simplify the quantification process, field

observation forms and the questionnaires are all discussed in detail in Chapter 4. The following subsections, therefore, are comments on the terminal visual field surveys.

3.8.1 Fredericton International Airport

The terminal facility at Fredericton was surveyed on June 14, 1977. It processes an annual passenger volume of 183,000 (1976 Statistics Canada figure). Although a rather small terminal facility, the survey time was 6½ hours. A breakdown of the total survey time involving two surveyors follows:

- i) one hour for the preliminary walkthrough and identification of all nodes and matrix formulation for the next survey,
- ii) two and a half hours for the visual survey and matrix compilation,
- iii) one hour for the camera and observational survey, and
- iv) two hours for the passenger survey.

A total of 14 mandatory nodes and 12 optional nodes were found in the terminal in the site survey. Two major visibility problems were found. The first was that passengers arriving and moving through the second set of doors of gate number 2 were required to make an immediate right turn to the baggage claim area. However, due to their concern with maneuvering through the doorway and the lack of adequate signage, some passengers were observed to walk by the area, move into the wait area, and then attempt to orientate to find the baggage claim area. As shown in the layout or floor plan, the baggage claim area and racetrack are rather isolated by walls, movable screens and doors.

FIGURE 3.12
FREDERICTON INTERNATIONAL AIRPORT (NTS)
 (FLOOR PLAN NODES)

FLOOR PLAN NODES (FREDERICTON AIRPORT)			
NODE No.	NODE NAME	NODE No.	NODE NAME
1	Entrance/exit, west	35	
2	Air Can. cargo info.	36	
3	Tick.Count. (AC/EPA)	37	
4	Washrooms (w)	38	
5	Car rental	39	
6	Security	40	
7	Hold room	41	
8	Wait room	42	
9	Washrooms (m)	43	
10	Entrance/exit, main	44	
11	Rest/coffee/bar	45	
12	Phone (hotel)	46	
13	Int.arr., lobby ent.	47	
14	Arrivals - domestic	48	
15	Baggage claim	49	
16		50	
17	Phone (local)	51	
18	Lockers	52	
19	Gate (1)	53	
20	Washrooms (m)	54	
21	Washrooms (w)	55	
22	Immig./RCMP Off.	56	
23	Info., Com'aire	57	
24	Airside	58	
25	Curb	59	
26	Police, first aid	60	
27		61	
28		62	
29		63	
30		64	
31		65	
32		66	
33		67	
34		68	

FIGURE 3.12 (CONT'D.)
FLOOR PLAN NODE LISTING

The second problem was with the opaque glass partitions surrounding the hold room area. This not only prevented well-wishers to see their parties off (visual and verbal communication), but prevented other users from seeing the apron and aircraft. Also, the location of this area and the opaque glass prevented those passengers in the baggage room visual contact with the rest of the terminal or their greeters.

The camera and observational survey finished, coincidentally, with the arrival of a domestic flight with a total of 63 deplaning passengers. Twenty-three of these passengers were interviewed, with 12 arriving for the first time in Fredericton. Of those 12, five recalled difficulty in finding their way through or around the terminal. Two expressed a difficulty in finding the washrooms, one the baggage claim, one the way out to a bus or taxi and one an information booth (there is no information booth at Fredericton).

The wait area portion of the survey was carried out in the central and main wait area. Eighty passengers were counted departing (counted leaving hold room to board craft) and of these 80, 27 were interviewed, with 23 of them leaving the airport for the first time. All those interviewed related that they had no difficulty in finding the wait area, due mainly to the "smallness" of the terminal. It was pointed out that when leaving the ticket counter area, the wait area was the only direction in which to move because the other direction led to an exit/entrance.

In summary, the surveyors felt that the terminal was fairly visible. From the field observation comments, there were problems with the existing signage and the presence of the wall visually separating the baggage claim area.

3.8.2 Moncton International Airport

The Moncton terminal facility, a fairly new building, was surveyed on June 15, 1977 and possibly because of its new design, it appeared to the surveyors that it was fairly visible. In 1975, Moncton processed an annual enplaning and deplaning passenger volume of around 204,800. A total of 23 nodes in the site survey were identified with only one directional sign.

The survey time for this facility is broken down as follows:

- i) one hour for node identification and matrix formulation,
- ii) three hours for the visual survey of all nodes with the matrix compilation,
- iii) one hour for the camera recordings and observation survey, and
- iv) one hour for passenger surveys.

Some visibility problems were observed. For example, separating the baggage claim area and the wait room area (see Figure 3.13) was a large square structural complex containing utility stairs, an elevator and four rooms. This structure was observed to create disorientation problems to all terminal users, particularly arriving passengers and greeters.

FIGURE 3.13
MONCTON INTERNATIONAL AIRPORT (NTS)
 (FLOOR PLAN NODES)

FLOOR PLAN NODES (MONCTON AIRPORT)			
NODE No.	NODE NAME		NODE No.
1	Entrance/exit, east		35
2	Ticket Count.-Air Can.		36
3	Ticket Count.-EPA		37
4	Schedule		38
5	Post box		39
6	Phones		40
7	Rest/coffee/bar		41
8	Security		42
9	Hold room		43
10	Wait area		44
11	Phones		45
12	Arrival - domestic		46
13	Airside		47
14	Curb		48
15	Entrance/exit, central		49
16	Washrooms (m & w)		50
17	Phones (bag. area)		51
18	Bag., entrance/exit		52
19	Baggage claim		53
20	Lockers		54
21	Customs/immigration		55
22	Car rentals		56
23	Arrival - Intern'l.		57
24			58
25			59
26			60
27			61
28			62
29			63
30			64
31			65
32			66
33			67
34			68

FIGURE 3.13 (CONT'D.)
FLOOR PLAN-NODE LISTING

It was also noted that any departing passengers who entered the front (curb) central doorway had poor visual contact with the ticket processing area due to the presence of a set of stairs connecting the second level administrative offices to the terminal processing level where the survey took place.

The curb portion of the passenger interview survey was carried out with the arrival of Air Canada flight 63 (domestic). Of the 42 deplaning passengers, 24 were interviewed. Five of those arriving for the first time recalled having some difficulty in the terminal. Two could not find the ticket counter area, three had difficulty finding the washrooms and two the phones.

The wait area portion of the survey interviewed 10 departing passengers of a possible total of 82 (counted as they left the hold room). Four of those interviewed were leaving the terminal for the first time. Of these, only one had difficulty in finding the washrooms. Six passengers had been in the terminal on previous occasions and one of these also had difficulty in finding the washrooms. Neither of the two passengers seeking the washrooms requested directional assistance. For both of the interviews, at the curb or in the wait area, some of those surveyed commented that the terminal layout was poor, broken up, cluttered and poorly lit, yet some stated the reason for not having any difficulties was because of its small size.

3.8.3 Saint John International Airport

The Saint John, New Brunswick airport terminal building was surveyed on June 16, 1977. It processes an annual passenger volume of around 193,200. The surveyors identified a total of 33 mandatory and optional nodes.

A visibility problem arose in the terminal during the survey which was observed to have a major impact on users, creating disorientation and confusion among arriving passengers, greeters, employees and departing passengers. It began with the arrival of a transborder flight and due to customs and immigration requirements, the baggage claim area was completely screened off by a large opaque sliding screen. Greeters had no visual contact with their arriving parties and because of this obstruction, could not tell if their parties had actually arrived. Also, because the car rental agencies were in the baggage claim area, their employers were requested to leave the area. This caused these users, as well as others, to mill around outside the enclosed area, which was directly in front of the hold room, security check and wait area. This accumulated crowd in turn caused disorientation and confusion to enplaning passengers and their well wishers.

By the screening off of the baggage claim area the greeters did not know exactly which door their parties would be exiting from. Realizing that perhaps their parties may exit to the curb, some began moving back through the terminal against the flow and

FIGURE 3.14

SAINT-JOHN NB. INTERNATIONAL AIRPORT (NTS)

(FLOOR PLAN NODES)

FLOOR PLAN NODES (SAINT JOHN AIRPORT)			
NODE No.	NODE NAME	NODE No.	NODE NAME
1	Entrance/exit, west	35	
2	Ticket counter-Air Can.	36	
3	Wait/area	37	
4	Entrance/exit, central	38	
5	Ticket counter -EPA	39	
6	Security	40	
7	Hold room	41	
8	Rest/coffee/bar	42	
9	Phones	43	
10	Arrivals - domestic	44	
11	Airside	45	
12	Washrooms (m)	46	
13	Washrooms (w)	47	
14	Cust/immig. (offices)	48	
15	Washrooms (w)	49	
16	Cust/immig. area	50	
17	Intern'l arriv. ent.	51	
18	Washrooms (m)	52	
19	Rent-a-car	53	
20	Baggage claim	54	
21	Phones	55	
22	Entrance/exit, east.	56	
23	Curb	57	
24	Fire exits	58	
25		59	
26		60	
27		61	
28		62	
29		63	
30		64	
31		65	
32		66	
33		67	
34		68	

FIGURE 3.14 (CONT'D.)
FLOOR PLAN NODE LISTING

through queues of departing passengers and well wishers. For approximately five to eight minutes those who wished to see and greet their arriving parties either moved back through the terminal or tried various doors in the general area* in an attempt to contact their parties. Due to the lack of visual contact between greeters and arriving passengers, the following was observed:

- i) The processing of enplaning passengers was hampered due to the contra-flow of greeters.
- ii) The processing of arriving passengers through customs and immigration was hampered due to the entry of greeters to the area (see note* below).
- iii) Concession employees (car rental agencies) had to protect cash boxes and added to the number of people milling around. They were effectively non-productive during the entire period.
- iv) Lack of visibility during this period created obvious disorientation and confusion to all concerned.

The following points were also noted:

- i) The simple placement of a visually obstructive barrier separating two areas created a severe visibility situation which caused adverse effects to other functions in the terminal.
- ii) The lack of visual contact by a non-critical user (the greeter) can create unexpected flow problems and confusion to all other users.
- iii) Concession employees (car rental employees) were not considered in the terminal plans, nor were the problems to which they may be subjected.

* As observed, an unlocked door into the customs and immigration area was found by some of the greeters, who entered the area. They were, of course, asked to leave. This in turn disrupted the customs and immigration process.

Although the terminal is relatively small, the problems encountered were such that it took nearly eight hours to complete the entire survey (including passenger interviews). A breakdown of the time follows:

- i) three quarters of an hour to identify and enter all nodes into the matrix,
- ii) four and a half hours to carry out the visual survey,
- iii) three quarters of an hour for the camera and observation survey, and
- iv) two hours for the passenger interviews.

Visual difficulties were observed due to the presence of the following conditions:

- i) a large number of structural columns, corners and divider walls,
- ii) a circular staircase to the administrative offices in the central area of the terminal,
- iii) opaque glass dividers obscuring a hold room, with the security check area around the corner from the ticket counter,
- iv) a rather small opening and access door to the customs and immigration area which in turn leads to the car rental and baggage claim areas,
- v) a complete isolation or separation with a 90° turn through a doorway to the baggage claim area, some telephones, car rentals and the ground transportation exit door (see floor plan).

At the Saint John airport, 19 enplaning domestic passengers were interviewed in the wait area. Forty-four passengers actually left the area to board their departing flight. Three of the enplaning passengers had used the terminal for the first time and

each experienced difficulty in the terminal. One had difficulty finding the car rental desks and the remaining two stated they had difficulty locating the restaurant. Sixteen had been in the terminal on previous occasions and three of these also experienced difficulties in finding their required nodes. Two had entered through the far baggage claim entrance/exit doors and had difficulty locating the ticket counters. The third entered via the main entrance and had difficulty locating the car rental desks. Three of the six who experienced problems asked assistance from employees of Air Canada. Of the 13 passengers who had been through the terminal previously and who did not experience any difficulty, four stated that in comparison to other terminals they had travelled through, nothing could be quickly found. The only reason stated as the reason why they did not ask for assistance was the small size of the terminal.

The curb area survey was taken with the arrival of a transborder flight - the same flight which caused the previously discussed problem. Because the surveyors had to interrupt their visual survey due to the confusion, a survey of the deplaning transborder passengers seemed appropriate. The screening off of deplaning passengers' inspection area did not allow for an accurate total of the passengers which actually deplaned. From the transborder flight, 20 of its passengers were interviewed with nine arriving at Saint John for the first time. Of these nine, six experienced difficulty finding their required nodes in the terminal. One couldn't find the ticket counter, two the wait

area, one a ground transportation information booth (none existed in the terminal) and two the car rental desks. Out of the 11 arriving passengers who had been through the terminal previously, two stated they had difficulty in finding a currency booth (again, none existed in the terminal). Of the remaining nine, plus the three passengers who had not been in the terminal before, seven stated they found the terminal rather easy to find their way through in comparison to others because of its small size. Five stated it was difficult because the terminal was "broken up" and in particular, the car rentals were hard to find.

It was at this point in the overall terminal survey that the author identified recurring contradictory responses in the fourth question requesting passengers to explain the reason why this particular terminal was perhaps easier, or more difficult than others to travel through. Few of the passengers who had been in the terminal previously stated in question two of the questionnaire that they had experienced some difficulty in finding their way through the terminal. However, in comparing the terminal to others, a larger number stated that this terminal was not easier to get through, and all identified specific areas or reasons why. This shows that some of those who stated in question two that they did not experience any difficulty actually did. With this, and recalling the "after survey" queries and comments, the author felt that the results did not fully or accurately express the orientation problems experienced by most passengers. Therefore, the passenger survey technique was discontinued and

replaced with an employee interview for the remaining terminal surveys. Although the passenger interviews proved inaccurate, the information collected was not discarded since it may possibly prove valuable in the validation of the quantification results of the visibility of the terminal.

In summary, the terminal had some continuity in its layout, namely that it was of simple linear form, but it lacked adequate layout considerations as shown in the accompanying layout (Figure 3.14) by the presence of many corners, the location of doorways and openings, divider walls, the isolation of processing areas and amenities, and the lack of directional signage - only one was observed.

An impression received by the surveyors was that the likelihood of passenger disorientation was predominant since some nodes were missed during the preliminary survey and were only picked up during the visual survey. The confusion of greeters and passengers who were unable to see each other during the arrival of the transborder flight and the initial survey problem of identifying nodes demonstrated the possible existence of low visibility indices and therefore a possible high percentage of disorientated terminal users.

3.8.4 Edmunston Airport

The Edmunston, New Brunswick terminal mainly serves general aviation enthusiasts and provides for transborder (U.S.)

and provincial flights. This facility was surveyed on June 17, 1977. It was observed to be a rather small, square terminal with little building data (no measurements or floor plan). The survey time was one and a quarter hours, with the following breakdown:

- i) 15 minutes for the preliminary survey and matrix formulation,
- ii) 30 minutes for a visual survey and matrix compilation,
- iii) 15 minutes for camera survey and impression recording, and
- iv) 15 minutes for employee interviews.

There were no directional signs, and only two or three nodes proving to be invisible. Although no customs and immigration areas actually existed, the owner/operator of the terminal advised the surveyors that in the case of transborder flights, the Royal Canadian Mounted Police and a customs official could be reached by phone, and the terminal itself becomes the inspection area. Further personal investigations with associated questioning were carried out in the storage room behind the ticket counter.

As indicated on the field observation form, the terminal appeared to be extremely visible. Although many of the areas overlapped or were dual purpose - for example the wait area and the restaurant seating - all were clearly identifiable (a bench and chairs for the wait area and two or three tables and chairs for the restaurant).

The most asked for nodes by terminal users were those of the phones and washrooms. The next was for a schedule or

FIGURE 3.15
EDMUNISTON AIRPORT (nts)
(FLOOR PLAN NODES)

FLOOR PLAN NODES (EDMUNSTON AIRPORT)				
NODE No.	NODE NAME		NODE No. NODE NAME	
1	Entrance/exit, curb.		35	
2	Wait, hold room		36	
3	Restaurant, coffee		37	
4	Ticket counter		38	
5	Baggage claim		39	
6	Ticket purchase		40	
7	Washrooms (m)		41	
8	Washrooms (f)		42	
9	Arrival/departure gate		43	
10	Curb		44	
11	Airside		45	
12	Phones (local, hotel)		46	
13	Customs, immigration		47	
14	Fire exit		48	
15			49	
16			50	
17			51	
18			52	
19			53	
20			54	
21			55	
22			56	
23			57	
24			58	
25			59	
26			60	
27			61	
28			62	
29			63	
30			64	
31			65	
32			66	
33			67	
34			68	

FIGURE 3.15 (CONT'D.)
FLOOR PLAN NODE LISTING

information regarding the arrival of a specific flight. They also indicated that during certain period, particularly on weekends, the airport became extremely busy with over 100 aircraft movements a day. On long weekends and holidays the volume was even greater, with the terminal full of well wishers, passengers and greeters.

3.8.5 Quebec City International Airport

The airport terminal building at Quebec City was surveyed on June 17, 1977. The building is quite new and processes an annual enplaning, deplaning passenger volume of 555,8000 (1976, Statistics Canada). The terminal is basically L-shaped (see terminal diagram), similar to those previously surveyed (with the exception of Edmunston, New Brunswick). Three well lit, four-sided directional sign clusters were observed in the terminal - one at the central main exit/entrance, one at the exit/entrance for arriving passengers and one in the baggage claim area. The presence of a large block of concessions in the central area of the terminal was observed by the surveyors to possibly create poor visibility and disorientation between the ticket purchase/check-in area and the rest of the terminal. The presence of the sign clusters appeared to reduce this problem, however, the close proximity of these clusters to each other created confusion with double sign readings.

FIGURE 3.16
QUEBEC AIRPORT (NTS)
(FLOOR PLAN • NODES)

FLOOR PLAN NODES (QUEBEC CITY AIRPORT)				
NODE No.	NODE NAME		NODE No. NODE NAME	
1	Entrance/exit, east		35	
2	Ticket counter		36	
3	First aid		37	
4	Entrance/exit, central		38	
5	Washrooms (m & w)		39	
6	Ground trans. info.		40	
7	Car rental		41	
8	Entrance/exit, west		42	
9	Coffee shop		43	
10	Restaurant, bar		44	
11	Phones		45	
12	Handi-phone		46	
13	Gift shop		47	
14	Wait area		48	
15	Gate (1)		49	
16	Security		50	
17	Gate (2)		51	
18	Baggage claim		52	
19	Customs officer		53	
20	Intern'l. arrivals		54	
21	Airside		55	
22	Curb		56	
23	Gate (3)		57	
24	Hold room		58	
25	Baggage info-Air Can.		59	
26			60	
27			61	
28			62	
29			63	
30			64	
31			65	
32			66	
33			67	
34			68	

FIGURE 3.16 (CONT'D.)
FLOOR PLAN NODE LISTING

A total of 15 mandatory and 13 optional nodes were identified for the visual survey. The following is a breakdown of the survey times:

- i) one hour for node identification and matrix entry,
- ii) three and one half hours for the visual survey,
- iii) one hour for the camera survey and field observational form entry, and
- iv) two hours for employee interviews.

Only three problems were found to exist in the terminal when it was visually surveyed and which might possibly contribute to passenger disorientation. They were:

- i) the large block of concessions in the central area of the terminal,
- ii) the close proximity to each other of the directional sign clusters, and
- iii) the extreme isolation of the customs and immigration area.

After completion of the visual survey, employees of the concessions, the facility and the airlines were interviewed. The total number of times employees stated that directional assistance to a particular node was required by a terminal user, is recorded in the interview summary, Appendix C-2. Also recorded are those nodes that were identified by the employees as being the first, second and third most required nodes for which terminal users requested directional assistance.

In summary, a total of nine employees were interviewed at Quebec International, and its summary survey sheets are found in Appendix C-2.

3.8.6 Ottawa International Airport

The Ottawa terminal building was surveyed during the second week of May 1977, on Thursday and Friday evenings, between 4:00 and 7:00 p.m., the weekly busy periods as related to the surveyors by the airport manager, staff, and verified by the airline schedule. A total of 68 mandatory and optional nodes were identified. After completing the initial walkthrough with the 68 by 68 visibility matrix column and row listings of all the nodes, the visual survey was undertaken beginning in the west wing departing passenger area and ending in the domestic and international passenger arrival area and entrance/exit points to the ground transportation facilities. All existing and non-existing sight lines between nodes were recorded in the visibility matrix.

The first two surveys - the initial walkthrough and the visual survey - were undertaken during the Thursday busy period (4-7 p.m.) while the remaining two - the camera recordings and employee interviews - were carried out on the following Friday evening. The total time to undertake the four surveys on both evenings was 10 hours, broken down as follows:

- i) two hours for the preliminary walkthrough and matrix and column listings, as well as the observation survey,
- ii) four hours for the actual visual survey and matrix compilation,
- iii) one hour for the camera recording, and
- iv) three hours for the employee interviews.

FLOOR PLAN NODES (OTTAWA AIRPORT)			
NODE No.	NODE NAME	NODE No.	NODE NAME
1	Entrance/exit, west	35	Washrooms (m,w)
2	Ticket counters	36	Bar/restaurant) 2nd
3	Ent./exit, west cent.	37	Wait area) level
4	Cara boutique	38	
5	Ins/currency counter	39	
6	Washrooms (m)	40	
7	Wait area - lobby	41	
8	Entrance, main front	42	
9	Stairs (to flr.2, w)	43	
10	Arrivals - dom. (west)	44	
11	Security check-in	45	
12	Arrivals - dom. (east)	46	
13	Sterile-hold	47	
14	Depart (west, A,B)	48	
15	Depart (east, C)	49	
16	Stairs (to flr.3, w)	50	
17	Washrooms (m & w)	51	
18	Rest/coffee/bar	52	
19	Cara News	53	
20	Entrance/exit	54	
21	Washrooms (m)	55	
22	Ent./exit, east cent.	56	
23	Snack bar	57	
24	Baggage claim	58	
25	Phones (local)	59	
26	Arrivals - intern'l.	60	
27	Car rental	61	
28	First aid	62	
29	Entrance/exit, east	63	
30	Taxi information	64	
31	Curb	65	
32	Airside	66	
33	Museum	67	
34	Information booth	68	

FIGURE 3.17 (CONT'D.)
FLOOR PLAN NODE LISTING

As detailed on the field observation survey form, Appendix A, the surveyors found that the terminal lacked unity and coherence, particularly with the complete separation of major processing areas in the two wings, and their angular layout. It was observed in the ticket and bag check-in areas that during the busy period, users depended on directional assistance from the check-in desk employees and signage to find their way to the wait, security, check and hold room areas in the center of the terminal. This was due to the large number of well wishers, greeters and arriving passengers already present in the central area who blocked visual contact with the three desired areas. An airline employee (Air Canada), who assisted passengers in the ticket and bag check-in queues by processing and ticketing bags in advance, was observed to be heavily questioned for directional assistance both by passengers in the queues and other users.

In the central terminal area (immediately in front of the security check and two arrival gates 20 and 21), a large number of conflicts were observed between passengers arriving and departing, well wishers and greeters. At the time of the survey, departing passengers and their well wishers were attempting to reach, through an arriving passenger flow (gate 20) and their greeters, the security check and hold room. Alternatively the arriving passengers were attempting to reach or find their greeters, and then the baggage claim area. A small number of the arriving passengers turned down the wrong wing (west) to the ticket and bag check-in area. After requesting and receiving directional

assistance, they returned and attempted to flow through the central area crown to the east wing.

In the baggage claim area, conflicts were observed between greeters moving into the terminal by the east wing side door to assist their parties with baggage (and again leaving by the side door), passengers flowing through the wing after claiming their luggage to the far east exit/entrance to the ground transportation facilities, and the crown of greeters and passengers waiting for their bags.

The two major problem areas identified in the terminal which appeared to create visibility and orientation problems were:

- i) the complete separation (visually and physically) in the two offset (angled) wings of the major processing areas; ticket and bag check-in in the west wing and baggage claim in the east wing, and
- ii) the close proximity of the two arrival gates with the security check and hold room areas.

A total of 12 employees were interviewed in the terminal and a summary of these interviews are shown in Appendix C-2.

In summary, the Ottawa International Airport proved to be a little more difficult to survey than the previous five due to its larger size, its different layout, and the large user volumes present during the busy period in which the survey took place. It proved to be an excellent example to the surveyors of what is to be expected when surveying larger terminals with more nodes, more complex layouts, and larger user volumes.

3.8.7 Survey Assessment

Prior to surveying the remaining four terminals in the research project, the surveyors assessed the results of the terminals already surveyed. The visibility of each terminal, its subsystems and components, were calculated from floor plans and site survey matrices, and were evaluated. Any identified problem areas or nodes were validated by both the passenger and employee surveys and the camera recordings. The calculated results were encouraging and it was felt by the author, and agreed by the other surveyors, that it may be possible to reduce costs associated with the remaining surveys by reducing the number of surveyors to one. From the experience gained from the previous surveys and assessments, one surveyor should be able to cope with any problems encountered. Therefore, the remaining four terminal facilities were visually surveyed by the author in order to assess the effect on time and costs associated with them. To assess and validate the accuracy of the visual surveys, more emphasis was placed on the camera readings and employee interviews.

During the assessment it was also agreed that the employee interviews should be continued for the following reasons:

- i) The results of the interviews corresponded well with the observational surveys and the actual quantifications of the visual surveys and floor plan analysis.
- ii) Comments by those interviewed reinforced their replies to questions asked in the interviews, with no contradictions.
- iii) Those employees interviewed at the Ottawa International Airport were friendly and courteous and did not mind being interrupted to respond to the questions.

- iv) Since the employee interviews took place after the busy periods, and therefore were unobstructive to terminal operations, the questions posed by users during the busy period were still fresh in the minds of the employees.

3.8.8 Ottawa Bus Terminal

The Ottawa bus terminal is operated by Voyageur Colonial Bus Lines, a provincial and transborder licensed motor coach carrier. The terminal building is approximately six years old and is rather centrally located relative to the city center and is in close proximity to an east/west freeway. For an average busy day it was observed by Johnson, et al (2) to handle 3,000 arriving/departing passengers, well wishers, greeters and visitors.

The terminal took seven hours to completely survey by one surveyor, and the individual survey times are recorded as follows:

- i) two hours for node identification, matrix and column listings and the observational survey,
- ii) four hours for the visual survey and matrix compilation,
- iii) one half hour for the camera recordings, and
- iv) two and a half hours for employee interviews.

A total of 20 mandatory and 21 optional nodes were identified in the terminal. Signage was observed to be efficiently

FIGURE 3.18

OTTAWA VOYAGEUR BUS TERMINAL (NTS)
(FLOOR PLAN NODES)

FLOOR PLAN NODES (OTTAWA BUS TERMINAL)			
NODE No.	NODE NAME		NODE No. NODE NAME
1	Entrance/exit, east	35	Gate (7)
2	Lockers	36	Gate (8)
3	Restaurant	37	Gate (9)
4	Bar	38	Gate (10)
5	Phones	39	Gate (11)
6	Washrooms (m)	40	Gate (12)
7	Washrooms (w)	41	Gate (13)
8	Washrooms (w)	42	Phones
9	Phones	43	
10	Lockers	44	
11	Boutique	45	
12	Entrance/exit, main	46	
13	Phones	47	
14	Wait, main	48	
15	Departure gate (1)	49	
16	Bus bays	50	
17	Ticket wickets	51	
18	Information Booth	52	
19	Lockers	53	
20	Phones	54	
21	Washrooms (m)	55	
22	Washrooms (w)	56	
23	Entrance/exit, west	57	
24	Ground trans. info.	58	
25	Lost and found	59	
26	Arrival gate (14)	60	
27	Parcel express	61	
28	Curb	62	
29	Phones	63	
30	Gate (2)	64	
31	Gate (3)	65	
32	Gate (4)	66	
33	Gate (5)	67	
34	Gate (6)	68	

FIGURE 3.18- (CONT'D.)
FLOOR PLAN NODE LISTING

located relative to the passenger flows and quite visible with illuminated yellow backgrounds and black lettering.

Two existing terminal layout problems which may create user disorientation were:

- i) the central location of the newsstand, and
- ii) the extreme isolated western location of the passenger arrival gates, ground transportation information center, and washrooms.

The observational survey sheet, Appendix A, also identifies other visual problems and benefits of the terminal.

Seven employees were surveyed and a summary sheet of these interview is shown in Appendix C-2. Those employees interviewed were courteous and replied with accurate responses. Discussion following the interviews verified responses to the questions with no contradictions.

Although no official count was taken of the actual number of users who were in the terminal during the survey, the terminal did appear relatively busy. There was a large number (30 to 50 passengers) of queues at the departure gates with a fairly constant flow of arrivals. These activities gave a good representation of visual problems, with the surveyor questioned seven times for directional assistance.

3.8.9 Ottawa Train Station

The Ottawa train passenger terminal is approximately 10 years old, and is located east of the city center. The two major

FIGURE 3.19
OTTAWA TRAIN STATION (NTM)
(FLOOR PLAN NODES)

FLOOR PLAN NODES (OTTAWA TRAIN STATION)				
NODE No.	NODE NAME		NODE No. NODE NAME	
1	Curb .		35	
2	Entrance/exit, main		36	
3	Info. booth (porters)		37	
4	Lockers		38	
5	Baggage claim		39	
6	Wait area (a)		40	
7	First aid		41	
8	Stationmaster		42	
9	Phones - local		43	
10	Phones - hotel		44	
11	Arr./dep. - east		45	
12	Wait area (b)		46	
13	Depart - east escal.		47	
14	Arr./dep. - centre		48	
15	Depart - west escal.		49	
16	Wait area (c)		50	
17	West doors		51	
18	Newsstand/rest/bar		52	
19	Barber shop		53	
20	Wait area (d)		54	
21	Washrooms (m)		55	
22	Lockers		56	
23	Washrooms (w)		57	
24	Rent-a-car		58	
25	Gr. Trans., taxi info.		59	
26	Ticket counter		60	
27	Model museum		61	
28	Platfoms		62	
29			63	
30			64	
31			65	
32			66	
33			67	
34			68	

FIGURE 3.19 (CONT'D.)
FLOOR PLAN NODE LISTING

railroad companies operating in the terminal are Canadian Pacific and Canadian National. The terminal, on an average busy day (Friday or Sunday), processes an average passenger volume of 2,200.** On December 26th, 1977, the day on which this survey took place, approximately 3,000 passengers either arrived or departed through the terminal. These figures do not reflect well wishers, greeters or visitors in the terminal at the time of the count.

