INTERMODAL AND MULTIMODAL TRANSPORTATION: ANALYSIS OF POLICY AND THE IMPACT OF PLANS FOR CONNECTABILITY OF TRANSPORTATION SYSTEMS BETWEEN SEAPORTS AND AIRPORTS

By

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To my parents–
Thank you for sacrificing a great deal so that I could build my life and career

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LIST OF ABBREVIATIONS

AGT	Automated Guideway Transit
CBD	Central Business District
DOT	Department of Transportation
FIHS	Florida's Intrastate Highway System
FLL	Fort Lauderdale-Hollywood International Airport
FTP	Florida Transportation Plan
GRT	Group Rapid Transit
HSR	High Speed Rail
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITS	Intelligent Transportation System
LGCP	Local Government Comprehensive Plan
LRC	Long Range Component
MIA	Miami-Dade International Airport
MPO	Metropolitan Planning Organization
PEV	Port Everglades
PRT	Personal Rapid Transit
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SCP	State Comprehensive Plan
SHS	State Highways System
SOV	Single Occupancy Vehicle
STIP	State Transportation Improvement Plan
TIP	Transportation Improvement Program
TMA	Transportation Management Area

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Ports have traditionally been gateways to, and symbols of a city or country as a whole. The airports and seaports play a major role in the economic welfare of a region. Due to continued economic connection and the movement of goods and people between seaports and airports, increased congestion is beginning to stress the highway and rail corridors in the State of Florida. Demand on the airport and seaport regional facilities are beginning to affect airport access, shipment reliability as well as highway congestion within urban areas. The congestion is beginning to "spread along major inter-city corridors and is concentrated at choke points along routes to/from airports, marine ports or intermodal rail terminals (Weisbrod, 2006)."

The paper explores Hillier's argument for understanding space and a programmatic set of transportation technologies within regional facilities that accommodate or facilitate a wide range of movement at regional scales and ranges occupying adjacent spaces in local, regional and global scales simultaneously.

Ultimately the goal is to separate the scales and means of congestion, whether it be the movement of people, such as employees, tourists or local citizens to these facilities, or the

separation of functionality of the regional facilities through the movement of cargo and freight. The analysis of the State of Florida's policies, strategic intermodal system and impact of plans can help to provide for the connectability of transportation systems and pedestrian movement from one regional economic generator to another.

The research examines several factors to fully understand the connectivity between two large scale activity centers, and importance of scales, congestion, diversity of movement and users, intermodalism, and state policies. The first step in the research was selecting a study area that involved a large scale activity center that integrated various modes of transportation and the continuous movement of pedestrians. Miami International Airport, located in south Florida and London Heathrow Airport were chosen as two study areas in order to understand a larger connection of pedestrian movement between two large scale activity centers. This analysis was then used to evaluate the connections between Fort Lauderdale/Hollywood International Airport and Port Everglades. Automated People Mover (APM) and Personal Rapid Transit (PRT) are used to represent such technology that has been deployed in a variety of contexts to connect airports to other regional activity centers.

CHAPTER 1
INTRODUCTION

> The cities without names as those we see from a distance, often as a glow on the night horizon, but which we cannot approach and enter. Perhaps their distance is maintained because we are only passing by, on our way somewhere else more familiar; or, perhaps, by our desire to keep them in our minds as inviolate and unknown, places for the future and not for now. All the elements of cities we know are there, the more or less familiar profiles of buildings where people like us, we imagine, live out their lives. But some differences are apparent. As we strain to see more, these differences reveal the utter strangeness of these cities, their remoteness in more than distance and time from us and what we have known. Any one of these cities seems—for want of a better word—uncertain. The structure of the city is tentative, as though it were a series of inconclusive gestures in space, almost like the *pentimenti* of an artist's drawing, as he or she searches for a form not known in advance. Gone is the familiar sense of work accomplished and, in its place, the uneasy feeling that the work undertaken was not meant to be accomplished.
>
> Our companion on one such journey, a distinguished architect, said, "Oh, don't be so surprised. Haven't you heard that those cities were designed by crazy fools? They started to build, but don't know how to finish. Still, they think they've created Utopia!"(Woods, 2008)

The accomplishment of transportation connectivity between two major activity centers will create a network of spaces. Those spaces, well planned, have the greatest potential of allowing people to move among scales, to invent their existence among a larger concept of movement. The creation of a sense of place among the bigger picture of an urban core is perhaps the most seamless, potentially complex order to fill. The certainty of a structure that connects two major systems is real and known and has the potential to create growth and alleviate conflicts between pedestrian movements among all scales.

Ports and Airports

Port and airport locations in the past have been perceived as typically serving a region or community in terms of functionality. They are regional facilities that facilitate transportation of people, cargo, petroleum and other industrial products. Their focus now is shifting their focus toward dealing with the mix and seamlessness of movement between these two facilities. The goal is to weave the idealism of "form following function" into the various scales, hierarchies

and typologies of users, functionality and connections for accommodation of multimodal transportation opportunities. The goal is to create a framework that concentrates on the continued development and growth of a region to link one major facility, the airport, to another major facility, the seaport, to the transit network for a region. Individual attention is required, at all scales, in order for a seamless movement along all transportation options between these two activity centers.

Managing the movement of passengers from one port terminal to another is a transportation issue that needs to be understood by identifying the type of users, the organization of the regional facility, and the connectability and accessibility of transportation technologies between the two. Researchers and policy makers have placed an emphasis on multi-modal transportation, intermodal transportation and economic development, but there is still a disconnection on how these systems work together as a whole. Identifying the patterns of transportation to each destination as well as the interaction on the site and an analysis of the pedestrian scale will provide a basis to make recommendations on how to balance access with the vital economic role of these ports in a region.

Ports and seaports play a major role in the economic development of the region. Although many policy makers assume other ground transportation systems are mature, “economic growth depend on maintain access to relevant suppliers and markets, and the nature of those access needs are continuing to shift dramatically as both markets and suppliers change” (Weisbrod, 2006).

Growth at airports and seaports is limited by continued congestion on U.S. highways and rail systems. Overseas air and sea shipments depend on improved access to and from U.S. air and marine ports. The need to control congestion around ports and airports is even more critical as

just-in-time delivery spreads the businesses supply chains along highway corridors or along choke points along routes to or from the ports or intermodal rail terminals (Weisbrod, 2006).

As international trade increases, it is critical for economic development reasons that we expand the range of options for intermodal airports, seaports and the road and rail corridors serving them. As the economies of scale for seaports increases, ground transportation companies and local communities will face higher 'externality' costs associated with the road and rail congestion. This congestion will in turn increase labor costs, reduce schedule reliability and increase air pollution costs at the port locations, along the corridors serving them and in the regions around them. The public and private costs of increasing ground-side road and rail capacity will become increasingly expensive when the congestion is concentrated at specific facilities and corridors, and where options for adding capacity are both limited and costly (Weisbrod, 2006).

"The most compelling argument for expanding our port and gateway options and access routes should be the economic welfare of our citizens. Expanding international trade routes with Canada and connecting Atlantic port facilities can potentially help to reduce the access isolation and resulting depressed economies of New England's northern tier. It can also help to increase options for American freight moving to/from the upper Midwest" (Weisbrod, 2006).

Summary

In short, seaports and airports play a major role in the global economy. The regional scale access to those global facilities is important. In order for these global facilities to operate efficiently, we need to address movement at multiple scales within and throughout these facilities and speeds for a variety of users using new transportation technology. Demand on these two regional facilities is beginning to affect airport access, shipment reliability and highway

congestion within urban areas. The congestion could adversely affect the overall economic development of our regions.

Ultimately the goal of a well-managed transportation system is to separate the scales and means of congestion, for all users of the system, employees, tourists, local citizens or the movement of cargo and freight. The analysis of the State of Florida's policies, strategic intermodal system and impact plans can help to provide for the connectability of transportation systems and pedestrian movement from one economic regional facility to another.

CHAPTER 2
LITERATURE REVIEW

Introduction

> Discrete systems, composed of nothing but mobile individuals, can quite easily form themselves into global systems whose existence as objective realities need not to be doubted. By examining simple cases, we can begin to build a picture of how such systems may arise, be lawful and have different types of structure (Hillier, 1984).

Little literature exists specifically on the connectability between seaports and airports; however, extensive research and literature exists regarding the research question of connectability of two large scale activity centers through the breakdown of scales, analysis of state policies and the articulation of Hillier's framework of space syntax. In Hillier's framework the general ideas of space and spatial configuration and how they can be broken down into components and analyzed as networks of choice can be used to understand the connectivity of transportation systems. The literature review is one that provides a comprehensive, yet programmatic, set of economic scales and transportation technologies that provide an extensive background for analysis on this topic.

Ports have traditionally been gateways to, and symbols of, a city or country as a whole. The airports as well as seaports play a major role in the economic welfare of a region. These facilities are the economic engines as well as reflections of the communities in which they are located. They contribute to the local economy through employment opportunities, international trade and other sources of revenue for the county or region. Passenger traffic reflects the level of economic development, demographics, business activity, and tourism. The cargo volumes are also an indication of the strength of the regional economy (Waters, 2007). "The economic facilities are gateways to a city. If the seaport or airport works, it becomes easy and pleasurable to visit the metropolis whether for business or leisure. When it doesn't work, there is a high possibility that people may not come back" (Waters, 2007). As aviation, cruise, and tourism

demand continues to grow, as well as higher demands for shipping and trade, increased traffic and passenger volumes will stress our nation's regional facilities.

Typically, the term "port" refers to waterside, large-scale complexes in urban areas. These complexes are equipped to dock boats, large ships and to handle importing and exporting of cargo. Port facilities including their terminals and cargo container areas both in private and public sector are part of what is known as an intermodal transportation system. The locations of ports are typically situated in or adjacent to urban population centers that cater to cruise ships and recreational adventures instead of the normal ocean-going travel liners and cargo container ships (Florida Department of Community Affairs, 2007). "For a city to attract and retain corporations with national and global ties-as well as talented people to work for them-efficient, functional airports and seaports that are easily reached will be increasingly important" .

With increased demand on global facilities, the movement of pedestrians is becoming critical. The problems associated with large scale activity centers are congestion that is beginning to spread along inter-city corridors that is contributing to inefficiencies such as delays, traffic violations due to illegal parking, u-turns, illegal passenger drop off and pickups and a lack of pedestrian and bicyclist safety. The proposed solutions are based upon their scales and connectivity.

The connection between seaports and airports must be understood within the context of the need to move people efficiently through multiple scales, speeds, and new transportation technologies in order to create a comprehensive framework for a wide range or global facilities. The argument for the connections will provide a background on definitions, scales, congestion issues, context, benefits, challenges and feasibility of intermodal centers as a hub for transportation options and various movements to accommodate pedestrians. It is time to

rediscover and create the human scale, to ultimately build communities and transportation networks for people, not cars. “The transit systems would be better patronized if they were connected effectively with the very spatially-dispersed patterns of origins and destinations in our cities” (Schneider, 2008).

Space Syntax

Before evaluating the effectiveness or adequacy of transport between two large scale activity centers, one should look deeper than the amount of congestion on the roads or punctuality of public transportation. The following questions one should begin to ask is: (a) To what extent can people either engage or participate in the activities they want. What are the traveling difficulties, costs of obtaining the work they want or choice of career, schools, shopping, cultural events or even the ability to reach those activities they want? Fundamentally the question being asked is how transport is broken down. (b) How accessible is the area that people want to live or prefer to live in or can afford to live? (c) How easy, cheap, fast and pleasant are the journeys that involve community activities and business activities? Are the journey to and from work, school, shopping and to the activity center enjoyable? What is the availability and distance for pedestrian accessibility and involving the use of the bicycle as a vehicle? (d) What are the odds of getting in an accident or the number of accidents that have occurred? All of these questions are difficult to formulate when trying to understand the connectivity of large scale activity centers within a few mile distance of each other. Breaking down and recognizing how space affects buildings, transportation systems and public areas enables one to assess the performance of a transit system and the ability to judge where improvement needs to be made to create a seamless movement of pedestrians from one major destination to another.

