

E-STATION FOR NEWARK
FINAL REPORT
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Submitted by

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16. Abstract <p>Many poor urban residents rely heavily on bus transportation. Often they must wait by the side of the road, in inclement weather, possibly in unsafe locations, with little certainty of when the bus will arrive. The poor also lack access to computers and the internet; they are on the wrong side of the digital divide. Both these problems can be addressed simultaneously with an innovative structure called an e-station, a new kind of enclosed bus station that uses technology to announce a bus' arrival. And while patrons wait, they can be introduced to computers and the internet.</p> <p>The e-station is a new type of building for which research, planning and design is a multi-disciplinary collaboration between the Departments of Architecture, Infrastructure Planning, Management, Information Technology, Biology, and Transportation Engineering at the New Jersey Institute of Technology. The academic team is developing the concept in partnership with the New Jersey Department of Transportation, NJ Transit, the City of Newark, private professionals and the community.</p> <p>The project's goal is to research, design and ultimately build a prototype e-station following a two-step process. In Step One, faculty-led student teams, guided by experts, researched available technologies and assessed the appropriate social services that an e-station could offer. The team received community input through a focus group. A conceptual framework was developed for students to design prototypes, which were analyzed by a professional construction manager to establish a development budget. Management students then developed business plan for the e-station. This final report documents Step One, which is complete, and discusses the financing and organizational issues involved in the construction and operation of the first e-station that will be part of Step Two.</p>			
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EXECUTIVE SUMMARY

As a series of enclosed, computer-equipped and staffed bus stations, e-stations improve the quality of public transportation and offer residents easy access to the Internet. The concept of the e-station anticipates New Jersey Transit's adoption of an intelligent transportation system, which will allow estimated arrival times of buses to be displayed in the station. Using kiosks, residents would be able to purchase tickets and plan trips. With banks of computers making the e-station an Internet portal, local residents will be able to receive and send e-mail, make job searches, complete job applications on line, and order goods. A Smart Card system will give access to the interior of the station and will allow those without credit cards to make e-commerce purchases. Each e-station will be sponsored and maintained by a local community organization in partnership with a private entrepreneur.

Research and design for the first e-station was undertaken by faculty and students in the New Jersey School of Architecture at NJIT with the participation of the School of Management and the departments of Computer Science and Transportation Engineering. Over the course of the academic year 2000-2001, students in four different courses took on the e-station as a course project. One studio in the Infrastructure Planning Program conducted research to create a conceptual framework for the e-station and a detailed web-based document. Two architecture studios, one in the graduate and one in the undergraduate program, analyzed potential sites and developed architectural design proposals. A team of students in the Small Business Institute in the School of Management developed a plan for operating and managing the e-station.

The conceptual framework developed places the e-station at the epicenter of four interconnecting networks: urban, transportation, information, and social. Via their use of the e-station, residents of inner city neighborhoods can forge a better connection with each of these networks. Approximately 2,000 square feet in size, each e-station would have a storefront facade allowing people on the street to see the activities going on

inside. An entrance/lobby will be accessible to everyone to wait, to see the bus display, to purchase tickets at vending machines, to use the ATM machine, and to view the information kiosks that provide short-term access to the Internet and travel information. Passing through the lobby, one will enter a secure, semi-public space where the computer terminals will be housed, where the concierge/facilitator will be working and where seminars and workshops can be held. Should the e-station become an e-commerce depot, storage space will allow for the deliveries of goods and for their pickup. As indicated by members of the community who attended a focus group to discuss the e-station, security is a major concern. When the station first opens, a security guard may be needed; over time, as the e-station becomes a focus of activity, the need for a guard may no longer be necessary.

As envisioned in the business plan, a private entrepreneur would provide the computer-related services of the e-station, possibly as a cyber café or a private mail center. The cost of operating and managing the e-station would then be covered primarily from base rents from these businesses and a small percentage of their gross revenue, paid to the station's non-profit owner. Funding for construction would be in the form of grants and construction loans.