During the survey, full wait rooms, large concession and ticket counter queues were observed. Aside from the other comments recorded in the observational survey sheet, four major design problems were recognized causing obstructed visual sight lines, and are described below:

- i) the four large structural columns in the terminal,
- ii) the central location of the ticket carousel,
- iii) the structural overhand on the sides of the terminal (relative to the curbside and platform side), 5.5 metres from the wall, which contains on its face, all relative identification signs, and
- iv) there were no directional signs in the terminal.

The total survey time was six hours, and is broken down as follows:

- i) one hour for node listings in the visibility matrix and observation survey recordings,

*** From random, busy day tally sheets for 1977 taken by rail officials and given by the station master. Christmas passenger volumes were estimated by the station master as 2.5 times busy day activities.*

- ii). three hours for the visual survey and matrix compilation,
- iii) half hour for the camera survey, and
- iv) one and a half hours for employee interviews.

A total of 31 nodes were identified, listed and visually surveyed. Twelve nodes were identified as mandatory and the remaining 19 as optional.

Eleven employees were interviewed following the observational survey, Appendix A. A summary of the employee interview results can be found in Appendix C-2.

In conclusion, few difficulties were encountered during the survey, except for large queues of departing passengers which caused visual obstructions in some cases, yet served as an excellent example of possible orientation problems which may be experienced by users. Arriving passengers were observed to have little difficulty flowing from the arrival gates to the curb. Both passenger types were assisted with luggage by porters, who were also observed to assist all users with directional assistance. The porters became, in effect, "roaming information booths" answering all questions posed by the users.

The surveys were undertaken by a single surveyor and did not prove to be too difficult. An assistant possibly would have reduced the total survey time, but not by any significant amount. All employees were courteous when interviewed and the questionnaire results proved fairly accurate with discussions

after the interviews, and with a brief visual assessment of the visibility matrix of the nodes identified by the employee for which queries by users were made.

3.8.10 Mirabel International Airport

Both Mirabel and Montreal International Airport (Dorval) were surveyed on three consecutive days, with the Mirabel surveys taking 17 hours (11 hours one day and six the next) and the Montreal terminal surveys taking 13 hours (four hours one day and nine the next). Again, similar to the other airport surveys taken, the international arrival and departure areas (hold rooms) were out of bounds to the surveyor. Both terminals were surveyed by one surveyor over a three day period (average 10 hours/day).

The first terminal, surveyed on December 27 and 28, 1977, was Mirabel with a total annual enplaning/deplaning passenger volume of 1,428,000 (1976 Statistics Canada). This figure does not include other terminal users such as well wishers, greeters and visitors. The airport is 64 km north of Montreal and its passenger terminal is a simple rectangle with dimensions of 400 metres in length and 100 metres in width, with passenger flow across the shorter dimension, between the curb and airside. It is basically a one and a half level terminal with passenger processing on the main floor and amenities and concessions on an elevated mezzanine.

FIGURE 3.20
MIRABEL INTERNATIONAL AIRPORT (NTS)
 (FLOOR PLAN NODES)

FLOOR PLAN NODES (MIRABLE AIRPORT)			
NODE No.	NODE NAME	NODE No.	NODE NAME
1	Curb	35	Washrooms (m & w)
2	Entrance/exit (E)	36	Chapel
3	Entrance/exit	37	Washrooms (m)
4	Entrance/exit	38	Washrooms (w)
5	Entrance/exit	39	Ice cream, snack
6	Entrance/exit	40	Wait area
7	Entrance/exit	41	Bar
8	Entrance/exit	42	Snack bar
9	Entrance/exit	43	Cafeteria
10	Entrance/exit (W)	44	Restaurant
11	Ticket lobby (1)	45	Coffee shop
12	Ticket lobby (2)	46	Bar
13	Ticket lobby (3)	47	Wait area
14	Ticket lobby (4)	48	Post office
15	Ticket lobby (5)	49	Wait area
16	Stairs, esc.-mezz.	50	Bowrings
17	Stairs, esc.-mezz.	51	Wait area
18	Arrivals	52	Washrooms (m & w)
19	Arrivals	53	Stores
20	Arrivals	54	Wait area
21	Arrivals	55	Greeters/w-wishers gal
22	Stairs, esc.-mezz.	56	Esc.-up-park lot
23	Stairs - mezz.	57	Esc.-down-park lot
24	Stairs, esc.-mezz.	58	Esc.-up-park lot
25	Stairs - mezz.	59	Esc.-down-park lot
26	Stairs, esc.-mezz.	60	Emplane lobby
27	Stairs - mezz.	61	Deplane lobby
28	Security	62	Airside
29	Security	63	Arrivals area
30	Security	64	Departures area
31	Security	65	Wellwishers' gallery
32	Security	66	Intermediate curb
33	Currency	67	Porters
34	Washrooms (m & w)	68	Car rental

FIGURE 3.20 (CONT'D.)
FLOOR PLAN NODE LISTING

FLOOR PLAN NODES (MIRABEL, AIRPORT)			
NODE No.	NODE NAME	NODE No.	NODE NAME
69	All ent/ex. - int.curb	103	
70	Lower level park curb	104	
71	All ent/ex.-lower lev	105	
72	Rapid transit	106	
73		107	
74		108	
75		109	
76		110	
77		111	
78		112	
79		113	
80		114	
81		115	
82		116	
83		117	
84		118	
85		119	
86		120	
87		121	
88		122	
89		123	
90		124	
91		125	
92		126	
93		127	
94		128	
95		129	
96		130	
97		131	
98		132	
99		133	
100		134	
101		135	
102			

FIGURE 3.20 (CONT'D.)
FLOOR PLAN NODE LISTING

Mirabel proved to be a rather large terminal to survey, with 55 mandatory nodes and 64 optional nodes identified, entered into the visibility matrix and then visually surveyed. The total times for each survey are detailed below:

- i) four hours for the initial walkthrough and matrix row and column listings in the visibility matrix and the observational survey,
- ii) ten hours for the visual survey and matrix compilation,
- iii) one hour for camera recording, and
- iv) two hours for employee interviews.

The main contribution to the survey time was the visual survey. It was during this survey that an assistant could have proved beneficial and reduced the total time. Similarly, the time involved for the initial walkthrough and matrix listings of the identified nodes could have been somewhat reduced with the aid of an assistant. The matrix sheet also proved to be rather cumbersome during the survey because of its size, as well as the large number of nodes, which had to be individually entered, visually surveyed and checked.

A total of 11 employees were interviewed and a summary of the results are shown in Appendix C-2. Employees on both the concession and amenities mezzanine and the main processing level were interviewed.

Few complications arose with the actual surveys. Arriving passengers and departing passengers were observed to

flow easily through the terminal with a few long queues but no crowds to impede visual observations during the survey. Signage within the terminal was abundant and proved (during daylight, as well as during the evening periods, after sunset) to be quite visible with most of the signs having illuminated yellow backgrounds and black lettering. The visual terminal design problems observed by the surveyor as possibly contributing to user disorientation were:

- i) the location of washrooms, lockers and most mezzanine access stairs and escalators at the rear of the terminal, relative to the curb,
- ii) those stairs which were accessible from the curb were somewhat hidden from actual visual contact, however, accessibility was assisted by directional signage, and
- iii) the location of the stairs and escalators in the terminal, offset to the terminal entrances/exits, at the terminal and lower two-level parking garage interface at the curb.

3.8.II Montreal International Airport (Dorval)

The international airport at Montréal, Quebec is in the suburb of Dorval and is located 20 km west of the downtown core. Its terminal facility was surveyed on December 28 and 29, 1977, with a total of 21 mandatory and 58 optional nodes identified and entered in the visibility matrix during the initial walkthrough. There are two terminal buildings at the airport, one a satellite and the other the main terminal building. The satellite serves only as an access point to or from the aircraft and contains its own bridges, wait areas and hold rooms. The satellite is connected to the main terminal by a series of tunnels. Deplaning passengers

FIGURE 3.21
DORVAL INTERNATIONAL AIRPORT (NTS)
 (FLOOR PLAN NODES)

FLOOR PLAN NODES (DORVAL AIRPORT)			
NODE No.	NODE NAME		NODE No. NODE NAME
1	Curb		35 Lockers
2	Information booth		36 Post office
3	Lotto booth		37 Currency/insurance
4	Entrance/exit (2)		38 Security
5	Ticket counter		39 Bar
6	Phones		40 Handi-phone
7	Entrance/exit (3)		41 Retail shops
8	Dom. arriv. esc. up		42 Lockers
9	Handi-phone		43 Telegrams
10	Entrance/exit (4)		44 Phones
11	Air Can. reservations		45 Lost and found
12	Retail shops		46 First aid, police
13	Phones		47 Bank
14	CP Air reservations		48 Entrance/exit (1)
15	Phones		49 Lockers
16	Quebec Air Reserv.		50 Int. arriv. esc. up
17	Security		51 Lockers
18	Handi-elev.		52 Telegrams
19	Drug store		53 Phones
20	Travel insurance		54 Washrooms (m & w)
21	Phones		55 Entrance/exit
22	Phones		56 Entrance/exit
23	Washrooms (m & w)		57 Handi-phone
24	Observation deck		58 Car rental
25	Lockers		59 Phone (hotel)
26	Coffee shop		60 Entrance/exit
27	Restaurant		61 Entrance/exit
28	Bar		62 Phones
29	Pay TV lounge		63 Arrivals - intern'l.
30	Lockers		64 Entrance/exit - curb
31	Nursery		65 Entrance/exit-bag cl.
32	Washrooms (m & w)		66 Phones (hotel)
33	Phones		67 Stairs - dom. arriv.
34	Stairs to rest.		68 AC/CPA bag. info.

FIGURE 3.21 (CONT'D.)
FLOOR PLAN NODE LISTING

FLOOR PLAN NODES (DORVAL AIRPORT)				
NODE No.	NODE NAME		NODE No. NODE NAME	
69	Baggage claim		103	
70	Phones		104	
71	Rent-a-car		105	
72	Phones		106	
73	Telegrams		107	
74	Handi-phone		108	
75	Lockers		109	
76	Phones		110	
77	Washrooms (m & W)		111	
78	Arrivals (tunnels)		112	
79	Baggage info. counter		113	
80	Airside		114	
81			115	
82			116	
83			117	
84			118	
85			119	
86			120	
87			121	
88			122	
89			123	
90			124	
91			125	
92			126	
93			127	
94			128	
95			129	
96			130	
97			131	
98			132	
99			133	
100			134	
101			135	
102				

FIGURE 3.21 (CONT'D.)
FLOOR PLAN NODE LISTING

arrive through the tunnels in the main terminal in either the international or domestic areas. These two separate areas are at ground level at each end of the terminal and are connected to the upper level by stairs and escalators (the international area has an elevator). This upper level contains processing nodes for departing passengers, as well as many of the amenities and concessions. With visual quantification, this separation (due mainly to the poor location of the access stairs and escalators) of the two major processing areas may prove a drawback in terminal visibility calculations. The large block in the center of the upper level may also prove to be a visual problem and cause user disorientation. Most of the airline agents are located at the sides of the terminal in the central block, perpendicular to the curb, with Air Canada, Allegany and Eastern parallel and facing the curb. Some concessions are located at the side walls of the terminal with most of the amenities to the rear, behind the central block (airside). Three security entrance gates to the hold room leading to bridges or tunnels to the satellite hold rooms are at different locations in the terminal on this second level.

The times involved for each survey are as follows:

- i) three hours for the initial walkthrough for the visibility matrix row and column entries and the observational survey,
- ii) seven hours for the full visual survey and matrix compilation,

- iii) one hour for camera recordings, and
- iv) two hours for the employee interviews.

Several well located and illuminated directional and identification signs were observed in the terminal and which appeared to aid users in reaching their required nodes. Each corner had two of these signs located perpendicular to the user flows.

A total of 17 employees were interviewed on both levels of the terminal, and a summary of these interviews can be found in Appendix C-2.

During the period of the survey (1½ days), the terminal proved to be quite active at all times, with small queues at most ticket counters, the restaurant, bars, and in front of the three security check-in areas. The following is a list of problem areas which, as shown on the observational sheet, may create some degree of user disorientation:

- i) the partially hidden escalators and stairs to the second level in the international and domestic arrival areas,
- ii) the large rectangular block in the central area of the terminal,
- iii) the amenities at the far end of the terminal relative to the curb, and
- iv) the separation of the three security check-in areas and gates and the distance between them.

In addition to the presence of the identification and directional signage, the information booths beside each main curbside entrance/exit doors proved to be quite valuable to users in obtaining directional assistance.

The terminal was similar to Mirabel, and proved rather difficult to survey due to the layout (two levels and large central block), and an assistant would have considerably reduced the total survey time.

3.9 Discussion

A total of eight airport terminals were surveyed. It took 20 hours to survey the first three terminals - Fredericton, Moncton and Saint John - which included the initial walkthrough and matrix listings, the observation surveys, visual surveys and passenger interviews. The remaining seven terminals took 69 hours to survey and included the same number of surveys for each terminal, except that the passenger interview portion was replaced with employee interviews. Three surveyors were involved in the first five terminals surveyed - Fredericton, Moncton, Saint John, Quebec City and Edmunston. The remaining five were done by only one surveyor.

In nearly all cases the survey undertaking attempted to coincide the visual survey portion with the busiest period of the day provided that their arrival time at the site was prior to that period. In some cases, because of the time involved to under-

take the visual survey and the short duration of some of the busy periods, the visual survey ended in a rather empty terminal. On the other hand, as discussed in section 3.5.3, Saint John's visual survey had to be stopped for a brief period because of the crowding and confusion created by greeters in front of the international arrivals area. Those surveys which were conducted during the Christmas period (December 26th to 29th, 1977) proved to be excellent examples of problems which may create some degree of user disorientation.

In all the terminals surveyed, the international and transborder inspection and baggage claim areas as well as all the hold rooms were out of bounds to the surveyors. All areas in the bus and train terminals were surveyed with few restrictions and those areas where the surveyors were not allowed, such as the platforms and tunnels to the platforms, were not required for the surveys.

Difficulties were encountered when surveying the large terminals with a corresponding large matrix sheet. It proved bulky and had to be constantly folded and unfolded, and was difficult to read and correspond nodes for the visibility entries. It was discovered after the surveys that the nodes could be recorded in an array format on individual sheets of standard size paper and carried around on a clipboard. This recording method for the field survey is discussed and detailed with an example in Chapter 6, Summary, Conclusions and Recommendations.

Based on the survey times alone, the costs involved for the four surveys in each terminal should be minimal, depending on the size of the terminal surveyed and the number of surveyors involved. As shown in the previous sections, one experienced surveyor was all that was required, in terms of manpower, for the last five terminals surveyed. For very large, complex terminals it is recommended that two surveyors be employed - one should be experienced, the second could be a trainee. Since the field survey is not complex, training costs are reduced, with a trainee assisting in the first survey and then being assisted in the second.

Materials required for the field survey are inexpensive (pens, pencils, ruler, eraser, clip board), with the exception of the camera required for the camera recording survey. A good camera is recommended with sensitive film (100 ASA or greater) in order to take accurate inside pictures of the terminal without a flash.

Expenses may be incurred with respect to travelling, depending on the number of terminals to be surveyed, their location and the number of surveyors involved. It is recommended that an activity analysis be undertaken (for the terminals to be surveyed, the busy periods identified, and a trip itinerary corresponding to these periods be drawn up in order to reduce travelling expenses.

The field survey is also very unobtrusive to terminal operations, since the visual survey is carried out during the busy period and does not obstruct or bother users. The employee interviews are carried after the busy period.

In the first survey series, quantifying user orientation in an existing terminal, the employee interview is necessary to validate and cross reference the visual survey results when identifying existing visibility problems. As a result of quantification, if any improvements are made to the terminal, a final visual survey and employee interview should be undertaken to verify these improvements. This is discussed further in Chapter VII.

Finally, both the field survey technique and floor plan analysis technique are not complex, are fairly inexpensive and are valuable in assessing any orientation problems which terminal users may be undergoing. Improvements made based on these surveys can prove valuable to terminal operations, causing efficient passenger throughput and add to the terminal's designed level of service, particularly with respect to the comfort and convenience of its users orientating through the facility.

CHAPTER 4

VISIBILITY INDICES

4.1 Introduction

For each terminal surveyed, three matrices were compiled: the visibility matrix compiled in the field, a visibility matrix compiled from the terminal's floor plans, and a base visibility matrix compiled from the field visual survey. Each of these must be quantified in order to evaluate the visibility of the terminal system, its subsystem and components in order to express in numerical terms (namely the visibility index) how orientated an individual terminal user would be in the particular terminal considered. The computations required for the visibility indices for each terminal as well as the equation used to calculate them are detailed and discussed in Appendix D. The terms and equations used to calculate the numerous visibility indices in Appendix D differ slightly to those detailed and numbered in the theoretical terminal quantification in Chapter 2. This was done purposely in order to differentiate between all the numerous computations and to correspond to the Fortran IV language of the computer program.

4.2 The Computer Program

Nearly 51 computations are required for the visibility index calculations for each matrix. Since there are three matrices compiled for each terminal, there is a total of 153 calculations. From the author's experience, these calculations

take, on the average, nearly 10 to 23 hours to do by hand (depending on the size of the terminal and the number of nodes). It is, therefore, obvious that a computer program be developed to ease the burden of these tedious calculations. The flow diagram for the computer program to do this is detailed in Figure 4.1, with sample printouts of visibility indices calculations in Appendix E and F.

A complete list of definitions of the computer program printout listings can be found in Appendix E-1. A summary table of some of the calculated visibility indices for all the terminals surveyed from the computer printouts can be found in Tables 4.2, 4.3 and 4.4.

4.3 Sample Calculations for Moncton

Referring to the Moncton airport visibility index printouts, in Appendix E (E-1, 2, and 3), the listing begins with the row and column totals of the visibility links for the nodes listed on the left hand side of the printout. Those visibility link totals under the column heading L, pertain to the visual link between the terminal system nodes entered due to perception of the nodes by physical observation and recognition and/or through a directional sign. That is, any entry is counted as one. The visibility link totals under the column heading LI are the totals for each row and column for the particular node considered which viewed other nodes in the terminal system by their physical presence only. LA and LO are the terminal system's node signage assistance

FIGURE 4.1
COMPUTER PROGRAM FLOW DIAGRAM

and node signage observation row and column totals. Under the M column, is the row and column totals of the number of times a mandatory node observed and recognized another mandatory node only, for the mandatory node subsystem quantification. Zero entries in the row and column entries, indicate that this particular node is not a mandatory node. The MT column has listed under it the row sight link totals for each mandatory node observation (orientation) to all other nodes in the terminal system as well as the other nodes in the mandatory node subsystem. The column listings are the total sight links to that particular mandatory node (accessibility) in the node listing column, from the network as well as the remaining mandatory node subsystem. All these totals are summed at the bottom of the listing, and used in the appropriate equation to calculate V, VM and VMT in the next listing. The VI, VA, and VO are the calculations for the total terminal system visibility indices discussed in Appendix D. These were quantified with the row and column totals depending on the method which the nodes were recognized and identified (physical presence, signage). Similarly VMI, VMA, and VMO are the mandatory node subsystem indices calculated by the equations also shown in Appendix D. The VMOS and VMAS are the orientation and accessibility indices quantification between the mandatory node subsystem and the remaining terminal network observed only a node's physical presence and/or through a directional sign - any entry counted as one, again discussed in Appendix D.

The next listing on the printout are the orientation and accessibility indices for particular components of the terminal. To show that any node can be quantified, in this research all mandatory nodes identified in the terminal as well as five select optional type nodes were chosen. These were all telephones (local only), any information booths, all bars, resaurants and coffee shops, all washrooms and any first aid rooms. Each of these were quantified further by calculating orientation and accessibility depending how the terminal system (orientation) or the node itself from the network (accessibility) was observed (physical presence, signage).

The final listing is the quantification of a terminal user type subsystem. The greeter was given as an example in Appendix D, yet four more user subsystems were also quantified. The indices calculated were the orientation indices - the perception of the rest of the terminal while in their respective subsystems. The nodes identified relative to the user type were obtained from Table 3.2, Chapter 3, and are summarized in Table 4.5 in this chapter.

In summary, the computer program took nearly 16 hours to develop to its present stage. It has the ability to quantify matrices 130×130 in size but provided the computer space is available, it can handle any size matrix. The 16 hours included "fine tuning" and compared to hand calculation times, which it reduces, the 16 hours spent on development proves quite minimal. For example, the quantification of all three Moncton air terminal

matrices by hand, takes close to 12 to 13 hours. The computer data sheet listings and key-punching of the Moncton air terminal data from the sheets, done by a rather inexperienced keypuncher took only three hours. In summary, for the ten terminals surveyed, including the two large terminals (Mirabel and Dorval), the program proved extremely valuable relative to the time saved.

4.4 Computer Printout for all Terminals Surveyed

Tables 4.2, 4.3 and 4.4 list a summary of all the calculated visibility indices from the computer program output for the base, floor plan and site survey matrices, respectively. The terminal base matrix, as explained in Chapter 3, Section 3.4, is a formation of the visibility matrix values, observed and measured in the field, to a common base terminal matrix. Simply stated, it is the quantification of a common base terminal node layout as it would exist if a terminal designer was constrained by the use of only 26 base nodes plotted on an existing terminal floor plan.

4.5 Discussion of Indices - Moncton/Fredericton Terminals

A summary of the visibility results from the base matrices for Moncton and Fredericton airports are included as examples and are blocked out in Table 4.2. They are discussed in the following comparative analysis. Their actual computer printouts, which will also be referred to, are shown in Appendices E-2 and E-4, respectively.

	TERMINAL SYSTEM				TERMINAL SUBSYSTEM			
	TOTAL TERMINAL VISIBILITY V%	IDENTI- FICATION INDEX VI%	ASSISTANCE INDEX VA%	OBSER- VATION INDEX VO%	TOTAL MANDATORY VISIBILITY VM%	MANDATORY IDENTI- FICATION INDEX VMI%	MANDATORY ASSISTANCE INDEX VMA%	MANDATORY OBSER- VATION INDEX VMO%
MONCTON	40.2	39.7	1.5	0.5	56.4	55.5	0.0	0.9
FREDERICTON	32.8	32.8	0.0	0.0	38.2	38.2	0.0	0.0
SAINT JOHN	34.8	33.8	1.2	0.6	66.4	66.4	0.0	0.0
EDMUNSTON	31.4	31.4	0.0	0.0	86.4	86.4	0.0	0.0
QUEBEC CITY	54.6	30.2	77.5	24.5	76.4	50.0	150.0	26.4
OTTAWA AIR	66.2	50.5	31.4	15.7	64.5	51.8	80.0	12.7
OTTAWA TRAIN	48.5	56.9	2.5	1.5	57.3	54.5	0.0	2.7
OTTAWA BUS	35.8	29.4	20.5	6.5	36.4	30.0	30.0	6.4
DORVAL	47.8	34.6	29.2	13.2	45.5	35.5	60.0	10.0
MIRABEL	33.5	24.3	14.6	9.2	20.9	18.2	20.0	2.7

TABLE 4.2
SUMMARY COMPUTATIONS
(BASE MATRIX)

	TERMINAL SUBSYSTEM					
	MANDATORY ORIENTATION	MANDATORY ACCESSIBILITY	ORIGINATING-DOMESTIC PASSENGER SUBSYSTEM			OBSERVATION INDEX
	VMOS%	VNAS%		TOTAL VISIBILITY INDEX	IDENTIFICATION INDEX	ASSISTANCE INDEX
				VV%	VVI%	VYA%
						VVO%
MONCTON	38.2	38.2		29.3	27.1	6.0
FREDERICTON	36.4	36.4		24.1	24.1	0.0
SAINT JOHN	29.1	29.1		32.3	32.3	0.0
EDMUNSTON	20.6	20.6		32.3	32.3	0.0
QUEBEC CITY	62.4	62.4		42.9	21.1	70.7
OTTAWA AIR	64.2	64.2		57.9	39.1	32.3
OTTAWA TRAIN	60.6	60.6		45.9	45.1	0.8
OTTAWA BUS	36.4	36.4		27.8	18.8	23.3
DORVAL	46.7	46.7		33.1	26.3	20.3
MIRABEL	28.5	28.5		27.1	21.1	11.3

TABLE 4.2 (CONT'D.)

SUMMARY COMPUTATIONS

(BASE MATRIX)

TERMINAL COMPONENT (NODE)								
TOTAL ORIENTA- TION INDEX	ORIENTA- TION IDENTI- FICATION INDEX	ORIENTA- TION ASSISTANCE INDEX	ORIENTA- TION OBSER- VATION INDEX	TOTAL ACCES- SIBILITY INDEX	ACCES- SIBILITY IDENTI- FICATION INDEX	ACCES- SIBILITY ASSISTANCE INDEX	ACCES- SIBILITY OBSER- VATION INDEX	
0%	01%	0A%	00%	A%	A1%	AA%	AO%	
56.0	56.0	0.0	0.0	60.0	48.0	40.0	17.0	
52.0	52.0	0.0	0.0	32.0	32.0	0.0	0.0	
44.0	44.0	0.0	0.0	40.0	40.0	0.0	0.0	
32.0	32.0	0.0	0.0	48.0	48.0	0.0	0.0	
72.0	20.0	116.0	52.0	48.0	36.0	16.0	4.0	
56.0	48.0	24.0	8.0	56.0	40.0	24.0	16.0	
56.0	56.0	0.0	0.0	40.0	40.0	0.0	0.0	
52.0	44.0	28.0	8.0	28.0	28.0	0.0	0.0	
0.0	0.0	0.0	0.0	4.0	4.0	0.0	0.0	

BAGGAGE CLAIM: ORIENTATION, ACCESSIBILITY								
MONCTON								
FREDERICTON								
SAINT JOHN								
EDMUNSTON								
QUEBEC CITY								
OTTAWA AIR								
OTTAWA TRAIN								
OTTAWA BUS								
DOORVAL								
MIRABEL								

TABLE 4.2 (CONT'D.)
SUMMARY COMPUTATIONS
(BASE MATRIX)

	TERMINAL SYSTEM				TERMINAL SUBSYSTEM			
	TOTAL TERMINAL VISIBILITY V%	IDENTI- FICATION INDEX VI%	ASSISTANCE INDEX IVA%	OBSER- VATION INDEX VO%	TOTAL MANDATORY VISIBILITY VM%	MANDATORY IDENTI- FICATION INDEX VMI%	MANDATORY ASSISTANCE INDEX VMA%	MANDATORY OBSER- VATION INDEX VMO%
MONCTON	41.1	41.1	0.0	0.0	40.7	40.7	0.0	0.0
FREDERICTON	40.2	40.2	0.0	0.0	50.6	40.6	0.0	0.0
SAINT JOHN	37.5	37.5	0.0	0.0	38.1	38.1	0.0	0.0
EDMUNSTON	60.4	60.4	0.0	0.0	80.6	80.6	0.0	0.0
QUEBEC CITY	41.3	41.3	0.0	0.0	55.2	55.2	0.0	0.0
OTTAWA AIR	24.3	23.9	0.4	0.4	28.6	27.9	0.0	0.7
OTTAWA TRAIN	47.0	47.0	0.0	0.0	69.2	69.2	0.0	0.0
OTTAWA BUS	37.0	37.0	0.0	0.0	53.8	53.8	0.0	0.0
DORVAL	12.5	12.5	0.0	0.0	23.6	23.6	0.0	0.0
MIRABEL	15.1	15.1	0.0	0.0	17.6	17.6	0.0	0.0

TABLE 4.3

SUMMARY COMPUTATIONS
(FLOOR PLAN MATRIX)

	TERMINAL SUBSYSTEM						
	MANDATORY ORIENTATION	MANDATORY ACCESSIBILITY	ORIGINATING-DOMESTIC PASSENGER SUBSYSTEM				OBSERVATION INDEX
	VMOS%	VMAS%	↑	TOTAL VISIBILITY INDEX	IDENTIFICATION INDEX	ASSISTANCE INDEX	VVO%
				VV%	VVI%	VYA%	
MONCTON	38.9	38.9		47.4	47.4	0.0	0.0
FREDERICTON	35.5	35.5		47.5	47.5	0.0	0.0
SAINT JOHN	32.6	32.6		38.0	38.0	0.0	0.0
EDMUNSTON	44.4	44.4		69.7	69.7	0.0	0.0
QUEBEC CITY	25.3	25.3		45.0	45.0	0.0	0.0
OTTAWA AIR	20.2	20.2		31.0	31.0	0.0	0.0
OTTAWA TRAIN	34.2	34.2		53.1	53.1	0.0	0.0
OTTAWA BUS	41.0	41.0		55.6	55.6	0.0	0.0
DORVAL	12.0	12.0		17.2	17.2	0.0	0.0
MIRABEL	9.1	9.1		15.2	15.2	0.0	0.0

TABLE 4.3 (CONT'D.)
SUMMARY COMPUTATIONS
(FLOOR PLAN MATRIX)

TERMINAL COMPONENT (NODE)								
TOTAL ORIENT- TATION INDEX	ORIENT- TATION IDENTI- FICATION INDEX	ORIENT- TATION ASSISTANCE INDEX	ORIEN- TATION OBSER- VATION INDEX	TOTAL ACCES- SIBILITY INDEX	ACCES- SIBILITY IDENTI- FICATION INDEX	ACCES- SIBILITY ASSISTANCE INDEX	ACCES- SIBILITY OBSER- VATION INDEX	
0%	01%	0A%	00%	A%	A1%	AA%	AO%	
40.9	40.9	0.0	0.0	40.9	40.9	0.0	0.0	
44.0	44.0	0.0	0.0	60.0	60.0	0.0	0.0	
34.8	34.8	0.0	0.0	30.4	30.4	0.0	0.0	
34.6	34.6	0.0	0.0	69.2	69.2	0.0	0.0	
62.5	62.5	0.0	0.0	58.3	58.3	0.0	0.0	
19.4	19.4	0.0	0.0	22.2	22.2	0.0	0.0	
63.0	63.0	0.0	0.0	40.7	40.7	0.0	0.0	
11.4 (DOM)	11.4 (DOM)	0.0 (DOM)	0.0 (DOM)	19.0 (DOM)	19.0 (DOM)	0.0 (DOM)	0.0 (DOM)	

BAGGAGE CLAIM : ORIENTATION , ACCESSIBILITY								
MONCTON								
FREDERICTON								
SAINT JOHN								
EDMUNSTON								
QUEBEC CITY								
OTTAWA AIR								
OTTAWA TRAIN								
OTTAWA BUS								
DORVAL								
MIRABEL								

TABLE 4.3 (CONT'D.)
SUMMARY COMPUTATIONS
(FLOOR PLAN MATRIX)

	TERMINAL SYSTEM				TERMINAL SUBSYSTEM			
	TOTAL TERMINAL VISIBILITY V%	IDENTI- FICATION INDEX VI%	ASSISTANCE INDEX VA%	OBSER- VATION INDEX VO%	TOTAL MANDATORY VISIBILITY VM%	MANDATORY IDENTI- FICATION INDEX VMI%	MANDATORY ASSISTANCE INDEX VMA%	MANDATORY OBSER- VATION INDEX VMO%
MONCTON	46.8	46.0	1.8	0.8	50.0	48.7	0.0	1.3
FREDERICTON	44.5	44.5	0.0	0.0	42.3	42.3	0.0	0.0
SAINT JOHN	36.6	35.7	1.2	0.9	46.2	64.2	0.0	0.0
EDMUNSTON	69.1	69.1	0.0	0.0	91.1	91.1	0.0	0.0
QUEBEC CITY	70.1	35.7	96.4	34.4	70.5	37.5	7.1	32.9
OTTAWA AIR	34.5	22.9	14.2	11.6	37.7	24.5	8.6	13.2
OTTAWA TRAIN	62.2	60.8	2.2	1.4	74.2	69.7	0.0	4.5
OTTAWA BUS	30.7	24.6	13.5	6.0	33.3	27.6	0.0	5.8
DORVAL	19.9	10.0	11.4	9.9	32.9	15.7	20.5	17.2
MIRABEL	15.8	9.3	9.4	6.5	18.0	13.3	0.0	4.7

TABLE 4.4

SUMMARY COMPUTATIONS
(SITE SURVEY MATRIX)

	TERMINAL SUBSYSTEM						
	MANDATORY ORIENTATION	MANDATORY ACCESSIBILITY	ORIGINATING - DOMESTIC PASSENGER SUBSYSTEM				
	VMOS%	VMAS%		TOTAL VISIBILITY INDEX	IDENTIFICATION INDEX	ASSISTANCE INDEX	OBSERVATION INDEX
				VV%	VVI%	VYA%	VVO%
MONCTON	40.8	40.8		44.7	39.5	10.5	5.3
FREDERICTON	41.1	41.1		43.1	43.1	0.0	0.0
SAINT JOHN	31.2	31.2		32.9	31.9	0.9	0.9
EDMUNSTON	37.5	37.5		79.2	79.2	0.0	0.0
QUEBEC CITY	69.7	69.7		53.0	27.8	63.5	25.2
OTTAWA AIR	32.9	32.9		33.3	24.1	12.6	9.1
OTTAWA TRAIN	64.0	64.0		62.3	62.3	0.0	0.0
OTTAWA BUS	34.5	34.5		54.4	41.2	47.4	13.2
DORVAL	16.1	16.1		12.9	9.8	4.1	3.1
MIRABEL	18.6	18.6		15.3	11.1	6.3	4.2

TABLE 4.4 (CONT'D.)
SUMMARY COMPUTATIONS
(SITE SURVEY MATRIX)

the various nodes through signs. All the low visibility index values in both terminal evaluations, as well as the high design index values, demonstrate that a user, attempting to locate his next required node or other nodes in the subsystem, may experience some degree of disorientation.