In order to associate and connect two destinations through a transit system and understanding "spatially-dispersed patterns of origins and destinations in our cities" (Schneider J. , 2008), one needs to look at social activity and interaction that happens within a space or corridor. The framework that is laid out in Hillier's (1984), The Social Logic of Space;

> Space syntax added to the existing panoply of spatial concepts a new one that potentially reshapes research questions: spatial configuration. The hope was that by learning to describe and analyse different kinds of spatial configuration, or pattern, in the city-for example the differences between the new social housing and traditional urban areas, which seemed prima facie to be critically different-it would be possible to detect any influence there might be of social factors in the construction of theses spatial patterns and also to explore any consequences there might be in terms of how social life could and did take place. By learning to control the spatial variable at the level of the complex patterns of space that make up the city, we might be able to gain insight into both the social antecedents and consequences of spatial form…
>
> In syntax terms, spatial *configuration* means relations between spaces which take into account other relations, and so in effect relations between all the various spaces of a system (Hillier & Vaughan, The City as One Thing, 2007).

Beginning to link the social and spatial concept of connectivity between a modern seaport node and an airport node within a multimodal transport system will in effect provide for a scale that moves from segregation to integration. First, in order to understand the diversity of movement and the users, the idea of separating various scales in order to understand intermodal and multimodalism needs to be addressed and how congestion, the pedestrian and the street grid begins to engage with space.

Economic Systems within Regional Facilities

Individual economic systems that comprise a regional facility contain a complexity of scales, systems and movements that all occur with time. A well thought out time pattern that allows for the freedom of complex organizations of structural systems to inhabit, to be present. Intermodalism and the ease of movement between various modes of transportation are essential in a seamless transition of the pedestrian from one destination to another.

This time pattern is a "shifting, dynamic field of the self determining, self organizing systems (Woods, 1997)." The layering of time is embedded into the transportation networks, buildings, materials, events, human life, and the landscape. It is one that is filled with complex layers and immersed into the depth of an overall compressed facility, the airport and seaport. The execution of layering scaled transportation systems into a city is all about time or the timing of those particulars in which it is woven into the urban fabric to define a global facility to where "…the unreachable becomes reachable, the unavailable become available, the unattainable…attainable (Charter, 2005)."

Layers of time within an economic facility can be occupied in all forms and in any state. It is up to one to decide how this illusion of time, scale and structure can be transformed and molded to exist for their experience of movement from one facility to the next. As humans we invent, create a world and then populate it with our own ideas, interests, and abstractions (Hailey, 2006). With these ideas, we begin to build and form our own layering of boundaries, peripheries and edges to create the internal and external beginnings of what we would define as a "cite," or global facility that reveals itself to be a "city" of smaller scale, consisting of layers with overgrowth from the city, which is the "cistern of the world (Bitz, 2006)." This substantial influx of people into the "city" must not only serve the needs of the local residents but also the additional burden caused by regional traffic.

> Addressing the impacts of urban growth and redevelopment through the establishment of an innovative system that enhances mobility by linking local and regional transportation networks, incorporating alternative transportation modes, and promoting traffic management (City of Boca Raton, 2009).

Connections are not formed by chance, rather by the relations to one another through various scales such as the pedestrian, the street grid and the facility that houses economic development. "The space in which we live, which draws us out of ourselves, in which the erosion of our lives,

our time and our history occurs, the space that claws and gnaws at us, is also, in itself, a heterogeneous space. In other words, we do not live in a kind of void, inside of which we could place individuals and things. We do not live inside a void that could be colored with diverse shades of light, we live inside a set of relations that delineates sites which are irreducible to one another and absolutely not super imposable on one another.

> Of course one might attempt to describe these different sites by looking for a set of relations by which a given site can be defined. For example, describing the set of relations that define the sites of transportation, streets, trains (a train is an extraordinary bundle or relations because it is something through which one goes, it is also something by means of which one can go from one point to another, and then it is also something that goes by). One could describe, via the cluster of relations that allows them to be defined, the sites of temporary relaxation-cafes, cinemas, beaches. Likewise one could describe, via the network of relations, the closed or semi-closed sites of rest-the house, the bedroom, the bed, el cetera. But among these sites, I am interested in certain ones that have the curious property of being in relation with all the other sites, but in such a way as to suspect, neutralize, or invent the set of relations that they happen to designate, mirror, or reflect. These spaces, as it were, which are linked with all the others, which however contradict all the other sites, are the two main types (Foucault, 1967).

Scales

Congestion

Congestion occurs at every scale, from the local, the regional to the national and international facilities. Congestion however, is not a bad necessarily, but with delays caused, fear of the safety of the pedestrian and slower traffic speeds, congestion has become a nuisance. The space requirements of a vehicle are much more than that of any other mode of transportation.

> …aggravated the problem of traffic congestion, especially in medium-size and large cities. Not only did the congestion defeat the major feature of the automobile-its high level of mobility-it led both to inefficiencies and to strong negative impacts of transportation on the urban environment. This has been the main reason for serious problem of our age, one summed up in the brief phrase, “collision of cities and cars” (Johnson, 1993) (Vuchic, 1999).

Container traffic as well as pedestrian traffic in the United States tends to be more highly concentrated and is becoming even more so as the use of larger, faster, and more specialized

vessels and planes call the ports that are capable of handling them. As the tourism and cargo demands continue, relieving congestion from one facility to the other is the goal. “The growth in container traffic has resulted in increased vessel, truck, and rail services in and around port regions. Challenges posed by the large-scale movement of container traffic include Maintaining efficient cargo flows from point-of-origin to final destination in a safe and secure manner, improving air quality and reducing noise surrounding port areas, and Removing freight bottlenecks at intermodal transfer locations where trucks and railroads connect to marine terminals” (U.S. Department of Transportation, 2007).

The auto and highway system has given the pedestrian within their automobile free reign of the spaces that they deploy themselves within. The commuter has unprecedented flexibility and movement. Along with this dynamic projection of movement, the automobile and the over abundances of commercial trucks have overtaken the city, the port facilities and the business centers of downtowns. Their primary function has been to serve the city but in fact the highways and roadways have created an environment that makes pedestrian movement difficult. The congestion caused by such a mobile structure has broken the urban fabric with the layout of buildings that aren’t well utilized, the mix of services that block the pedestrian’s access to the direct connection with other economic facilities, the airport, seaport and the downtown business center. The dependency on automobiles has lead to a magnitude of congestion that doesn’t make the movement between any modes of transportation seamless but rather erodes the urban livability of neighborhoods and communities by reducing options for those that are trapped in the excess of congestion on the streets and roadways.

> At some level of congestion, any given driver will choose to avoid dealing with the congestion, either in favor of an alternative route, an alternative mode, changing the departure time of the trip, a shorter trip to a similar activity, or avoiding the trip altogether…and the reverse is true, too. If the congestion eases because a new road is built or an old one enlarged, the cost of travel is reduced and the number of trips, even spontaneous ones, will increase (Motavalli, 2001).

Equal attention needs to be provided not only for the pedestrian but for the bicycle, auto, and public transit that serves activity centers, community facilities and commercial districts in order to encourage pedestrian activity and in turn relieve the increased volume on the roadways. Promoting transportation choices (intermodalism) will allow for a livable city and an increase of connectability. However, traffic congestion cannot be solved. The roadways are ever increasing vehicle mileage and trips per day by building new highways, extra lanes and additional roadway to accommodate the traffic.

> …By the time most expressways or freeways (those are real misnomers-they are not express and certainly not free) are funded and built, they are near, at, or over capacity. The reason is simple: development follows on the heel of infrastructure expansion. Since roadways are the current favored investments no or few comparable travel options exist for the great majority of the population. Walking to your destination has become an event of the past. Pedestrian amenities or necessities fall to the responsibility of local levels of government. Usually towns and enlightened cities plan for accessibility or mobility. It is never done at the regional scale. The pedestrian is simply a Forgotten Factor in Regional Transportation Planning (Havlick, 2001).

Street Grid

The street grid is a large scale within the regional economy. The street is a division of space and of the pedestrian. The cost of a roadway is great. “It is not to be measured merely in congestion, lost energy, and time. More important are the positive benefits that are forsworn. By giving away land to parkers, or renting it for a pittance, cities are squandering some of the most valuable real estate that they have. There are much better uses for it than the non-movement of vehicles. Its highest and best use is transportation: specifically, for pedestrians. They are the major component of center-city transportation” (Whyte, 1988).

Yet as a place to walk around and experience, incorporating scale and hierarchy into the global system will make individuals the unmotivated motivators of the new transportation system. “It is assumed that human beings will deploy themselves in space in some way, perhaps without interconnection from one individual to the next, in which case the process is random…The question then is how far individuals have to relate their spatial actions to those of others in order to give rise to pattern and form in space” (Hillier, 1984).

Pedestrian

After the street grid, the pedestrian is the next large scale within a regional economy. The pedestrian is the lively hood of the systems. The pedestrian and then the street grid have contributed to the rapid growth of urban centers and traffic congestion. In order to accomplish a transportation system that is seamless, that runs smoothly, to link one site to the next, attention needs to be paid not only at the overall large scale of the network but at all scales no matter how minute they may seem. The smallest, yet most important economic system that holds together a regional facility is the pedestrian. As large facilities become more densely populated there is increasing interest in predicting and understanding fine scale pedestrian movement. Beginning to understand the scale can in turn help to develop cities and connections for effective transport infrastructure facilities and how the pedestrian uses urban spaces in all conditions.

The pedestrian, is a social being, “he is also a transportation unit, and a marvelously complex and efficient one. He is self-contained, self-propelled, and moves forward with a field of vision about 100 degrees wide, further widening this with back-and-forth scanning movements at almost 180 degrees. He monitors a host of equations: two crossing patterns at left front, 290 feet a minute, three on the right, angle on the cars 30 degrees and closing, a pair abreast dead ahead, a traffic light starting to flash DON’T WALK. In fractions of a second he responds with course shifts, accelerations, and retards, and he signals to others that he is doing

so. Think of the orders and computers it would take to match him! Transportation engineers are spending millions on developing automated people-mover systems. But the best, by far, is the person (Whyte, 1988)."

As Whyte demonstrates, the pedestrian is a unique being by itself and therefore is a smaller scale that is actually enormous in characteristic and influences the patterns of movement within a facility or urban core.

Pedestrians in global facilities are efficient. They walk fast and with authority to get from one place to another. In both airports and seaports, observations show that these pedestrians are on a timed schedule, the movement in and out, giving and taking. Those movements are well organized and orchestrated in such a manner that at first glance is congested and irrational but when one pulls away to look at the larger scale, the overall picture is well timed and systematic. "With the subtlest of motions, they signal their intentions to one another: a shift of the eyes, a degree or so off axis, a slight move of a hand, a wave of a folded newspaper" (Whyte, 1988).

Land Use and Transportation

Planning between major activity centers needs to be accomplished not only at multiple scales but through land use as well. The highway system has given the automobile an unprecedented flexibility to the commuter and credit in shaping the cities in which we live. The commuter could now go cross town laterally between transit lines instead of traveling radially through central business districts or the core of the city. The car provides a convenient, flexible and relatively low-cost of transportation which is favorable amongst a majority of users. Planning between major activity centers needs to be accomplished at multiple scales.

Land use and transportation planning are very much like the chicken and the egg. Which came first? "In short term, land use shapes the demand for transportation. Many a highway has been built because population or commercial growth produced congestion and delays, which

generated political pressures to deal with the situation. On the other hand, the provision of roads changes land values and thus alters the intensity with which land is used, and, with that outcome, alters the entire pattern of land use. The interstate highway system, to take the largest example, was designed to facilitate movement of vehicles from one existing urban center to another, something it does very successfully (Levy, 2006)." Historically, cities have developed along their topographic axes. The early highways followed the axes along coasts, rivers, canals and valleys which then in turn encouraged linear development.

Overall network geometry determines the probable points of density increase. Radial systems, such as those found in Boston, Washington, D.C., and Paris, have inherent centers through which most traffic must pass en route between points. Rectangular grid systems, like those in Miami and New York City, tend to be less centralized; shifts and amplifications of local development occur through association with other economic systems (via ports, rivers, and bridges) or with higher capacity pathways (Florida State University and FAU-FIU Joint Center, 1986).