Research on potential sites identified Springfield Avenue at South 10th Street as the best location for the first e-station. It receives significant bus traffic and NJ Transit is studying the location for a connecting bus transfer station. The block between South 10th and South 11th is the site of a future supermarket being developed in partnership with CREST, a local community development organization that has endorsed the e-station and is committed to its development. It is possible that the e-station could be incorporated into the supermarket; this possibility was explored in several design proposals. Across Springfield Avenue is Vartech, a locally-owned computer store that currently provides residents with low-cost access to computers and gives workshops. Vartech is also interested in the e-station and could serve as the private entrepreneur for its development, in partnership with CREST.

1 PLANNING AND DESIGN

1.1 Project Description

Residents of many inner city neighborhoods in the U.S. face two kinds of needs regarding access to goods and services. The first need is for improved public transportation. In Newark, for instance residents who rely on buses must wait by the side of the road, unprotected from cold or inclement weather, possibly in unsafe locations, with little certainty of when the bus will arrive. The second kind of need is access to the Internet. Without it, residents are deprived of the many advantages it offers, from e-mail to job information to purchasing goods through e-commerce. As a series of enclosed, computer-equipped and staffed bus stations, e-stations address both of these needs for access.

1.1.1 What is an e-station?

The e-station is a new type of building conceived by faculty and students in the New Jersey School of Architecture. The first and most important function of e-stations is to enhance the quality of public transportation. In Newark, this means providing enclosed bus shelters to increase the safety and comfort of those waiting for the bus and connecting the shelters to an intelligent transportation system. New Jersey Transit is currently studying the deployment of such a system. Within this system, buses on major avenues such as Springfield Avenue will be fitted with electronic devices to transmit digital signals via a cellular network. These signals show the location of the bus using a global positioning system. A computer in each e-station accesses this information and allows its estimated time of arrival to be displayed on a board within the station.

The second key purpose of e-stations is to provide a portal to the Internet. In this way, Newark residents who do not have computers at home will be able to benefit from the opportunities offered by both local and worldwide connections to information, services and resources. The e-stations fulfill the role of an Internet service provider to those people who do not have the financial resources to pay for their own provider or to

purchase their own computers. As an Internet portal, the e-station will offer a variety of community and social services. At the very least, users can receive and send e-mail messages and generally increase their computer literacy. Internet access will enable residents to make job searches and offer the opportunity to complete job applications online. To do this, residents will be able to use the One Stop System currently in place in Newark to discover what jobs are available and to apply for them. An e-station can also serve as a One Stop Center with a career counselor available to provide additional in-person services of the One Stop system.

Other legal, medical and social services information will be available on line. Nurses can be consulted without waiting in doctors' offices or in emergency rooms. Similarly, fines can be paid without traveling to and waiting in court. Information about events and opportunities can be offered through a community bulletin board. And classes can be offered at the e-station to give residents basic skills in using the Internet. As e-stations evolve, additional services connected to the Internet can be developed. One is the opportunity for residents to purchase goods on-line and to have the purchases delivered to the e-station, possibly to boxes rented by individual customers. A Smart Card system would allow those without credit cards to make e-commerce purchases while delivery to the e-station would resolve problems of arranging for the receipt of goods at home when residents are at work.

Each e-station will be staffed by a concierge/facilitator who is always present when the station is open. This person, or persons, employed by the community sponsor or the private entrepreneur of the e-station performs all the necessary tasks of providing services.

In order to ensure the safety of e-stations, access to them will be gained with cards fitted with the necessary bar codes. It is anticipated that eventually Smart Cards will be adopted; these, equipped with an electronic chip, are read through a radio frequency transmission when the card is passed in front of a receiver. Smart Cards would be issued by a local bank or other commercial establishment with payments made with

cash, credit card or money order. Once e-stations also allow for e-commerce deliveries, purchases could be made with the Smart Card. Bus tickets could also be purchased with the Smart Card.

Equipped with pay telephones and an ATM machine, e-stations offer additional services that are often absent or sparse in Newark residential neighborhoods. People without phones in their homes can use the e-station and its voice-mail system as a telecommunication service.