Individual component analysis concentrates the visibility measurements to particular nodes. The accessibility values give a measure of how a user, orientated through vision, would attempt to observe a single particular node from the rest of the terminal network. The orientation index, on the other hand, is a measure of how a user, orientated through vision, would be attempting to observe other nodes in a terminal network from a single particular node. Both the node's accessibility and orientation values are quantified as to whether it was observed physically, through a sign or a combination of these visual contact methods.

In the Moncton terminal, the visibility indices show that the most accessible node through vision was the waiting room and the least visible was the ticket purchase counter. Three other nodes which were found to be poorly visible from the rest of the terminal network were the custom and immigration areas and the mens' and womens' washrooms. Regarding the orientation index results, the node which offered the least orientation to a user in the Moncton terminal was the airside node. Three nodes which did offer good visibility to a user of the rest of the terminal were the phones, the waiting room area and the hold room.

TERMINAL COMPONENT (NODE)								
TOTAL ORIEN- TATION INDEX	ORIEN- TATION IDENTI- FICATION INDEX	ORIEN- TATION ASSISTANCE INDEX	ORIEN- TATION OBSER- VATION INDEX	TOTAL ACCES- SIBILITY INDEX	ACCES- SIBILITY IDENTIFI- CATION INDEX	ACCES- SIBILITY ASSISTANCE INDEX	ACCES- SIBILITY OBSER- VATION INDEX	
0%	01%	0A%	00%	A%	A1%	AA%	AO%	
59.1	59.1	0.0	0.0	68.2	50.0	40.9	18.2	
48.0	48.0	0.0	0.0	44.0	44.0	0.0	0.0	
40.6	40.6	0.0	0.0	40.6	40.6	0.0	0.0	
80.0	80.0	0.0	0.0	70.0	70.0	0.0	0.0	
92.6	48.1	148.1	44.4	81.5	59.3	100.0	22.2	
25.4	22.4	7.5	3.0	28.4	19.4	9.0	9.0	
53.3	53.3	0.0	0.0	43.3	43.3	0.0	0.0	
21.1 (DOM)	12.5 (DOM)	14.3 (DOM)	11.6 (DOM)	10.7 (DOM)	10.7 (DOM)	0.0 (DOM)	0.0 (DOM)	

BAGGAGE CLAIM: ORIENTATION, ACCESSIBILITY								
MONCTON								
FREDERICTON								
SAINT JOHN								
EDMUNSTON								
QUEBEC CITY								
OTTAWA AIR								
OTTAWA TRAIN								
OTTAWA BUS								
DORVAL								
MIRABEL								

BAGGAGE CLAIM: ORIENTATION, ACCESSIBILITY

TABLE 4.4 (CONT'D.)
SUMMARY COMPUTATIONS
(SITE SURVEY MATRIX)

From this table and appendices, the index value for V , the total visibility index, which is a measure of the visibility of all the nodes in a terminal, recognized and observed by their physical presence and/or through signage (with any node entry counted as one) is observed in the tables and printouts for the Moncton terminal system to be $V=40.2\%$. When compared to Fredericton with $V=32.0\%$, the lower value indicates that the base layout in the Moncton terminal is more visible. In other words, an airport terminal user in the Fredericton airport applied base node system would be subjected to more disorientation factors than the same applied base node system in Moncton.

The sign observation index V_O , is a measure of those nodes in a terminal which are identified and recognized by a directional sign only. For Moncton this value is $V_O=0.5\%$. The node identification index V_I , which is a measure of the node system's visibility by its physical presence alone, plus the sign observation index V_O , equals the stated system's visibility index V .

The sign assistance index V_A , is a measure of the system's visibility as it is assisted by signage. That is, some of the nodes in the terminal system may be identified and recognized alone (physical presence), as well as through a directional sign. The assistance index is basically a measure of all directional signage in the terminal whether the node was observed and recognized only by a sign or by its physical presence. That is, all directional signage entries are counted (slashes). If this is

the case, that is, nodes in the system were observed and recognized as they stand alone (physical presence) and yet they are also observed through a directional sign, or any number of directional signs, then as discussed in the previous chapter, there may exist a degree of oversignage. This degree is calculated by subtracting V_O from V_A . Fredericton V_A and V_O values are both 0%, indicating that none of the nodes are observed and recognized physically, assisted by a directional sign or seen through a directional sign. On the other hand, Moncton's base system observational index of 0.5%, with a V_A value of 1.5%. Subtracting these two indexes yields an over-signage index of 1.0%. That is, a node (or nodes) has been observed physically and through a sign, or a number of signs (directional).

Physical observation and recognition of nodes in a system, as well as signage assistance, may actually aid a user by assuring him/her that the node or nodes desired are, in fact, the correct ones. But if the node or nodes are observed and recognized through more than one directional sign, say two, three or more, the bombardment of this information may actually cause confusion and disorientation. This particular problem was observed in the Quebec City terminal. For example, the individual node listing in the base matrix printout for node seven, and the security check-in, has an accessibility assistance index AA of 212.0%. Subtracting its accessibility observation index $A_O=48.0\%$ yields an oversignage index of 164.0%. Reviewing the base matrix entries for the Quebec City terminal, Figure 4.2, reveals under the security check-in node column (reading down) that this node was observed from

other particular nodes, five and six times through different directional signs.

It should be noted that the system evaluation portion of user orientation quantification is only a preliminary indication of the visibility or orientation problems which may be found in a terminal facility. Further analysis, namely of its subsystems and components, is required to fully quantify and reveal specific problems.

The mandatory node subsystem computations are related to the passenger type user of the terminal. These are the nodes which must be present in any transportation terminal and are required to process various passenger types (boarding, de-boarding, connecting) in order that passengers may complete, begin or continue a trip. The mandatory node subsystem visibility for Moncton $V_M = 56.4\%$, shows that slightly over one-half of all the subsystem nodes are visible to a user in the mandatory node subsystem. Of these, 55.5% (V_{MI}) are visible by physical presence alone, with 0.9% (V_{MO}) observed only through a directional sign.

The value of $V_{MA} = 0.0\%$ demonstrates that none of the nodes are physically observed or observed through a directional sign, and hence, there is no oversignage problem present. For the Fredericton terminal, the fact that values of V_{MA} and V_{MO} are 0.0% and that V_M equals $V_{MI} = 38.0\%$ indicates that no directional signs are present in the terminal. The values V_{MOS} and V_{MAS} , the subsystem orientation and accessibility indices, were calculated to show the

visibility of a subsystem user has with the rest of the terminal system (V_{MOS}) and the visibility of a user in the terminal system who wishes to access or use a node in the subsystem (V_{MAS}). These two indices are calculated by totalling a node's individual visibility link entries present due either by its physical presence or observed through a directional sign (any entry counted as one). These values were only calculated to show that subsystem orientation and accessibility indices can also be determined or calculated by entries due to physical presence, either through a sign, or a combination of these observation and recognition methods. This is shown with the five identified terminal user type subsystems displayed at the bottom of the computer printouts (Appendix E) and the single originating-domestic passenger results in Table 4.2. In all cases, the evaluation results of the visibility of the subsystems pertaining to the user types chosen were less in the Fredericton terminal than the same subsystems evaluated in the Moncton terminal. In other words, if the base nodes required by an originating-domestic passenger are evaluated as they exist in the Moncton terminal layout, and these same base nodes are again evaluated as they exist in the Fredericton terminal layout, the calculated indexes show that an originating-domestic passenger in the Fredericton terminal would experience more visual and hence, disorientation problems than the same passenger type using the Moncton subsystem. Of the four passenger subsystems identified and evaluated, the originating-domestic passenger has, in both terminals, the least visual contact with its individual subsystem nodes. In Moncton, two of the subsystems have some contact with

the various nodes through signs. All the low visibility index values in both terminal evaluations, as well as the high design index values, demonstrate that a user, attempting to locate his next required node or other nodes in the subsystem, may experience some degree of disorientation.

Individual component analysis concentrates the visibility measurements to particular nodes. The accessibility values give a measure of how a user, orientated through vision, would attempt to observe a single particular node from the rest of the terminal network. The orientation index, on the other hand, is a measure of how a user, orientated through vision, would be attempting to observe other nodes in a terminal network from a single particular node. Both the node's accessibility and orientation values are quantified as to whether it was observed physically, through a sign or a combination of these visual contact methods.

In the Moncton terminal, the visibility indices show that the most accessible node through vision was the waiting room and the least visible was the ticket purchase counter. Three other nodes which were found to be poorly visible from the rest of the terminal network were the custom and immigration areas and the mens' and womens' washrooms. Regarding the orientation index results, the node which offered the least orientation to a user in the Moncton terminal was the airside node. Three nodes which did offer good visibility to a user of the rest of the terminal were the phones, the waiting room area and the hold room.

Comparing these results to Fredericton's node analysis it can be seen from the computer printouts that the curb and ticket purchase counter nodes in the Fredericton terminal were the least visible from the rest of the terminal network (accessibility). The ticket purchase counter in the Moncton terminal was also the least visible. Unlike Moncton, the mens' and womens' washrooms, as well as the customs and immigration area in Fredericton, proved quite visible. The waiting room area in Fredericton, similar to Moncton, had a high visibility index.

In both terminals, except for a few nodes at Moncton, all the nodes themselves proved to have rather poor visibility qualities. Although the terminals are very similar in design and layout, the evaluation of the base nodes, as they exist in each terminal, demonstrated that the Fredericton terminal network system has a slightly less visual quality than that of Moncton. This is also verified by the higher design improvement indexes found from the Fredericton analysis for each of its nodes, as well as the analysis of its subsystems and total terminal system.

4.6 Summary

This chapter has detailed the calculations involved in the quantification of the data compiled in the three matrices and has demonstrated how a terminal user's orientation can be expressed in numerical terms. It particularly concentrates on a hierarchical data analysis method, namely identifying the orientation of users in the system, in any particular subsystem

for any particular terminal component. A total terminal user orientation quantification method, discussed in Chapter 5, can exactly pinpoint any specific problem areas. The measurement techniques detailed in this research, as discussed further in the following chapter, only identify certain areas and certain components (nodes) which show and prove that there may exist user orientation problems.

The following chapter demonstrates further how all the required data recorded or compiled in the three matrices, namely the site surveys, the floor plan analysis and the base matrix, can be compared and validated to identify orientation problems in the terminal facility, due either to its layout or signage system, and how they can be improved to reduce said problems. Any improvements are then drawn on floor plans, and then quantified again to evaluate whether identified orientation problems are reduced or eliminated, thus verifying the orientation quantification theory of this research.

CHAPTER 5

VALIDATION AND DEMONSTRATION

5.1 Validation by Passenger Interviews

Although proved to give inaccurate results after the first three terminals surveyed due to some contradictory responses, the passenger interview sheets did contain valuable surveyor notes and are fairly representative of typical user orientation problems in a terminal. These are discussed and compared to the site and floor plan quantified visibility indices results in the following paragraphs in order to validate the theory for measuring terminal user orientation. The passenger interview sheet for Moncton airport (Appendix B) and its visibility matrix results summarized in Table 4.4, as well as the computer printout (Appendix E-1), will be used for this validation.

From the curb passenger interview at Moncton (Appendix B), two passengers recalled having difficulty locating the ticket counter, three the washrooms and one the phones. For the waiting room passenger interview portion, two stated they had difficulty in finding the washrooms, and one the phones.

Since both the deplaning (curb) and enplaning (waiting room) passenger types experienced difficulty in finding the two particular nodes, the washrooms and phones, this indicates that these nodes must have poor visual characteristics causing a degree of disorientation. Referring to the computer printouts for Moncton's visual site survey (Appendix E-1) node 17, the washrooms, have a low

accessibility index (36.4%). The nodes which were of the poorest visual quality were the phones, node 11 (4.5%) and the next lowest, the phones at node 21 (13.6%). The most visible of the three sets of phones in the terminal were those at node four (54.5%), which are located in the ticket counter wing. On the average, the phones for the floor plan analysis had a visibility of 39.4%. From the camera recordings, the reason for this node's high accessibility value was due to the presence of an overhead identification sign (see Figure 5.1). Relative to the rest of the nodes in the terminal and the total terminal system's visibility index, the phones and washrooms, as well as the two ticket counters (Air Canada 40.9% and Eastern Provincial Airlines 36.4%) all had low accessibility indexes.

Comparing the calculated results of the two data collection methods (floor and site) demonstrates that in most cases their total system visibility results are about the same. Yet, as shown by the differences in the component analysis, in this case the phones, the effect of identification signs assisting in observation and recognition of a node, is apparent. Therefore, a site survey of an existing terminal, implemented in conjunction with the floor plan analysis is shown, with this example, to be advantageous.

In summary, relative to the calculated indexes of the other nodes in the terminal, the phones, washrooms and the ticket counter were of low visual quality and therefore did actually cause, as validated by the passenger interview results, terminal user disorientation.

FIGURE 5.1
MONCTON INTERNATIONAL AIRPORT
(IDENTIFICATION SIGNS)

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5.2 Validation by Employee Interviews

Since the passenger interviews were found to be invalid, an employee interview survey was derived in order to validate more accurately the theory outlined in this thesis, namely that of quantifying terminal user orientation in a terminal facility. In the following paragraphs, the quantified results of the visual link measurements undertaken by the site survey and floor plan analysis of the Ottawa Voyageur bus terminal are discussed and validated by the results of the employee interviews.

The Ottawa bus terminal's total terminal visibility index, Appendix E-4 (site) was calculated to be only 30.7%, Table 4.4. Three node types fall below this value. They are the departure gates, washrooms and the phones. The least visible node in the terminal is gate 1 (10.0%). The average accessibility of all the gates in the terminal is 19.4%. The next least accessible node was the womens' washroom (node 29 in the printout) with an index of 12.5%. On the average, the visibility of all the mens' and womens' washrooms in the terminal (4) is only 16.0%. The phones, node 30 and node 36, appeared to be the next least visible nodes in the terminal, since from the computer printout each had a low index value of only 15.0%. Again, on the average, the five sets of phones in the terminal had a visibility index of 21.0%.

From the floor plan site line measurements, the least visible node in the terminal was the women' washroom, node seven,

with 0%. The average accessibility of all the phones in the terminal was calculated to be 36.0%. The second least accessible node was the entrance and exit to curb, 14.6%, with the next being the restaurant, node 3, with 17.1% and the phones, node 42, with the same index value of 17.1%. On the average, all the phones (5) in the terminal had an accessibility index of 28.8%. The departure gates, on the other hand, all had rather high accessibility indexes with their average being 67.5%.

From the employee interviews undertaken in the bus terminal, the total number of queries by the total number of employees received for directional assistance for a particular node were,

- a) the departure gates - five employees,
- b) phones - four employees,
- c) washrooms - three employees,
- d) curb - two employees, and
- e) restaurant and bar - two employees.

The remaining nodes, as listed in Appendix C-2, were requested by one employee each. The most frequently requested node, the second column listing, as stated by the employees, were the departure gates. The washrooms and phones were also recognized by four employees as being the most requested nodes.

In summary, those nodes identified by the employees who received requests from terminal users for directional assistance

corresponds to those identified in the quantified results both from the site survey and floor plan analysis, thereby validating the techniques for quantifying areas which contribute to terminal user orientation. Although the gates proved rather inaccessible through visual contact in the site survey quantified results, the floor plan results indicated rather high accessibility indexes. The employee interview results nearly duplicated those of the visual site survey, particularly with respect to the departure gates and phones. This fact justified the need for a site survey to be carried out in conjunction with the floor plan analysis, particularly when evaluating passenger orientation in existing facilities.

5.3 Demonstration of Site Line Analysis - Moncton

In order to demonstrate how the site line analysis method proposed in this thesis can be used to measure terminal user orientation, the following three improvements were made to the Moncton International Airport:

- i) the implementation and quantification of a signage information system to improve the existing identified orientation problems in the existing terminal based on the quantified floor plan and site survey measurements already undertaken and validated in the previous section of this chapter,
- ii) hypothetical, physical adjustments to the existing structure of the terminal facility to improve the identified orientation problems in the terminal based on the quantified floor plan and site survey measurements already undertaken and validated in the previous section of this chapter, and
- iii) the implementation and evaluation of a signage system to improve the identified orientation problems in the terminal based on the quantification carried out in the previous item (ii) namely the physical improvements.

The demonstration, particularly with reference to item (ii) above, will further demonstrate how the design of a terminal facility can actually assist or deter an individual terminal user in finding his/her way around the terminal facility.

Since it is difficult for the author to actually undertake and evaluate, by site survey analysis, any structural changes or improvements to the Moncton terminal, the orientation problems requiring these improvements identified by both the floor plan and site survey visibility, calculations will be made on the existing floor plan of the facility, Appendix F. This will also further prove the validity of the application of the floor plan technique if used to evaluate user orientation in a new terminal design.

A flow diagram of the procedure which was carried out in the sight line analysis of the 10 terminals surveyed, and which is used in the following sections to evaluate and improve the Moncton airport, is shown in Figure 5.4.

5.3.1 Existing Improvements - Signage Only

As quantified and validated in Section 5.1 and the first few paragraphs of Section 5.2, the phones (including hotel), wash-rooms and ticket counters were identified to have low accessibility indexes, thereby possibly creating terminal user disorientation. From the site survey and floor plan analysis index calculations (see computer printouts, Appendices E-1 and E-2), the site survey visibility matrix quantification identified the customs and

FIGURE 5.4
SITE LINE ANALYSIS
FLOW DIAGRAM

immigration areas to be of low accessibility (18.2%) while from the floor plan it is found to be 50.0%. Similarly, the arrivals and departure gates were found by the floor plan calculation of the visibility matrix, to also be low with the security gate to be 27.3% (departures), arrival gate - domestic to be 36.4% and the arrival gate - international to be 36.4%. Again from the floor plan results, the baggage claim area and the lockers in the far corner of the baggage claim area are found to have a poor accessibility index of 40.9% and 36.4% respectively. Therefore, in total, the following seven nodes are poorly accessible as quantified and discussed above:

- i) phones (local and hotel) - validated,
- ii) washrooms - validated,
- iii) ticket counters - validated,
- iv) customs and immigration,
- v) arrival and departure gates (3),
- vi) baggage claim, and
- vii) lockers.

In order to locate at what point these seven nodes were poorly accessible, analysis of the remaining node orientation indexes, as well as the floor plan compiled matrix, indicated that they were all poorly visible from the nodes in the rest of the terminal, namely the ticket counter wing. Therefore, to improve these existing poor visibility conditions, a signage cluster with the appropriate symbols and directional arrows corresponding to the previously listed seven nodes should then be placed in advance and facing those nodes in the ticket counter, and be fully visible to them. Therefore, side (1) should be facing the ticket counter area, erected (suspended

from ceiling) at the point indicated in Figure 5.2, which corresponds to the distance limitations stated in Section 3.2.1 for letter heights (used here) of 12 inches (0.3 m).

By similarly evaluating the computer program quantifications of the original compiled floor plan matrix, the following four nodes were identified to be poorly accessible from the nodes in the baggage claim area. They are:

- i) ticket and baggage check-in,
- ii) post box,
- iii) phones, and
- iv) the ground transportation area (bus, taxi).

These nodes with their corresponding symbols and directional signs are then placed on side (2) facing the baggage claim area of the centrally located signage cluster.

The visibility links measured in the Moncton terminal due to its nodes physical presence and/or identified through the directional signage addition, it was then compiled in a matrix and quantified. The original matrix - physical node entries (ones - 1's), was used with signage slashes entered for those nodes now visible through a directional sign. The results of the quantification of this matrix is shown in the computer printout, Appendix F-1. When compared to the existing terminal floor plan quantification, it can be seen that the visibility of the total system has increased from 41.1% (existing floor plan analysis) to 59.7%. The three main nodes, identified and validated as being poorly accessible are as follows: the phones

FIGURE 5.2
MONCTON INTERNATIONAL AIRPORT (NTS)
 (FLOOR PLAN NODES)

have increased from 39.4% to 53.3%; the washrooms from 40.9% to 77.3%; and the ticket counters from 29.6% to 52.5%. The other identified poorly accessible nodes increased as follows:

- i). customs and immigration from 50.0% to 81.8%,
- ii) lockers from 36.4% to 77.3%,
- iii) arrival gates from 36.4% to 72.7%,
- iv) departure gates from 27.3% to 54.5%,
- v) post box from 31.8% to 50.0%, and
- vi) ground transport from 68.2% to 86.4%.

Similarly, the orientation indexes for the other nodes, that is, how accessible these nodes were from the particular node, also increased.

5.3.2 Terminal Design Change - Physical Only

In order to demonstrate the application of orientation index theory to a new facility design, major structural changes were then made to the Moncton terminal, Figure 5.3. Those nodes on the original terminal layout which had poor accessibility and orientation indexes were identified through quantification of the floor plan and site survey analysis. Seven structural changes were made to the existing terminal facility in order to improve the identified user orientation problems:

- i) removal of the central block of maintenance rooms and goods movement elevators,
- ii) removal of the central administration office access stairs,
- iii) stepping or offsetting the ticket counters,
- iv) removal of the central phone carousel,

- v) slightly protruding the three entrances and exits as well as the arrival gates,
- vi) implementation of an identification signage system, where for each node on the outside walls of the terminal, one sign is attached above, on or in close proximity of the node, facing outwards to the terminal, and another at 90° to the node, and
- vii) the implementation of an information booth.

It should be noted that the directional signage cluster shown in Figure 5.3 in the central area of the terminal is not considered in this evaluation at this time. Accordingly, the new design was measured based on sight lines found to exist due to the physical presence of the terminal nodes by measuring sight lines on the floor plan. The quantified results for this improved terminal design are shown in the computer printout, Appendix F-2. When these results are compared to the original Moncton terminal floor plan indices, Appendix E-3, it can be seen that the total visibility of the system has increased from 41.1% to 72.8% - nearly a 30% increase. The accessibility indexes for the three previously identified and validated nodes have increased 40.9% to 60.0% for the washrooms, from 29.6% to 54.0% for the ticket counters and from 39.4% to 70.0% for the phones (local and hotel). An average overall increase for both the orientation and accessibility indexes for all the rest of the nodes in the terminal was approximately 30.0%.

5.3.3 Physical and Signs

Using the individual improved node visibility indices results and relating them to the total terminal visibility index,

FIGURE 5.3
MONCTON INTERNATIONAL AIRPORT (NTS)
 (IMPROVED LAYOUT WITH ONE DIRECTIONAL SIGN)

those indexes which are found to be equal to or less than the total visibility index, have the potential for improvements.

Those nodes identified from the computer printout and the compiled matrix requiring improvement, are signed and then placed (symbols with directional arrows) on a central suspended sign cluster (Figure 5.3, sign cluster in centre). They are as follows:

Side (1) - facing the ticket counter wing and visible to nodes one to 14 including node 17 were

- a) arrivals
- b) phones - hotel and local
- c) customs and immigration area
- d) lockers
- e) washrooms, male and female
- f) car rentals

Side (2) - facing the baggage claim area and visible to all nodes 15 to 24 were

- a) post box
- b) ticket and baggage check-in
- c) lockers
- d) gift shop
- e) restaurant
- f) information booth.

Therefore, the visibility of nodes, or rather, the existence of sight links between them, were measured and compiled in a matrix, identified and recognized due to their physical presence as they stood alone, or through an identification sign or the implemented directional signs. Their quantified matrix compilation results are shown in Appendix F-3, the "improved design - physical plus signs" computer printout. Comparing this to the terminal quantification of the new design, which was evaluated due to node physical presence in the terminal and displayed

in the computer printout titled "improved design - physical", Appendix F-2, it can be seen that the total terminal's visibility index has improved from 72.8% to 85.8%. Those nodes identified with low accessibility qualities, possibly contributing to user disorientation, listed above are, with their previous accessibility indexes and their improved accessibility indexes, listed below:

- a) arrivals - from 78.0% to 90.0% (avg.)
- b) phones - hotel and local - from 70.0% to 86.0% (avg.)
- c) customs and immigration area - from 52.0% to 88.0%
- d) lockers - from 60.0% to 90.0%
- e) washrooms (m and f) - from 60.0 to 92.0%
- f) car rentals - from 88.0% to 96.0%
- g) post box, stamps - from 76.0% to 88.0%
- h) ticket counters and baggage check-in - from 54.0% to 90.0% (avg.)
- i) lockers (above) - from 60.0% to 90.0%
- j) gift shop - from 60.0% to 92.0%
- k) restaurant - from 80.0% to 92.0%
- l) information booth - from 84.0% to 96.0%

A further iteration can be carried out again, with a new design proposal, correcting once again poor orientation areas by structural changes. In turn, they can be quantified and any nodes identified as having low orientation and accessibility can be reduced by the implementation of a more advanced directional and identification signage system.

Although not discussed in the above paragraphs, the terminal subsystems, which were quantified and displayed in the printouts in Appendix E, can also be seen to increase in orientation characteristics. For example, the greeter subsystem would find his/her orientation increase from $V_V=39.5\%$ in the existing terminal (no signs) to $V_V=88.7\%$ in the new improved

terminal design sign signs, Appendix F-3. The improved results indicate that a greeter in the terminal would have little difficulty in finding any required node.

In summary, it can be seen how the floor plan matrix measurements can be used to evaluate new or existing terminal facility designs. In addition, the implementation of the site survey may also be carried out to further identify any orientation deficiencies such as improper locations of aesthetic facades, poor lighting, reflection, refraction, etc. which could not be identified carrying out the floor plan sight line measurements.

In conclusion, application of the sight line technique will assist in providing an optimum terminal design, whether it be designing a new terminal, or simply improving an existing facility with respect to transportation terminal user orientation.

CHAPTER 6

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary

Transportation terminal facility design must take into account the ability of the individual to perceive an object-goal in order to orientate through or around a terminal facility. This thesis describes a method, namely sight line analysis, to measure human orientation through visual perception of the object-goal. This was completed measuring site lines by a site survey or on a floor plan in order to assess an existing facility. The calculated results or visibility indices were validated by passenger and employee interviews as well as objective and camera surveys. A relationship was shown to exist between human orientation, the facility's layout and existing information signage systems. Once this relationship was theoretically shown to exist, indices were calculated for various types and sizes of existing facilities. Once these results are validated and orientation problem areas identified, an existing facility can be improved by the addition of a signage information system.

To demonstrate that the methodology may be applied to new facility designs, the same terminal system, with the previously identified orientation problem areas considered, was improved by hypothetically changing its physical structure. The results indicated an increase in user orientation relative to nodal perception. Any further identified orientation areas were then

hypothetically signed again and it was observed that user orientation increased. Therefore, the methodology application to new facility design was shown to be practicable.

Vision is shown as the main contributing factor for terminal user orientation through the use of information and direction systems. It is clear from this thesis that for most terminals, their users have not been adequately informed and directed to minimize delay and frustration. In designing terminals, planners must place more emphasis on user movements to better serve the purpose of a terminal. This thesis is a contribution to research in this area by offering a quantified methodology to measure human orientation in transportation terminals.