The general consensus seems that major metropolitan areas have favored the automobile over other modes of transportation. Public transportation systems and alternatives have declined and the trend has been toward more highways being built through cities to accommodate the growth. Improving transit leads to more decongested streets by reducing automobile travel as well as improving air quality. "Those concerned with urban design often favor transit because it leads to more compact land-use pattern that is much friendlier to pedestrians than is a city designed for automobile transportation. Distances between destinations are shorter, and less land area is given over to streets (Levy, 2006)."

Intermodal/Multimodal Transportation Characteristics

"*Intermodal Transportation* may be defined as the transportation of a person of a load from its origin to its destination by a sequence of at least two transportation modes, the transfer from one mode to the next being performed at the intermodal terminal. The concept is very general and thus, it means many things to many people; transportation of containerized cargo by a combination of truck, rail and ocean shipping, dedicated rail services to move massive quantities of containers and trailers over long distances, main transportation mode for the international movement of goods, central piece in defining transportation policy for the European Community, trips undertaken by a combination of private (e.g., car) and public (e.g., light rail) transport, and so on (Crainic, 2005)."

Transportation systems affect human society in the most significant aspects. The Policy Guide on Surface Transportation (1997) on the American Planning Association website states the aspects of transportation systems on human society:

- Land development and land use;
- Economic activity;
- Goods movement and trade;
- Jobs and wages for thousands of workers;
- Access to places and work, education, health care, social life, and commerce for individuals;
- Overall livability of communities and metropolitan areas

The above lists are the most important to the research. The success of a transportation system and its functionality can have consequences for the built and the natural environment for people and communities that inhabit them. Transportation issues impact people on every scale and within the everyday life of those who live within communities that have high congestion.

The dilemma has been to either build more roads to accommodate the growth of private vehicles or to create public transit alternatives to relieve congestion and provide greater access to a wider range of individuals and working classes. The key to deal with strategies to alleviate the broader social issues as housing, employment opportunities and a higher quality of life is accessibility. People must be able to have access and mobility in order to obtain a better quality of life.

"Traditional transportation planning was based on profiles and characteristics of residential households (family size, income, vehicle owned) and the area itself (population density, distance from the central business district (Rosenbloom and Black, 2000)." The last criticism of failing to create more livable and sustainable communities is a concern that has not gone without notice within federal transportation agencies (Edwards, 2001).

Intermodal Center

Imagine an opportunity, the combination of a transportation gateway and a mixed-use activity center (regional facility) that integrates into the urban fabric to create a dynamic, innovative transportation corridor that complements the existing regional grid, local grid and creates a sense of place. "The transportation facility will allow people to transfer from one travel destination to the next, from the airport, to the port, or even into the economic core of a city and central business district. As described, this vision is an Intermodal Center (IMC), an "airport without runways"" (Earth Tech, 2005).

What is it?

An IMC is a massive transportation hub that provides end connection to commuters who would use the other regional transit projects to access the Airport and the Seaport. It provides connectivity between all forms of ground transportation that is available within a city between the two regional facilities (the airport and seaport), while alleviating congestion on the local

street grid and around each port. The Intermodal Center links rail, both heavy and light, and public bus service to provide the regional accessibility.

The IMC offers a seamless centralized transfer between the three scales of the regional facility, the transportation element, as well as the pedestrian and bicycling ground movement. The "unique structure, satisfies the specific requirements of all modes of transportation to incorporate the existing infrastructure into the design, while adding an airport connection to taxis, cruise ports, parking facilities, rental car outlets and other modes of transportation" (Earth Tech, 2005).

Hillier would define the space of an IMC as an elementary cell; it has an inside as well as an outside. The simplest building is, in effect, consisting of a boundary, a space within the boundary, an entrance, and a space outside the boundary defined by the entrance, all of these spaces being part of a system which was placed in a larger space of some kind which it 'carried' it. All these elements seemed to have some kind of sociological reference: the space within the boundary established a category associated with some kind of inhabitant; the boundary formed a control on the category, and maintained its discreteness as a category; the world outside the system was the domain of potential strangers, in contradistinction to the domain of inhabitants; the space outside the entrance constituted a potential interface between the inhabitant and the stranger; and the entrance was a means not only of establishing the identity of the inhabitant, but also a means of converting a stranger into a visitor (Hillier, 1984).

Intermodal Center Scale

How does this scale of a transportation network interconnect into the IMC (the structure of space) that therefore connects one regional facility to the other? An intermodal center becomes a "cell," and therefore the inhabitants, the visitors of the center become another element of movement or a secondary "cell" (passenger cell) that can be subdivided. The subdivision of the

passenger cell becomes a pathway of growth and begins to define space within the local grid. The growth is a linear network that is created to move passengers from one destination to the next that can be thought of as a settlement. "…buildings tend to grow by accumulating boundaries; settlement space tends to grow by accumulating spaces into one continuous system. Settlement space is richer in its potential, in that more people have access to it, and there are fewer controls on it" (Hillier, 1984).

Transit Modes

Transit plays large roles in the diversity of movement of people from one space to another. Vuchic (1999) explains in his book Transportation for Livable Cities that cities that have a balanced multimodal transportation system that accommodates pedestrians, cars and transit are better-quality than other metropolitan areas who may restrict the vehicle or try to rebuild the city to accommodate for adequate transportation for everyone. A balanced transportation system provides for an environment that benefits humans and creates a system of space, rather than providing for vehicles.

Largely, transit has many different roles in urban areas. From the use of commuters to work, transporting children to school, transit serves as the main distributor for various modes of transportation from bus, rail and air travel to and from terminals and destinations. Overall, transit allows for high capacity of pedestrian movement and allows for less of a carbon footprint by producing fewer pollutants and the consumption of less energy.

Bus Rapid Transit

Bus Rapid Transit (BRT) is a "form of fixed route bus service that combines features like bus-only lanes and bus priority at traffic signals to provide faster, more efficient transportation. BRT includes improvements to infrastructure, vehicles and scheduling in order to provide higher quality bus service for commuters" (National BRT Institute, 2008). With the already existing bus

services serving communities near regional facilities and downtown areas, faster bus service and expanding into different or more corridors will allow better connections into and between these existing facilities. Benefits such as increased reliability, the ability to build and improve incrementally, the flexibility to serve the suburbs as well as the densely populated cities, the improvement of alternative transit, fostering increased ridership and contributing to the nation's effort to reduce oil usage will greater effect a city and county which already has the foundation for such transit implementations.

The existing transit systems that are available today could be better utilized if they were connected with "very spatially-dispersed patterns of origins and destinations in our cities" (Schneider, 2008). By providing a connective tissue into the existing framework of buses, rail and park-and-ride facilities, BRT along with Automated People Movers (APM) and Personal Rapid Transit (PRT) would allow for a seamless transfer and complement the already existing multimodal transport system within cities.

Automated People Mover

A smaller scale than the BRT an automated people mover (APM) system is one that is a fully automated light rail system that operates on an elevated single track in a central business district of a city. The APM "is a passenger transport system with high levels of electronic intelligence so that vehicles are operated by computers over exclusive guide ways without need for attendants. Today, almost 130 installations operate around the world" (Airfront.21, 2008). The system can provide connectability between administrative offices, sports arenas, hotels, commercial, banking, retail districts. The service is free from congestion of vehicle or pedestrian traffic.

Advantages of APMs are numerous. They can be used to better configure land use patterns and parking, allowing strong pedestrian focus in a city or business center's core, which can be

virtually car-free. Principles for smart growth or a new urbanism with using APMs are 1) they can create higher density centers while interconnecting different parts of a center, 2) the dimensions for guideways and stations are significantly smaller which means that they can negotiate sharper turns and steeper grades, 3) transit improvements will allow for better real estate development due to the nature of the APMs small scale and integration into existing buildings, and lastly 4) smaller stations that lesson carbon footprints and the quality of less noise all can be integrated directly into buildings.

However, APM have a carrying capacity of 20 to 100 passengers. These passengers are mostly standing during their trip to the destination. APM have been used in airports for surface transportation for the past 30 years. With ever increasing technological advances, a new APM had been developed that is smaller, 3-4 passenger vehicle transports, has been implemented. The new category is called Personal Rapid Transit.

Personal Rapid Transit

"Personal Rapid Transit (PRT) uses small (3 to 4 passenger) vehicles (transportation pods or T-Pods) to automatically transport passengers and their luggage non-stop to their destinations along designated guideways. Trips are typically on-demand and T-Pods are often waiting at stations prior to the arrival of passengers. The resulting "short wait and trip times combine with seated travel to provide an exceptionally high level of service" (Personal Rapid Transit, 2000).

There are no schedules or fixed routes with PRTs. Ultimately, the passenger decides when and where to go, and they depart within seconds of arriving at a PRT station. The guideways for PRT can be built underground, at grade or over streets. PRT vehicles can be used for the transport of cargo, mail and waste.

PRT compared to other means of transport (Personal Rapid Transit, 2000) is energy efficiency and uses four times less energy than the automobile which means that there is no

pollution at the point of use. Electric power plants are getting cleaner with the development of renewable sources and fusion reactors. PRTs travel time is 3-5 times faster than buses and 2-3 times faster than the automobile in rush hour. Additionally, PRT is extremely safe due to automation, moderate and constant speed, operation on rails, no fuel on board, redundant design, avoidance of at grade crossings, and separation from pedestrians and other types of traffic.

Other incentives of using Personal rapid transit has one guideway lane that has two times the passenger capacity of a freeway lane, and four times the capacity of a street lane with traffic lights. There is no need for parking lots. Two-hundredths of a percent of land use compared to thirty percent for the automobile. One post every thirty meters compared to the space taken up by two asphalt lanes. The comfort of the passengers is taken into account so that they can either read or watch TV in privacy during the journey. Other incentives are noise control- a factor of one hundred less noise than automobiles, buses, and trains, a 24 hours service and the ease of use of the system is easy and safe enough for children aged 10 and above to use it without adult help. The handicapped and the elderly will also have fewer difficulties than with automobiles or conventional mass transit.

“Personal Rapid Transit is inherently more energy-sustainable, or "greener," than automobiles and conventional transit. The key to PRT's lower energy usage is its small size (translating into light weight), non-stop service (eliminating most energy-wasting starting and stopping), and on-demand service (PRT vehicles don't move until needed) (Kinetic Network Seattle, 2004).” If you look at Table 2-1, the table shows how PRT compares to other modes of transit. However, PRT is not the answer to everything. It cannot replace the car, although it can replace travel one takes by bus or train. It has been designed to be a more convenient option and suitable for travel and connectability from one regional facility to another. How convenient it

could be to fly into an airport, retrieve luggage and then transfer onto a PRT pod (FIGURE 2-1 and FIGURE 2-2) and travel to the next destination such as a seaport for cruise tourism or straight into the business/retail center of a city. PRT can even be an option for transfers along a route to a park-and-ride lot or into an urban core. FIGURE 2-3 illustrates a PRT route on a grid that has the potential to move along the street grid or through buildings and large facilities.

Smart Growth

Implementing Smart Growth principles and guidelines into the global facilities or a new program that assures good master planning of a transportation network between the two facilities would only enhance a region but relieve congestion along major corridors and throughout communities that are facing impacts of continued growth of these ports, expansion of trade routes and activity centers or urban city cores. Smart growth invests time, attention, and resources in restoring community and vitality to center cities and older suburbs in attempt to eliminate urban sprawl. Eradicating infrastructure in the cities and rebuilding developments further out may be more of an economic cost than thought to be believed.

The goal here is to achieve a sense of community and place. Meanwhile, expanding the range of transportation, employment and housing choices to preserve and enhance resources and promote environmental and public health is a continued effort. Smart growth can be implemented with walkable neighborhoods, the creation of housing opportunities and choices, mixed land uses, compact building design, encouraging higher density development, transportation choices, a strong sense of place, and making development decisions fair, predictable and cost effective (Smart Growth Online).