E-stations are a form of mixed-use development following in many ways the model of a traditional train station, which offered customers a variety of services in addition to comfortable and predictable access to train service. E-stations can also stimulate adjacent mixed-use development in the form of laundromats, newspaper stands, dry-cleaners, daycare centers, drugstores and fast food restaurants.

Approximately 2,000 square feet in size, each station would have a storefront facade, adequate seating, storage or other flexible space, banks of computers, a concierge desk, pay telephones, and an ATM machine. E-stations will be sponsored and maintained by local community organizations in partnership with private entrepreneurs.

1.1.2 Why are e-stations needed?

Residents in many inner city neighborhoods, including Newark, depend on local bus service for their transportation. Without private cars and with the expense of taxis, buses are needed to get to jobs, school, medical care, shopping, entertainment, family and friends. Given the loss of stores in many Newark neighborhoods, buses become particularly important as a means of fulfilling everyday shopping needs. A significant number of Newark residents already take buses to jobs in suburban locations⁽¹⁾. While the bus service itself, provided by NJ Transit is adequate in Newark, the experience of waiting for the bus is seriously deficient. In residential neighborhoods, there are no bus shelters to give protection from inclement weather or a place to sit. There is no

indication when buses will arrive and waiting on the street can be unsafe. Improving the predictability, comfort and safety of waiting for the bus is an important aspect of improving public transit. In this way, the e-station is consistent with the state's initiative to reinforce the development of public transit.

The e-station combines improved public transit with access to the Internet. Such access, from the home or a place of work, is lacking in the lives of many poor inner city residents. While computer use and Internet access continue to increase among minority groups, the gap between these groups and the nation at large is widening. Between 1998 and 2000, Internet access rose from 31 to 44 percent in all households in the U.S. However, the increase among African American households was only 11 to 23 percent. In 2000, about a third of the U.S. population was using the Internet at home but only 16 percent of Hispanics and 19 percent of African Americans were doing so.⁽²⁾ Without access to the Internet, minority groups are deprived of significant sources of information and services; the "digital divide" presents yet another disadvantage to them. Lack of access to computers prevents the development of skills, necessary for so many jobs today.

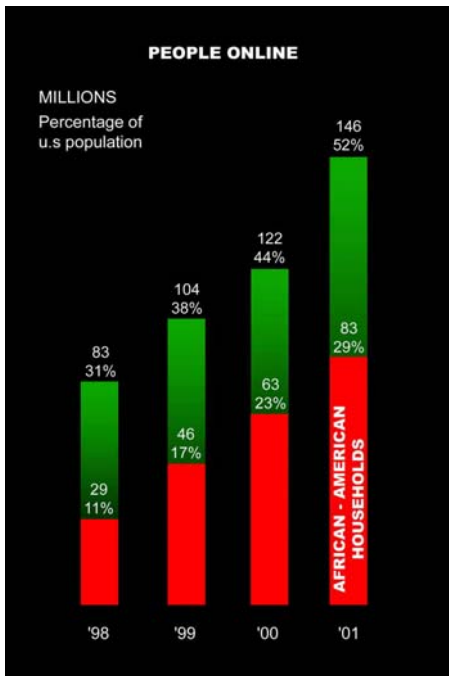


Figure 1 The Digital Divide (www. digitaldividenetwork.org).

Computer training is available in various community and educational organizations; access to the Internet is available in Newark public libraries and, for a fee, in three cybercafes and the lobby of a downtown hotel. Information about job training and employment is offered in One Stop Centers in various locations in Newark. So, why combine computers and Internet access with a bus shelter connected to an enhanced transportation system? There are essentially three reasons. The first is to make computers and use of the Internet as visible and as easily available as possible. One can see right into an e-station from the street; one can enter and try a computer without making an appointment or discovering the organization's schedule. One can check employment opportunities and reply to them with a resume on a regular basis. In this way, the e-station is consistent with federally funded efforts to make job and social service information available on the Internet. Also, one can begin gradually: first using the touch screen format of computers for purchasing bus tickets and then moving on to more involved computer use. The second reason is that by virtue of its location and use as a bus station, the e-station incorporates computers and Internet access into people's

daily routine, combining them with other tasks and activities (such as bus travel, using the ATM machine, shopping at adjacent stores). Third, the fully developed e-station will allow residents to purchase goods online and, moreover, to have them delivered to the e-station. At present, Newark neighborhoods lack commercial facilities, shopping on-line addresses a current need. Delivery to the e-station solves the problem of the reluctance of private companies to deliver to some Newark neighborhoods and can increase convenience for those who are not home to receive packages.