6.2 Conclusions

1. A methodology to quantify terminal user orientation relative to the ability of a user to perceive an object-goal through sight lines in a passenger transportation terminal facility has been developed. This methodology is termed sight line analysis.
2. The thesis demonstrates how the application of linear graph, matrix algebra and network theories, coupled with psychological and visual perception research, can be used to calculate terminal visibility indices from sight line measurements found to exist on a floor plan or in a terminal.

3. It is also demonstrated in this thesis how the calculated visibility indices can identify user orientation problem areas in a terminal, and how they can be validated with a passenger or employer interview questionnaire.
4. Sight line analysis with the use of floor plans and site surveys can be applied to assess the performance of an existing or new terminal facility in providing adequate terminal user orientation and movement.
5. The thesis shows that identification and adequate directional signage information systems play a major role in assisting terminal users' orientation capabilities.

The following is a list of the advantages of applying the sight line analysis method when assessing user orientation to a new or existing facility design:

1. Firstly, sight line analysis has explored and demonstrated how to quantify the relationship between terminal facility design and terminal user movements relative to visual perception of a desired object-goal. There is no other method available which assesses user orientation numerically by visual perception measurement.
2. The data collection requires low man-power and few materials.
3. It can be used to evaluate new terminal facility designs and their ability to provide a user with adequate visual perception of an object-goal, thereby reducing possible orientation problems.

4. It can be used to evaluate existing conditions in a terminal facility in order to justify structural modifications or the implementation of an adequate, efficient signage information system.
5. The methodology can be used to evaluate terminal user orientation in all types and sizes of transportation terminal facilities.
6. The computations involved in the quantification are simple and can be done by hand, or with a computer program.

Despite the previously listed advantages, the following is a list of some of the limitations of the proposed methodology:

1. Its development only considered intercity passenger terminal systems. Also, only one bus terminal and one railway station were surveyed and quantified.
2. In all cases of airport terminal matrix compilations, the international arrivals area and sterile areas (holdrooms) were out of bounds to the author and hence were not considered in the total terminal evaluation. Because of the simplicity of the methodology, these can be easily included at a later date.
3. The method assumes that all terminal users can recognize and identify all the various components of a passenger terminal facility.

4. It also assumes that all terminal users are literate and have normal vision to comprehend or see the particular signage system (words and symbols) used in all passenger terminal facilities.
5. The actual number of signs which assist and reassure a user relative to that number which bombard and confuse is not accurately known. The methodology only considers that if a node is visually perceived and recognized, there is no need for a directional sign. If not then only one, in the appropriate location, should be applied.
6. The angle of visual perception to a node used in floor plan analysis has been established based on the author's field observations.
7. Compilation of the required matrices for large terminals can prove to be long and tedious. Similarly, they must be transferred to computer sheets, which in turn must be key-punched on data cards.
8. It is not known what portion of the population of terminal facility users, on the average, rely totally on orientation by signage information systems and those which rely on physical observation, or a combination of the two systems.
9. Large amounts of computer memory storage are required when inputting matrices for large terminals.

10. The calculated visibility indices were validated with the passenger and employee interviews which were drawn from a small population.

6.3 Recommendations

1. The author recommends completion of the quantification and establishment of accurate visibility indexes for the airport terminal facilities surveyed by surveying the international arrivals and hold room areas.
2. Although intercity passenger terminal facilities were surveyed, it is the belief of the author that this methodology is unique and can easily be adapted to assist pedestrians in other systems such as institutions, office complexes, shopping malls and perhaps even major pedestrian street systems.
3. Since visual perception is a major factor in this research, a good understanding of its relation with other pedestrian orientation factors, as well as other quantification techniques, is recommended before using the method. There is a need for further research in the field of visual perception relative to the moving pedestrian with regard to his speed and the objects perceived at this speed, avoidance reflexes and the relationship to perception and the need for increased knowledge with respect to the amount which a person can perceive and retain while walking.
4. This methodology should be applied to reduce any user disorientation areas in terminal design. However, once an optimal layout

has been chosen, only then should signage information systems be implemented or identified to be required. Furthermore, when an existing facility has been quantified and disorientation areas identified, rather than implement costly structural changes, the application of this method can recommend an adequate proposed information system prior to its installation.

5. The validation interviews (passenger, employee), although not used to actually quantify orientation problems, but rather to find out if there were any orientation difficulties experienced by terminal users, needs more research with perhaps consultation with market analysts or psychologists specializing in questionnaire and interview formation. The author recommends neither the passenger nor employee interviews detailed in this thesis be applied until appropriate specialists be consulted and an appropriate validation procedure is established.
6. It was observed by the author that as terminal facilities increase in size, the nodes tended to decentralize, that is, spread out and increase in number. The visibility indices of the terminal system, its subsystems and components decreased accordingly. Further research of this decentralization aspect, namely the main processing nodes and their effect on terminal user orientation and movement, is recommended.
7. Advanced matrix analysis, such as that used in telecommunication networks (20) allow for the actual immediate computation of the existing two-way links between nodes. Because of the amount

of time and accumulated costs to do this initial research, data collection and quantification, this further analysis was not undertaken. However, examples of this analysis are only briefly listed below.

Squaring the initially compiled visibility matrix will give the following:

- a) the diagonal entries of the squared matrix lists the total number of two-way links between the node and other nodes in the network. For example, if a node x has a squared matrix diagonal entry of four, then exactly four two-way links exist between x and other nodes in the terminal. That is, node x can see and recognize four other nodes, and node x can also be seen and recognized those same four nodes.
- b) All the off diagonal entries of the squared matrix indicate the possible two-step connections between the nodes indicated by the matrix. For example, across the row of node A but under y column node heading, perhaps the entry is 3. Then A will be able to see three different nodes (different than y) and from these three different nodes, A will be able to then see y. This is useful when attempting to establish both the number of nodes which a particular node can see and what those nodes can actually see.

Prihar's (23) research further describes how application of matrix algebra can reduce complex calculations and demonstrates rather interesting relationships. The author of this thesis recommends further readings in this area and application to this methodology which may offer a more advanced theoretical and practical solution to establish user orientation in passenger transportation terminal facilities.

REFERENCES

1. Braaksma, John P., "A Computerized Design Method for Preliminary Airport Terminal Space Planning", The Transport Group, Dept. of Civil Engineering, University of Waterloo, Canada, October, 1973.
2. Johnson, William P., "Intercity Bus Terminal Performance Analysis", Dept. of Civil Engineering, Carleton University, Canada, March, 1977.
3. Braaksma, John P., Ramsay, W.A., "A Computer Aided Methodology for Selecting Optimum Airport Terminal Concepts", Transport Canada, February, 1978.
4. Hoel, Lester A., Demetsky, Michael J., Virkler, Mark R., "Criteria for Evaluating Alternative Transit Station Designs", U.S. Department of Transportation, Washington, D.C., February, 1976.
5. Wortman, R.H., "A Comprehensive Approach to the Planning of Urban Passenger Terminals", Paper presented at the A.S.M.E. Joint Transportation Engineering Conference, Chicago, Ill., October 11-14, 1970.
6. Highway Capacity Manual, Washington, D.C.: Highway Research Record (Special Report 87), 1965.
7. Fruin, J., Pedestrian Planning and Design, Metropolitan Association of Urban Designers and Environmental Planners Inc., New York, N.Y., 1971.
8. Dewar, Robert E., "Psychological Factors in the Perception of Traffic Signs", Transport Canada, February, 1973.
9. Geometric Design Manual, Roads and Transportation Association of Canada, Ottawa, Ontario, 1977.
10. Tunnard, C., Pushkarev, B., Man Made America: Chaos or Control? Yale University, April, 1967.
11. Appleyard, D., (Lynch, and Myer) The View from the Road, Massachusetts Institute of Technology Press, Cambridge, Mass., 1964.
12. Mitropoulos, E., "Space Networks" Towards a Space Notation for use in Complex Library Systems", Architectural Psychology, Proceedings of the Lund Conference, pp. 148-156, 1973.
13. Kaplan, A., "Designing for Man in Motion", American Institute of Architects Journal, pp. 42-44, November, 1971.

14. Cantilli, Edmund J., Fruin, John J., "Information Systems in Terminals", Traffic Quarterly, Vol. 26, pp. 231-247, 1972.
15. Hoel, L., Roszner, Ervin S., "Transit Station Planning and Design: State of the Art", Carnegie Mellon University, January, 1975.
16. Howard, I.P., Templeton, W.B., Human Spatial Orientation, University of Durham, England, John Wiley and Sons, 1966.
17. Gibson, James J., The Perception of the Visual World, Houghton, Mifflin Co., Boston, 1950.
18. Airport Buildings Signs Manual, Transport Canada, 1974.
19. International Air Transport Association, Air Terminals Reference Manual, Sixth Edition, Montreal, Quebec, Canada, December, 1976.
20. Capacity of Passenger Air Terminal Buildings: Interim Report on Literature Search, Transport Canada, May, 1977.
21. Bronzaft, A.L., Dobrow, S.B., O'Hanlon, T.J., "Spatial Orientation in a Subway System", Environment and Behaviour, Vol. 8, No. 4, December, 1976.
22. Garrison, W.L., Marble, D.F., "Graph Theoretic Concepts", Transportation Geography: Comments and Readings, McGraw-Hill Book Co., 1974.
23. Prihar, Z., "Topological Properties of Telecommunication Networks", Proceedings of the Institute of Radio Engineers, No. 44, 1956.

APPENDIX A

FIELD OBSERVATION FORMS

FIELD OBSERVATION SURVEY

TERMINAL: *FREDERICTON AIRPORT*DATE AND TIME: *JUNE 14 1977*

SURVEYORS - ONE : *W. J. CROOK*
 - TWO : *C. Y. MO*
 - THREE: *DR. J. P. BRANKSMA*

OBSERVATION COMMENTS

1. PASSENGER FLOW PATTERNS (CONFLICTS, DIRECTION, ETC)
 1. GENERALLY ALONG TERMINAL - MOVEMENTS TO THE LEFT
 2. SMALL CONFLICTS OBSERVED WITH USERS AROUND MAIN FRONT DOOR AND WAIT AREA
2. TERMINAL LAYOUT (CONTINUITY, UNITY, OTHER)
 1. FLOW NOT CONTINUOUS WITH ARRIVING DOMESTIC COMING THROUGH CENTRAL ARRIVAL GATE. THEY MUST MOVE TO THE RIGHT INTO BAG CLAIM AREA, THEN BACK OUT TO EXIT-TO CURB
3. VISUAL PROBLEM AREAS (CORNERS, COLUMNS, PHYSICAL OBJECTS, LIGHTING, REFRACTION)
 1. LARGE STRUCTURE WITH PILLARS, LOCKERS, BAG HARBOUR COUNTER IN CENTRE OF TERMINAL - MAIN OBSTRUCTION TO VISION.
 2. MIXED ROOM W/AS OPACINE GLASS PARTITIONS - POOR VISUAL CONTACT
4. SIGNAGE (LOCATION, HT, ANGLE-ADEQUACY, NUMBER OF, OVER-UNDERSIGNAGE)
 1. ONLY ONE DIRECTIONAL SIGN SEEN ONLY BY ARRIVING DOMESTIC - BAGGAGE CLAIM - JUST IN FRONT OF CENTRAL ARRIVING GATE
 2. UNDER-SIGNED
5. NODES (VISIBILITY, LOCATION, ACCESS)
 1. POOR LOCATION OF WOMENS WASH ROOM
 2. BAG CLAIM DEVICE VERY ISOLATED - POOR MARK TYPE
 3. NO INFO BOOTH
6. GENERAL COMMENTS:
 - FAIRLY VISIBLE TERMINAL
 - STRUCTURE CENTRE OF TERMINAL MAIN VISUAL OBSTRUCTION IN TERMINAL

FIGURE A-1

OBSERVATION SURVEY
 (FREDERICTON, N.B. AIRPORT)

FIELD OBSERVATION SURVEY

TERMINAL: *MONCTON AIRPORT*DATE AND TIME: *JUNE 13/77*

SURVEYORS - ONE : *U.J. CLOK*
 - TWO : *C.Y. MID*
 - THREE: *DR. J. P. BARAKSMA*

OBSERVATION COMMENTS

1. PASSENGER FLOW PATTERNS (CONFLICTS, DIRECTION, ETC)
 1. *FLOWS ALONG TERMINAL - MOVEMENT TO THE LEFT*
 2. *Few CONFLICTS OBSERVED*
2. TERMINAL LAYOUT (CONTINUITY, UNITY, OTHER)
 1. *GOOD CONTINUITY - DEPARTING ENTER WEST WING DOOR, MOVE TO LEFT AND OUT TO AIRSIDE. ARRIVING PASSENGERS ENTER CENTRE GATE (DOM), EAST GATE (INT, TRANS) TO BAG CLAIM AND OUT CURB EXIT IN BAG CLAIM AREA*
3. VISUAL PROBLEM AREAS (CORNERS, COLUMNS, PHYSICAL OBJECTS, LIGHTING, REFRACTION)
 1. *STRUCTURAL CENTRE BLOCK AND STAIRS TO ADMIN OBSTRUCTS VISUAL CONTACT BETWEEN BAG CLAIM AREA AND TICKET COUNTER AREA.*
 2. *Few WINDOWS TO CURB AND AIRSIDE*
4. SIGNAGE (LOCATION, HT, ANGLE-ADEQUACY, NUMBER OF, OVER-UNDERSIGNAGE)
 1. *ONLY ONE DIRECTIONAL SIGN PRESENT. OVER ARRIVAL GATE. VERY SMALL*
 2. *TWO IDENTIFICATION SIGNS (SYMBOL - PHONES, RESTAURANT) IN TICKET COUNTER WING*
5. NODES (VISIBILITY, LOCATION, ACCESS)
 1. *WASHROOMS POORLY LOCATED GIVING WAY TO POOR VISUAL CONTACT FROM MANY POINTS IN TERMINAL*
 2. *PHONES DIFFICULT TO FIND*
 3. *MANY COLUMNS AND SOME COLUMNS*
6. GENERAL COMMENTS:
 - *CENTRE STRUCTURE AS WELL AS CENTRALLY LOCATED STAIRS TO ADMIN - MAIN OBSTRUCTION TO VISUAL CONTACT WITH MAJOR FUNCTIONAL AREAS OF TERMINAL*
 - *WASHROOMS, BAG CLAIM, BAG CLAIM EXIT/ENTRANCE ALL AREAS ISOLATED*
 - *PHONES DIFFICULT TO LOCATE FROM CERTAIN MAIN AREAS OF TERMINAL*

FIGURE A-2

OBSERVATION SURVEY
 (MONCTON, N.B. AIRPORT)

FIELD OBSERVATION SURVEY

TERMINAL: SAINT JOHN AIRPORT

DATE AND TIME: JUNE 16/77

SURVEYORS - ONE : U. J. COOK

- TWO : C. Y. MO

- THREE: DR. J. P. BRACKEMA

OBSERVATION COMMENTS

1. PASSENGER FLOW PATTERNS (CONFLICTS, DIRECTION, ETC)
 1. FLOWS ALONG TERMINAL - MOVEMENT TO THE LEFT
 2. CONFLICTS (HEAVY) OBSERVED DURING SURVEY IN FRONT OF HOLD ROOM AREA BETWEEN GARETAS (INT FLIGHT) AND DEPART PAX
2. TERMINAL LAYOUT (CONTINUITY, UNITY, OTHER)
 1. FAIR CONTINUITY WITH ARRIVING ENTERING TERMINAL WEST ENT, EXIT, TO COUNTER, TO HOLD - ALL TO LEFT
 2. ARRIVING PAX - DOMESTIC MOVE TO RT TO BAG CLAIM AND THEN OUT BAG CLAIM - CURB ENT/EXIT.
3. VISUAL PROBLEM AREAS (CORNERS, COLUMNS, PHYSICAL OBJECTS, LIGHTING, REFRACTION)
 1. MANY CORNERS WITH SOME STRUCTURAL COLUMNS BLOCKING VISION STAIRS
 2. CENTRALLY LOCATED CAUSED SOME VISUAL CONTACT OBSTRUCTION. OPAQUE GRASS ON HOLD ROOM DIVIDER ALSO VISUAL OBSTRUCTION
4. SIGNAGE (LOCATION, HT, ANGLE-ADEQUACY, NUMBER OF, OVER/UNDERSIGNAGE)
 1. ONE DIRECTIONAL SIGN (HAND PAINTED ON CARDBOARD) DIRECTING ONLY INT AND TRANSBORDER PAX ARRIVING THROUGH WEST ENT/EXIT GATES TO BAG CLAIM
 2. TWO IDENTIFICATION SIGNS - SYMBOLS (REST AND PHONES)
5. NODES (VISIBILITY, LOCATION, ACCESS)
 1. BAG CLAIM, CAR RENTALS DIFFICULT TO FIND - VERY ISOLATED
 2. SCRAMBLING USE BAG CLAIM AREA WITH LARGE OPAQUE SURFACES BLOCKS VISUAL CONTACT BETWEEN GARETAS AND THEIR ARRIVING PARTY
6. GENERAL COMMENTS:
 - CAR RENTALS, BAG CLAIM DRIVE VERY ISOLATED
 - LARGE NUMBER OF COLUMNS, CORNERS AND DIVIDERS
 - STAIRS TO ADMIN CAUSES SOME VISUAL OBSTRUCTION
 - DRAWING OF VINYL CURTAIN SEPARATING INT ARRIVALS (VISUALLY) FROM GARETAS PROVED SEVERE PROBLEM

FIGURE A-3

OBSERVATION SURVEY
(SAINT JOHN, N.B. AIRPORT)

FIELD OBSERVATION SURVEY

TERMINAL: EDMUNSTON N.B. AIRPORT (GAMMA AVIATION)

DATE AND TIME: JUNE 17/77

SURVEYORS - ONE : W.J. COOK
 - TWO : C.V. MO
 - THREE: DR. J.P. BARNESMA

OBSERVATION COMMENTS

1. PASSENGER FLOW PATTERNS (CONFLICTS, DIRECTION, ETC)
 - 1 - STRAIGHT THROUGH TERMINAL
 - 2 - NO CONFLICTS
 - 3 - ONE ENT/EXIT GATE, ONE ENT/EXIT CURB.
2. TERMINAL LAYOUT (CONTINUITY, UNITY, OTHER)
 - 1 - VERY COMPACT, VERY SMALL - WELL LAYED OUT
 - 2 - SOME AREAS SERVED DUAL PURPOSES (ONE COUNTER FOR TICKETS, BAG CLAIM, BAG CHECK)
3. VISUAL PROBLEM AREAS (CORNERS, COLUMNS; PHYSICAL OBJECTS, LIGHTING, REFRACTION)
 - 1 - NO CORNERS, NO COLUMNS, OBJECTS TO OBSTRUCT VISION.
 2. WELL LIT, GLASS ON THREE SIDES OF BUILDING
4. SIGNAGE (LOCATION, HT, ANGLE-ADEQUACY, NUMBER OF, OVER-UNDERSIGNAGE)
 1. NO SIGNS, EXCEPT BLACK BOARD WITH HANDWRITTEN ARRIVAL, DEPART TIMES AND OTHER INFO.
5. NODES (VISIBILITY, LOCATION, ACCESS)
 1. WASHROOMS, PHONES DIFFICULT TO LOCATE AS WELL AS FIRE EXIT
 2. BAG CLAIM OUTSIDE (AIRSIDE) OF TERMINAL BUILDING
 3. CUSTOMS INSPECTION ISOLATED
6. GENERAL COMMENTS:

EXCELLENT VISUAL CONTACT TO ALL NODES
 WELL LAYED OUT

FIGURE A-4
 OBSERVATION SURVEY
 (EDMUNSTON, N.B. AIRPORT)

FIELD OBSERVATION SURVEY

TERMINAL: QUEBEC CITY AIRPORT.

DATE AND TIME: JUNE 17 '77

SURVEYORS - ONE : W. J. COOK

- TWO : C. Y. MO

- THREE: DR J. P. BRAKESMA

OBSERVATION COMMENTS

1. PASSENGER FLOW PATTERNS (CONFLICTS, DIRECTION, ETC)
 1. FLOWS ALONG AND THROUGH THE TERMINAL TO THE LEFT
 2. CONFLICTS IN FRONT OF SECURITY CHECK, BAG CLAIM AND EAST ENT/EXIT
 3. SIMILAR TO PREVIOUS TERMINALS - MINUTE PARADOX STIMULI
2. TERMINAL LAYOUT (CONTINUITY, UNITY, OTHER)
 1. FAIRLY GOOD CONTINUITY IN FLOWS - DEPARTING ENTER WEST ENT/EXIT TICKETS COUNTER TO HOLD AND OUT TO GATE. ARRIVING (DOM) IN CENTRAL ENT/EXIT, STRAIGHT TO BAG CLAIM, STRAIGHT OUT WEST ENT/EXIT.
3. VISUAL PROBLEM AREAS (CORNERS, COLUMNS, PHYSICAL OBJECTS, LIGHTING, REFRACTION)
 1. FEW COLUMNS, SOME CORNERS WITH LARGE CENTRAL STRUCTURAL COMPLEX IN CENTER OF TERMINAL HOUSING RETAIL SHOPS AND CAR RENTALS
 2. LIGHTING SUBDUED (YELLOW FLUORESCENT)
4. SIGNAGE (LOCATION, HT, ANGLE-ADEQUACY, NUMBER OF, OVER-UNDERSIGNAGE)
 1. 3 LARGE DIRECTIONAL SIGN CLUSTERS SUSPENDED FROM CEILING. ONE OVER CENTRAL ENT/EXIT (CURA), ONE OVER EAST ENT/EXIT CURA, ONE OVER BAGCLAIM DEVICE. LOCATION AND NUMBER OF SIGNS FROM CLUSTERS MAY CREATE OVERSIGNAGE PROBLEMS
5. NODES (VISIBILITY, LOCATION, ACCESS)
 1. INT ARRIVALS AREA ISOLATED
 2. LARGE CENTRAL BLOCK OF CONCESSIONS VISUALLY OBSTRUCTIVE TO MAJOR FUNCTIONAL AREAS
 3. PHONES RATHER DIFFICULT TO FIND
6. GENERAL COMMENTS:
 - GOOD SEPARATION OF FLOWS
 - WAIT AREA, HOLD ROOM, BAG CLAIM AREA HAVE EXCELLENT VISUAL CONTACT WITH REST OF TERMINAL
 - CENTRAL BLOCK OF CONCESSIONS MAIN VISUAL OBSTRUCTION
 - WAREHOUSES APPAR 714 OR DIFFICULT TO LOCATE DUE TO CENTRAL BLOCK OF CONCESSIONS

FIGURE A-5

OBSERVATION SURVEY
(QUEBEC CITY AIRPORT)

FIELD OBSERVATION SURVEY

TERMINAL: OTTAWA AIRPORT

DATE AND TIME: MAY 1977

SURVEYORS - ONE : W. J. COOK
 - TWO :
 - THREE :

OBSERVATION COMMENTS

1. PASSENGER FLOW PATTERNS (CONFLICTS, DIRECTION, ETC)
 1. TERMINAL IS LINEAR AND PAS FLOW ALONG OR LENGTH WISE TO CENTRAL ARRIVAL AND DEPART AREAS.
 2. MAJOR CONFLICTS BETWEEN ALL USERS IN THIS CENTRAL AREA - PARTICULARLY WALKWISERS, CARRIERS ARRIV. DEPART DAY
2. TERMINAL LAYOUT (CONTINUITY, UNITY, OTHER)
 1. ANGULARITY OF TERMINAL CAUSES SIGHT PROBLEMS BUT DEPARTING FUNCTIONS IN ONE END AND ARRIVING IN ANOTHER
 2. LACKS UNITY, BROKEN UP (TWO STOPS IN TWO WINGS ETC)
3. VISUAL PROBLEM AREAS (CORNERS, COLUMNS, PHYSICAL OBJECTS, LIGHTING, REFRACTION)
 1. MANY COLUMNS, LOTS OF NOOKS AND "CRANNIES"
 2. ARRIVALS CENTRAL DOOR VISUAL CONTACT WITH BAG CLAIM
 3. ANGULARITY OF TERMINAL MAIN VISUAL PROBLEM
4. SIGNAGE (LOCATION, HT, ANGLE-ADEQUACY, NUMBER OF, OVER UNDERSIGNAGE)
 1. 2 LARGE SIGN CLUSTERS, WELL PLACED (AT ENT/EXIT TO TWO WING AREAS. IN TAIL) OTHER SIGNS (DIRECTIONAL) THROUGHOUT TERMINAL. LACK OF SIGNS POSSIBLY IN BAG CLAIM AND TICKET AREAS.
5. NODES (VISIBILITY, LOCATION, ACCESS)
 1. WASHROOMS, RESTAURANT (MAIN FLOOR) AND BAG CLAIM AREA APPROP. T'S HAVE GOOD VISUAL ACCESS. ENT. ARRIVALS AREA APPROP. ALSO TO BE ISOLATED.
 2. INFO AREA IN RATHER POOR LOCATION
6. GENERAL COMMENTS:
 - ANGULARITY OF BUILDING LAYOUT IS MOST SEVERE VISUAL PROBLEM!
 - LOCATION OF PROCESSING AREAS (ARRIVALS, DEPARTURES HOLD ROOM, WAIT AREA, MAIN ENT/EXIT) ALL CENTRALIZED APPEARS TO CREATE CONFUSION AND DISORIENTATION TO ALL.

FIGURE A-6

OBSERVATION SURVEY
 (OTTAWA, CNT. AIRPORT)

FIELD OBSERVATION SURVEY

TERMINAL: OTTAWA VOYAGEUR BUS TERMINAL

DATE AND TIME: DECEMBER 24/77

SURVEYORS - ONE : W.J. COOK
 - TWO :
 - THREE :

OBSERVATION COMMENTS

1. PASSENGER FLOW PATTERNS (CONFLICTS, DIRECTION, ETC)

1. FLOWS ARE MAINLY ACROSS TERMINAL
2. MOST USERS, REGARDING TO BOTH ENTER AND EXIT MAIN TERMINAL CENTRAL DOOR
3. SOME CONFLICTS IN TICKET LOBBY AREA & WAIT AREA (QUEUES)

2. TERMINAL LAYOUT (CONTINUITY, UNITY, OTHER)

1. TERMINAL IS LINEAR, LONG AND NARROW WITH MOST OF THE AMENITIES AND CONCESSIONS IN ONE END
2. ARRIVALS AND DEPARTURES SEPARATED

3. VISUAL PROBLEM AREAS (CORNERS, COLUMNS, PHYSICAL OBJECTS, LIGHTING, REFRACTION)

1. CENTRAL STRUCTURAL BLOCK IN TERMINAL APPEARS TO CREATE POOR VISUAL CONTACT TO MAINLY DEPARTING PASSENGERS AND OTHERS ENTERING MAIN ENTRANCE
2. FEW COLUMNS, LIGHTING EXCELLENT, GOOD VIEW OF BUS BAYS

4. SIGNAGE (LOCATION, HT, ANGLE-ADEQUACY, NUMBER OF, OVER-UNDERSIGNAGE)

1. SIGNING APPEARS TO BE GOOD, BLACK LETTERS ON ILLUMINATED YELLOW BACKGROUND. SOME SIGNAGE CLUSTERS SUSPENDED FROM CEILING. OTHERS (IDENTIFICATION) DIRECTLY OVER DOOR

5. NODES (VISIBILITY, LOCATION, ACCESS)

1. SOME NODES WERE DIFFICULT TO OBSERVE DUE TO THEIR BEING RECESSED INTO THE WALLS (WASHROOMS, PHONES, LOCKERS)
2. PHONES, LOCKERS AND WASHROOMS APPEAR TO BE LEAST VISIBLE
3. ARRIVALS GATE FAIRLY ISOLATED. NOOR

6. GENERAL COMMENTS:

- LARGE NEWSSTAND IN CENTRE OF TERMINAL APPEARS TO CREATE WORST CASE OF VISUAL ~~OBSTRUCTION~~ OBSTRUCTION
- ARRIVALS GATE FAR WEST END OF TERMINAL ALSO APPEARS DIFFICULT TO LOCATE
- RECESSING CERTAIN NODES ALSO APPEARS TO CREATE ACCESS PROBLEMS
- GOOD SIGNAGE THROUGHOUT.