By promoting such principles of smart growth, such as walkable communities, it allows for a more attractive place to live, work, play and visit. Pedestrian activity is made possible by the design element of the location of services, transportation, housing, and offices. Destinations

within close proximities promotes the meshing of such essential benefits for human beings as a whole by creating lower transportation costs, and improved personal and environmental health. Preserving open space and critical habitats proves to be connected components of smart growth in accepting such expansion. Reusing the land that has been abandoned, idled or under-used in industrial and commercial facilities can be a catalyst for neighborhood revitalization, lessen development pressure and use the infrastructure that currently exists.

Not only implementing Smart Growth principles into the design of the economic facilities but within a community or region as a whole will enhance the connectability of new transportation technologies between the two facilities.

Transit Oriented Development (TOD)

The alternative transit options "could also be used effectively to extend the TOD concept beyond the traditional quarter-mile walk distance design metric, providing a considerably larger area or development/redevelopment around mass transit stations, and attracting new patrons who are now using autos exclusively and extensively (Schneider, 2008)."

Transit Oriented Development as an approach to combat traffic congestion and protect the environment has caught on all across the country. The trick for real estate developers has always been identifying the hot transportation system. Today, highways are out; urban transit systems are in. –The Urban Land Institute (ULI)

The seaport and airport are active activity centers and economic facilitators of a city. By incorporating TOD into the connective tissue of a PRT or APM transit network, additionally will enhance the sense of place through work, livability, learning, shopping and relaxation. TOD "can do more than simply shift some car trips to transit: it also increases Accessibility and Transportation Options through land use Clustering and mix, and non-motorized transportation improvements. This reduces the distance required for car trips, allows a greater portion of trips to

be made by walking and cycling, and allows some households to reduce their car ownership, which together can result in large reductions in vehicle travel (Transportation Demand Management Encyclopedia, 2007)

Transit Oriented Development (TOD) is an approach to development in the city that focuses on land uses around a transit station or within a transit corridor such as an activity center as a medium for such a design concept. TOD is typically characterized by (Transportation Riders United, 2006):

- A mix of uses
- Moderate to high density
- Pedestrian orientation and connectivity
- A variety of Transportation choices
- Reduced parking
- High quality of design

The housing components of such projects give residents in the city easy access to public transportation such as busses, light rail, and trains for commuting into “activity centers” or work within the city or elsewhere (Transportation Riders United, 2006). Implicating a TOD in the framework will take several elements, such as, supportive market conditions, a commitment to transit, strong local leadership, and supportive public policies. The quality of the transit service is important and must be frequent, clean, safe and reliable. Leadership must be prevalent in the public and private sectors of planning. The areas of the transit stations and activity centers must have development potential and be competitive with other sites within the corridor and the city. Public policies and tools that channel development into the transit corridors should be supportive as well.

Table 2-1. Transport Energy Use of PRT versus other Modes of Transportation

MODE	BTUs per passenger
PRT	839
Vanpool	1,362
Motorcycle	2,274
Commuter Rail	2,714
Rail Transit	3,268
Auto	3,581
Commercial Air	3,703
Personal Truck	4,057
Bus Transit	4,127
Amtrak	4, 830

Source: Lowson, M.V. (2004). "A new approach to sustainable transport systems."

Figure 2-1. Rendering of a PRT system inside the DIA main terminal. While the system looks large in the foreground, observing the return guideway in the background provides an appreciation of its small scale. Source: Muller, 2007

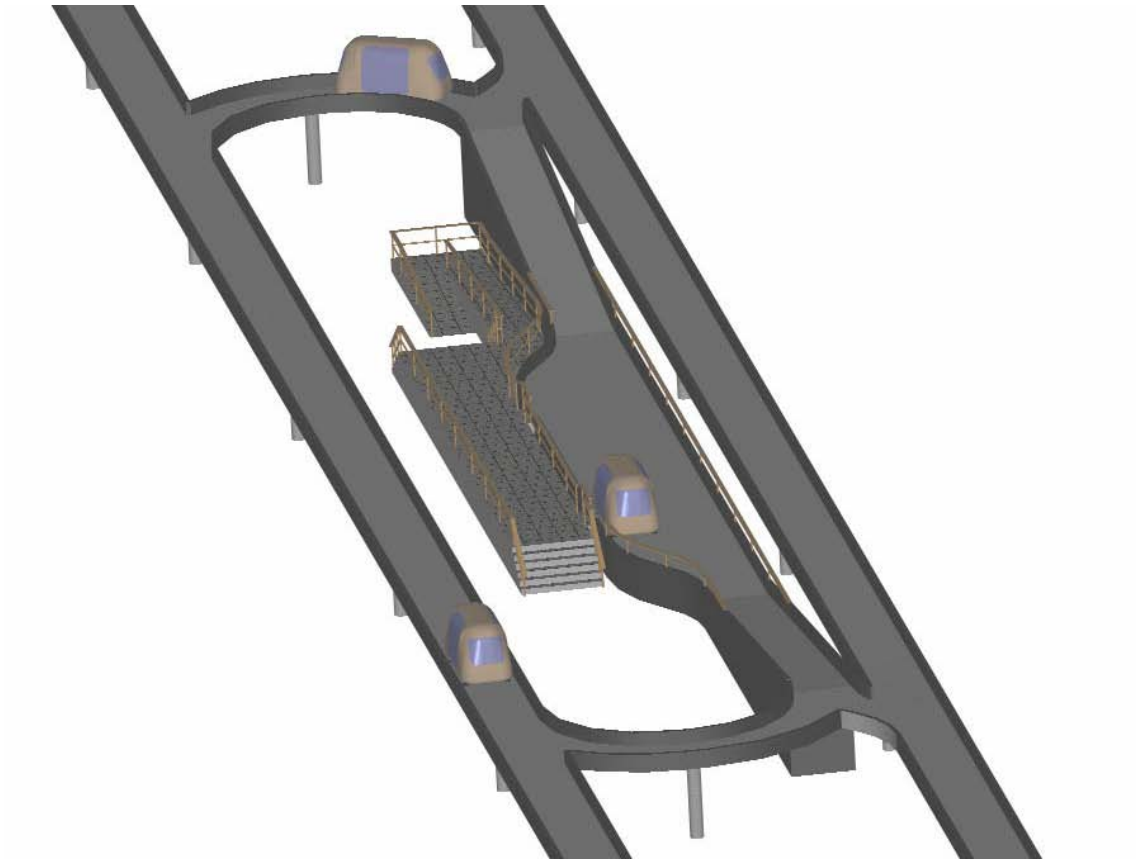
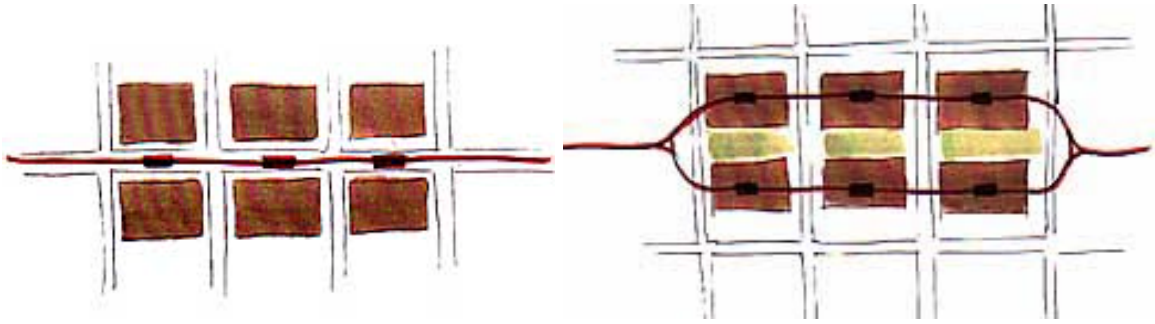


Figure 2-2. In-Course Prt Station (Rendering). Source: Muller, 2007



ALONG STREET THROUGH BUILDINGS

Figure 2-3. PRT and position on a grid. Source: Muller, 2007

CHAPTER 3

METHODOLOGY

Introduction

The research methods and materials for this study are described in this chapter. This research uses case study methodology and a theoretical argument of space and scale to investigate and understand the seamless movement of pedestrians between two large scale activity centers through alternative transportation modes while redefining the definition of intermodal and multimodal transportation. The case study methodology was chosen because it allows for an extensive understanding of intermodalism within the framework of the research question.

The paper explores a theoretical argument (Hillier's) for understanding space and a programmatic set of transportation technologies within regional facilities that accommodate or facilitate a wide range of movement at regional scales and ranges occupying adjacent spaces in local, regional and global scales simultaneously. Furthermore, these facilities are regulated by a set of local, regional, state and federal regulations that influence their deployment in specific contexts.

The research encompassed several factors to fully understand the connectivity between two large scale activity centers and the breakdown of scales, congestion, diversity of movement and users of the regional facilities and an analysis of intermodalism and state policies.

Site Selection #1

The first step in the research was selecting a study area that involved a large scale activity center that integrated various modes of transportation and the continuous movement of pedestrians. Miami International Airport, located in south Florida has local economic growth, tourist attractions and a large Latin American population base. This airport was selected because

given the land-locked nature of the site and the location for international trade and flights to Latin America, the Caribbean and Canada. This site is relatively in close proximity, 26 miles to the main case study of Fort Lauderdale/Hollywood International Airport (FLL) and Port Everglades (PEV). The airport has recently developed a massive transportation hub, the Miami Intermodal Center (IMC), which will be completed in 2012. When completed, the intermodal center will ultimately create connectivity between all forms of ground transportation from air, to rail while placing an emphasis on pedestrians and bicycles (City of Miami, 2000). The intermodal center will also connect to transportation systems in Miami, Fort Lauderdale, the Palm Beaches and the Florida Keys in order to decongest the streets near the airport.

Critical areas around this site were chosen to determine similarities and differences between the case study sites and the study area of MIC. MIC is bordered by transportation networks, the Metrorail, Interstate 95, Interstate 395 and the Florida State Road 836 (Dolphin Expressway). The MIC is also using an APM system, the MIA Mover that will connect the airport and the terminals of the intermodal center with a 1.25 mile system.

Site Selection #2

The second study site, Heathrow Airport in London, was chosen because of the airports deployment of the world's first PRT system. Another large scale activity center, the Heathrow Airport currently has a PRT system under construction. The new system will replace the existing shuttle buses on site and serve as an internal framework of intermodalism and connectivity between terminals, parking facilities and businesses.

These two case studies, Miami International Airport and London's Heathrow Airport, were chosen to understand the similarities of scale and transportation technologies in the movement of people from one activity center to another and apply them to the connection between FLL and PEV. Additionally the two case studies were chosen as examples of

incorporation of PRT and an intermodal center in each instance. These case examples will determine the effectiveness of the systems and illustrate how the facilities can facilitate transit oriented development and how other modal options are integrated into their framework.

Transportation

Secondly, various scales of transit modes is defined and explored. The combination of transportation connections and the accessibility to the modes are feasible to the research that begins to sets up the framework of intermodalism and effectively integrating pedestrian movement among multiple scales. The policy analysis determines the opportunities and constraints to the use of transportation within large scale movements.

Policy Analysis

A policy analysis of Florida's 2025 Transportation Plan, the Strategic Intermodal System and Safe, Accountable, Flexible, Efficient Transportation Equity Act (SAFETEA-LU) is analyzed to determine if there are any deficiencies in the policy framework. The overall objective is to analyze the framework of how Fort Lauderdale International Airport and Port Everglades are going to integrate a PRT system between the regional facilities to alleviate the congestion on major arterials and to move people seamlessly from one location to the other.

With the policy analysis, the term intermodalism and its lack of a specific definition are relevant to the research. Intermodalism is defined as the "ability to connect, and the connections between, modes of transportation between any place in the United States and any place in a foreign country; between places in the United States through a foreign country; or between place in one or more foreign countries through the United States" (U.S. Department of Transportation, 2009). Beginning to redefine the broad term of intermodal transportation to include all modes of transportation is relevant. The scale of the pedestrian and how that scale begins to intertwine into

the term allows for an accurate evaluation of the built environment and the movement of pedestrians seamlessly.