1.1.3 e-stations and Other Technology Centers

The development of information technology, the proliferation of services and information that depend upon it and recognition of the "digital divide" have led to the invention of several types of facilities that increase the accessibility of computer services to low-income populations. One type, called "community technology centers," provides computer access to people who do not have such access elsewhere or who do not have access to additional applications such as the Internet or scanners. Such centers may be part of a larger organization such as a library, job-training center or community-based organization or they may be stand-alone organizations whose primary objective is to provide such access and additional education and training opportunities connected to computer technology. For instance in the Springfield Avenue area in Newark Corinthian Housing CDC gives computer training courses and public access to computers.

One stand-alone organization is Plugged In, in East Palo Alto gives community residents of all ages the opportunity to use computers for research, homework and resume preparation and to take one of 30 different classes. It is also the home of Plugged In Enterprises, a student-run business offering Internet-related services and Web page design. The Community Technology Centers' Network (CTCNet) has provided essential support and guidance in the establishment of such centers since the early 1980s. ⁽³⁾ In these centers, access to computer technology is not a goal in itself but rather the means to reach other educational, social or economic opportunities; it is

expected that many users will be able to take the skills and knowledge gained to pursue additional education elsewhere or to take new jobs.

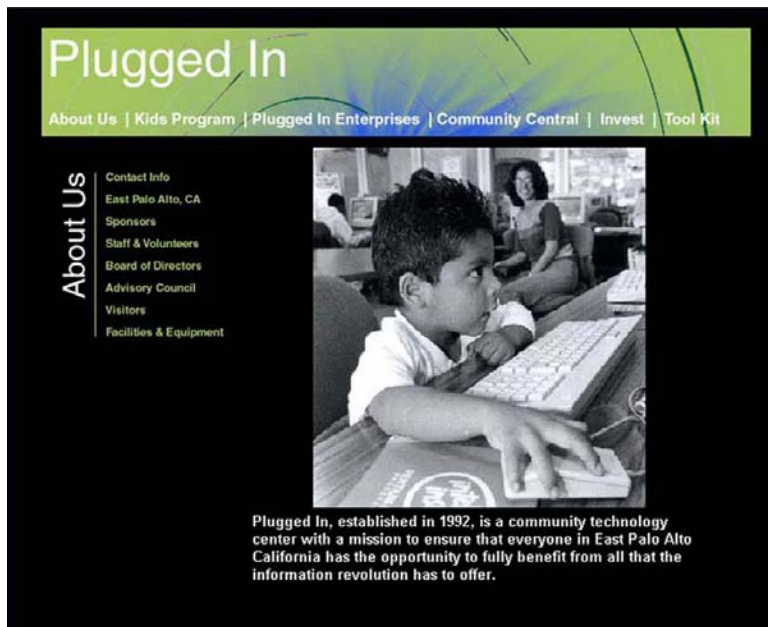


Figure 2 Plugged In Palo Alto, one of the first technology centers in the United States

The e-station bears some similarity to community technology centers since its goal is also to provide computer access at noncommercial rates to low income populations in their own communities and will seek to offer classes and workshops. However, unlike community technology centers, the e-station will be directly connected to public transportation and will make computers easily visible and accessible right from the street. The objective is to introduce computers to hesitant users in a gradual fashion, from first checking trip times and routes to sending and receiving e-mail and then to more intensive applications to make computer use part of a daily routine to fulfill a variety of needs for information and services.