FIGURE A-7

OBSERVATION SURVEY
 (OTTAWA, ONT. BUS TERMINAL)

FIELD OBSERVATION SURVEY

TERMINAL: OTTAWA TRAIN STATION

DATE AND TIME: DEC 26/77

SURVEYORS - ONE : W. J. COOK
 - TWO :
 - THREE :

OBSERVATION COMMENTS

1. PASSENGER FLOW PATTERNS (CONFLICTS, DIRECTION, ETC)
 1. PASSENGERS MOVE ACROSS TERMINAL BETWEEN PLATFORM AND CURB
 2. ALL CONCESSIONS TO SIDE
 3. DEPARTURE AND ARRIVAL GATES ALL DUAL PURCHASE
2. TERMINAL LAYOUT (CONTINUITY, UNITY, OTHER)
 1. TICKET COUNTER (CAROUSEL) CENTRALLY LOCATED
 2. ALL AMPLITIES AND CONCESSIONS TO ONE SIDE OF TERMINAL
 3. USER FLOWS THROUGH TERMINAL - CURB ONE END, PLATFORMS AT OTHER END.
3. VISUAL PROBLEM AREAS (CORNERS, COLUMNS, PHYSICAL OBJECTS, LIGHTING, REFRACTION)
 1. FOUR LARGE STRUCTURAL COLUMNS IN THE TERMINAL APPEARED TO CREATE SOME VISUAL PROBLEMS
 2. RECESSED CONCESSIONS AND AMPLITIES ALSO APPEARED TO CAUSE POOR VISUAL CONTRAST, PARTICULARLY ALONG THE SAME WALL
4. SIGNAGE (LOCATION, HT, ANGLE-ADEQUACY, NUMBER OF, OVER/UNDERSIGNAGE)
 1. IDENTIFICATION SIGNS WERE THE ONLY SIGNS PRESENT THEY WERE LARGE AND ILLUMINATED, BUT WERE CAN BE TURNED OUT OVER THE MOOR. THIS WAS OBSERVED TO CAUSE USERS ON THE SAME SIDE TO WALK OUT, LOOK BACK AND UP TO FIND MOOR ON THE SIDE.
5. NODES (VISIBILITY, LOCATION, ACCESS)
 1. TICKET COUNTERS, WAIT AREA AND GATES AS WELL AS CURB AND EXITS APPEARED TO HAVE GOOD VISIBILITY. THOSE MOORS ALONG WALLS MAY HAVE POOR VISIBILITY DUE TO RECESSING IDENTIFICATION SIGNS ON OVERHANG.
6. GENERAL COMMENTS:
 1. PILLARS AND CENTRAL TICKET COUNTER APPEAR TO CREATE WORST CASES OF VISUAL OBSTRUCTIONS. RECESSING DOWNWAYS TO SOME OF MOORS NEXT WORSE PROBLEM
 2. IDENTIFICATION SIGNS GOOD, BUT OUT ON OVERHANG OBSERVED TO CREATE PROBLEMS
 3. PORTALS ACT AS INFORMATION OFFICERS

FIGURE A-8

OBSERVATION SURVEY
 (OTTAWA, ONT. TRAIN STATION)

FIELD OBSERVATION SURVEY

TERMINAL: MIRABEL INTERNATIONAL AIRPORT

DATE AND TIME: DEC 27/28, - 1977

SURVEYORS - ONE : W.J. COOK
 - TWO :
 - THREE:

OBSERVATION COMMENTS

1. PASSENGER FLOW PATTERNS (CONFLICTS, DIRECTION, ETC)
 1. USERS MOVE ACROSS SHORT SIDE OF TERMINAL
 - TERMINAL IS LONG BUT ALL PROCESSING ACROSS AND THROUGH TERMINAL.
 2. ONLY CONFLICTS OBSERVED WHEN TICKET COUNTER QUEUES "SHAKED OUT INTO LOBBY AREA."
2. TERMINAL LAYOUT (CONTINUITY, UNITY, OTHER)
 1. LAYOUT EXCELLENT, PAX PROCESSING AND FLOW PATTERNS EXCELLENT. MAIN PROCESSING AREAS SEPARATE - DEPARTING ONE END, ARRIVING OPPOSITE END. PROCESSING LEVEL MAIN FLOOR. ALL (MOST) CONCESSIONS AND AMENITIES ON SECOND LEVEL.
3. VISUAL PROBLEM AREAS (CORNERS, COLUMNS, PHYSICAL OBJECTS, LIGHTING, REFRACTION)
 1. LARGE COLUMNS WITH SOME CORNERS POSSIBLY CAUSED SOME VISUAL PROBLEMS. GOOD LIGHTING, FEW PHYSICAL OBSTRUCTIONS.
 2. POOR VISUAL CONTACT, EXCEPT FROM MERRAINE - OF INT. ARRIVALS AREA.
4. SIGNAGE (LOCATION, HT, ANGLE-ADEQUACY, NUMBER OF, OVER-UNDERSIGNAGE)
 1. EXCELLENT ABUNDANCE OF IDENTIFICATION SIGNS AND DIRECTIONAL SIGNS EITHER SUSPENDED FROM CEILING OR ON SIGN POSTS IN TERMINAL. ABUNDANCE OF MONITORS. POSSIBILITY OF OVERSIGNAGE.
5. NODES (VISIBILITY, LOCATION, ACCESS)
 1. MOST NODES FAIRLY VISIBLE. WASHROOMS AND STAIRS TO MERE DIFFICULT TO LOCATE FROM CURB SIDE OF AIRPORT. DESCENDING STAIRS FROM MERE AT REAR OF TERMINAL, THE TICKET COUNTERS ARE AT FRONT DIFFICULT TO LOCATE.
6. GENERAL COMMENTS!
 1. FAIRLY VISIBLE TERMINAL, WELL Laid OUT, GOOD SIGNAGE (BLACK LETTERS ON ILLUMINATED YELLOW BACK GROUNDS)
 2. WASHROOMS, SECURITY CHECK-IN GATES ETC. APPEAR TO BE LEAST VISIBLE NODES.

FIGURE A-9

OBSERVATION SURVEY.
 (MIRABEL, P.Q. AIRPORT)

FIELD OBSERVATION SURVEY

TERMINAL: MONTREAL (DORVAL) INTERNATIONAL AIRPORT

DATE AND TIME: DEC 28/29 - 1977

SURVEYORS - ONE : W. J. COOK
 - TWO :
 - THREE :

OBSERVATION COMMENTS

1. PASSENGER FLOW PATTERNS (CONFLICTS, DIRECTION, ETC)
 1. USER FLOW PATTERNS WERE CIRCULAR, AROUND A LARGE CENTRAL BLOCK OF TICKET COUNTERS, AMMENITIES ETC.
 2. TERMINAL WAS TWO LEVEL WITH ARRIVING DOM PAX AT ONE LEVEL ONE END AND INT. ARRIVALS AT OTHER END SAME LEVEL
2. TERMINAL LAYOUT (CONTINUITY, UNITY, OTHER)
 1. DEPARTING PAX ADDRESSED UPPER LEVEL BUT CIRCULAR AROUND CENTRAL BLOCK.
 2. INT ARRIVALS IN AND OUT TO CURB - GROUND LEVEL
 3. DOM " " " " " " " " " " " "
 4. CONNECTING HAD TO GO UP TO SECOND PROCESSING LEVEL
3. VISUAL PROBLEM AREAS (CORNERS, COLUMNS, PHYSICAL OBJECTS, LIGHTING, REFRACTION)
 1. LARGE CENTRAL BLOCK APPEARS TO CREATE VISUAL CONTACT PROBLEMS. LARGE COLUMNS APPEAR TO CREATE SOME PROBLEMS. ALL AMMENITIES AT REAR OF TERMINAL (END LEVEL).
 2. SECURITY GATES ARE ALL SEPARATED.
4. SIGNAGE (LOCATION, HT, ANGLE-ADEQUACY, NUMBER OF, OVER-UNDERSIGNAGE))
 1. GOOD DIRECTIONAL SIGNAGE CLUSTERS WELL LOCATED THROUGHOUT TERMINAL. ALSO EXCELLENT USE OF IDENTIFICATION (SYMBOL) SIGNS USED AT VARIOUS DOORS. LACK OF SIGNAGE TO LOWER ARRIVALS AREA.
5. NODES (VISIBILITY, LOCATION, ACCESS)
 1. DOM AND INT ARRIVAL AREAS POORLY VISIBLE (THROUGH SIGNS OR PHYSICAL)
 2. AMMENITIES AND CONCESSIONS AT REAR OF TERMINAL SECOND PROCESSING LEVEL APPEAR TO HAVE POOR ACCESS RELATIVE TO CURB.
6. GENERAL COMMENTS:
 1. CENTRAL STRUCTURAL BLOCK MAIN VISUAL CONTACT PROBLEM CAUSING USERS TO CIRCLE AROUND TERMINAL
 2. THREE SECURITY CHECK-IN AREAS COMPLETELY SEPARATE, ONE VERY ISOLATED. ALL APPEARED TO BE DIFFICULT TO FIND.
 3. SEPARATION OF INT & DOM ARRIVALS BY FLOOR AND AT SEPARATE ENDS ALSO APPEARS TO POSSIBLY CREATE VISUAL AND ORIENTATION PROBLEMS.

FIGURE A-10

OBSERVATION SURVEY
 (DORVAL, P.Q. AIRPORT)

APPENDIX B

PASSENGER INTERVIEWS

B-1. Fredericton Airport
B-2 Moncton Airport
B-3 Saint John Airport

B-1

FREDERICTON AIRPORT

CURB
PASSENGER INTERVIEW
(ARRIVING)

TERMINAL: FREDRICKTON, New Brunswick

DATE AND TIME: JUNE 14/77

SURVEYORS - ONE : W. J. COOK

- TWO : C.Y. Mo

- THREE: Dr. J. P. BRAARSMAN

FLIGHT DESCRIPTION: INTERNATIONAL ☐ TRANSBORDER ☐ DOMESTIC ☒

1. ARE YOU A PASSENGER ARRIVING AT THIS AIRPORT?

[illegible]

2. IS THIS THE FIRST TIME YOU HAVE ARRIVED AT THIS AIRPORT?

[illegible][illegible]

3. IN PROCEEDING FROM YOUR
(AIRCRAFT, TRAIN, BUS) -
DO YOU RECALL HAVING ANY
DIFFICULTY IN FINDING YOUR
WAY THROUGH THE TERMINAL?

YES:

/	/	/	/	/

	/	/	/	/	/
NO:	/	/			

3. EACH TIME YOU HAVE ARRIVED AT THIS TERMINAL, DO YOU HAVE ANY DIFFICULTY IN FINDING YOUR WAY THROUGH IT?

YES:

/	/	/	/	/
/	/	/	/	/
/		-		

4. DO YOU RECALL WHERE YOUR DIFFICULTY OCCURED?

TICKET COUNTER:						
WAIT ROOM:						
SECURITY:						
BAGGAGE CLAIM:	/					

4. IF YOU HAVE TRAVELLED THROUGH OTHER TERMINALS, DO YOU FIND THIS ONE EASIER TO GET THROUGH THAN THE OTHERS?

OVER →

FIGURE B-1.1
ARRIVING PASSENGER INTERVIEW
(CURB), SAMPLE

FIGURE B-1.1; CONT.

OTHERS:

DOORS OUT : 1

WASHROOMS : 1 1

NO INFO BOOTH : 1

YES:

1	1	1	1	1
1	1	1	1	1
1	1	1	1	1

NO:

1	1	1	1	

5. DID YOU ASK FOR DIRECTONAL ASSISTANCE?

YES:

1				

NO:

1	1	1	1	

FROM WHOM?

SECURITY GUARD (COMMISSIONAIRE)

5. CAN YOU BRIEFLY EXPLAIN WHY?

YES! SMALL SIZE 1111111111

SIMILAR TO OTHERS

1111111111

NO! HARD TO FIND WAY

OUT OF 111111

BAG CLAIM AREA

SURVEYORS COMMENTS:

- THREE PAX STATED THAT THIS TERMINAL WAS EASIER THAN OTHERS YET COMMENTED THAT IT WAS HARD TO GET OUT OF BAG CLAIM AREA.

- ALTHOUGH ONLY ONE PAX STATED THAT DIRECTIONAL ASSISTANCE WAS REQUIRED, FOUR OTHER PAX ADMITTED, AFTER THE INTERVIEW THAT THEY ASKED ASSISTANCE OF THE COMMISSIONAIRE.

WAIT ROOM
PASSENGER INTERVIEW
(DEPARTING)

TERMINAL: FREDRICKTON, NEW BRUNSWICK

DATE AND TIME: JUNE 14 / 77

SURVEYORS - ONE : W.J. COOK

- TWO : C. Y. Mo

- THREE: DR. J. P. BRAAKSMA

FLIGHT DESCRIPTION: INTERNATIONAL ☐ TRANSBORDER ☐ DOMESTIC ☐

1. ARE YOU A PASSENGER LEAVING THIS AIRPORT?

[illegible]

2. IS THIS THE FIRST TIME YOU HAVE LEFT THIS AIRPORT?

[illegible][illegible]

3. IN PROCEEDING FROM YOUR GROUND TRANSPORTATION - DO YOU RECALL HAVING ANY DIFFICULTY IN FINDING YOUR WAY THROUGH THE TERMINAL?

YES:

	/	/	/	/	/
NO:	/	/	/	/	/
	/	/	/	/	/
	/	/	/	/	/
	/	/	/	/	/
	/	/	/	/	/

3. EACH TIME YOU HAVE LEFT THIS TERMINAL, DO YOU HAVE ANY DIFFICULTY IN FINDING YOUR WAY THROUGH IT? - . .

YES:

NO:					

4. DO YOU RECALL WHERE YOUR
DIFFICULTY OCCURED?

TICKET COUNTER:						
WAIT ROOM:						
SECURITY:						
BAGGAGE CLAIM:						

4. IF YOU HAVE TRAVELLED THROUGH OTHER TERMINALS, DO YOU FIND THIS ONE EASIER TO GET THROUGH THAN THE OTHERS?

OVER →

FIGURE B-1.2
DEPARTING PASSENGER INTERVIEW
(WAIT ROOM), SAMPLE

FIGURE B-1.2; CONT.

OTHERS:

5. DID YOU ASK FOR DIRECTIONAL ASSISTANCE?

YES:

NO:

FROM WHOM?

YES:

/	/	/	/	/
/	/	/	/	/
/	/	/	/	/
/	/	/	/	/
/	/	/	/	/

NO:

/	/	/		

5. CAN YOU BRIEFLY EXPLAIN WHY?

YES: SMALL SIZE // // // //

WELL LAYED OUT // // // //

NO: BAGGAGE CLAIM HARD

TO FIND I

LOCKERS HARD TO FIND

//

SURVEYORS COMMENTS:

THREE PASSENGERS COMMENTED THAT THE BAGGAGE CLAIM AREA AND LOCKERS WERE HARD TO FIND

FOR THE DISCUSSION FOLLOWING THE INTERVIEW TWO PAS. STATED THEY DID HAVE DIFFICULTY IN FINDING A MORE ONE WAS THE LOCKERS AND THE OTHER THE WOMENS WASH ROOM. THEY BOTH ASKED A COMMISSIONAIRE.

B-2

MONCTON AIRPORT

FIGURE B-2.1; CONT.

OTHERS:

WASHROOMS	:	/	/	/			
PHONES	:	/	/				
	:						

5. DID YOU ASK FOR DIRECTIONAL ASSISTANCE?

YES:	/				

NO:	/	/	/	/	/
	/				

FROM WHOM?

STUDENT SURVEYOR

YES:	/	/	/	/	/
	/				

NO:	/	/	/	/	/
	/	/	/		

5. CAN YOU BRIEFLY EXPLAIN WHY?

YES: SMALL SIZE IIIII

JUST AS EASY

AS OTHERS IIIII

BUT - CLUTTERED III

BROKEN UP II

SURVEYORS COMMENTS:

- MOST PAX SURVEYED FELT EASY TERMINAL TO GET AROUND

- SOME COMMENTED ON LIGHTING AND TERMINAL WAS CLUTTERED

- NO CONTERADCTIONS DURING FOLLOWING DISCUSSIONS

FIGURE B-2.2; CONT.

OTHERS:

WASH ROOMS

PHONES

/	/				
/					

YES:

/	/	/	/	/
/	/			

NO:

5. DID YOU ASK FOR DIRECTIONAL ASSISTANCE?

YES:

NO:

/	/	/		

FROM WHOM?

TICKET COUNTER

5. CAN YOU BRIEFLY EXPLAIN WHY?

YES: SMALL SIZE 111111

* BUT - POORLY LAYED OUT 1

- CLUTTERED 1

- POOR LIGHTING 11

- NO SIGNS 11

SURVEYORS COMMENTS:

* ALTHOUGH PAX SAID THEY HAD NO DIFFICULTY FINDING THEIR WAY ABOUT THE TERMINAL COMPLAINED THAT IT WAS POORLY LAYED OUT ETC (ABOVE) ONE PAX WHO STATED THAT NO PROBLEMS WERE EXPERIENCED, DID RECALL AFTER THE INTERVIEW THAT HE DID ASK AT THE TICKET COUNTER WHERE THE WASHROOMS WERE THEREFORE ONE RESPONSE RECORDED AS NO DIFFICULTY WAS OBSERVED, BUT A DIRECTIONAL ASSISTANCE RECORDED WAS MADE.

B-3

SAINT JOHN AIRPORT

CURB
PASSENGER INTERVIEW
(ARRIVING)

TERMINAL: SAINT JOHN, NEW BRUNSWICK - AIRPORT

DATE AND TIME: JUNE 16/77

SURVEYORS - ONE : W. J. COOK

- TWO : C.Y. MD

- THREE: DR. J. P. BRAAKSMA

FLIGHT DESCRIPTION: INTERNATIONAL ☐ TRANSBORDER ☒ DOMESTIC ☐

1. ARE YOU A PASSENGER ARRIVING AT THIS AIRPORT?

[illegible]

2. IS THIS THE FIRST TIME YOU HAVE ARRIVED AT THIS AIRPORT?

YES :

[illegible]

NO:

[illegible]

3. IN PROCEEDING FROM YOUR (AIRCRAFT, TRAIN, BUS) - DO YOU RECALL HAVING ANY DIFFICULTY IN FINDING YOUR WAY THROUGH THE TERMINAL?

YES:

/	/	/	/	/
/				

NÒ:

/	/	/		

3. EACH TIME YOU HAVE ARRIVED AT THIS TERMINAL, DO YOU HAVE ANY DIFFICULTY IN FINDING YOUR WAY THROUGH IT?

YES:

/	/		

NO:

/	/	/	/	/
/	/	/	/	

4. DO YOU RECALL WHERE YOUR DIFFICULTY OCCURED?

TICKET COUNTER:

1					
---	--	--	--	--	--

WAIT ROOM:

1	1				
---	---	--	--	--	--

SECURITY:

--	--	--	--	--	--

BAGGAGE CLAIM:

--	--	--	--	--	--

4. IF YOU HAVE TRAVELLED THROUGH OTHER TERMINALS, DO YOU FIND THIS ONE EASIER TO GET THROUGH THAN THE OTHERS?

OVER:

FIGURE B-3.1

ARRIVING PASSENGER INTERVIEW
(CURB), SAMPLE

FIGURE B-3.1; CONT.

OTHERS:

CURRENCY	/	/			
GRND TRANS INFO	/				
CAR RENTAL	/	/			

5. DID YOU ASK FOR DIRECTIONAL ASSISTANCE?

YES:	/	/	/		

NO:	/	/	/	/	/

FROM WHOM?

SECURITY OR CUSTOMS OFFICER
"III"

YES:

/	/	/	/	/
/	/			

NO:

/	/	/	/	/

5. CAN YOU BRIEFLY EXPLAIN WHY?

NO: CAR RENTAL HARD TO FIND
 BAGGAGE CLAIM HARD TO FIND
 POOR LAY OUT
 NO SIGNS

YES: SMALL
 EASY TO GET AROUND
 STRAIGHT AND SMALL

SURVEYORS COMMENTS:

- SERIOUS PROBLEM WHEN TRANSBORDER ARRIVED AND SCREEN PULLED ACROSS TO BLOCK OFF CUSTOMS AND IMMIGRATION AREA. GARRETS COULD NOT SEE THEIR PARTY. AT THE SAME TIME DEPARTING TAXI WERE ATTEMPTING TO BE SECURITY CLEARED AND ENTER THE HOLD ROOM. THEY FOUND DIFFICULTY IN DOING THIS DUE TO LARGE CROWD OF GARRETS - WHO FINDING THEY COULD NOT REACH THEIR PARTY HEADED BACK THROUGH THE TERMINAL OUT TO THE CURB. SOME FOUND AN ACCESS INTO THE AREA BUT WERE IMMEDIATELY REMOVED BY CUSTOMS OFFICIALS

- SOME TAXI INTERVIEWED AS WELL AS GARRETS WHO SAID THEY HAD NO PROBLEMS YET COMPLAINED OF NOT SEEING THEIR PARTY

FIGURE B-3.2; CONT.

OTHERS:

CAR RENTAL

RESTAURANT

/	/				
/	/				

5. DID YOU ASK FOR DIRECTIONAL ASSISTANCE?

YES:

/	/	/			

NO:

/	/	/			

FROM WHOM?

AIR CANADA III

YES:

/	/	/	/	/	
/	/	X	X	X	

NO:

/	/	/	X		

5. CAN YOU BRIEFLY EXPLAIN WHY?

YES: SMALL SIZE: IIIIIIIII

NO LEVELS II

NO: BROKEN UP, CAN'T FIND

ANYTHING IIII

HAVE TO WALK AROUND

II

SURVEYORS COMMENTS:

SOME DAY INTERVIEW SAID THAT THIS TERMINAL WAS EASY YET DISCUSSION AFTER INTERVIEW DID REVEAL SOME DIFFICULTY. SOME WHO SAID HAD NO PROBLEMS DID ACTUAL HAVE PROBLEMS (9) eg - FIND SECURITY CHECK, CAR RENTALS, LOCKERS, PHONES. 4 ANSWERS ELIMINATED IN QUESTION 3 "NO" AND IN "YES" "NO" OF QUESTION 4.

APPENDIX C

EMPLOYEE INTERVIEWS

C-1 Summary Sheets of Employee
Interviews

C-1

SUMMARY SHEETS OF EMPLOYEE
INTERVIEWS

TERMINAL: OTTAWA AIR				DATE: MAY/77 # 12			
REQUESTS FREQUENCY NODE	MOST FREQUENT REQUESTS	SECOND MOST FREQUENT REQUESTS	THIRD MOST FREQUENT REQUESTS	TOTALS			
CUSTOMS & IMMIG.	//	///	/	2	3	1	6
TICKET COUNTERS		//	///	0	2	3	5
BAGGAGE AREA	///	////	//	3	4	2	9
DEPART AREA	/	/		1	1	0	2
RESTAURANT			///	0	0	3	3
WOMENS WASHROOM	/	/	//	1	1	2	4
MENS WASHROOM		/	//	0	1	2	3
GRND. TRANS, CURB	/	/	/	1	1	1	3
HOTELS	//			2	0	0	2
CARTS	/			1	0	0	1
SCHEDULE	/			1	0	0	1

AVERAGE NUMBER OF QUESTIONS PER DAY 40

BUSIEST DAY: FRIDAY TO SUNDAY TIME: 4:00 PM FRID. - 8:00 PM SUN.

IN COMPARISON TO OTHER TERMINALS, THIS TERMINAL IS EASY 2;
HARD 0, FOR USERS TO GET AROUND.

IN YOUR OWN OPINION, THIS TERMINAL IS EASY 5; HARD 6,
FOR USERS TO GET AROUND.

REASONS: EASY 1. TERMINAL SMALL

2. LAYOUT SIMPLE

HARD 1. POOR LAYOUT, LONG WALKS

2. SHOULD BE IN STRAIGHT LINE

FREQUENT
COMMENTS:

1. SHOULD BE STRAIGHT THROUGH

2. PAX SHOULD MOVE ACROSS WIDTH

3. NEED COVERED BRIDGES

FIGURE C-1.1
EMPLOYEE INTERVIEW SUMMARY

TERMINAL: EDMUNSTON AIRPORT				DATE: JUNE 17/77 # (2)			
REQUESTS FREQUENCY NODE	MOST FREQUENT REQUESTS	SECOND MOST FREQUENT REQUESTS	THIRD MOST FREQUENT REQUESTS	TOTALS			
CORRECT HIGHWAY	//			2	0	0	2
WASHROOMS		//		0	2	0	2
PHONES			//	0	0	2	2

AVERAGE NUMBER OF QUESTIONS PER DAY

BUSIEST DAY: WEEKENDS TIME: FRIDAYS, SATS., SUNS.

IN COMPARISON TO OTHER TERMINALS, THIS TERMINAL IS EASY _____;
HARD _____, FOR USERS TO GET AROUND.

IN YOUR OWN OPINION, THIS TERMINAL IS EASY 2; HARD 0;
FOR USERS TO GET AROUND;

REASONS: EASY. 1. SQUARE, SIMPLE, SMALL

2. _____

HARD 1. WASHROOMS, PHONES

2. _____

FREQUENT COMMENTS: 1. AM I ON THE RIGHT HIGHWAY TO?

2. WASHROOMS, USE OF PHONE

3. _____

FIGURE C-1.2
EMPLOYEE INTERVIEW SUMMARY

TERMINAL: <u>QUEBEC CITY AIRPORT</u> DATE: <u>JUNE 17/78</u> # <u>10</u>				
<div>REQUESTS FREQUENCY</div> <div>NODE</div>	MOST FREQUENT REQUESTS	SECOND MOST FREQUENT REQUESTS	THIRD MOST FREQUENT REQUESTS	TOTALS
INFO. BOOTH	/			1 0 0 1
TICKET COUNTER	/	//	/	1 2 1 4
WASHROOMS	///	////	/	3 4 1 8
CUSTOMS & IMMIG.	//	//	///	2 2 3 7
SCHEDULE	/			1 0 0 1
COFFEE SHOP, REST	//	/	///	2 1 3 6
ARRIVALS ENT.			/	0 0 1 1
CURRENCY			/	0 0 1 1
TOBACCO SHOP			/	0 0 1 1

AVERAGE NUMBER OF QUESTIONS PER DAY 25

BUSIEST DAY: SUNDAYS, SATURDAYS TIME: AFTERNOONS

IN COMPARISON TO OTHER TERMINALS, THIS TERMINAL IS EASY 1;
HARD 2, FOR USERS TO GET AROUND.

IN YOUR OWN OPINION, THIS TERMINAL IS EASY 3; HARD 4,
FOR USERS TO GET AROUND.

REASONS: EASY 1. SMALL SIZE 4
 2. NEWER 1

HARD 1. BROKEN UP, MIXED UP 3
 2. TOO SMALL 1

FREQUENT
COMMENTS: 1. NEEDS INFO. BOOTH
 2. NEEDS CURRENCY COUNTER
 3.

FIGURE C.3
EMPLOYEE INTERVIEW SUMMARY

REQUESTS FREQUENCY		MOST FREQUENT REQUESTS	SECOND MOST FREQUENT REQUESTS	THIRD MOST FREQUENT REQUESTS	TOTALS			
NODE								
TICKETS	/				1	0	0	1
NEWSSTAND		/			0	1	0	1
MAIL BOX		/			0	1	0	1
RESTAURANT & BAR		/	/		0	1	1	2
PHONES	//	/	/		2	1	1	4
CURB				//	0	0	2	2
WASHROOMS	//	/			2	1	0	3
INFO. BOOTH		/			0	1	0	1
LOST & FOUND				/	0	0	1	1
DEPARTURE GATES	///	/	/		3	1	1	5
PARCEL EXPRESS		/			0	1	0	1

AVERAGE NUMBER OF QUESTIONS PER DAY 20

BUSIEST DAY: FRIDAY, SUNDAYS TIME: 2:00 PM - 6:00 PM

IN COMPARISON TO OTHER TERMINALS, THIS TERMINAL IS EASY 1;
HARD 0, FOR USERS TO GET AROUND.

IN YOUR OWN OPINION, THIS TERMINAL IS EASY 6; HARD 0;
FOR USERS TO GET AROUND.

REASONS: EASY 1. GOOD SIGNAGE 6
2. WELL LAID OUT, SMALL 7
HARD 1.
2.
FREQUENT COMMENTS: 1. WELL PLANNED: PARK - TICKET - GATE 2
2. VERY OPEN, WELL LIGHTED 2
3. NEED HOTEL, GROUND TRANSPORTATION INFO. 2

FIGURE C-1.4
EMPLOYEE INTERVIEW SUMMARY

REQUESTS FREQUENCY		MOST FREQUENT REQUESTS	SECOND MOST FREQUENT REQUESTS	THIRD MOST FREQUENT REQUESTS	TOTALS		
NODE							
GATES	//				2	0	0
GROUND TRANSPORT.	/	/			1	1	0
BAGGAGE	//	/		///	2	1	3
SCHEDULE	///	/			3	1	0
PARKING				/	0	0	1
PHONES	/	//			1	2	0
WOMENS WASHROOM.	/	//		//	1	2	2
MENS WASHROOM	/	/		/	1	1	1
RESTAURANT		//		/	0	2	1
INFO. BOOTH	/				1	0	0
STATION MASTER				///	0	0	3

AVERAGE NUMBER OF QUESTIONS PER DAY 20

BUSIEST DAY: FRIDAYS, SUNDAYS **TIME: 4:00 PM - 7:00 PM**

IN COMPARISON TO OTHER TERMINALS, THIS TERMINAL IS EASY .3
HARD 4, FOR USERS TO GET AROUND.

IN YOUR OWN OPINION, THIS TERMINAL IS EASY 4; HARD 0
FOR USERS TO GET AROUND.

REASONS: EASY	1.	WELL LAID OUT	3
	2.	GOOD SIGNAGE	3
HARD	1.	PILLARS BLOCK VISION, FUNCTIONAL PROBLEM	3
	2.	SIGNAGE PROBLEMS, VISUAL PROBLEMS	3

FREQUENT COMMENTS:	1.	PEOPLE DON'T LOOK, ASK FIRST	3
	2.	NEED DROPPED OR SIGNAGE BOARDS	2
	3.		

FIGURE C-1.5
EMPLOYEE INTERVIEW SUMMARY

REQUESTS FREQUENCY		MOST FREQENT REQUESTS.	SECOND MOST FREQENT REQUESTS	THIRD MOST FREQENT REQUESTS	TOTALS			
NODE								
TICKET COUNTER	////	/	/	4	1	2	7	
TAXI, BUSES		/	/	0	1	1	2	
WASHROOMS	//	/	////////	2	1	8	11	
PHONES	/	/	//	1	1	2	4	
RESTAURANT, BAR		////////	/	0	7	1	8	
SCHEDULE	//	/		2	1	0	3	
BAG CLAIM		/		0	1	0	1	
INT'L. ARRIVALS	//	/	/	2	1	1	4	
DOMESTIC ARRIVALS		//		0	2	0	2	
DEPART GATES	////////	/		6	1	0	7	
CURRENCY			//	0	0	2	2	

AVERAGE NUMBER OF QUESTIONS PER DAY 1.00

BUSI-EST DAY: FRIDAY TO SUNDAY. TIME: 7:00 PM to 8:00 PM

IN COMPARISON TO OTHER TERMINALS, THIS TERMINAL IS EASY 1;
HARD 3, FOR USERS TO GET AROUND.

IN YOUR OWN OPINION, THIS TERMINAL IS EASY 7; HARD 6,
FOR USERS TO GET AROUND.

REASONS: EASY	1.	<u>GOOD SIGNAGE</u>	5
	2.	<u>CIRCULAR (LAYOUT)</u>	4
HARD	1.	<u>SIGNS POOR (LACK)</u>	6
	2.	<u>POOR LAYOUT</u>	3
FREQUENT COMMENTS:	1.	<u>PEOPLE DON'T READ SIGNS</u>	8
	2.	<u>LACKS INFO.</u>	1
	3.		