Secondary data was collected from the Broward County SunPort Intermodal Center and People Mover Study that included reports from two separate public workshops, a corridor report and additional background information. Port Everglades Master Plan also provided secondary information to the research. Aerial photographs were obtained through Google Earth to demonstrate the relationship between the two large activity centers, Port Everglades and Fort Lauderdale/Hollywood International Airport, and the close proximity and street connectivity between them.

Observations/Analysis of Space

The data collection entailed observations as well as an analysis of the use of space from Hillier's framework from his book, The Social Logic of Space. "Observation provides the opportunity to document activities, behavior and physical aspects without having to depend on peoples' willingness and ability to respond to questions" (Steele, 1996). In the realm of space are the two overall themes, community space and the organization of large-scale activity centers. Space in this research was determined by an overview of space and how humans interact with space, the pedestrian, the street grid and congestion. The transportation modes, intermodal center as well has congestion incorporates a wide range of scales and definitions. "Neighborhoods are composed by a mosaic of buildings and open spaces, creating public and private realms. Streets give neighborhoods shape, buildings provide tridimensional quality, and outdoor rooms create spaces that will enrich the neighborhood with human interaction (Alexander, 1977)."

Summary

The methodology in this research was a case study methodology that focused on a theoretical argument on the organization of space. This chapter laid out the organization and

procedures used to determine the various scales of intermodalism and connectivity of two large scale activity centers through the use of transit modes. Miami International Airport in Florida and the Heathrow Airport in London were two site selections used for the research. The case study of Port Everglades and Fort Lauderdale/Hollywood International Airport was used after evaluating two separate site selections that were similar but different in that they are large scale activity centers which contain an internal transportation network and not connecting to other larger facilities.

The secondary data, book and journal resources were used to understand space and various scales of the regional facilities and how pedestrians move through the space. The aerial photographs, charts, comparisons and use of reports from the case study were obtained for research materials for the study.

CHAPTER 4
FINDINGS

Introduction

The goal is to use Hillier's theory of space as a framework for the scale of the pedestrian, the street grid and redefinition of intermodalism for other economic/regional facilities in the state of Florida to promote connectability and relieve traffic congestion. Ultimately these results could be used in future locations such as the Orlando International Airport and Port Canaveral or Tampa International Airport and the Tampa Port. Each of these regions is unique and sensitive to environmental impacts, types of international trade, variety of tourism options as well as the proximity between the two facilities.

Study Areas

Applied Use of People Movers

The world's first airport people mover is dated back to 1971 at Tampa International Airport. However, there aren't any documented cases of connecting economic drivers such as the airport and seaport; there are airport people movers that are common in the United States as well as at hospitals and within downtown districts. Other examples are Lake Buena Vista, Florida: Disney Monorail, Disneyworld; Detroit, Michigan: Detroit People Mover-elevated loop system; Jacksonville, Florida in the form of a monorail (the Jacksonville Skyway and Downtown People Mover); Miami, Florida: Metromover; and Las Colinas, Dallas, Texas-Las Colinas APT System. These examples are only a few of many other people mover systems in the U.S. and Europe.

Miami International Airport in Florida was selected because of the land-locked nature of the site and the location for international trade and flights to Latin America, the Caribbean and Canada. This site is relatively in close proximity,-26 miles-to the main case study of Fort Lauderdale/Hollywood International Airport (FLL) and Port Everglades (PEV). The MIC is also

using an APM system that is similar to the people mover system that Port Everglades and Fort Lauderdale/Hollywood International Airport is using in the case study discussed toward the end of this chapter. The MIA Mover will connect the airport, other ground transportation modes, such as rail, pedestrian and bicycle movements, and the terminals of the intermodal center in a 1.25 mile system.

Miami International Airport, FL

Background and Overview

The location of Miami International Airport (MIA) is influential due to the proximity to tourist attractions, local economic growth and a large population base of Latin Americans and Europeans. MIA has flights to airports throughout the United States, Latin America, the Caribbean as well as Canada. The Miami Intermodal Center (IMC) at the Miami International Airport is

> "planned to ultimately serve as the transportation hub for the airport, connecting air, rail and ground transportation systems. Additionally, retail and passenger services will be included within the facility, and provisions have been included for potential future developments. The project includes future plans for the construction of an APM to transport passengers between the terminals of the MIA and the MIC facilities" (Valente, 2008).

The origin of the MIC was found in reports dated in the early 1980's when the city anticipated a need to create connectivity of transportation options to the region due to growth and economic development in the southeast.

Model

The "MIA Mover," is a 1.25 mile system that will connect the Miami International Airport terminals with the MIC. The MIC is an off-airport multi-modal transportation center that connects regional rail, bus and rental car facilities. With the center, transfer to and between modes of transportation will be smooth and efficient.

> "To cope with the increasing numbers of users of the airport and nearby facilities, the APM system- a driverless, automated passenger transport system- was selected to replace the bus system currently used for transportation between the airport terminals and various facilities located in the immediate vicinity, including car rental offices and rail stations used for commuting. The APM features rubber-tired vehicles providing for low-noise, safe operation and a smooth and comfortable ride" (JCN Network, 2008).

The deployment of APM and PRT is beginning to be deployed at other airports. However, it is not a new concept. In the 1970s Morgantown, VA implemented one of the first PRT systems that started off being a new transportation method at the time. The system connects three Morgantown campuses of West Virginia University and downtown Morgantown. The single line is 3.6 miles long and contains five stations (Presbyterian College, 2007). The uniqueness of this PRT system in particular is that it can operate on an on-demand needed basis. The PRT vehicle can bypass stations so that any station can be reached non-stop from another location. On-demand service means that there are relatively little to no waiting time due to the direct capabilities of moving people straight to their destinations. During the low-traffic times, the PRT car will stop at all stations.

However, the Morgantown system "suffered teething problems resulting in other proposed PRT systems being cancelled and further PRT development languishing for about three decades" (Muller, 2007). Now, modern PRT systems are being developed and have much smaller vehicles than the Morgantown PRT and other airport APMs. The vehicles at Heathrow Airport in London will seat 4 passengers and are small and efficient for a safe and secure travel experience.

Heathrow Airport, London

Background and Overview

Heathrow Airport in London currently has a PRT system under construction. Once completed, it will be the world's first true commercial PRT system. The PRT system will begin by connecting Terminal 5 with the long-term parking facility and if successful, the system will

extend throughout the airport. The airport application will link the businesses and staff car parks through the access tunnel into a redeveloped Central Terminal Area. ULTra, the new PRT system will replace the existing shuttle buses. With an average of 8,000 passengers per day, the PRT system will save 8.4 minutes per trip.

Model

The PRT system at Heathrow will consist of 18 vehicles. The PRT vehicles are low energy, batteries powered and are driverless. Generating zero local emissions the PRT vehicles will be more energy efficient than their shuttle buses. Additionally, ULTra will help the airport to not only contribute to improvements in the environment but to reduce the congestion on the airport roads (Heathrow Airport London, 2008).

The vehicles travel at 25 mph and are on a dedicated guide-way network that spans 1.5 miles. The wait time for passengers is roughly around 12 seconds, which enables 95% of the passenger's access within a minute or less. The capacity of the vehicle is 4 passengers which enables the travel to be safe and secure as well as light, small and efficient (Heathrow Airport London, 2008).

In the State of Florida, each airport and seaport in a regional area has a specific specialization, which does not allow for the same interconnected grid of transportation networks such as Port Everglades and Fort Lauderdale-Hollywood International Airport and Miami Port and Miami International Airport and their connectability to rail, central business districts and other modes of transportation alternatives. Typically, in Florida, each port facilities are a single site with an internal diversity of resources.

The state of Florida is experiencing many growth-related issues. Issues such as rapid growth population in the past, this year the state is expecting no growth. Growth patterns between the regions are beginning to reach capacity limits, the ecosystems are becoming stressed

and infrastructure facilities are aging. Large scale developments such as shopping centers, large residential communities, such as mixed-use developments and sports complexes will often affect a number of adjacent communities such as cities and surrounding counties.

> Florida's transportation system traditionally has been planned by mode, facility, or ownership. The weakest links are often the connections between modes, such as acces from seaports, airports, and other passenger and freight terminals to highways, rail corridors, waterways, and other transportation hubs (Florida, 2009).

The State of Florida (2009) estimates that there will be 24.4 million residents in the State of Florida by 2025 and that there will be an estimated 92 million visitors by this point as well. This is an increase of twenty-three precent compared to 2003 levels. Many challenges are at stake for the State, such as capacity constraints.

> "Most urban and interregional highway corridors are expected to be heavily congested during peak periods, even after planned transportation improvements are made. More than thrity of the state's airports are projected to be operating at more than eighty percent capacity, the point at which expanded capacity should be under constuction. Florida's seaports must impove waterside, terminal and landside infrastructure to handle rapid growth in frieght and cruise passenger activity. Significant additional capacity is needed in rail and urban transit systems to provide variable options for moving people and freight within and between urban areas" (Florida, 2009).

The airports and seaports are regulated by a set of local, regional, state and federal regluations that influence their depoloyment of intermodal transportaion in specific contexts. These policies standardize the movement of pedestrians among various scales of transportation modes from air to rail, sea and the roadways, integrating into downtown urban areas. The state policies are the 2025 Florida Transportation Plan, Florida Strategic Intermodal System (SIS) and Safe, Accountable, Flexible, Efficient Transportation Equity Act (SAFETEA-LU), Regional Transportation Plan and ISTEA.

State Policy

2025 Florida Transportation Plan

The Florida Transportation Plan is oriented towards land development and transportation relationships and the coordination of these modes of transportation. The policies are to meet the transportaion needs of residents, tourists and business people now until 2025 as well as link modal facilities and create a balanced transportation system. The five goals of this plan are (Florida, 2009):

A safer and more secure transportation system for residents, businessses, and visitors;

Enriched quality of life and responsible environmental stewardship;

Adequate and cost-efficient maintenance and preservation of Florida's transportation assests;

Stronger economy through enhanced mobility for people and freight; and

Sustainable transportation investments for Florida's future.

Florida Strategic Intermodal System

Another policy is the Florida Strategic Intermodal System (SIS) that is developed by the Florida Department of Transportation (FDOT) and "represents a shift in the way the state views the development of an investment in Florida's transportation system. Once established, the system will be used to target expenditures aimed at enhancing Florida's economic competitiveness and will include an increased corridor emphasis in planning and funding projects. The system will be composed of facilities and services of statewide and regional significance for aviation, highway, intermodal rail, seaport, space and transit systems, and accommodations for bicycles and pedestrians" (National Policy Consensus Center, 2003).

The SIS is a transportation system that: is made up of statewide and regionally significant facilities and services, which makes it strategic, contains all forms of transportation for moving

both people and goods, as well as linkages that provide for a smooth and efficient transfer between modes and major facilities (intermodal), and it integrates individual facilities, services, forms of transportation (modes) and linkages into a single, integrated transportation network (system).

The benefits of having a facility that is selected as an existing or emerging project for the SIS in a community includes "1) augmented funding which translates into improved development, operation and maintenance of the facility, 2) a larger amount of jobs related to the construction and operation of the facilities, and 3) increased capacity and access to residential and commercial districts that may be greater than accounted for in the land use plan" (State of Florida, 2007).

Creating a transportation network that provides for the various scales of transit and pedestrian activity while integrating a seamless movement from one vital economic facility to another is important. There are many new transportation technologies available that need to be understood by identifying the type of users or economic systems, the inter-framework of the regional facility, and the connectivity and accessibility of transportation technologies between the two and quite possibly circulation into business and retail centers of a downtown. Identifying the patterns of transportation to each destination as well as the interaction on the site and an analysis of the pedestrian scale will be the basis to provide additional access and continued economic viability to those port regions.

Additionally, the Federal Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), calls for a national transportation system that links all forms of transportation, improves public transportation systems and services, provides better access to seaports and airports and enhances efficient operation of transportation facilities and services (Together,

1995). The 2020 Florida Transportation Plan supports connectivity of facilities through transportation networks though their mission and three underlying goals. Goal 1: Safe transportation for residents, visitors and commerce; Goal 2: Protection of the public's investment in transportation; Goal 3: A statewide interconnected transportation system that enhances Florida's economic competitiveness; and Goal 4: Travel choices to ensure mobility, sustain the quality of the environment, preserve community values and reduce energy consumption.