A "televillage center" also provides computer access as well as education and training in low income communities but it provides those services within a wide array of other functions and is located adjacent to major public intersections so it can become the core of a mix of for-profit, not-for-profit and government facilities.⁽⁴⁾ As envisioned, one might pay a parking ticket, meet with a Social Security Administration benefits counselor or

meet with a business mentor as well as using computer technologies for educational or professional purposes. A prototype televillage center, Blue Line TeleVillage, was developed by the Los Angeles County MTA between 1995 and 1997, adjacent to the Metro Blue Line light rail system in the City of Compton. This 2,500 square foot space was located in the city-owned Transit Center and contained a computer center, a video conference center, a telework center, two kiosks for the local housing authority, two ATMs, and a community meeting room.⁽⁴⁾ The Transit Center contained the Compton Chamber of Commerce, a police sub-station, a day care center, a Head Start program, a number of retail outlets and the City of Compton's Business Assistance Center.

The e-station shares several features of a televillage center. It is to be located adjacent to a major transportation route, providing easy access to computers directly from public transit. It is an independent facility, not part of a larger organization, as with many community technology centers. It should be located adjacent to other urban functions so that it can work as a catalyst, bringing customers to these other functions as well as drawing users from them, becoming part of a larger area of economic development and, at the same time, being easily accessible to people as they pursue other activities.

1.1.4 Research and Design for the First e-station

The idea of e-stations is an innovative one that combines elements that are currently available and in use in some places but that have not been brought together in this manner before. How exactly this could be done, what kinds of additional issues have to be considered and resolved, what kind of building is required, and where the first one could be located all required research, analysis and design.

This research and design endeavor was undertaken in the summer of 2000 by faculty and students in the New Jersey School of Architecture under the leadership of Darius Sollohub, Associate Director of the Infrastructure Planning Program in the School of Architecture, and with the participation of the School of Management, and the

departments of Computer Science and Transportation Engineering. The effort was supported by grants from the New Jersey Department of Transportation, the National Center of Transportation and Industrial Productivity and the Casino Reinvestment Development Authority. The e-station concept has received enthusiastic support and input from New Jersey Transit, both the Business Development and Transportation Engineering Departments of the City of Newark, and the following community based organizations: Corinthian Housing, New Visions, CREST, and Tri-City People's Corporation.

After some initial planning in the summer, two graduate studios in the fall semester focused on the e-station: one in infrastructure planning and one in architecture. The studio in the Masters of Infrastructure Planning program assessed the newly available transportation, telecommunication and computer technologies to determine their appropriate interface for the e-station concept. The studio also researched related programs and the social services that an e-station could offer and community needs related to the e-station. The goal of the studio was to define the technological and social infrastructure of e-stations. The studio instructor, Darius Sollohub, and the students met with a number of experts, collected a broad range of information and developed an understanding of the related technologies. With this information and the formulation of a theoretical framework for the e-station, defined in terms of four networks outlined in Section II below, the students created a detailed web-based document for presentation and for exposure on the World Wide Web.

To collect information and elicit opinions from residents in the area of the first e-station, a focus group was led by Professor William Havlena of the School of Management at NJIT in the fall of 2000 with invited residents of the Springfield Avenue neighborhood. The main topics of discussion were transportation, social services and shopping (See Appendix I for report on focus group). During the focus group, residents heavily stressed issues of security and education. Because of this emphasis, education and security became links on each of the five main pages of the e-station web site.

Kyriacos Mouskos, Research Professor at The City College of New York gave a seminar on the state of intelligent transportation in relation to bus rapid transit. He then conducted a literature search and made recommendations for the technology to be incorporated into the e-station.

The second fall 2000 studio, under the direction of Tony Santos in the Masters of Architecture program, developed architectural design proposals for the e-station at two different sites, at Broad Street downtown and on Springfield Avenue. Images of proposed e-stations from this studio appear on the e-station web site, and issues raised in the studio became the basis for a second architecture studio devoted to the e-station held in the spring semester. Information presented on the web-based document and material from the fall architectural studio served as the foundation for an undergraduate architecture studio taught in the spring by Darius Sollohub. This studio focused exclusively on the Springfield Avenue site. Ideas from both architecture studios are presented in Section Three below.