FIGURE C-1.7
EMPLOYEE INTERVIEW SUMMARY

APPENDIX D

VISIBILITY INDICES

- D-1 Visibility Indices of a Terminal System
- D-2 Visibility Indices of Terminal Subsystems
- D-3 Visibility Indices of Terminal Components

D-1

VISIBILITY INDICES OF A TERMINAL SYSTEM

APPENDIX D-1

VISIBILITY INDICES OF A TERMINAL SYSTEM

Four indices are calculated to quantify the visibility of a terminal system. They are:

1. Terminal Visibility Index, V

The terminal's visibility index is calculated by applying equation (4) of Chapter II:

$$V = \frac{L}{n(n-1)} \times 100, L = \sum(\ell_t \text{ or } \ell_f)$$

where: V = a measure of the total visibility between all the nodes in a terminal network system, as observed by its physical presence and/or a direction sign expressed in percent

L = the sum of column or row totals of any existing measured sight lines between each mandatory or optional node in a terminal network system as observed and recognized to exist by their physical presence, through an associated identification sign or through a directional sign. Any entry, except zero, for each node's visibility for this case is counted as one*

* An example of this is observed in the row sum of the Moncton field visibility matrix Figure . . . Node 7, the security gate sees the baggage claim through a sign as well as physically and this is recorded as (1/). This entry is therefore counted as only one / and the row total is then 12.

- l_t = the row sight line totals for all nodes where any existing sight line is counted as one (1)
- l_f = the column sight line totals for all the nodes where any existing sight line entry is counted as one (1)
- n = the total mandatory and optional nodes identified in a terminal network.

This index simply tells just how visible all the nodes of the terminal are, either through a sign or through their physical presence. It gives a good indication of the possible visibility problems that may be encountered by a user in the terminal. That is, a high visibility index indicates that a user should be more orientated in the terminal than an index result which is low. Also V , when evaluated from the base matrix, gives an index which may be used for visibility comparison purposes between different terminals and how orientated a user is in one particular terminal relative to another.

In Chapter 2, Figures 2.9a, 2.10b, 2.11 and 2.12b show for each node's visibility, link totals for the rows and columns to the right and at the bottom of the visibility matrix. In the lower right hand corner of the matrix are the link sums of these row and column totals which were used in related equations, calculating the visibility indices of the detailed hypothetical example. For the Moncton International Airport visibility matrix compiled at the site, the sum of the row totals, which in this

case equals the sum of the column totals shown in Appendix E-1 is 237. Substituting into the above equation yields a terminal visibility index of 46.8% (Table 4.4). Similarly, the sum of the row totals, or column totals for both the floor plan matrix and base matrix are 208 and 261 respectively. Substituting these values into the above terminal visibility equation reveals V equal to 41.1% for the floor plan and 40.2% for the base matrix (Tables 4.2 and 4.3).

For all the remaining calculations relative to Moncton International's terminal system, subsystems and components, the appropriate sight link sums of the row and column totals with corresponding column titles relative to the equations used to calculate the required site survey visibility index, all of which are defined and discussed in the following paragraphs, are listed in its computer printout, Appendix E-1.

2. Terminal Node Identification Index, VI

The terminal's node identification index is calculated by applying equation (4) of Chapter 2 and,

$$VI = \frac{LI}{n(n-1)} \times 100, \quad LI = \sum \{l_{tI} \text{ or } l_{fI}\},$$

where:

- VI = a measure of the total visibility between all the nodes observed and recognized by their physical presence only, in any terminal network, expressed in percent.

LI = the sum of column or row totals of all existing measured sight lines between each mandatory or optional node in a terminal network system as observed and recognized to exist by their physical presence only. The one (1) matrix entries for each node's visibility for this case are counted, totalled and summed.

l_{ti} = the row sight line totals for all nodes where an existing sight line was entered as one (1), due to visibility by its physical presence.

l_{fi} = the column sight line totals for all nodes where an existing sight line was entered as one (1), due to visibility by its physical presence.

n = the total mandatory and optional nodes identified in a terminal network..

The node identification index demonstrates how visible all the nodes are in the terminal due to their physical presence alone, without the assistance of directional signs. When calculated from the matrix entries, it gives a good idea of how orientated a terminal user would be if he/she depended on the observation and recognition of any particular node. It also gives an idea of the contribution that can be made with the application of a signage system. For a new terminal design, a low index would express possible user disorientation problems and re-evaluation of the layout should be undertaken. For an existing terminal, a low index would also indicate possible user disorientation, and

a detailed study of the areas where this problem occurs should be carried out. Once identified, appropriate layout changes and/or appropriate signage installation may be necessary, depending on associated costs. Substituting the sums of the row and column sight link totals from its computer printout listings, Appendix E, for Moncton International, reveals identification indices:

VI (site survey) = 46.8%

VI (floor plan) = 41.1%

VI (base matrix) = %

3. Terminal Node Signage Assistance Index, VA

The terminal's signage assistance index is calculated by applying equation (4) of Chapter 2, and,

$$VA = \frac{LA}{n(n-1)} \times 100, \quad LA = \sum \{ \ell_{tA} \text{ or } \ell_{fA} \}$$

where:

VA = a measure of the total visibility between all the nodes assisting their physical observation and recognition through directional signage in any terminal network, expressed in percent.

LA = the sum of column or row totals of all existing sight lines between each mandatory or optional node in a terminal network system as observed and recognized to exist through a direction sign. The slash (/) or slashes in the matrix entries for each node's visibility for this case are counted, totalled and summed.

t_A = the row sight line totals for all nodes where an existing sight line was entered as a slash (/) or slashes due to visibility through a directional sign.

f_A = the column sight line totals for all nodes where an existing sight line was entered as a slash (/) or slashes due to visibility through a directional sign.

n = the total mandatory and optional nodes identified in a terminal network.

The node signage index is a value demonstrating how signage has assisted in the recognition of nodes in a terminal even though they may have already been observed and recognized by their physical presence. As previously pointed out, due to increased pedestrian traffic during the busy periods, users may begin to depend on signage, particularly when attempting to find low profile nodes or nodes which cannot be observed by themselves or through an identification sign. For the Moncton International Airport terminal, the calculations of the signage assistance indices for each matrix compilation are shown in Appendix E-1.

4. Terminal Node Signage Observation Index, VO

The terminal's signage observation index is calculated by applying equation (4) of Chapter 2, and,

$$VO = \frac{LO}{n(n-1)} \times 100, LO = \sum \{l_{tO} \text{ or } l_{fO}\}$$

$$\text{and } VO = V - V$$

where:

VO = a measure of the total visibility between all the nodes observed and recognized through directional signage only, in any terminal network, expressed in percent.

LO = the sum of column or row totals of all existing sight lines between each mandatory or optional node in a terminal network system as observed and recognized to exist through a direction sign only. The slash (/) or slashes in the matrix entries for each node's visibility for this case are counted, totalled and then summed.

l_{tO} = the row sight line totals for all nodes where an existing sight line was entered as a slash (/) or slashes due to visibility through a directional sign only.

l_{fO} = the column sight line totals for all nodes where an existing sight line was entered as a slash (/) or slashes due to visibility through a directional sign only.

n = the total mandatory and optional nodes.

There is a difference between the signage assistance index V_A and the signage observation index V_O . The assistance index is a value associated with the visibility of nodes observed through

signs only, as well as by their physical presence. In other words, if a node was seen and recognized as it stood in the terminal, and also seen and recognized through a directional sign or signs, with entries of one, slash (1/...), it was these slashes, as well as those due to observation of a node through a directional sign(s) only (0/...), which were counted, totalled and summed. The signage observation index V_0 considered only the latter case of the above entries. That is, only those nodes which were observed through a directional sign with entries of zero, slash(es) (0/...) were considered, with the entered slashes counted, totalled and summed.

Considering these two signage indices and the previous terminal visibility index and node identification index, simple understanding of their relationships may assist in the evaluation of a terminal's orientation characteristics. These are detailed as follows:

$$(a) \quad V_0 + V_I = V$$

if $V_0 + V_I \neq V$, an error exists in computation and matrix entries.

$$(b), \text{ if } V_0 + V_I > 100\%$$

$$\text{and } 0 < V_I < 100\%$$

further investigation will reveal that there exists visual overdesign with respect to directional signage.

(c) if $VO + VI = 100\%$

there exists total adequate design with respect to visual observation of any node, thereby severely reducing any possible user disorientation problems.

(d) $VO + VI < 100\%$

$$0 < VI < 100\%$$

further investigation will reveal that there exists visual overdesign with respect to directional signage and a degree, depending on the value of $VO + VI$ or V , if user disorientation is expected to exist.

For Moncton International Airport:

(a) $VO + VI = V$

$$0.8\% + 46.0\% = 46.8\% = V$$

Therefore, there are no computational or matrix entry errors found from the visibility site survey.

(b) if $VO + VI > 100\%$

and $0 < VI < 100\%$

$$0.8 + 46.0 > 100\%$$

$$0 < 46.0 < 100\%$$

Therefore, there are no serious oversignage problems at the Moncton airport.

(c) if $VO + VI \neq 100\%$

$$0.8 + 46.0\% \neq 100\%$$

Therefore, Moncton Airport should have some orientation problems since

(d) $VO + VI = 100\%$

$0.8 + 46.0\% < 100\%$

D-2

VISIBILITY INDICES OF TERMINAL SUBSYSTEMS

APPENDIX D-2

VISIBILITY INDICES OF TERMINAL SUBSYSTEMS

Five subsystems are used to prove the applicability of the equations developed to quantify user orientation in terminal facilities. These are the mandatory nodes and five terminal user types, namely:

- i), the originating-domestic passenger,
- ii) the terminating-transborder passenger,
- iii), the connecting; domestic-domestic passenger,
- iv) the connecting; transborder-domestic passenger, and
- v) the greeter.

In the following paragraphs, only two of these subsystems will be quantified. They are the mandatory node subsystem and the greeter subsystem. All five are quantified by the terminal program discussed later. The two subsystems will be quantified on how visible the nodes only in the subsystem are to its user, how visible the other nodes in the terminal network are to a user when in the subsystem, and finally, how visible the subsystem is to a user who is in the terminal network.

The mandatory node subsystem consists of all those mandatory nodes identified in the terminal, through which a passenger must be processed in order to begin a trip, end a trip or connect and proceed further on a trip. The mandatory nodes for Moncton Airport are indicated with an asterisk (*) in the rows and columns in the survey visibility matrix (site), Figure 3.4.

Since a subsystem can be isolated and considered as a single system, the mandatory node subsystem of a terminal can be evaluated exactly the same as a terminal system. That is, the four indices calculated in the previous section for the terminal network, can be directly applied to a subsystem in order to quantify user orientation in that subsystem. For example, in order to calculate a subsystem visibility index for the mandatory nodes, the sum of the totals for either the row entries under the mandatory nodes only or the sum of the totals for the column entries of the mandatory nodes are used, which are then substituted into equation (8) from Chapter 2, Section 2.4.1.

$$VM = \frac{l(m)}{n(m) \{n(m) - 1\}} \times 100, \quad (m) = \sum \{lt(m) \text{ or } lf(m)\}$$

where:

VM = a measure of the visibility between all the nodes observed and recognized by their physical presence and/or through a directional sign in a particular chosen subsystem. In this case, the mandatory node subsystem (m) expressed in percent.

$l(m)$ = the sum of the column or row totals of any existing measured sight line between the subsystem nodes only, in a terminal network as observed and recognized to exist by their physical presence, through an associated identification sign or through a directional sign.

The mandatory node subsystem (m) is considered in this case and any entry except zero for each node's visibility is counted as one.

$\ell_t(m)$ = the row sight line totals for all the mandatory nodes only where any existing sight line entry is counted as one (1).

$\ell_f(m)$ = the column sight line totals for all the mandatory nodes only where any existing sight line entry is counted as one (1).

$n(m)$ = the total nodes identified in the subsystem to be quantified. In this case it is the mandatory node subsystem (m).

From Figure 3, 13 mandatory nodes were identified from 23 nodes listed and surveyed in the field at Moncton airport, and are shown with an asterisk (*) in the visibility matrix in Figure 5.

Applying the equations from the terminal system quantification, they can also quantify the mandatory node subsystem, as shown in the above example. From the Moncton airport's visibility matrix (Site), either the row total sums for the mandatory nodes and their column total sums are substituted into the above equation yields a:

1. Mandatory Subsystem Visibility Index, VM

$$\begin{aligned}
 VM &= \frac{l_{(m)}}{n_{(m)} \{n_{(m)} - 1\}} \times 100, \quad l_{(m)} = \Sigma \{l_{t(m)} \text{ or } l_{f(m)}\} \\
 &= \frac{78}{13(13-1)} \times 100 \\
 &= 50.0\%
 \end{aligned}$$

Similarly, with the same equations used to calculate the four terminal system visibility indices, they can be adopted to calculate subsystem visibility indices for the mandatory node subsystem. Therefore for Moncton airport subsystem visibility indices, its mandatory nodes are calculated using the appropriate totals and sum entries from the site visibility matrix.

2. Mandatory Subsystem Node Identification Index, VMI

$$\begin{aligned}
 VMI &= \frac{l_{i(m)}}{n_{(m)} \{n_{(m)} - 1\}} \times 100, \quad l_{i(m)} = \Sigma \{l_{ti} \text{ or } l_{fi}\} \\
 VMI &= \frac{75}{13(13-1)} \times 100\% \\
 &= 48.7\%
 \end{aligned}$$

3. Mandatory Subsystem Node Signage Assistance Index, VMA (mandatory nodes)

$$\begin{aligned}
 VMA &= \frac{l_{a(m)}}{n_{(m)} \{n_{(m)} - 1\}} \times 100, \quad l_{a(m)} = \Sigma \{l_{ta} \text{ or } l_{fa}\} \\
 &= \frac{0}{13(13-1)} \times 100\% \\
 &= 0\%
 \end{aligned}$$

4. Mandatory Subsystem Node Signage Observation Index, VMO
(mandatory nodes)

$$\begin{aligned}
 VMO &= \frac{V_{O(m)}}{n_{(m)} \{n_{(m)} - 1\}} \times 100\% \\
 &= \frac{2}{13(13-1)} \times 100\% \\
 &= 1.3\%
 \end{aligned}$$

Since the previous few paragraphs have quantified orientation relative to a user's visibility in the subsystem itself, the following discusses and quantifies user orientation and accessibility between the subsystem and the rest of the terminal. Equation (9) of Section 2.4.1, Chapter 2, can be used to calculate a subsystem's orientation and accessibility indices, for any particular identified subsystem. For the mandatory node subsystem orientation index, sums of row totals for the mandatory nodes for the field visibility matrix for Moncton Airport are substituted into equation (9) as follows:

$$VMOS = \frac{V_{O(m)}}{n_{(m)} \{n - n_{(m)}\}} \times 100\%$$

where:

VMOS = a measure of the visibility between all the nodes observed and recognized by their physical presence and/or through a directional sign from a particular subsystem, to all other nodes in the terminal, except those in the subsystem. In this case, all optional nodes are observed from the mandatory node subsystem which are considered in the row totals.

$l_{o(m)}$ = the sum of row totals of any existing measured sight line between the subsystem nodes and all other nodes in the terminal network as observed and recognized to exist by their physical presence, through an associated identification sign or through a directional sign. For this case the row totals, which are the sight lines between the mandatory node subsystem (m) and the optional nodes, are summed with any entry counted as one (1).

$n_{o(m)}$ = the total nodes identified in the subsystem to be quantified. In this case it is the mandatory node subsystem (m).

n = the total mandatory and optional nodes identified in the terminal network system.

From the field visibility matrix for Moncton Airport, the sight links between each mandatory node to any other node, which here are the entries under the remaining optional nodes, were totalled across the row, with any entry for this case counted as one, and then moving down the matrix, all totals were summed. The sum of the row totals entered into the above equation, yields an orientation index for the mandatory subsystem, as:

$$\begin{aligned} VMOS &= \frac{l_{o(m)}}{n_{(m)} (n - n_{(m)})} \times 100\% \\ &= \frac{53}{12 (23 - 13)} \times 100\% \\ &= 40.8\% \end{aligned}$$

Again, similar to the system node quantification, indices such as a subsystem identification index, signage assistance index, signage observation index and a design improvement index, although not calculated in this research, can be quantified in order to totally evaluate orientation of users in the subsystem.

The subsystem orientation index, calculated above, is simply a measure of how well a terminal user travelling through a particular subsystem, can observe and identify other nodes in the terminal network in case he/she needs, or is required to use them. On the other hand, equation (9) can also be applied for the subsystem quantification of a subsystem accessibility index, which is a measure of how visible a particular subsystem is to a terminal user in the terminal network. This is valuable to design orientation considerations since it is a measure of how well a user, who has left a subsystem for something which may be needed at another node in the subsystem (pick-up luggage in a locker) or for another reason, can find his way back to the subsystem. It is given by equation (9) in the following form:

$$VMAS = \frac{\sum a(m)}{n(m) \cdot \{n - n(m)\}} \times 100\%$$

where:

VMAS = a measure of the visibility between all the nodes observed and recognized by their physical presence and through a directional sign to a particular subsystem from all other nodes in the terminal, except those in

the subsystem. In this case, the mandatory node subsystem is observed for the optional nodes which are considered in the column totals.

$\ell_{a(m)}$ = the sum of the column totals of any existing measured sight line between the terminal nodes and the nodes in the subsystem as observed and recognized to exist by their physical presence, through an associated identification sign or through a directional sign. For this case, the column totals which are the sight links between the mandatory node system (m) and the optional nodes are summed with any entry counted as one (1).

$n_{(m)}$ = the total nodes identified in the subsystem to be quantified. In this case it is the mandatory node subsystem (m).

The sight links in the field visibility matrix for Moncton Airport for each mandatory node to the remaining optional nodes were totalled down the columns, with any entry counted as one, and moving across the matrix, all the totals were summed. The sum of the row totals are entered in the above equation, yielding an accessibility index for the mandatory subsystem as:

$$\begin{aligned} \text{VMAS} &= \frac{\ell_{a(m)}}{n_{(m)} \{n - n_{(m)}\}} \times 100\% \\ &= \frac{53}{13 (23-13)} \times 100\% \\ &= 40.8\% \end{aligned}$$

Further analysis of user orientation and accessibility between a user in a subsystem and the terminal network involves calculating the five previously discussed indices calculated for the terminal system and the mandatory node subsystem. That is, calculating:

- i) Subsystem Visibility Index V_o ,
- ii) Subsystem Node Identification Index V_{io} ,
- iii) Subsystem Node Signage Assistance Index V_{ao} ,
- iv) Subsystem Node Signage Observation Index V_{oo} , and
- v) Subsystem Design Improvement Index V_{do} ,

for either a user's orientation in the subsystem to the rest of the terminal network or a user's accessibility for the terminal network to the subsystem. In the following discussions, the greeter subsystem of Moncton Airport will be quantified considering greeter orientation in the subsystem to the rest of the nodes in the terminal network. The definitions stated in the previous equations used in the five terminal system and subsystem indices calculations are the same. For subsystem orientation calculations, a subsystem user wishes to observe other nodes in the remaining terminal network from a particular subsystem. Therefore equation (9) of Chapter II, Section 2.4.1 applies, which is the same used in the mandatory node subsystem orientation and accessibility calculations above.

Referring to the User Types table in Chapter 4, Table 4.5 listing the requirements for each terminal user type, the

following nodes were identified to be required by a greeter entering the terminal to meet an arriving passenger:

- i) all optional nodes except
 - the car rental counters
 - lockers
- ii) all mandatory nodes except
 - security check-in
 - hold rooms
 - ticket purchase
 - departure areas or gates.

Therefore, row totals for each of the greeter nodes identified in the Moncton airport and crossed (+) in its corresponding visibility matrix (site) Figure 3.4, are then summed and substituted into the following equations to calculate the appropriate greeter subsystem orientation indices:

1. Greeter Subsystem Visibility Index, $VV_{(g)}$

$$\begin{aligned}
 VV_{(g)} &= \frac{\ell_{(g)}}{n_{(g)} \{n - n_{(g)}\}} \times 100\%, \quad \ell_{(g)} = \sum \{\ell_{t(g)}\} \\
 &= \frac{39}{19 (23-19)} \times 100\% \\
 &= 51.3\%
 \end{aligned}$$

2. Greeter Subsystem Node Identification Index, $VVI_{(g)}$

$$\begin{aligned}
 VVI_{(g)} &= \frac{\ell_{i(g)}}{n_{(g)} \{n - n_{(g)}\}} \times 100\%, \quad \ell_{i(g)} = \sum \{\ell_{ti(g)}\} \\
 &= \frac{39}{19 (23-19)} \times 100\% \\
 &= 51.3\%
 \end{aligned}$$

3. Greeter Subsystem Node Signage Assistance Index, $VVA_{(g)}$

$$\begin{aligned}
 VVA_{(g)} &= \frac{l_{a(g)}}{n_{(g)} \cdot \{n - n_{(g)}\}} \times 100\%, \quad l_{a(g)} = \sum \{l_{ta(g)}\} \\
 &= \frac{0}{19 \cdot (23-19)} \times 100\% \\
 &= 0\%
 \end{aligned}$$

4. Greeter Subsystem Node Signage Observation Index, $VVO_{(g)}$

$$\begin{aligned}
 VVO_{(g)} &= \frac{l_{o(g)}}{n_{(g)} \cdot \{n - n_{(g)}\}} \times 100\%, \quad l_{o(g)} = \sum \{l_{to(g)}\} \\
 &= \frac{0}{19 \cdot (23-19)} \times 100\% \\
 &= 0\%
 \end{aligned}$$

In summary, two subsystems identified in the Moncton International airport terminal were quantified in this subsection. The orientation of a user in the mandatory node subsystem was quantified relative to the visibility of the user and expressed by various indices. Basically, the four indices calculated for the mandatory node subsystem only demonstrated the ability of a user to orientate himself/herself in the system through a combination of a node's physical presence, an identification sign or directional sign (VM), by the node's physical presence only (VI), by a node's physical presence assisted by a sign (VMA), and only through a sign (VMO). To show a measure of orientation ability, a terminal user who requires a node outside the subsystem in the terminal network or requires to return to the subsystem from the terminal network, an orientation and accessibility index for the

mandatory node subsystem needs to be calculated. These two indices were calculated based on a user's ability to orientate by a node's physical presence, a directional sign or any combination of the two.

On the other hand, the greeter subsystem is used to further demonstrate how the orientation of a user in a particular subsystem can be quantified, so that any identified subsystem can be quantified to evaluate a terminal facility. The greeter subsystem was quantified in relation to how he perceives the terminal network from the subsystem (orientation) by perception of a node either by its physical presence or a directional sign (any entry is one), by the physical presence of the node only, by the node's physical presence and assisted by a sign and through a directional sign only.

4 OF DE 4

D-3

VISIBILITY INDICES OF TERMINAL COMPONENTS

APPENDIX D-3

. VISIBILITY INDICES OF TERMINAL COMPONENTS

At any component or node in a terminal system or subsystem, a terminal user may wish to perceive and then orientate to any other component or node in the system or subsystem.

Two methods used to quantify a user's ability to visually orientate himself to the desired node are node orientation and node accessibility quantification. Each node in the terminal system can be quantified relative to the ability of a user standing at a particular node and perceiving - observing and recognizing - any other node in the system (node orientation). Similarly, each node can be quantified relative to the ability of a user standing at any other node and wishing to perceive one particular node (accessibility). For example, the orientation index can be calculated demonstrating the ability of a user standing at the front main entrance and wishing to perceive either the total network system or a particular subsystem, or for that matter, a particular node. Similarly, an accessibility index can be calculated indicating the ability of a user standing at any node in the system, in a particular subsystem or at another particular node, and wishing to perceive the front main entrance and exit.

The calculated orientation index is simply the totals of the appropriate entries in the matrix, in the row of the particular

node in question, and substituting it into equation (4) developed in Section 2.4.1, Chapter 2. Similarly the accessibility of any node or component is simply the appropriate entries in the matrix under the column of the particular node in question and substituted into the same equation. The two equations are:

1. Node Orientation Index

$$O = \frac{l_o}{n-1} \times 100\%, \quad l_o = \sum \{l_{to}\}$$

2. Node Accessibility Index

$$a = \frac{l_a}{n-1} \times 100\%, \quad l_a = \sum \{l_{fa}\}$$

where, for (1):

O = a measure of the visibility to all nodes in a terminal system observed and recognized by their physical presence and/or through a directional sign, from any particular node; expressed in percent.

l_o = the total of all the appropriate node entries across the row of the particular node considered. In this case, any entry is counted as one.

b = the total number of mandatory and optional nodes identified in the terminal network.

and where for (2):

A = a measure of the visibility from all nodes in a terminal system observed and recognized by their physical presence

and/or through a directional sign, to any particular node expressed in percent.

$\sum a$ = the total of all the appropriate node entries, down the column of the particular node considered. In this case, any entry is counted as one.

n = the total number of mandatory and optional nodes identified in the terminal network.

For the Moncton Airport, the row total of any entry in the field visibility matrix, Appendix E-1, for the entrance and exit, east (node 1), is 8. Substituting this into the orientation equation gives a node orientation index for node 1 of:

$$\begin{aligned} O &= \frac{\sum o}{n-1} \times 100\% \\ &= \frac{8}{23-1} \times 100\% \\ &= 36.4\% \end{aligned}$$

The column total of 9 for the same node, substituted into the accessibility equation gives an accessibility index for that node, node 1, of:

$$\begin{aligned} A &= \frac{\sum a}{n-1} \times 100\% \\ &= \frac{9}{23-1} \times 100\% \\ &= 40.9\% \end{aligned}$$

Similar to the greeter subsystem analysis, the orientation of a user from a particular component or node to the rest of the terminal network, can be quantified relative to the visibility of the system through the various visibility contact methods and which are expressed by the five indices mentioned previously. This is done by the application of the above orientation equation and substituting into the equation, the appropriate entries counted from the matrix. The accessibility of a user from any node in the system to a particular node can similarly be quantified. For the east entrance/exist of the Moncton terminal and using the site visibility matrix in Appendix E-1, the following orientation and accessibility indices can be calculated.

Node Orientation
Indices

O = 36.4%
OI = 36.4%
OA = .0%
OO = .0%
OD = 63.6%

Node Accessibility
Indices

A = 40.9%
AI = 40.9%
AA = .0%
AO = .0%
AD = 59.1%

where:

o and a - are the orientation and accessibility indices of a node's visibility to the terminal network and from the terminal network respectively, observed by physical presence and/or through a directional sign. That is, any entry in the row for the orientation index and column for the accessibility index totals counted as one.

OI and AI - are the orientation and accessibility indices of a node's visibility to the terminal network and from the terminal network respectively, observed by node physical presence only. That is one (1) entry in the row for orientation index and column for the accessibility index are counted.

OA and AA - are the orientation and accessibility indices of a node's visibility to the terminal network and from the network respectively observed by physical presence and by signage assistance. That is, one (1) and slash(es) (/...) entries are totalled per entry and in the rows for the orientation index and columns for the accessibility index.

OO and AO - are the orientation and accessibility indices of a node's visibility to the terminal network and from the network respectively observed by signage assistance only. That is, node entries with slash(es) only are counted and are totalled in the rows for the orientation index and columns for the accessibility index.

The discussion in this and the previous subsections show the numerous calculations required to adequately quantify user orientation relative to his/her visibility in a terminal network. Although the calculations can prove rather long and tedious, particularly when hand calculated, they are necessary when identifying individual orientation problem areas so that alternate solutions (physical changes and/or sign changes) can be considered and evaluated before implementation.

APPENDIX E
COMPUTER PRINTOUTS OF
VISIBILITY INDICES

- E-1 Definitions of Computer Printout Terms
- E-2 Moncton Airport - Visibility Indices (Site)
- E-3 Moncton Airport - Base Indices
- E-4 Moncton Airport - Floor Plan Indices
- E-5 Ottawa Bus Terminal - Visibility Indices (Base)

APPENDIX E-1

DEFINITIONS OF COMPUTER

PRINTOUT TERMS

APPENDIX E-1

DEFINITIONS OF COMPUTER PRINTOUT TERMS

L = the sum of column or row totals of any existing measured sight lines between each mandatory or optional node in a terminal network system as observed and recognized to exist by their physical presence, through an associated identification sign or through a directional sign. Any entry, except zero, for each.

LI = the sum of column or row totals of all existing measured sight lines between each mandatory or optional node in a terminal network system as observed and recognized to exist by their physical presence only. The one (1) matrix entries for each node's visibility for this case are counted, totalled and summed.

LA = the sum of column or row totals of all existing sight lines between each mandatory or optional node in a terminal network system as observed and recognized to exist through a direction sign. The slash (/) or slashes in the matrix entries for each node's visibility for this case are counted, totalled and summed.

LO = the sum of column or row totals of all existing sight lines between each mandatory or optional node in a terminal network system as observed and recognized to exist through a direction sign only. The slash (/) or slashes in the matrix entries for each node's visibility for this case are counted, totalled and then summed.

M = the sum of the column or row totals of any existing measured sight line between the subsystem nodes only, in a terminal network as observed and recognized to exist by their physical presence, through an associated identification sign or through a directional sign. The mandatory node subsystem (m) is considered in this case and any entry except zero for each node's visibility is counted as one.

MTS = the sum row totals of any existing measured sight line between the subsystem nodes and all other nodes in the terminal network as observed and recognized to exist by their physical presence, through an associated identification sign or through a directional sign. For this case the row totals, which are the sight lines between the mandatory node subsystem (m) and the optional nodes, are summed with any entry counted as one (1). Also displayed is the column totals of any existing measured sight line between the terminal nodes and the nodes in the subsystem as observed and recognized to exist by their physical presence, through an associated identification sign or through a directional sign. For this case, the column totals which are the sight links between the mandatory node system (m) and the optional nodes are summed with any entry counted as one (1).

System Visibility Indices:

V = a measure of the total visibility between all the nodes in a terminal network system, as observed by its physical presence and/or direction sign expressed in percent.

VI = a measure of the total visibility between all the nodes observed and recognized by their physical presence only, in any terminal network, expressed in percent.

VA = a measure of the total visibility between all the nodes assisting their physical observation and recognition through directional signage only in any terminal network, expressed in percent.

VO = a measure of the total visibility between all the nodes observed and recognized through directional signage only, in any terminal network, expressed in percent.

• Subsystem Visibility Indices:

VI = VVI = a measure of the visibility between all the nodes observed and recognized by their physical presence and/or through a directional sign in a particular chosen subsystem. In this case, the mandatory node subsystem (m) expressed in percent.

VMI = VVI = a measure of the total visibility between all the nodes observed and recognized by their physical presence only, in any terminal subsystem, expressed in percent.