Goal 3's objective related closely to the overall purpose of providing alternative transportation between the seaport and airport to move people as well as goods more effectively and efficiently. The objectives for this goal is to "place priority on completing the Florida Interstate Highway System, complete a statewide high speed rail system, to improve major airports, seaports, railroads and truck facilities to strengthen Florida's position in the global economy, to improve connections between seaports, airports, railroads and the highway system for efficient interregional movement of people and goods and to manage and preserve designated transportation corridors in cooperation with local governments and through advance acquisition of right-of-way" (Together, 1995).

Safe, Accountable, Flexible, Efficient Transportation Equity Act (SAFETEA-LU):

In addition to SIS, SAFETEA-LU's federal guidelines for statewide regional planning support the transportation plan of intermodal network with feasible goals. Following the transportation plan the federal requirements at a minimum, include:

The projected transportation demand of person and goods in the metropolitan planning area over the period of the transportation plan;

Existing and proposed transportation facilities (including major roadways, transit, multimodal and intermodal facilities, pedestrian walkways and bicycle facilities, and intermodal connectors) that should function as an integrated metropolitan transportation system, giving

emphasis to those facilities that serve important national and regional transportation functions over the period of the transportation plan. In addition, the locally preferred alternative selected from the Alternatives Analysis under the FTA's Capital Investment Grant program (49 U.S.C. 5309 and 49 CFR part 611) needs to be adopted as part of the metropolitan transportation plan as a condition for funding under 49 U.S.C. 5309;

Operational and management strategies to improve the performance of existing transportation facilities to relieve vehicular congestion and maximize the safety and mobility of people and goods;

Assessment of capital investment and other strategies to preserve the existing and projected future metropolitan transportation infrastructure and provide for multimodal capacity increases based on regional priorities and needs. The metropolitan transportation plan may consider projects and strategies that address areas or corridors where current or projected congestion threatens the efficient functioning of key elements of the metropolitan area's transportation system;

Design concept and design scope descriptions of all existing and proposed transportation facilities in sufficient detail, regardless of funding source, in nonattainment and maintenance areas for conformity determinations under the EPA's transportation conformity rule (40 CFR part 93). In all areas (regardless of air quality designation), all proposed improvements shall be described in sufficient detail to develop cost estimates;

Transportation and transit enhancement activities, as appropriate; and

A financial plan that demonstrates how the adopted transportation plan can be implemented.

Case Study

Fort Lauderdale-Hollywood International and Port Everglades

Introduction

Improvements to transportation facilities, such as airports, seaports and railways in the State of Florida are crucial in strengthening the states' economic position. Florida has roughly six hundred and fifty-seven private airports and one hundred and three public airports. With these airports there is sixty percent of the commercial airports that are beginning to reach traffic capacity. Additionally, ninety-four million passengers in 1994 passed through these airports to begin to play an essential role in the leading markets of tourism within our state's economy (Transportation F. D., 1996).

Florida's seaports, like others on the East and Gulf Coasts including New York/New Jersey, the Port of Virginia, the Port of Charleston, and the Port of Savannah, are seeing a diversion of trade from congested West Coast ports. Florida's capture of this booming Asian trade means that the state's roads will not have to experience an influx of trucks carrying goods to Florida markets from other out-of-state ports. Conversely, to capture this trade, the state's transportation system must be able to move goods and people more efficiently and more cost effectively than elsewhere (Council, 2007).

Port Everglades (PEV) and Fort Lauderdale-Hollywood International Airport (FLL) are unique economic facilities due to the relative location to one another (See Figure 4-4). There is roughly two miles between these two facilities. The connectability of the locations has become an issue of access congestion of people and freight driven by the demand of the airport and seaport as well as being a major economic engine in the county. With efforts on synergy between the facilities, the county's goal is to support transit and economic development for the county as well as the region through an Intermodal Center and People Mover. "The People Mover is a

proposed as a system to ease travel for visitors flying into Fort Lauderdale-Hollywood International Airport to their cruise ships at the port. The project would cost as much as $1.4 billion, but designed to boost tourism and would take off congested thoroughfares like U.S. 1 and 17th Street" (Wright, 2008).

Study Project

Port Everglades is the economic powerhouse in South Florida. A gateway for international trade and cruise ship tourism, it is one of the three busiest cruise ports worldwide (Broward County, 2003). "Tourism has always been one of the County's core industries. During 2003, more than 8.5 million visitors contributed $7.0 billion into the local economy according to the Greater Fort Lauderdale Convention and Visitors Bureau. In 2004, the number exceeds 9 million visitors. As a result of the population growth and increase in tourism experienced by Broward County, the air passenger traffic at the Fort Lauderdale-Hollywood International Airport (Airport) and the cruise passenger traffic at Port Everglades (Seaport) have increased substantially" (State of Florida Department of Transportation, 2004).

Both the Airport and Seaport play a major role in the economic welfare of the region. "The Airport contributes more than $2.3 billion to the local economy and employs 31, 500 people either directly or indirectly. The Seaport infuses more than $2.4 billion into Broward County's economy and provides more than 19,000 jobs through its cruise and international trade activity…due to the land locked nature of each economic facility, the Broward County Intermodal Center and People Mover project (Project) is likely to be the only feasible means to provide additional access and ensure continued economic viability for the Airport and Seaport access/egress points" (State of Florida Department of Transportation, 2004).

The airport to seaport interaction show that 32.8% (See Table 4-2) of the current cruise-bound passengers transfer directly from the airport to the seaport. Additionally, there are 34.9%

(See Table 4-2) of the cruise-bound passengers that arrive at the airport a day before they leave on a cruise and stay in hotels overnight. With another 32.3% (See Table 4-2) of regional users such as local residents and employees, there is an anticipated 67.7% (See Table 4-2) ridership of the people mover system (County, 2008).

Description of Project

The Broward County Intermodal Center and People Mover System Corridor Report that is in the Vision 2020 Plan has a framework for future development at each port and the elements that would promote regional transportation and transit improvements. The key elements are listed as the Intermodal Center (IMC) and the People Mover.

Intermodal Center

The Intermodal Center (IMC) is a transportation hub that will provide end connection to the commuters who would use the other regional transit projects to access the Airport and the Seaport. Additionally, the IMC could also serve the requirements of remote parking, kiss-ride and potential joint development.

People Mover

The People Mover will provide an effective mode of transportation between the Intermodal Center and the Airport or Seaport. This will provide convenient access to the employees of the Airport and the Seaport, and to local residents and visitors who utilize these facilities. Additionally, the People Mover will also enhance the capacity to transport multi-day cruise passengers, who use the Airport for their air travel and Seaport for their Cruise. There will be an increased level of service and convenience for multi-day cruisers utilizing the Airport to access cruises at the Seaport. The People Mover will also reduce traffic and congestion along the port and airport roadways.

Observations

Both the seaport and airport are located within two miles of one another and along a major arterial corridor, I-595. The seaport has other major feeder roads such as 17th Street Causeway, I-95, and US-1 (Federal Highway). The linearity of the seaport and airport is considered best for adaptation for transit in contrast to a circular system. The use of the existing highway and transportation framework will provide for the development of a PRT network.

Human Scale

Understanding the human scale and how the pedestrian transfers from one regional facility to the next is an intrinsic part of the understanding of architecture throughout history as Hillier (1984) has demonstrated. The human scale, within space can be manipulated to inspire awe, intimidate, elevate the spirit or reinforce feelings of sheltering and security (Kostof, 1985). Buildings, streets and open spaces are carved out of the urban fabric in order to demonstrate hierarchy and to link together "by a specialized and separate system of spaces for movement" (Hillier, 1984).

Upon observation at the seaport and airport the movement of people within these systems is awkward and disheveled. Theoretically, pedestrians are strangers to the facilities and therefore they are likely to be moving constantly through the spaces. Locals who are accustomed to the regional networks become static factors at the airport and seaport. They have more static relations to the various parts of the system and the communities that surround the sites. The axial extension of public spaces between the facility accesses the transient people through the use of the PRT system, while the overall organization creates static zones, which the locals have more control over their communities and the overall congestion.

The result is that the public space is the movement element of the pedestrians through the existing street grid. Hillier (1984) explains as a string and bead model. The string represents

movement while each bead added to the string represents static movement or a static node. People move to the space, the economic facility, not through it. This is when the public space becomes a static zone.

In addition to the creation of spaces, these spaces are becoming unlivable. The streets are congested within the surrounding communities as well as the highway system is at capacity. There is an estimated 50,000 jobs created between both Port Everglades and Fort Lauderdale/Hollywood International Airport and with that an estimated 32.4% of the employees are expected to ride the People Mover System. The transit facilities in the area, the tri-rail, shuttle services, bus routes and taxis are already underutilized and are not interconnected into the framework of connecting the two ports or to the central business districts of the area.

Figure 4-1. Vicinity Map of Port Everglades and Fort Lauderdale Hollywood International Airport (2 mile distance between two facilities)

Table 4-1. Cruise Passenger Ridership. Peak afternoon projections.

Potential APM PM Ridership				
Cruise Pax Type	Percent (per O-D Survey)	Base	Medium	High
FLL-PEV Direct	32.8%	32.8%	32.8%	32.8%
From Hotels (FLL users)	34.9%	0%	17.45%	34.9%
Other Regional Users	32.3%	0%	0%	0%
Total Anticipated Riders		32.8%	50.25%	67.7%

Source: (Broward County, 2008)

CHAPTER 5
DISCUSSION

> No matter how functional the individual parts of the system may be, the effectiveness of the overall system depends on the interconnectivity of the different parts and modes…Connections now much reach beyond a single mode, to foster an integrated and efficient transportation system. U.S. House of Representatives, Subcommittee on Highways and Transit, June 18, 2002.

Choosing when and how to deploy new technologies; and connect regions and communities to all of the arteries of commerce such as the roads, railroads, airports, and seaports in order to provide a citizen with greater choices and mobility is the overall objective.

Florida has a strategic advantage, its geographic location. The state provides a land bridge between world markets and the nation. But this advantageous geographic location can also be an obstacle to successful trade relationships if the length of the Florida peninsula creates service inefficiencies and higher transportation costs that prevent the state from outperforming its competitors in these two critical areas. In 2005 and 2006, through the funding provided under the state's SIS and SIS Growth Management programs, Florida's seaports made significant headway in connecting their facilities to the major trade corridors that carry goods the length and breadth of Florida's peninsula. It is hoped that the state will be able not only to fund additional road and rail links, but also to accelerate construction. To make an even greater difference in today's competitive environment, however, Florida needs to promote its strategic statewide significant trade corridors for both federal and state funding (Florida Department of Community Affairs, 2007).

Redefining Intermodal and Multimodal Transportation

The difference in promoting statewide trade corridors, efficient movement of people, advances in transportation all lies in the interpretation and definitions of state policies. In order to link regional transportation through the air and seaport as well as all modes of transportation

seamlessly on an economic scale, using specific transportation technologies to create growth and alleviate conflicts of pedestrian and cargo movement needs to be addressed. “One of the most venerated of planning concepts has been the separation of vehicular from pedestrian traffic. And for whose benefit has this been” Vehicles (Whyte, 1988)? Given, vehicles hinder pedestrian access that encompasses a regional network, trying to combine alternative transportation benefits such as automated people movers, personal rapid transit and bus rapid transit allows for the pedestrian to become, literally, an additional transportation unit.

However, the emphasis on intermodal, multimodal transportation and economic development has been used too broadly and delineates conflicting scales. The term “intermodalism” has been used in various applications and typically includes both passenger transportation and the containerization of freight. The inconsistency of the definition fails to address the various scales of transportation in order for there to be an efficient and effective movement among modes. An overall definition of intermodal transportation does not exist. The emphasis of intermodalism is captured in the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991. Section 2 of ISTEA states:

> …to develop a National Intermodal Transportation System that is economically efficient, environmentally sound, provides the foundation for the nation to compete in the global economy and will move people and goods in an energy efficient manner.
>
> A National Highway System (NHS), consisting primarily of existing Interstate routes and a portion of the Primary System, is established to focus Federal resources on roads that are the most important to interstate travel and national defense, roads that connect with other modes of transportation, and are essential for international commerce (United States of America, 1991).

Competition between various modes of transportation has begun to produce a transport system that is fragmented and not integrated into the framework of cities and their infrastructure. In addition to this, research literature has acquired a large number of definitions that merely suggest that there is not a fundamental interpretation of this term. Merriam Webster Dictionary

begins to define intermodal as “involving the use of more than one mode of transport for a journey; used for intermodal transport” (Merriam-Webster Dictionary, 1963). This definition contains a fundamental characteristic of intermodalism, the use of multiple carriers and the trip of one journey. However, the definition lacks detail as well as the variety of scales. Containerization is not mentioned, which most definitions reference neither is the use of freight or passenger movement as the basis of the definition.

The Organization for Economic Co-Operation and Development (OECD), which brings together other countries with the same mission on committing to democracy and a market economy, defines intermodal transportation on its website as: “Movement of goods (in one and the same loading unit or a vehicle) by successive modes of transport without handling of the goods themselves when changing modes” (OECD, 2003). In addition to the vehicle bias, the definition has another serious flaw. Only one mode and two types of routes of transportation are mentioned in this definition. The vehicle can be a road or rail vehicle or vessel which is a fundamental untruth and suggests that the transportation involved is in the form of container or trailer movement. There is no mention of other movement of scales except for freight which is large and heavy. Freight transport is higher volume; long distance shipping that requires larger staging areas to assemble cargo containers and flatbeds. This definition should be considered inappropriate.

The United States Department of Transportation’s Federal Highway Administration defines intermodal transportation as: “the ability to connect, and the connections between, modes of transportation; the transportation between any place in the United States and any place in a foreign country; between places in the United States through a foreign country; or between places in one or more foreign countries through the United States” (Transportation U. D., 2009).

This definition is too broad in that it includes everything and there is a constraint for potential research in this area. The types of modes are not defined, neither is scale mentioned. There is a broad range from national to international clauses and doesn't clearly define whether there is container or non-container moments or movement through air or by sea, rather just the broad sense of the term connections, modes and transportation movements internally in the United States and between foreign countries.

Intermodal is also referenced to include multimodal which doesn't clear up the broad spectrum of the term either. Multimodal in this sense only adds more confusion by definition: "the availability of transportation options using different modes within a system or corridor" (Transportation U. D., 2009). This term is often confused with intermodalism. Intermodal is multiple modes of connections that are access and destination oriented. Connectivity is required within each category but it doesn't necessary need to connect the categories. Multimodal on the other hand is similar in that it is multiple modes of transportation; however, a multimodal system enhances the capacity across modes. Multimodalism is both capacity and access/location driven (Oberstar, 2003).

Containerization seems as though it is the common theme in all the definitions presented. Intermodal transportation in all instances was connected with the aiding definition or correction of intermodal freight transportation. The definitions were typically restricted to freight and not the movement of people or pedestrians. The terms were relatively broad but in some instances there were specific modes that were mentioned within the definition as well as specific corridors or routes. Ultimately, these definitions are varied and varied in the sense of who is defining it and what their overall objective is for intermodalism. This proves that there is not a general

definition of intermodal transportation and the reason why there is such a disparity among scales and transportation systems that often more than not, fail.

It seems almost typical that Congress, other officials and policy makers use the term intermodalism and multimodalism in the broadest interpretations as synonymous of one another. "As part of an intermodal transportation policy, an underlying principle should be to focus on the movement of passengers and freight from one point to another, irrespective of the number of modes involved. This is challenging since transportation policy and funding decisions—whether surface, aviation, maritime, passenger rail, or pipeline and hazardous materials—tend to be made modally and often in a disjointed fashion" (Beek, 2008).

> What is puzzling about the situation today is why we should have undertaken such extensive revisions to urban and locality structures, when the effects of the new forms of spatial arrangement appear, at best, as no improvement and, at worst, as socially damaging. It is often said that changes in the urban surface were the result of the invention and spread of the motor car. This is untenable for one very simple reason: the morphological prototypes of the new urban surface were developed fifty years before the invention of the motor car, and by the time when the motor car was only beginning to penetrate the more affluent regions of society, the diffusion of the new prototypes was under way (Hillier, 1984).

Florida's urban surface, with the principles of syntactic analysis in mind shows a fundamental shift from a system that is continuous, "open, and distributed street system, to one that is discontinuous, that is, divided into a number of relatively closed local domains," as Hillier suggests. The essence of this change is encapsulated in a change in habitual terminology: a street is an open and distributed local event in a larger open and distributed system, whereas the generic term that has replaced it, the estate, refers to a discrete, probably closed local domain with some degree of segregation from surrounding estates" (Hillier, 1984).

In terms of spatiality and interconnection, we have begun to think of systems and facilities as closed and nondistributed. There is a strong tendency to use physical boundaries when planning for transportation systems between economic facilities as well as lacking in internal

hierarchy of the systems from the most important, the pedestrian to the most familiar, the destination (facility) which is connected by the street grid. Ports have generally oriented themselves to increasing industrial production and have failed to support the "non-productive workers whose responsibilities include both the organization of production and the organization of social reproduction" (Hillier, 1984). Therefore, it is the relationship to each of the systems that make the space and the ability to eliminate the concept of non-interchangeable zones or corridors.

Beginning to adopt a more unified and long-range approach to planning policy that addresses causes as well as symptoms; we must get beyond treating such issues as open space preservation, affordable housing, highway congestion, transportation, air quality, and infrastructure costs independently, as if there are no linkages between them. "For those interested in an integrated federal transportation policy, this creates little confidence that the sum of the modal parts will result in a national transportation policy. We have previously addressed this challenge in the context of freight policy and recommended four actions that would help orient policy toward the promises of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). As policymakers again direct attention to intermodal transportation solutions incorporating concerns about the national economy, energy and the environment, incorporating intermodal thinking is vital. While such thinking in passenger transportation has arguably advanced to a greater degree than it has with freight-in part because of increased flexibility and advances in statewide and local planning-decision-making is still too circumscribed within modal silos resulting in suboptimal solutions" (Beek, 2008).

Applicability

In order to have an effective inter-modal transportation system, all modes must be utilized to their full potential and integrated into a seamless system. Honorable Emil H. Frankel, Assistant Secretary for Transportation Policy, U.S. DOT, June 18, 2002

The case study of the Fort Lauderdale/Hollywood International Airport and Port Everglades connectability effort is distinctive due to the proximity between the two facilities (roughly 2 miles). Even though there is such a close proximity to each economic engine, a closer look at Port Everglades and the number of people dispersing through the facility, there is a noticeable spillover effect of the traffic congestion from the port into the existing neighborhoods.

In the Broward County Corridor Report, the project was divided into three segments. Those segments include the Airport, the Port and the area that is located between the Port and Airport. The following criteria were established to meet the needs of the corridor level-analysis (County, 2008):

- *System functionality with People Mover corridor option alternatives:* Options with higher ratings were options that were compatible with the greatest number of options from the People Mover component of the project
- *Property Impacts:* The right-of-way acquisition necessary for the proposed location was factored in, with location entirely on public lands lending to a high rating, and location requiring property acquisition scoring lower.
- *Inter-modality:* The ability of the option to connect to other elements of the regional transportation system was evaluated
- *Environmental Impacts:* The degree to which the proposed location impacted wetlands or undeveloped areas or posed impacts to T&E species was evaluated
- *Security Issues:* The ability of the location to function within the increased restrictions of port access were considered, as were the amount additional infrastructure necessary to make any given option comply with the increased restrictions.

The applicability of Transit Oriented Development in this case would not be efficient. There is a disparity of scales from looking at Calthorpe's (1993) basic TOD layout.

TOD suggests that it will increase pedestrian and transit trips while also reducing the number and length of the automobile trips. The scale of Calthorpe's model that includes a central business district that is designed to link the central city cores, suburban downtown, and other major activity centers doesn't relate to Airports and Seaports, even though they are activity centers in their own sense, through scale. However, the TOD is made up of a commercial area, with civic and transit uses that are integrated into the framework. There are housing opportunities and public space surrounding it which is similar to the Port Everglades and Fort Lauderdale-Hollywood International Airport case study. The densities at that activity center however are much larger and cannot take into consideration the concept of TOD. In summary, the design principles of transit-oriented developments are to:

- Organize growth on a regional level to be compact and transit supportive;
- Place commercial, housing, jobs, park, and civic uses within walking distance of transit stops;
- Create pedestrian friendly street networks which directly connect local destinations;
- Provide a mix of housing types, densities, and costs;
- Preserve a mix of housing types, densities, and costs;
- Preserve sensitive habitat, riparian zones, and high quality open space;
- Make public spaces the focus of building orientation and neighborhood activity; and
- Encourage infill and redevelopment along transit corridors within existing neighborhoods.

The ports do not work in the framework of a TOD because they would need to be more transparent and have an integrated network within the facilities. Ports have the capacity or availability to be transit oriented but without the development part of TOD and integration of residential housing units.

PRT works exceptionally well in the case study due to the organization around short trip distances from one point to the other. Table 5-1, shows the distance traveled with each PRT system in the study area and within the case study. Each application, the distances are effective primarily because of the short distance, under 5 mile track that they travel between stations. The development of the activity center is distributed according to how much market capture any given center could support based on limited regional connectivity. In the Miami International Airport as well as the London Heathrow Airport, the use of PRT or APM is limited to under a five mile radius from the airport to the intermodal centers.

The People Mover project and the Broward County Intermodal Center is likely to be the only feasible means by which the county is going to be able to provide additional access and ensure that the Airport and Seaport have continued economic viability. Both the Airport and Seaport are located at the east end of the county near the coastline. The landlocked nature of each economic engine as well as the access corridors of I-595, US-1 and surface streets, it is very unlikely that the traditional roadway improvements will suffice in providing the access that is necessary to meet the demands of passengers, employees and freight.

Additionally, the policies that regulate seaports and airports focus mainly on cargo and not on pedestrian movement. Agencies, whether economic development or department of transportation fail to place an emphasis on moving passengers from one activity center to another and the various modes that need to be used. Global connectivity is unsuccessful at the state, regional, and local scales and needs to be addressed more closely through the breakdown of the scales that pedestrian movement is coordinated.

Table 5-1. Comparison of Distance Traveled with PRT Systems

Site	System Used	Distance of Network
Miami International Airport	APM: Miami Mover	1.25 miles
London Heathrow Airport	PRT: Ultra	1.5 miles
Morgantown, VA	PRT	3.6 miles
Port Everglades/Fort Lauderdale/Hollywood Intern.	PRT	2 miles

CHAPTER 6
CONCLUSION AND FURTHER RESEARCH RECOMMENDATIONS

The seaport and airport facilities are regulated by a set of local, regional, state and federal regulations that influence their deployment in specific contexts and further they are regulated by a set of professional practices as well.

Seaports and airports play a major role in the global economy. The regional scale access to those global facilities is important. In order for the global facilities to operate efficiently, we need to address movement at multiple scales within and throughout these facilities and speeds for a variety of users using new transportation technology. Demand on the airports and seaports are beginning to affect access, shipment reliability as well as highway congestion in urban areas. The ability to reach the airport or even seaport via mass public transportation and not other factors like on-time departures, lost luggage incidents, or the time it takes to clear security in these facilities in crucial in creating a comprehensive framework for the State of Florida and the movement of people efficiently.

Looking Ahead

Looking ahead for the next fifty years, it is critical for the development reasons that we expand the range of options for international airports, seaports and the road and rail corridors that are servicing them. The policies that frame intermodal transportation is used too broadly and with that there is a discrepancy amongst agencies and how they deploy the terminology. The scale from pedestrian to containerized cargo is vast and needs to be broken down into smaller pieces.