VMA = VVA = a measure of the total visibility between all the nodes assisting their physical observation and recognition through directional signage in any terminal subsystem network expressed in percent.

VMO = VVO, = a measure of the total visibility between all the nodes observed and recognized through directional signage only in any terminal subsystem network expressed in percent.

VMAS = a measure of the visibility between all the nodes observed and recognized by their physical presence and through a directional sign to a particular subsystem from all other nodes in the terminal, except those in the subsystem. In this case, the mandatory node subsystem is observed for the optional nodes which are considered in the column totals.

MVOS = a measure of the visibility between all the nodes observed and recognized by their physical presence and/or through a directional sign from a particular subsystem, to all other nodes in the terminal, except those in the subsystem. In this case, all optional nodes are observed from the mandatory node subsystem which are considered in the row totals.

Component Visibility Indices:

O and A - are the orientation and accessibility indices of a node's visibility to the terminal network and from the terminal network respectively, observed by physical presence and/or through a directional sign. That is, any entry in the row for the orientation index and column for the accessibility index totals counted as one.

OI and AI - are the orientation and accessibility indices of a node's visibility to the terminal network and from the terminal network respectively, observed by node physical presence

only. That is one (1) entry in the row for orientation index and column for the accessibility index are counted.

OA and AA - are the orientation and accessibility indices of a node's visibility to the terminal network and from the network respectively observed by physical presence and by signage assistance. That is, one (1) and slash(es) (/...) entries are totalled per entry and in the rows for the orientation index and columns for the accessibility index.

OO and AO - are the orientation and accessibility indices of a node's visibility to the terminal network and from the network respectively observed by signage assistance only. That is, node entries with slash(es) only are counted and are totalled in the rows for the orientation index and columns for the accessibility index.

E-2

MONCTON AIR - VISIBILITY INDICES (SITE)

WATER CHARACTER AIR VIABILITY MATRIX

VARIABLE:

[illegible]

TOTAL TERMINAL SYSTEM/MANDATORY SUBSYSTEM:

$\lambda = 46.97$ $\lambda = 46.97$
 $\lambda = 46.97$ $\lambda = 46.97$

VM = 5.0%
VMI = 43.7%

V495 = 45.5%

V4A5 = 45.3%

VA = 1.5%
 VB = .4%
 VMA = .0%
 VMB = 1.3%

COMPONENTS		(B)	(A)
NODE	DESCRIPTION	ORIENTATION	ACCESSABILITY
1	ENT EXIT EAST	36.4%	40.9%
2	TICKET COUNTER AIR CANADA	36.4%	40.9%
3	TICKET COUNTER EPA	36.4%	36.4%
4	PHONES ()	45.5%	54.5%
5	COFFEE REST BAR (J)	63.6%	58.2%
6	WAIT AREA	77.3%	86.4%
7	SECURITY AND GATE	54.5%	45.5%
8	AIRSIDE	13.6%	63.6%
9	HOLD ROOM	68.2%	63.6%
10	POST BOX	40.9%	45.5%
11	PHONES LOCAL + HOTEL	59.1%	4.5%
12	CAR RENTALS	59.1%	63.6%
13	ARRIVAL GATE	45.5%	40.9%
14	CUSTOMS IMMIG AREA	45.5%	13.2%
15	LOCKERS	45.5%	59.1%
16	BAGGAGE CLAIM	59.1%	68.2%
17	WASH WOMEN	36.4%	36.4%
18	ENT EXIT CENTRAL	63.6%	40.9%
19	ENT EXIT WEST (HAG CLAIM)	18.2%	27.3%
20	CURB	40.9%	68.2%
21	PHONES ()	27.3%	13.6%
22	SHOP-BOUTIQUE	63.6%	63.6%
23	SCHEDULE	40.9%	27.3%

ORIENTATION AND ACCESSABILITY INDICES NODE BY NODE

1 ENT EXIT EAST

ORIENTATION ACCESSABILITY

3 = 36.4% A = 40.9%
 31 = 36.4% AI = 40.9%
 3A = 0% AA = 0%
 3B = 0% AB = 0%

2 TICKET COUNT AIR CANADA

3 = 36.4% A = 40.9%
 31 = 36.4% AI = 40.9%
 3A = 0% AA = 0%
 3B = 0% AB = 0%

3 TICKET COUNT ERM

3 = 36.4% A = 36.4%
 31 = 36.4% AI = 36.4%
 3A = 0% AA = 0%
 3B = 0% AB = 0%

4 PHONES (C)

3 = 45.5% A = 54.5%
 31 = 45.5% AI = 54.5%
 3A = 0% AA = 0%
 3B = 0% AB = 0%

5 COFFEE BEST BAR (C)

3 = 63.2% A = 63.2%
 31 = 59.1% AI = 63.2%
 3A = 4.5% AA = 0%
 3B = 4.5% AB = 0%

6 WAIT AREA

3 = 77.3% A = 86.4%
 31 = 72.7% AI = 86.4%
 3A = 4.5% AA = 0%
 3B = 4.5% AB = 0%

7 SECURITY AND GATE

3 = 54.5% A = 45.5%

8 AIRSIDE

SI= 54.5% AI= 45.5%
 SA= 4.5% AA= .0%
 SB= .0% AB= .0%

S = 13.0% A = 63.6%
 SI= 13.0% AI= 63.6%
 SA= .0% AA= .0%
 SB= .0% AB= .0%

9 HELD 89.4

S = 68.2% A = 63.6%
 SI= 68.2% AI= 63.6%
 SA= 4.5% AA= .0%
 SB= .0% AB= .0%

10 POST 89X

S = 40.9% A = 45.5%
 SI= 40.9% AI= 45.5%
 SA= .0% AA= .0%
 SB= .0% AB= .0%

11 PHONES LOCAL + HOTEL

S = 59.1% A = 4.5%
 SI= 59.1% AI= 4.5%
 SA= 4.5% AA= .0%
 SB= .0% AB= .0%

12 CAR RENTALS

S = 59.1% A = 63.6%
 SI= 59.1% AI= 63.6%
 SA= 4.5% AA= .0%
 SB= .0% AB= .0%

13 ARRIVAL GATE

S = 45.5% A = 40.9%
 SI= 45.5% AI= 40.9%

14 CUSTOMS IMMIG AREA

SA= 4.5% AA= .0%
 SB= .0% AB= .0%

S = 45.5% A = 18.2%
 SI= 45.5% AI= 18.2%
 SA= .0% AA= .0%
 SB= .0% AB= .0%

15 LOCKERS

S = 45.5% A = 59.1%
 SI= 45.5% AI= 59.1%
 SA= .0% AA= .0%
 SB= .0% AB= .0%

16 BAGGAGE CLAIM

S = 59.1% A = 68.2%
 SI= 59.1% AI= 50.0%
 SA= .0% AA= 40.9%
 SB= .0% AB= 18.2%

17 WASH WOM-MEN

S = 36.4% A = 36.4%
 SI= 36.4% AI= 36.4%
 SA= .0% AA= .0%
 SB= .0% AB= .0%

18 ENT EXIT CENTRAL

S = 63.6% A = 40.9%
 SI= 59.1% AI= 40.9%
 SA= 4.5% AA= .0%
 SB= 4.5% AB= .0%

19 ENT EXIT WEST (FAG CLAIM)

S = 18.2% A = 27.3%
 SI= 18.2% AI= 27.3%
 SA= .0% AA= .0%

2 CURA

90 = .0% AB = .0%

9 = 40.9% A = 68.2%
 91 = 40.9% AI = 68.2%
 9A = .0% AA = .0%
 9B = .0% AB = .0%

21 PHONES (3)

9 = 27.3% A = 13.6%
 91 = 27.3% AI = 13.6%
 9A = .0% AA = .0%
 9B = .0% AB = .0%

22 SHOP-BOUTIQUE

9 = 63.0% A = 63.6%
 91 = 59.1% AI = 63.6%
 9A = 4.5% AA = .0%
 9B = 4.5% AB = .0%

23 SCHEDULE

9 = 40.9% A = 27.3%
 91 = 40.9% AI = 27.3%
 9A = .0% AA = .0%
 9B = .0% AB = .0%

SUBSYSTEMS-ORIENTATION ONLY

FOR NODES 1 2 3 4 5 6 7 8 9 10 11
 12 15 17 18 19 21 22 23

VV = 44.7% VVI = 32.5% VVA = 1.5% VVB = 5.3%

FOR NODES 1 4 5 6 8 10 11 12 14 15 16
 17 18 19 20 21 22

TERMINATING-TRANSBORDER

V = 46.1% VI = 42.1% VVA = 0% VVB = 0%

CONNECTING: DOMESTIC TO DOMESTIC

FOR DOES 2 3 4 5 6 7 8 9 10 11 13
17 21 22 23

V = 42.5% VI = 40% VVA = 30.8% VVB = 2.5%

CONNECTING: TRANSFER TO DOMESTIC

FOR DOES 3 4 5 6 7 8 9 10 11 13
14 15 16 17 21 22 23

V = 48.7% VI = 44.7% VVA = 0% VVB = 0%

GREETER

FOR DOES 1 2 3 4 5 6 7 8 9 10 11 13 14
16 17 18 19 20 21 22 23

V = 51.3% VI = 41.3% VVA = 0% VVB = 0%

STOP = 1

E-3

MONCTON AIR - BASE INDICES

APPENDIX E-3

MONCTON AIR - BASE MATRIX

MONCTON AIR - BASE MATRIX									
VARIABLES:									
	LI	LA	LI	LA	LI	LA	LI	LA	LI
1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1
4	1	1	1	1	1	1	1	1	1
5	1	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1
11	1	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1	1
13	1	1	1	1	1	1	1	1	1
14	1	1	1	1	1	1	1	1	1
15	1	1	1	1	1	1	1	1	1
16	1	1	1	1	1	1	1	1	1
17	1	1	1	1	1	1	1	1	1
18	1	1	1	1	1	1	1	1	1
19	1	1	1	1	1	1	1	1	1
20	1	1	1	1	1	1	1	1	1
21	1	1	1	1	1	1	1	1	1
22	1	1	1	1	1	1	1	1	1
23	1	1	1	1	1	1	1	1	1
24	1	1	1	1	1	1	1	1	1
25	1	1	1	1	1	1	1	1	1
26	1	1	1	1	1	1	1	1	1
TOTAL	251	241	254	10	10	10	10	10	10

TOTAL TERMINAL SYSTEM/MANDATORY SUBSYSTEM:

VM = 50.4%
VMI = 55.5%
VMA = 0.0%
VMB = 0.9%
VMC = 50.5%
VMT = 45.0%

V = 40.2%
VI = 39.7%
VA = 1.5%
VB = 0.5%
VC = 50.2%

CODE	DESCRIPTION	(%)	ACCESSABILITY
1	EXIT	32.0%	98.0%
2	TICKET AND RAIL CHECK-1	40.0%	35.0%
3	RAILS (2)	68.0%	72.0%
4	CARRETT, RAIL (2)	55.0%	60.0%
6	RAIL STATION AREA	53.0%	80.0%
7	SECURITY AND GATE	60.0%	48.0%
8	ARRIVAL	12.0%	60.0%
9	RAILWAY	68.0%	60.0%
10	ARRIVAL GATE (S)	40.0%	48.0%
12	CUSTOMS AND IMMIGRATION	48.0%	58.0%
13	CUSTOMS CLAIM	36.0%	60.0%
15	CASH DESK (2)	42.0%	28.0%
16	CURB	36.0%	60.0%
2	TICKET PURCHASER	40.0%	8.0%
21	TICKET PURCHASER (2)	0.0%	0.0%
25	RAILWAY (2)	40.0%	28.0%
26	FIRST AND ONLY, POST AND RAIL	0.0%	0.0%

ORIENTAL AND ACCESSABILITY INDICES CODE BY CODE

ORIENTAL ACCESSABILITY

1 = 32.0% A = 68.0%
21 = 32.0% A1 = 0.0%

EXIT EXIT CODE

AA= 0%
 AD= 0%
 AD= 32.0%

2 TICKET AND BAG CHECK-IN

AI= 40%
 AI= 40%
 AA= 0%
 AD= 0%
 AD= 0%
 AD= 0%

3 BUSES (M)

AI= 56%
 AI= 68%
 AA= 2%
 AD= 0%
 AD= 32%

4 OFFER, PEST, AND (M)

AI= 56%
 AI= 52%
 AA= 4%
 AD= 0%
 AD= 44%

5 OFFER, PEST, AND (M)

AI= 56%
 AI= 54%
 AA= 4%
 AD= 0%
 AD= 32%

7 SEC RITY AND GATE

AI= 56%
 AI= 60%
 AA= 4%
 AD= 0%
 AD= 40%

1. 12.1%

1 = 12.1%
 11 = 12.1%
 1A = 12.1%
 1B = 12.1%
 1C = 12.1%

2. 12.1%

2 = 12.1%
 21 = 12.1%
 2A = 12.1%
 2B = 12.1%
 2C = 12.1%

3. 12.1%

3 = 12.1%
 31 = 12.1%
 3A = 12.1%
 3B = 12.1%
 3C = 12.1%

4. 12.1%

4 = 12.1%
 41 = 12.1%
 4A = 12.1%
 4B = 12.1%
 4C = 12.1%

5. 12.1%

5 = 12.1%
 51 = 12.1%
 5A = 12.1%
 5B = 12.1%
 5C = 12.1%

6. 12.1%

6 = 12.1%
 61 = 12.1%
 6A = 12.1%
 6B = 12.1%
 6C = 12.1%

16 CURB

3 = 40.0% A = 28.0%
 31 = 40.0% AI = 28.0%
 3A = .0% AA = .0%
 3B = .0% AB = .0%
 3D = 60.0% AD = 72.0%

3 = 36.0% A = 60.0%
 31 = 36.0% AI = 60.0%
 3A = .0% AA = .0%
 3B = .0% AB = .0%
 3D = 64.0% AD = 40.0%

2 TICKET PURCHASER

3 = 40.0% A = 8.0%
 31 = 40.0% AI = 8.0%
 3A = .0% AA = .0%
 3B = .0% AB = .0%
 3D = 60.0% AD = 92.0%

21 LIFE (M)

3 = .0% A = .0%
 31 = .0% AI = .0%
 3A = .0% AA = .0%
 3B = .0% AB = .0%
 3D = 100.0% AD = 100.0%

25 KASHKON (P)

3 = 40.0% A = 28.0%
 31 = 40.0% AI = 28.0%
 3A = .0% AA = .0%
 3B = .0% AB = .0%
 3D = 60.0% AD = 72.0%

26 FIRST AID, POLICE, LBSI AND FOUND.

3 = .0% A = .0%
 31 = .0% AI = .0%
 3A = .0% AA = .0%

SD= 100% AD= 100%
 DD=100% AD=100%

SUBSYSTEMS-IRIATION ONLY

FOR CODES 1 2 3 4 5 6 7 8 9 10 11 12 13
 14 15 16 17 18 19 20 21 22 23 24 25 26

VV = 29.3% VVI = 27.1% VVA = 0.2% VVJ = 2.3% VVD = 70.7%

FOR CODES 1 2 3 4 5 6 7 8 9 10 11 12 13
 14 15 16 17 18 19 20 21 22 23 24 25 26

VV = 40.0% VVI = 40.0% VVA = 0.0% VVJ = 0.0% VVD = 60.0%

FOR CODES 1 2 3 4 5 6 7 8 9 10 11 12 13
 14 15 16 17 18 19 20 21 22 23 24 25 26

VV = 40.3% VVI = 38.2% VVA = 0.3% VVJ = 2.4% VVD = 59.7%

FOR CODES 1 2 3 4 5 6 7 8 9 10 11 12 13
 14 15 16 17 18 19 20 21 22 23 24 25 26

VV = 44.3% VVI = 44.3% VVA = 0.0% VVJ = 0.0% VVD = 55.7%

FOR CODES 1 2 3 4 5 6 7 8 9 10 11 12 13
 14 15 16 17 18 19 20 21 22 23 24 25 26

VV = 41.9% VVI = 41.9% VVA = 0.0% VVJ = 0.0% VVD = 58.1%

STOP

E-4

MONCTON AIR - FLOOR PLAN INDICES

APPENDIX E-4

MONCTON AIR - FLOOR PLAN NODES

MONCTON AIR FLOOR PLAN - EXISTING PHYSICAL

VARIABLES:		L		LI		LA		LB		M		MTS	
REC'D	ROW	CEL	RMW	CS-	RMW	CUL	NODE	RUN	CUL	RMW	CEL	RMW	CEL
1	5	7	6	7	0	0	1	0	0	3	3	3	0
2	7	7	7	7	0	0	2	0	0	3	3	4	0
3	6	6	6	6	0	0	3	0	0	2	2	4	0
4	7	5	7	5	0	0	4	0	0	0	0	0	3
5	7	7	7	7	0	0	5	0	0	0	0	0	4
6	10	8	10	8	0	0	6	0	0	0	0	0	4
7	10	1	10	11	0	0	7	0	0	0	0	0	7
8	9	6	9	5	0	0	8	0	0	3	3	3	0
9	13	4	13	14	0	0	9	0	0	3	3	3	0
10	13	14	13	14	0	0	10	0	0	7	7	5	0
11	12	2	12	12	0	0	11	0	0	0	0	0	0
12	8	8	2	8	0	0	12	0	0	5	6	2	0
13	4	10	4	10	0	0	13	0	0	4	6	0	0
14	10	15	10	15	0	0	14	0	0	8	11	2	0
15	8	9	8	9	0	0	15	0	0	5	6	3	0
16	9	9	9	9	0	0	16	0	0	0	0	0	7
17	6	6	6	5	0	0	17	0	0	0	4	0	4
18	3	6	8	5	0	0	18	0	0	5	5	3	0
19	9	9	9	9	0	0	19	0	0	5	5	4	0
20	11	8	11	8	0	0	20	0	0	0	0	0	5
21	11	11	11	11	0	0	21	0	0	6	6	0	0
22	13	12	13	12	0	0	22	0	0	0	0	0	7
23	11	8	11	8	0	0	23	0	0	6	4	5	0
TOTAL		208	208	204	0	0		0	0	74	74	49	49

TOTAL TERMINAL SYSTEM/MANUILLERY SUBSYSTEM:

VMDS= 35.9%

VMAS= 34.9%

VM = 40.7%

VMI = 40.7%

V = 41.1%

VI = 41.1%

VA = .0% VMA = .0%
 VP = .0% VMG = .0%

COMMENTS	MODE	DESCRIPTION	(B)	ORIENTATION	(A)	ACCESS- ABILITY
1	ENT	EXIT WEST	27.3%	31.8%	31.8%	
2	TICKET	COUNTER AIR CANADA	31.8%	31.8%	31.8%	
3	TICKET	COUNTER EPA	27.3%	27.3%	27.3%	
4	SCHEDULE		31.8%	31.8%	22.7%	
5	MAIL	B-X	31.8%	31.8%	31.8%	
6	PHONES	WEST (C)	45.5%	45.5%	36.4%	
7	COFFEE, REST, BAR	(C)	45.5%	45.5%	50.0%	
8	SECURITY	AID GATE	40.9%	40.9%	27.3%	
9	HOLDING	ROOM	59.1%	59.1%	63.6%	
10	WAIT	AREA	59.1%	59.1%	63.6%	
11	PHONES	HOTEL+LOCAL (C)	54.5%	54.5%	54.5%	
12	ARRIVAL	GATE DOMESTIC	36.4%	36.4%	36.4%	
13	AIRSIDE		18.2%	18.2%	45.5%	
14	CURB		45.5%	45.5%	68.2%	
15	ENT	EXIT CENTRAL	36.4%	36.4%	40.9%	
16	WASH	MEN WOM (C)	40.9%	40.9%	40.9%	
17	PHONES	BAG CLAIM AREA (C)	27.3%	27.3%	27.3%	
18	ENT	EXIT EAST	36.4%	36.4%	27.3%	
19	BAG	CLAIM	40.9%	40.9%	40.9%	
20	LOCKERS		50.0%	50.0%	36.4%	
21	CUSTOMS	AND IMMIGRATION AREA	50.0%	50.0%	50.0%	
22	CAR	RENTALS	59.1%	59.1%	54.5%	
23	ARRIVAL	GATE INT-TRANS	50.0%	50.0%	36.4%	

ORIENTATION AND ACCESSABILITY INDICES MODE BY MODE

ORIENTATION ACCESSABILITY

1 ENT EXIT WEST

2 TICKET COUNTER AIR CANADA

9 = 27.3%	A = 31.8%
91 = 27.3%	AI = 31.8%
9A = .0%	AA = .0%
9B = .0%	AB = .0%

3 TICKET COUNTER EPA

9 = 27.3%	A = 27.3%
91 = 27.3%	AI = 27.3%
9A = .0%	AA = .0%
9B = .0%	AB = .0%

4 SCHEDULE

9 = 31.8%	A = 22.7%
91 = 31.8%	AI = 22.7%
9A = .0%	AA = .0%
9B = .0%	AB = .0%

5 MAIL BOX

9 = 31.8%	A = 31.8%
91 = 31.8%	AI = 31.8%
9A = .0%	AA = .0%
9B = .0%	AB = .0%

6 PHONES TEST (C)

9 = 45.5%	A = 36.4%
91 = 45.5%	AI = 36.4%
9A = .0%	AA = .0%
9B = .0%	AB = .0%

7 COFFEE, PEST, BAR (C)

9 = 45.5%	A = 50.0%
-----------	-----------

8 SECURITY AND GATE

SI = 45.5% AI = 50.0%
 SA = .0% AA = .0%
 SO = .0% AB = .0%

SI = 40.9% A = 27.3%
 SI = 40.3% AI = 27.3%
 SA = .0% AA = .0%
 SO = .0% AB = .0%

9 FLOORS

SI = 59.1% A = 63.6%
 SI = 59.1% AI = 63.6%
 SA = .0% AA = .0%
 SO = .0% AB = .0%

10 WAIT AREA

SI = 59.1% A = 63.6%
 SI = 59.1% AI = 63.6%
 SA = .0% AA = .0%
 SO = .0% AB = .0%

11 PHONES (HOTEL+LOCAL (0))

SI = 54.5% A = 54.5%
 SI = 54.5% AI = 54.5%
 SA = .0% AA = .0%
 SO = .0% AB = .0%

12 ARRIVAL GATE DOMESTIC

SI = 36.4% A = 36.4%
 SI = 36.4% AI = 36.4%
 SA = .0% AA = .0%
 SO = .0% AB = .0%

13 AIRSIDE

SI = 18.2% A = 45.5%
 SI = 18.2% AI = 45.5%

14 CURB

GA=	.0%	AA=	.0%
GB=	.0%	AB=	.0%

G=	45.5%	A=	63.2%
GI=	45.5%	AI=	63.2%
GA=	.0%	AA=	.0%
GB=	.0%	AB=	.0%

15 ENT EXIT CENTRAL

G=	36.1%	A=	40.9%
GI=	36.1%	AI=	40.9%
GA=	.0%	AA=	.0%
GB=	.0%	AB=	.0%

16 WASH MEN WP'1 (C)

G=	40.9%	A=	40.9%
GI=	40.9%	AI=	40.9%
GA=	.0%	AA=	.0%
GB=	.0%	AB=	.0%

17 PHONES BAG CLAIM AREA (C)

G=	27.3%	A=	27.3%
GI=	27.3%	AI=	27.3%
GA=	.0%	AA=	.0%
GB=	.0%	AB=	.0%

18 ENT EXIT EAST

G=	36.4%	A=	27.3%
GI=	36.4%	AI=	27.3%
GA=	.0%	AA=	.0%
GB=	.0%	AB=	.0%

19 BAG CLAIM

G=	40.9%	A=	40.9%
GI=	40.9%	AI=	40.9%
GA=	.0%	AA=	.0%

2 LOCKERS

50 = .0% AB = .0%

51 = 50.0% A = 36.4%
 52 = 50.0% AI = 36.4%
 53 = .0% AA = .0%
 54 = .0% AB = .0%

21 CUSTOMS AND IMMIGRATION AREA

55 = 50.0% A = 5.0%
 56 = 50.0% AI = 5.0%
 57 = .0% AA = .0%
 58 = .0% AB = .0%

22 CAR RENTALS

59 = 59.1% A = 54.5%
 60 = 59.1% AI = 54.5%
 61 = .0% AA = .0%
 62 = .0% AB = .0%

23 ARRIVAL GATE INT-TRANS

63 = 50.0% A = 35.4%
 64 = 50.0% AI = 35.4%
 65 = .0% AA = .0%
 66 = .0% AB = .0%

SUBSYSTEMS-ORIENTATION ONLY

ORIGINATING-DOMESTIC
 FOR CODES 1 2 3 4 5 6 7 8 9 10 11
 13 15 16 17 18 20 22 23

5V = 47.4% /VI = 47.4% VVA = .0% VVB = .0%

TERMINATING-TRANSPORTER
 FOR CODES 1 5 6 7 10 11 14 15 16 17 18
 19 20 21 22 23

VV = 34.8% /VI = 34.8% VVA = .0% VVB = .0%

FOR CODES 2 3 4 5 6 7 8 9 10 11 12
 13 16 17 23

CONNECTING DOMESTIC TO DOMESTIC

VV = 37.5% /VI = 37.5% VVA = .0% VVB = .0%

FOR CODES 2 3 4 5 6 7 8 9 10 11 13
 16 17 19 20 21 23

CONNECTING TRANSBORDER TO DOMESTIC

VV = 42.2% /VI = 42.2% VVA = .0% VVB = .0%

FOR CODES 1 2 3 4 5 6 7 8 9 10 11 12 13
 14 15 16 17 18 19 21 23

GREATER

VV = 39.5% /VI = 39.5% VVA = .0% VVB = .0%

STOP 0

E-5.

OTTAWA BUS TERMINAL - VISIBILITY INDICES (BASE)

VMS= 37.0%
VMS= 37.0%

VM = 31.2%
VMI = 31.2%
VMA = 31.2%
VMS = 31.2%

VM = 36.5%
VMI = 36.5%
VMA = 36.5%
VMS = 36.5%

COMPONENTS		(2)	(A)
NODE	DESCRIPTION	ORIENT- TATION	ACCESS- ABILITY
1	ENT EXIT C BR	56.0%	48.0%
2	TICKET, ENT AND EXIT C BR	48.0%	60.0%
3	PHONES (1)	40.0%	60.0%
4	COFFEE, REST, A (1)	36.0%	48.0%
6	WAIT ROOM (1)	68.0%	48.0%
7	SECURITY A C BR	68.0%	56.0%
8	ATIS (1)	28.0%	76.0%
9	WASH ROOM	.0%	.0%
1	AP-VAL GATE (1)	64.0%	64.0%
12	CUSTOMER SERVICE (1)	.0%	.0%
14	SAGBAG CLIP	12.0%	.0%
15	CASH (1)	60.0%	28.0%
16	CURB	20.0%	44.0%
2	TICKET PURCHASES	48.0%	56.0%
21	INFET (1)	36.0%	56.0%
25	WASH ROOM (1)	56.0%	28.0%
26	FIRST TRIPOLICE, REST AND BOUND.	64.0%	28.0%

ORIENTATIONAL ACCESSABILITY

ENT EXIT C BR

VM = 36.5% / A = 48.0%
VI = 36.5% / AI = 36.5%

1A= 28. % AA= 50.0%
 1H= 2. % AB= 12.0%

2. TICKET AND AAB CHECK-14

2A= 4. % A= 0.0%
 2I= 1. % AI= 30.0%
 2A= 1. % AA= 0.0%
 2H= 2. % AB= 2.0%

3. P-00125 (10)

3A= 4. % A= 0.0%
 3I= 2. % AI= 0.0%
 3A= 2. % AA= 3.0%
 3H= 1. % AB= 0.0%

4. CIPPEE, 0003, HAA (10)

4A= 3. % A= 4.0%
 4I= 3. % AI= 3.0%
 4A= 1. % AA= 52.0%
 4H= 1. % AB= 10.0%

6. AIR 30.0.000

6A= 0. % A= 4.0%
 6I= 0. % AI= 4.0%
 6A= 8. % AA= 1.0%
 6H= 1. % AB= 0.0%

7. SECURITY, 0.0.0.0

7A= 0. % A= 50.0%
 7I= 0. % AI= 50.0%
 7A= 8. % AA= 0.0%
 7H= 1. % AB= 0.0%

8 AIRSIDE

A = 24.0% A = 75.0%
 AI = 24.0% AI = 75.0%
 AA = 0.0% AA = 0.0%
 AU = 0.0% AU = 0.0%

9 AIRSIDE

A = 0.0% A = 0.0%
 AI = 0.0% AI = 0.0%
 AA = 0.0% AA = 0.0%
 AU = 0.0% AU = 0.0%

10 AIRSIDE

A = 64.0% A = 64.0%
 AI = 40.0% AI = 36.0%
 AA = 36.0% AA = 52.0%
 AU = 24.0% AU = 24.0%

12 CUSTOMS AND INSPECTION AREA

A = 0.0% A = 0.0%
 AI = 0.0% AI = 0.0%
 AA = 0.0% AA = 0.0%
 AU = 0.0% AU = 0.0%

14 STORAGE CLERK

A = 12.0% A = 0.0%
 AI = 12.0% AI = 0.0%
 AA = 0.0% AA = 0.0%
 AU = 0.0% AU = 0.0%

15 AIRSIDE

16 CURS

1 = 6.0% A = 28.0%
 11 = 36.0% A1 = 28.0%
 1A = 4.0% AA = .0%
 19 = 24.0% A9 = .0%

2 = 2.0% A = 44.0%
 11 = 2.0% A1 = 44.0%
 1A = .0% AA = .0%
 19 = .0% A9 = .0%

2 TICKET PURCHASES

3 = 48.0% A = 56.0%
 11 = 48.0% A1 = 32.0%
 1A = 12.0% AA = 6.0%
 19 = 8.0% A9 = 24.0%

21 100% BONUS (A)

3 = 36.0% A = 56.0%
 11 = 28.0% A1 = 36.0%
 1A = 16.0% AA = 6.0%
 19 = 8.0% A9 = 2.0%

25 100% BONUS (A)