Beginning to adopt a more unified and long-range approach to planning policy that addresses causes as well as symptoms; we must get beyond treating such issues as open space preservation, affordable housing, highway congestion, transportation, air quality, and

infrastructure costs independently, as if there are no linkages between them. The movement and scale of pedestrians in relation to the street grid, the economic facility and the transportation network is imperative for intermodalism. “Coordinating the four traditional methods of transportation-road, rail, water, and air-into a system that promotes the seamless transition of people between modes are enormous. Incorporating the human element into a meaning for intermodal transportation may provide the impetus toward the realization of such a transportation network” (Jones, 2003).

Transit-oriented development can be simply defined as “a mix of uses, at various densities, within walkable radius of a transit stop.” A more meaningful definition incorporates the goal of creating a functional integration of transit and surrounding development which each supports and strengthens each other. In the case of activity centers such as ports and airports, TOD doesn’t work well with the scale of the community. Although there are similarities in the context of the surrounding region to support TOD, the context of a port is in sense a large city within itself. TOD are typically located within walking distance of a transit stop or station and are served with light rail, commuter rail, streetcar, bus rapid transit or local bus system. In the case of the Port Everglades/Fort Lauderdale International Airport case study, incorporating the TOD principles and characteristic wouldn’t work due to the magnitude of scale and the unintended consequences of such a large facility.

A transportation network design that encompasses the overall network geometry determines the probably points of density increase. When looking at the transportation network in Boston, Washington D.C. or Paris, it is a radial system that has inherent business centers through which traffic must pass between points. This is in reference to Hillier’s (1986) hub and spoke concept. New York’s transportation network on the other hand is less centralized and is a

rectangular grid. The shifts and amplifications of the local development occur through association with other economic systems, such as the ports, rivers, and bridges. The linear grid is best suited for the adoption of transit in contrast to the circular system. Highways and railroads have already provided the framework for not only development to occur but for the existing land use as well to implement more efficient transportation alternatives.

Recommendations

Further research recommendations would begin to seek out other states and what policies and procedures are being implemented for the movement of people within regional facilities. Identifying other seaport and airport locations to see what obstacles they face with pedestrian movement and what has proven to be effective or ineffective. Further research in security of bringing pedestrians into the airport to the intermodal center and the intermodal center to the seaport or within any combination of travel would be interesting to understand when using a transportation mode such as PRT or APMs. Research in how PRT and APM systems began, where they are currently being deployed and the effectiveness or lessons learned from implementation would be advised for further research.

Exploring international transportation initiatives to understand how relationships between object and space and human interaction and pedestrian movement are being addressed would be useful in aiding more information to the research. Ultimately knowing the zoning and land use is important for integration of a new transportation network and creating transparency between how pedestrians use the PRT or APMs and connecting to existing regional transportation networks.

APPENDIX
GLOSSARY

AGT Automated Guideway Transit-A generic term that includes all advanced systems with automated, driverless vehicles traveling on exclusive guideways or roadways.

CBD Central Business District-The single business and commercial region, which dominates the financial life of an urban region and may also contain a very substantial portion of the specialty commercial activity. (Traditional area of this type of activity, which may have been supplanted by other outlying areas in recent years).

Congestion/Congested- The level at which transportation system performance is no longer acceptable due to traffic interference. The level of acceptable system performance may vary by type or transportation facility, state or local government policy, geographic location (metropolitan area or subarea, rural area, etc.) and time of day.

Controlled Access (Facility) - A street or highway to which the right of way access is highly regulated to maximize operational efficiency and safety of the through traffic using the facility. All persons have a right of access to or from such facilities at the locations and in the manner determined by the Florida Department of Transportation.

Customers-Residents, visitors and businesses that have the need or desire to travel and/or ship goods from place to place.

Density-The number of people per square mile in an urban area.

DOT Department of Transportation

Factors/ISTEA-Sets of factors and criteria in state and federal laws to be considered in the development of long range statewide and metropolitan transportation plans.

Fixed Route-An invariant path over which a transit vehicle is assigned and operated.

FIHS Florida's Intrastate Highway System- A system of existing and future limited access and controlled access facilities which have the capacity to provide high-speed and high-volume traffic movements in an efficient and safe manner.

FTP Florida Transportation Plan- A statewide, comprehensive transportation plan, to be annually updated, which is designed to establish long range goals to be accomplished over a 20-25 year period and to define the relationships between the long range goals and short-range objectives and policies implemented through the work program.

Goals-A statement of the long term end or outcome toward which programs and activities are ultimately directed.

Goods Movement- Movement from place to place over the transportation system of all forms of raw materials, manufactured products, packages and mail and other items involved in commerce. One or more of the following means of transportation may be used: trucks, railroads, airplanes and ships.

GRT Group Rapid Transit- A GRT System that serves groups of people with similar origins and destination. Stations are on sidings off of the main guideway, permitting through traffic to bypass. There is extensive use of switching, and guideways may merge or divide into branch lines to provide service on a variety

of routes. Vehicles have a capacity of ten to sixty passengers. Headways range from 60 seconds down to 3 seconds.

Guideway- Specifically designed way traversed by transit vehicles constrained to the way.

Headway- The time interval between identical points on successive vehicles passing the same point along the way.

HSR High Speed Rail-A fixed guideway transportation system for transporting people or goods, capable of operating speeds in excess of 125 miles per hour.

ITS Intelligent Transportation System- A wide range of advanced technologies and ideas, which, in combination, can improve mobility and transportation productivity, enhance safety, maximize the use of existing transportation facilities, conserve energy resources and reduce adverse environmental effects.

Intermodal- A transportation element that accommodates and interconnects different modes of transportation and serves the movement of people and goods. Intermodal facilities include highway elements providing terminal access, ports, pipeline farms, airports, marine and/or rail terminals, major truck terminals, and transit terminals including park and ride facilities and intercity bus terminals.

ISTEA Intermodal Surface Transportation Efficiency Act of 1991- The most recent federal law establishing planning and programming requirements for surface (highway, transit, bicycle and pedestrian) transportation facilities and services.

Interregional- Generally, travel or trips that traverse two or more countries. This includes travel or trips between metropolitan areas, or between metropolitan and nonmetropolitan areas.

Interstate- Travel or trips that traverse two or more states. Also refers to the Interstate Highway System.

Light Rail Transit- Generally a duo-rail electric traction service which runs at street level (with or without segregation). Passengers board from the street, there is overhead collection of power, and train operations during rush hours do not exceed three vehicles.

LGCP Local Government Comprehensive Plan-An adopted plan of a municipality or county which describes its future development and growth, including appropriate land development regulations.

LRC Long Range Component-Long range part of the FTP, updated at least every five years, or more often as needed to reflect changes in the issues, goals and long range objectives for the ensuing 20 years.

Major Activity Center- A defined urban area where pedestrian traffic is dense-shopping area, school, industrial park, sports complex.

Master Plans-A multimodal study that selects and evaluates various alternatives for provision of mobility within an interstate highway corridor. Master plans provide decision-makers with guidance in the selection of alternatives and meet the requirements of major investment studies. The formal Project Development and Environment (PD&E) process refines the preferred alternative developed by

the master plan and completes the National Environmental Policy Act (NEPA) process.

Metropolitan Area-The geographic area in which the metropolitan transportation planning process required by state and federal law is carried out. The area covers the existing urbanized area and the area expected to become urbanized within 20 years (See also Urbanized Area.)

Mobility- The ability of people to complete desired trips or for goods to be moved from place to place.

Modal System Plans-Departmental plans which provide input to the Florida Transportation Plan (for example, needs and key modal issues). These plans also contain the details of Florida Transportation Plan implementation for development, operation and maintenance of individual methods of moving people and goods (along highways, railroads, in buses, on bicycles, etc.)

Mode- A method or means of travel from place to place (highways, transit, railroads, bicycle, walking, water, air, etc.) or means of transportation.

Monorail- A guideway where vertical vehicle support and later guidance is provided by a single track or rail.

Network- A system of real or hypothetical interconnecting links form the configuration of transit routes and stops that constitute the total system.

Objectives, Long Range- One or more statements, for each goal, that are focused on achieving part of the goal. Objectives are developed considering any legal jurisdictional, or resource limitations to achieving the goal in its broadest interpretation. Specific objectives may be associated with more than one goal.

Objectives, Short Range- One or more statements, for each long range objective, of the specific, measurable, intermediate end that is achievable and marks progress toward a goal. Specific objectives may be associated with more than one goal and/or long range objective.

Paratransit- Those elements of public transit which provide service between specific origins and destination selected by the individual user with such service being provided at a time that is agreed upon by the user and the provider of the service. Paratransit service is provided by taxis, limousines, “dial-a-ride,” buses and other demand-responsive operations that are characterized by their nonscheduled, non-fixed route nature.

People Mover-Becoming a generic term for any slow moving AGT system which is placed in dense urban areas or activity centers. Also a trademark of the WEDway People Mover System at Disneyland.

PRT Personal Rapid Transit-A term restricted to systems with small vehicles carrying one person or one person with related party (up to six people maximum) traveling together by choice. System requires a network with off-line stations and extensive switching. Under computer control, vehicles switch at guideway intersections to follow the shortest uncongested path from origin to destination without intermediate stops. Vehicle headways are usually less than 3 seconds, approaching fractional second headways for high capacity service.

Prototype- A working system or component designed to demonstrate technical operation only.

Public Transit-Service provided for the carriage of passengers and their incidental baggage within cities and metropolitan areas, usually on a fare-paying basis. The term is not applied to intercity transportation.

SCP State Comprehensive Plan- A plan, enacted in Florida law, that provides long range guidance for the orderly social, economic and physical growth of the state. The plan is composed of goals, objectives and policies that are statewide in scope. It is contained in Chapter 187, Florida Statutes.

SHS State Highways System- A network of approximately 12,000 miles of highways owned and maintained by the state or state-created authorities. Major elements include the interstate, Florida's Turnpike and other toll facilities operated by transportation authorizes and arterial highways.

STIP State Transportation Improvement Plan- A program that includes all projects within a state that are funded under the Federal Transit Act and Title 23, developed in cooperation with MPOs and local governments and consistent with local and state long range plans. In Florida, project with state funding are also included.

Statewide (Transportation) System-An interconnected system of statewide transportation facilities and services, the primary function of which is to serve international, interstate and interregional customers. Elements include the Florida Intrastate Highway System, air carrier airports, seaports, multicounty railroad passenger and freight services, interstate and interregional intermodal terminal and facilities, etc.

Transit, Public- The transporting of people by a system, operated locally or regionally, consisting of one or more types of vehicles and/or services available for public passenger travel and mobility.

TIP Transportation Improvement Program- A priority list of projects developed by a metropolitan planning organization this is to be carried out within the three-year period following adoption. The TIP must include documentation of federal and state funding sources for each project and be consistent, to the maximum extent feasible, with adopted local government comprehensive plans.

Travel- The movement of persons or goods from one place to another by one mode or a combination of modes.

Trip- The one-way movement of one person between his or her origin and destination, including the walk to and from the means of transportation.

Urbanized Area- A geographic region containing 50,000 or more residents as designated by the U.S. Bureau of the Census, within boundaries fixed by state and local officials and approved by the U.S. Department of Transportation for transportation planning and federal funding activities.

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BIOGRAPHICAL SKETCH

> Greatness is not in where we stand, but in what direction we are moving. We must sail sometimes with the wind and sometimes against it-but sail we must, and not drift, nor lie at anchor (Oliver Wendell Holmes).

Stephanie Murray is an artistic, innovative urban designer who grew up in Lighthouse Point, Florida. She is the oldest of three siblings. After high school, she attended the University of Florida and received a Bachelor of Arts in architecture. Upon receiving her undergraduate degree she decided to pursue her master's degree in Urban and Regional Planning at the University of Florida and a certificate in historic preservation. She hopes to continue her education and pursue a second master's degree in building construction at the University of Florida.

Her interests in planning include community redevelopment, transportation planning, urban design, seaport planning and coastal management. Outside of school, Stephanie enjoys spending time with her family and friends, being active, the beach, water activities and traveling. Stephanie's goals include becoming a successful planner at a seaport or airport, a sustainable builder, traveling around the world, and continually being a catalyst for change.