3 = 50.0% A = 28.0%
 11 = 36.0% A1 = 28.0%
 1A = 20.0% AA = .0%
 19 = 2.0% A9 = .0%

26 FIRST AND POLICE, FIRST AND FUND.

3 = 54.0% A = 28.0%
 11 = 44.0% A1 = 12.0%
 1A = 20.0% AA = 32.0%

22.1% AB= 14.0%

SUBSYSTEMS- REF. TABLE ONLY

PRIME-ATLANTIC-DOMESTIC

FOR CODES 1 2 3 4 5 6 7 8 9 11-13
15 17 18 21 24 25 26

VV = 27.3% VI = 19.5% VVA = 23.3% VVD = 9.1%

TELE-ATLANTIC-TRANSORDER

FOR CODES 1 3 4 5 6 10 11 12 13 14 15
16 18 19 21 22 23 24 25 26

VV = 40.3% VI = 30.8% VVA = 21.7% VVD = 10.1%

CONNECTING-DOMESTIC TO DOMESTIC

FOR CODES 2 3 4 5 6 7 8 9 11 15 17
18 19 20 21 24 25 26

VV = 29.2% VI = 24.3% VVA = 19.4% VVD = 4.9%

CONNECTING-TRANSORDER TO DOMESTIC

FOR CODES 2 3 4 5 6 7 8 9 11 12 13
14 15 17 18 19 21 22 24 25 26

VV = 47.7% VI = 33.0% VVA = 40.5% VVD = 14.8%

PRIME-TELE

FOR CODES 1 2 3 4 5 6 8 10 12 14 15
16 17 18 19 21 22 23 24 25 26

VV = 36.2% VI = 22.5% VVA = 11.4% VVD = 6.7%

*STEP 2

APPENDIX F

APPLICATION OF SITE LINE ANALYSIS -
VISIBILITY INDICES

- F-1 Moncton Air Floor Plan Matrix
 - Existing Layout with Improved Signage
- F-2 Moncton Air Floor Plan Matrix
 - Improved Design, Physical
- F-3 Moncton Air Floor Plan Matrix
 - Improved Design, Physical and Signs

APPENDIX F-1

MONCTON AIRPORT FLOOR PLAN MATRIX
(EXISTING LAYOUT WITH IMPROVED SIGNAGE)

APPENDIX F-1

MONITOR AIR FLOOR PLAN MATRIX - EXISTING IMPROVED SIGNS

VARIABLE:

	L	LI	LA	LS	M	MTS
NODE	RWM	CEL	RWM	CEL	RWM	CEL
1	15	12	1	5	3	7
2	16	12	1	5	3	7
3	16	11	1	5	3	7
4	16	11	1	5	3	7
5	16	11	1	5	3	7
6	18	11	1	5	3	7
7	16	11	1	5	3	7
8	13	12	1	5	3	7
9	14	14	1	5	3	7
10	15	14	1	5	3	7
11	16	17	1	5	3	7
12	14	14	1	5	3	7
13	14	14	1	5	3	7
14	15	17	1	5	3	7
15	14	17	1	5	3	7
16	15	17	1	5	3	7
17	16	17	1	5	3	7
18	18	16	1	5	3	7
19	19	16	1	5	3	7
20	11	17	1	5	3	7
21	11	18	1	5	3	7
22	18	16	1	5	3	7
23	11	18	1	5	3	7
TOTAL	302	12	208	129	129	70

TOTAL TERMINAL SYSTEM/MANDATORY SUBSYSTEM:

V = 59.7% VM = 54.9% VMBS = 59.8%
 VI = 41.1% VMI = 40.7% VMAS = 55.6%

VA = 25.5%
VP = 18.6%

VM2 = 46.2%
VM3 = 14.3%

COMPONENTS		(G)	(A)
NODE	DESCRIPTION	ORIENT- TATION	ACCESS- ABILITY
1	ENT EXIT WEST	68.2%	54.5%
2	TICKET COUNTER AIR CANADA	72.7%	54.5%
3	TICKET COUNTER EPA	72.7%	50.0%
4	SCHEDULE	72.7%	45.5%
5	MAIL BOX	72.7%	50.0%
6	PHONES WEST (C)	81.8%	50.0%
7	COFFEE, REST, BAR (C)	72.7%	50.0%
8	SECURITY AND GATE	59.1%	54.5%
9	HOLDING	63.6%	63.6%
10	JAIT AREA	68.2%	63.6%
11	PHONES METFL+LOCAL (C)	72.7%	77.3%
12	ARRIVAL GATE DOMESTIC	63.6%	63.6%
13	AIRSIDE	18.2%	45.5%
14	CURB	45.5%	86.4%
15	ENT EXIT CENTRAL	63.6%	77.3%
16	WASH MEN WOM (C)	68.2%	77.3%
17	PHONES BAG CLAIM AREA (C)	27.3%	27.3%
18	ENT EXIT EAST	36.4%	27.3%
19	BAG CLAIM	40.9%	40.9%
20	LOCKERS	50.0%	77.3%
21	CUSTOMS AND IMMIGRATION AREA	50.0%	81.8%
22	CAR RENTALS	81.8%	72.7%
23	ARRIVAL GATE INT-TRANS	50.0%	81.8%

ORIENTATION AND ACCESSABILITY INDICES NODE BY NODE

ORIENTATION ACCESSABILITY

1 ENT EXIT WEST

9 = 68.2% A = 54.5%
 91 = 27.3% A1 = 31.8%
 9A = 45.5% AA = 22.7%
 90 = 40.9% A0 = 22.7%

2 TICKET COUNTER AIR CANADA

9 = 72.7% A = 54.5%
 91 = 31.8% A1 = 31.8%
 9A = 45.5% AA = 22.7%
 90 = 40.9% A0 = 22.7%

3 TICKET COUNTER EPA

9 = 72.7% A = 51.0%
 91 = 27.3% A1 = 27.3%
 9A = 45.5% AA = 22.7%
 90 = 45.5% A0 = 22.7%

4 SCHEDULE

9 = 72.7% A = 45.5%
 91 = 31.8% A1 = 22.7%
 9A = 45.5% AA = 22.7%
 90 = 40.9% A0 = 22.7%

5 MAIL BOX

9 = 72.7% A = 51.0%
 91 = 31.8% A1 = 31.8%
 9A = 45.5% AA = 22.7%
 90 = 40.9% A0 = 15.2%

6 PHONES TEST (O)

9 = 81.8% A = 50.0%
 91 = 45.5% A1 = 36.4%
 9A = 45.5% AA = 22.7%
 90 = 36.4% A0 = 13.6%

7 CFFEE, REST, BAR (C)

9 = 72.7% A = 50.0%

8 SECURITY AND GATE

91= 45.5% AI= 50.0%
 9A= 45.5% AA= .0%
 9B= 27.3% AB= .0%

B = 59.1% A = 54.5%
 91= 40.9% AI= 27.3%
 9A= 40.9% AA= 40.9%
 9B= 18.2% AB= 27.3%

9 HOLDING

91= 63.0% A = 63.6%
 9A= 59.1% AI= 63.6%
 9B= 45.5% AA= .0%
 9C= 4.5% AB= .0%

10 WAIT AREA

91= 68.2% A = 63.6%
 9A= 59.1% AI= 63.6%
 9B= 45.5% AA= .0%
 9C= 9.1% AB= .0%

11 PHONES HOTEL+LOCAL (3)

91= 72.7% A = 77.3%
 9A= 54.5% AI= 54.5%
 9B= 27.3% AA= 45.5%
 9C= 18.2% AB= 22.7%

12 ARRIVAL GATE DOMESTIC

91= 63.0% A = 63.6%
 9A= 36.4% AI= 36.4%
 9B= 27.3% AA= 45.5%
 9C= 27.3% AB= 27.3%

13 AIRSIDE

91= 18.2% A = 45.5%
 9A= 18.2% AI= 45.5%

14 CURB

SA = .0% AA = .0%
 SD = .0% AB = .0%

S = 45.5% A = 80.4%
 SI = 45.5% AI = 68.2%
 SA = .0% AA = 45.5%
 SD = .0% AB = 13.2%

15 ENT EXI. CENTRAL

S = 63.0% A = 77.3%
 SI = 36.4% AI = 40.9%
 SA = 27.3% AA = 45.5%
 SD = 27.3% AB = 36.4%

16 WASH MEI WEN (C)

S = 68.2% A = 77.3%
 SI = 40.9% AI = 40.9%
 SA = 27.3% AA = 45.5%
 SD = 27.3% AB = 36.4%

17 PHONES BAG CLAIM AREA (C)

S = 27.3% A = 27.3%
 SI = 27.3% AI = 27.3%
 SA = .0% AA = .0%
 SD = .0% AB = .0%

18 ENT EXI EAST

S = 36.4% A = 27.3%
 SI = 36.4% AI = 27.3%
 SA = .0% AA = .0%
 SD = .0% AB = .0%

19 BAG CLAIM

S = 40.9% A = 40.9%
 SI = 40.9% AI = 40.9%
 SA = .0% AA = .0%

2 LOCKERS

50= .0% A0= .0%

51= 50.0% A= 77.3%
 52= 50.0% A1= 35.4%
 53= .0% A2= 45.5%
 54= .0% A3= 45.9%

21 CUSTOMS AND IMMIGRATION AREA

55= 50.0% A= 81.8%
 56= 50.0% A1= 50.0%
 57= .0% A2= 45.5%
 58= .0% A3= 31.8%

22 CAR RENTALS

59= 81.8% A= 72.7%
 60= 59.1% A1= 54.5%
 61= 27.3% A2= 45.5%
 62= 22.0% A3= 18.2%

23 ARRIVAL GATE INT-TRANS

63= 50.0% A= 81.8%
 64= 50.0% A1= 35.4%
 65= .0% A2= 45.5%
 66= .0% A3= 45.5%

SUBSYSTEMS-ORIENTATION ONLY

ORIGINATING-DOMESTIC

FOR CODES 1 2 3 4 5 6 7 8 9 10 11
 13 15 16 17 18 20 22 23

VV = 69.7% VVI = 47.4% VVA= 33.5% VV0= 22.4%

TERMINATING-TRANSBORDER

FOR CODES 1 5 6 7 10 11 14 15 16 17 18
 19 20 21 22 23

VV = 50.9% /VI = 34.8% VVA= 19.6% VVU= 16.1%

CONNECTING:DOMESTIC TO DOMESTIC

FOR CODES 2 3 4 5 6 7 8 9 10 11 12
13 16 17 23

VV = 63.3% /VI = 37.5% VVA= 4.0% VVU= 25.8%

CONNECTING:TRANSFER TO DOMESTIC

FOR CODES 2 3 4 5 6 7 8 9 10 11 13
16 17 19 20 21 23

VV = 62.7% /VI = 42.2% VVA= 31.3% VVU= 20.6%

GREETER

FOR CODES 1 2 3 4 5 6 7 10 11 12 13
14 15 16 17 18 19 21 23

VV = 63.2% /VI = 39.5% VVA= 31.6% VVU= 23.7%

STEP 0

APPENDIX F-2

MONCTON AIRPORT FLOOR PLAN MATRIX
(IMPROVED DESIGN, PHYSICAL)

APPENDIX F-2

STRUCTURE AIR FLOOR PLAN MATRIX-I PROVED DESIGN PHYSICAL

VARIABLE:

	L	LI	LA	LG	M	MTS
NODE	ROW	COL	ROW	COL	ROW	COL
1	15	13	0	0	9	8
2	16	12	0	0	10	8
3	20	15	0	0	12	8
4	20	11	0	0	12	5
5	19	15	0	0	0	0
6	13	15	0	0	0	0
7	20	20	0	0	0	0
8	22	19	0	0	0	0
9	25	21	0	0	0	0
10	25	24	0	0	14	13
11	20	20	0	0	12	11
12	23	24	0	0	12	13
13	24	23	0	0	13	12
14	20	20	0	0	9	10
15	19	22	0	0	0	0
16	18	19	0	0	9	10
17	24	23	0	0	0	0
18	20	21	0	0	0	0
19	18	15	0	0	0	0
20	16	16	0	0	0	0
21	19	15	0	0	9	8
22	15	14	0	0	10	12
23	13	14	0	0	0	0
24	13	13	0	0	0	0
25	5	19	0	0	7	9
26	5	22	0	0	9	8
TOTAL	473	473	0	0	145	145
					114	114

TOTAL TERMINAL SYSTEM/MANDATORY SUBSYSTEM:

VM = 69.0%
 VM = 69.0%
 VMA = .0%
 VMD = .0%

VM = 69.0%
 VM = 69.0%
 VMA = .0%
 VMD = .0%

VM = 69.0%
 VM = 69.0%
 VMA = .0%
 VMD = .0%

COMPONENTS		(B)	(A)
MODE	DESCRIPTION	ORIENT- TATION	ACCESS- ABILITY
1	ENT EXIT WEST	60.0%	52.0%
2	TICKET COUNTER	64.0%	48.0%
3	TICKET COUNTER	80.0%	60.0%
4	SCHEDULE	80.0%	44.0%
5	LOCKERS	76.0%	60.0%
6	GIFT SHOP	76.0%	60.0%
7	BART REST COFFEE	80.0%	80.0%
8	POST BOX STAMPS	88.0%	76.0%
9	INFO BIRTH	100.0%	84.0%
10	MAIN EXIT EXIT	100.0%	96.0%
11	SECURITY GATE	80.0%	80.0%
12	HOLD ROOM	92.0%	96.0%
13	WAIT AREA	96.0%	92.0%
14	ARRIVALS DOMESTIC	80.0%	80.0%
15	CAR RENTALS	76.0%	88.0%
16	ARRIVALS INTN TRANS	72.0%	76.0%
17	MONITOR SCHED	96.0%	92.0%
18	PHONES LOCAL	80.0%	84.0%
19	WASHROOMS M AND F	72.0%	60.0%
20	ENT EXIT EAST	64.0%	64.0%
21	BAG CLAIM	76.0%	92.0%
22	PHONES HOTEL	60.0%	56.0%
23	LOCKERS	52.0%	56.0%
24	CUSTOMS AND IMMIGR	52.0%	52.0%
25	AIRSIDE	20.0%	76.0%
26	CURB	20.0%	88.0%

ORIENTATION AND ACCESSABILITY INDICES MADE BY CODE

ORIENTATION ACCESSABILITY

1 ENT EXIT WEST

S = 60.0% A = 52.0%
 SI = 60.0% AI = 52.0%
 SA = .0% AA = .0%
 SO = .0% AO = .0%

2 TICKET COUNTER

S = 64.0% A = 48.0%
 SI = 64.0% AI = 48.0%
 SA = .0% AA = .0%
 SO = .0% AO = .0%

3 TICKET COUNTER

S = 80.0% A = 60.0%
 SI = 80.0% AI = 60.0%
 SA = .0% AA = .0%
 SO = .0% AO = .0%

4 SCHEDULE

S = 80.0% A = 44.0%
 SI = 80.0% AI = 44.0%
 SA = .0% AA = .0%
 SO = .0% AO = .0%

5 LOCKERS

S = 76.0% A = 60.0%
 SI = 76.0% AI = 60.0%
 SA = .0% AA = .0%
 SO = .0% AO = .0%

6 GIFT SHOP

S = 76.0% A = 60.0%
 SI = 76.0% AI = 60.0%

9A= .0% 1A= .0%
9B= .0% 1B= .0%

7 EAR, REST, COFFEE

9A= 80.0% 1A= 80.0%
9B= 80.0% 1B= 80.0%
9C= .0% 1C= .0%
9D= .0% 1D= .0%

8 POST BOX STAMPS

9A= 88.0% 1A= 76.0%
9B= 88.0% 1B= 76.0%
9C= .0% 1C= .0%
9D= .0% 1D= .0%

9 INFO SOUTH

9A= 100.0% 1A= 84.0%
9B= 100.0% 1B= 84.0%
9C= .0% 1C= .0%
9D= .0% 1D= .0%

10 MAIN ENT EXIT

9A= 100.0% 1A= 96.0%
9B= 100.0% 1B= 96.0%
9C= .0% 1C= .0%
9D= .0% 1D= .0%

11 SECURITY, GATE

9A= 80.0% 1A= 80.0%
9B= 80.0% 1B= 80.0%
9C= .0% 1C= .0%
9D= .0% 1D= .0%

12 HOLD ROOM

9A= 92.0% 1A= 96.0%
9B= 92.0% 1B= 96.0%
9C= .0% 1C= .0%
9D= .0% 1D= .0%

13 WAIT AREA

DU= .0% AO= .0%

SI= 96.0% A= 92.0%
 SI= 96.0% AI= 92.0%
 SA= .0% AA= .0%
 DU= .0% AD= .0%

14 ARRIVALS DOMESTIC

SI= 80.0% A= 80.0%
 SI= 80.0% AI= 80.0%
 SA= .0% AA= .0%
 DU= .0% AD= .0%

15 CAR RENTALS

SI= 76.0% A= 88.0%
 SI= 76.0% AI= 88.0%
 SA= .0% AA= .0%
 DU= .0% AD= .0%

16 ARRIVALS INTN TRANS

SI= 72.0% A= 76.0%
 SI= 72.0% AI= 76.0%
 SA= .0% AA= .0%
 DU= .0% AD= .0%

17 MONITOR, SCHED

SI= 96.0% A= 92.0%
 SI= 96.0% AI= 92.0%
 SA= .0% AA= .0%
 DU= .0% AD= .0%

18 PHONES LOCAL

SI= 80.0% A= 84.0%
 SI= 80.0% AI= 84.0%
 SA= .0% AA= .0%
 DU= .0% AD= .0%

19 WASHRUBS M AND F

9 = 72.0% A = 60.0%
 9I = 72.0% AI = 60.0%
 9A = .0% AA = .0%
 90 = .0% A0 = .0%

20 ENT EXIT EAST

9 = 64.0% A = 64.0%
 9I = 64.0% AI = 64.0%
 9A = .0% AA = .0%
 90 = .0% A0 = .0%

21 BAG CLAIM

9 = 76.0% A = 92.0%
 9I = 76.0% AI = 92.0%
 9A = .0% AA = .0%
 90 = .0% A0 = .0%

22 PHONES HOTEL

9 = 60.0% A = 56.0%
 9I = 60.0% AI = 56.0%
 9A = .0% AA = .0%
 90 = .0% A0 = .0%

23 LOCKERS

9 = 52.0% A = 56.0%
 9I = 52.0% AI = 56.0%
 9A = .0% AA = .0%
 90 = .0% A0 = .0%

24 CUSTOMS AND IMMIGR

9 = 52.0% A = 52.0%
 9I = 52.0% AI = 52.0%
 9A = .0% AA = .0%
 90 = .0% A0 = .0%

25 AIRSIDE

9 = 20.4% A = 76.0%
 91 = 20.4% AI = 76.0%
 9A = .0% AA = .0%
 90 = .0% AB = .0%

26 CURS

9 = 20.4% A = 88.0%
 91 = 20.4% AI = 88.0%
 9A = .0% AA = .0%
 90 = .0% AB = .0%

SUBSYSTEMS-PIETATION ONLY

ORIGINATING-DOMESTIC
 FOR CODES 1 2 3 4 5 6 7 8 9 10 11
 12 13 14 15 16 17 18 19 20 23 25
 VV = 75.0% VVI = 75.0% VVA = .0% VVB = .0%

TERMINATING-TRANSBORDER
 FOR CODES 1 5 6 7 8 9 10 13 15 16 17
 18 19 20 21 22 23 24 25
 VV = 65.4% VVI = 65.4% VVA = .0% VVB = .0%

CONNECTING-DOMESTIC TO DOMESTIC
 FOR CODES 2 3 4 5 6 7 8 9 11 12 13 14
 16 17 18 19 22 25

VV = 73.2% VVI = 73.2% VVA = .0% VVB = .0%

CONNECTING-TRANSBORDER TO DOMESTIC
 FOR CODES 2 3 4 5 6 7 8 9 11 12 13
 16 17 18 19 21 22 23 24 25

VV = 79.2% VVI = 79.2% VVA = .0% VVB = .0%

FOR CODES 1 4 6 7 8 9 10 13 14 16 17
 GREATER
 18 19 20 21 22 24 25 26

VV = 69.9% VVI = 69.9% VVA = .0% VVB = .0%

STOP 0

APPENDIX F-3

MONCTON AIRPORT FLOOR PLAN MATRIX
(IMPROVED DESIGN, PHYSICAL PLUS SIGNS)

APPENDIX F-3

FUNCTION AIR FLOOR PLAN MATRIX-IMPROVED DESIGN PHYSICAL + SIGNS

VARIABLE:				LI		LA		LB		M		MTS	
NODE	ROW	CAL	ROW	CAL	NODE	ROW	CAL	ROW	CAL	ROW	CAL	ROW	CAL
1	22	13	7	0	1	7	0	12	8	10	0	10	0
2	22	22	6	10	2	6	10	12	11	10	0	10	0
3	24	23	4	8	3	4	8	13	12	11	0	11	0
4	24	11	4	0	4	4	0	13	5	11	0	11	0
5	24	23	5	8	5	5	8	0	0	0	13	0	13
6	24	23	5	8	6	5	8	0	0	0	13	0	13
7	24	23	4	3	7	4	3	0	0	0	13	0	13
8	22	22	0	3	8	0	3	0	0	0	12	0	12
9	25	24	0	3	9	0	3	0	0	0	14	0	14
10	25	24	0	0	10	0	0	14	13	11	0	11	0
11	24	20	4	0	11	4	0	13	11	11	0	11	0
12	24	24	0	0	12	0	0	12	13	11	0	11	0
13	24	23	0	0	13	0	0	13	12	11	0	11	0
14	23	21	0	2	14	0	2	12	11	11	0	11	0
15	23	24	4	5	15	4	5	0	0	0	14	0	14
16	22	24	4	0	16	4	0	11	13	11	0	11	0
17	24	23	0	0	17	0	0	0	0	0	13	0	13
18	22	21	1	0	18	1	0	0	0	0	13	0	13
19	22	23	4	8	19	4	8	11	8	9	0	11	0
20	20	16	4	0	20	4	0	12	12	11	0	11	0
21	23	23	4	0	21	4	0	0	0	0	13	0	13
22	22	22	7	8	22	7	8	0	0	0	13	0	13
23	20	22	7	8	23	7	8	9	12	11	0	11	0
24	20	22	7	9	24	7	9	4	10	1	0	1	0
25	5	20	0	0	25	0	0	3	13	2	0	2	0
26	5	22	0	0	26	0	0	0	0	0	0	0	0
TOTAL				558	474	474	84	84	164	142	142	142	142

TOTAL TERMINAL SYSTEM/MANDATORY SUBSYSTEM:

V = 85.8%
 VI = 72.9%
 VA = 12.9%
 VB = 12.9%

VM = 78.1%
 VMI = 69.0%
 VMA = 21.4%
 VMB = 9.0%

VMS = 36.1%
 VMAS = 36.1%

COMPONENTS

NO	DESCRIPTION	(9)	ORIEN- TATION	ACCESS- ABILITY
1	ENT EXIT WEST		88.0%	52.0%
2	TICKET COUNTER		88.0%	88.0%
3	TICKET COUNTER		96.0%	92.0%
4	SCHEDULE		96.0%	44.0%
5	LOCKERS		96.0%	92.0%
6	GIFT SHOP		96.0%	92.0%
7	BAR, REST, COFFEE		96.0%	92.0%
8	POST BOX STAMPS		88.0%	88.0%
9	INFO B2ETH		100.0%	96.0%
10	MAIN EXIT		100.0%	96.0%
11	SECURITY GATE		96.0%	80.0%
12	HOLD ROOM		92.0%	96.0%
13	WAIT AREA		96.0%	92.0%
14	ARRIVALS DOMESTIC		92.0%	84.0%
15	CAR RENTALS		92.0%	96.0%
16	ARRIVALS INTN TRAVS		88.0%	96.0%
17	MONITOR, SCHED		96.0%	92.0%
18	PHONES LOCAL		88.0%	84.0%
19	WASHROOMS M AND F		88.0%	92.0%
20	ENT EXIT EAST		80.0%	64.0%
21	BAG CLAIM		92.0%	92.0%
22	PHONES HOTEL		88.0%	88.0%
23	LOCKERS		80.0%	88.0%
24	CUSTOMS AND IMMIGR		80.0%	88.0%
25	AIRSIDE		20.0%	80.0%
26	CURB		20.0%	88.0%

ORIENTATION AND ACCESSABILITY: INDICES MODE BY MODE

ORIENTATION ACCESSABILITY

1 ENT EXIT WEST

J = 88.0%	A = 52.0%
JI = 60.0%	AI = 52.0%
JA = 28.0%	AA = .0%
JO = 28.0%	AO = .0%

2 TICKET COUNTER

J = 88.0%	A = 88.0%
JI = 64.0%	AI = 48.0%
JA = 24.0%	AA = 40.0%
JO = 24.0%	AO = 40.0%

3 TICKET COUNTER

J = 96.0%	A = 92.0%
JI = 80.0%	AI = 60.0%
JA = 16.0%	AA = 32.0%
JO = 16.0%	AO = 32.0%

4 SCHEDULE

J = 96.0%	A = 44.0%
JI = 80.0%	AI = 44.0%
JA = 16.0%	AA = .0%
JO = 16.0%	AO = .0%

5 LOCKERS

J = 96.0%	A = 92.0%
JI = 76.0%	AI = 60.0%
JA = 20.0%	AA = 32.0%
JO = 20.0%	AO = 32.0%

6 GIFT SHOP

J = 96.0%	A = 92.0%
JI = 76.0%	AI = 60.0%

5A= 20.0% AA= 32.0%
5B= 20.0% AB= 32.0%

7 BAR, REST, COFFEE

9 = 96.0% A = 92.0%
9I= 80.0% AI= 80.0%
9A= 16.0% AA= 12.0%
9B= 16.0% AB= 12.0%

8 POST BOX STAMPS

9 = 88.0% A = 88.0%
9I= 88.0% AI= 76.0%
9A= .0% AA= 12.0%
9B= .0% AB= 12.0%

9 INFO BOOTH

9 = 100.0% A = 96.0%
9I= 100.0% AI= 84.0%
9A= .0% AA= 12.0%
9B= .0% AB= 12.0%

10 MAIN ENT EXIT

9 = 100.0% A = 96.0%
9I= 100.0% AI= 96.0%
9A= .0% AA= .0%
9B= .0% AB= .0%

11 SECURITY GATE

9 = 96.0% A = 80.0%
9I= 80.0% AI= 80.0%
9A= 16.0% AA= .0%
9B= 16.0% AB= .0%

12 HELD ROOM

9 = 92.0% A = 96.0%
9I= 92.0% AI= 96.0%
9A= .0% AA= .0%

13 WAIT AREA

30= .0% A0= .0%

31= 96.0% A = 92.0%
 32= 96.0% A1= 92.0%
 33= .0% AA= .0%
 34= .0% A0= .0%

14 ARRIVALS DOMESTIC

35= 92.0% A = 84.0%
 36= 80.0% A1= 80.0%
 37= 12.0% AA= 4.0%
 38= 12.0% A0= 4.0%

15 CAR RENTALS

39= 92.0% A = 96.0%
 40= 76.0% A1= 88.0%
 41= 16.0% AA= 8.0%
 42= 16.0% A0= 8.0%

16 ARRIVALS INTN TRANS

43= 88.0% A = 96.0%
 44= 72.0% A1= 76.0%
 45= 16.0% AA= 20.0%
 46= 16.0% A0= 20.0%

17 REINTER, SCHED

47= 96.0% A = 92.0%
 48= 96.0% A1= 92.0%
 49= .0% AA= .0%
 50= .0% A0= .0%

18 PHONES LOCAL

51= 88.0% A = 84.0%
 52= 84.0% A1= 84.0%
 53= 4.0% AA= .0%
 54= 4.0% A0= .0%

19 WASHROOMS M AND F

9 = 88.0% A = 92.0%
 9I = 72.0% AI = 60.0%
 9A = 16.0% AA = 32.0%
 90 = 16.0% A0 = 32.0%

20 ENT EXIT EAST

9 = 80.0% A = 64.0%
 9I = 64.0% AI = 64.0%
 9A = 16.0% AA = .0%
 90 = 16.0% A0 = .0%

21 BAG CLAIM

9 = 92.0% A = 92.0%
 9I = 76.0% AI = 92.0%
 9A = 16.0% AA = .0%
 90 = 16.0% A0 = .0%

22 PHONES HOTEL

9 = 88.0% A = 88.0%
 9I = 60.0% AI = 56.0%
 9A = 28.0% AA = 32.0%
 90 = 28.0% A0 = 32.0%

23 LOCKERS

9 = 80.0% A = 88.0%
 9I = 52.0% AI = 56.0%
 9A = 28.0% AA = 32.0%
 90 = 28.0% A0 = 32.0%

24 CUSTOMS AND IMMIGR

9 = 80.0% A = 88.0%
 9I = 52.0% AI = 52.0%
 9A = 28.0% AA = 36.0%
 90 = 28.0% A0 = 36.0%

25 AIRSIDE

0 = 20.0% A = 80.0%
 01 = 20.0% A1 = 80.0%
 0A = .0% AA = .0%
 0B = .0% AB = .0%

26 CURB

0 = 20.0% A = 88.0%
 01 = 20.0% A1 = 88.0%
 0A = .0% AA = .0%
 0B = .0% AB = .0%

SUBSYSTEMS-ORIENTATION ONLY

ORIGINATING-DOMESTIC

FOR NODES 1 2 3 4 5 6 7 8 9 10 11
 12 13 15 17 18 19 20 23 25

VV = 92.5% VVI = 75.0% VVA = 17.5% VVB = 17.5%

TERMINATING-TRANSORDER

FOR NODES 1 5 6 7 8 9 10 13 15 16 17
 18 19 20 21 22 23 24 26

VV = 79.7% VVI = 66.2% VVA = 13.5% VVB = 13.5%

CONNECTING-DOMESTIC-TO DOMESTIC

FOR NODES 2 3 4 5 6 7 8 9 11 12 13 14
 16 17 18 19 22 25

VV = 84.3% VVI = 73.2% VVA = 11.1% VVB = 11.1%

CONNECTING-TRANSORDER TO DOMESTIC

FOR NODES 2 3 4 5 6 7 8 9 11 12 13
 16 17 18 19 21 22 23 24 25

VV = 80.0% VVI = 79.2% VVA = .8% VVB = .8%

FOR NODES 1 4 6 7 8 9 10 13 14 16 17
GREETER
18 19 20 21 22 24 25 26

VV = 88.7% VVI = 69.9% VVA = 13.8% VVD = 18.8%

STOP 0

END

SECRET

FIN