In the spring semester, a team of students in the Small Business Institute in the School of Management at NJIT, under the guidance of Professor Bruce Kirschhoff, used the same material collected in the fall to develop a business plan for operating and managing the e-station. This plan, which incorporates opportunities for private entrepreneurs to work in partnership with community organizations, is presented in Section Four.

The research, design and financial planning for the first e-station, as presented in this report and its appendices, is the first step of a longer process. The research team intends that the information and ideas in this document serve as the basis for additional discussion, for establishment of both a steering committee and a private-public partnership to develop an e-station on Springfield Avenue and South 10th Street. Additional work will include the development of legal arrangements for such a partnership, the selection of a specific site and the determination of its relationship to adjacent facilities (such as the anticipate supermarket on Springfield Avenue), raising

funds for construction and initial operation of the station, coordinating with the community technology network, and the completion of building design and construction documents.

1.2 Infrastructure: Connecting Four Networks

The e-station is at the epicenter of four larger orders or networks. The e-station is proposed for inner city communities in Newark, itself an *urban network*.

Many community residents are important clients of the *transportation* network, depending substantially on bus transportation.

In these same communities, residents have limited access to the *information network*; they are on the far side of the so-called "digital divide" and many have no computer or Internet access.

Residents' connection to a *social network* is strained. They are without direct access to commercial and social amenities: supermarkets, pharmacies, doctors, jobs, and counseling.

The integration of the urban fabric, transportation systems, information networks and the local community, which the e-station aims to achieve, creates a sum far greater than its parts. The e-station does not presume to invent new technologies; nor does it assume an identity possible only in our imaginations. Its success is directly related to the simple and clear organization of existing technologies and systems



Figure 3 View of north side of Springfield Avenue from project site

1.2.1 The Urban Network

The endeavor to develop the e-station concept began with an analysis of the urban fabric. The e-station is proposed for the city of Newark, located at the heart of the New York-New Jersey metropolitan area. The development of the e-station complements the city's recent revival. Beginning in the 1990's, Newark reversed the decline that followed the riots of 1967 with numerous projects: the New Jersey Center for the Performing Arts and the Newark Bears Riverfront Stadium. Beyond the downtown area, there has been significant growth in the residential sector. For the first time in 75 years, Newark has had a boom in residential construction.

Newark's extensive mass transit network has been essential to its rebirth. The e-station engages the transportation network at two contrasting locations. One is downtown, adjacent to Broad Street Station; the other is in the West Side Park neighborhood along Springfield Avenue. Both sites straddle heavily used bus corridors. The studio collated passenger ridership and did field surveys during rush hour at the Springfield Avenue site. Not surprisingly, 60 percent of embarking passengers were outbound, as inner city residents are increasingly employed in suburban locations. Newark's Broad Street Station is a major stop for trains connecting western suburbs with Hoboken and Manhattan. Over the last decade, ridership has increased over 25 percent with the introduction of Midtown Direct service on both the Morris and Essex and Montclair-Boonton lines. The Newark-Elizabeth light rail, which will terminate at the station, will open in 2005, with projected ridership of over 13,000 daily by 2015. When one includes the bus routes that pass it, Broad Street Station is a heavily used, intermodal link.

Along Springfield Avenue, the West Side park neighborhood is home to several well-organized community-based organizations that have played an important role in Newark's residential re-development. The community is trying to restore Springfield Avenue to prominence as a shopping corridor. The neighborhood currently lacks a central focus and is without many amenities. Because it met the criteria for Newark Community projects funding from the Casino Reinvestment Development Authority, the design team focused its research on how the e-station could specifically serve the Springfield Avenue, West Side Park community. The site chosen for construction of the first e-station is Springfield Avenue and South 10th Street. This site receives significant bus traffic: it is adjacent to or very close to four bus lines (Numbers 1, 5, 25, and 42).

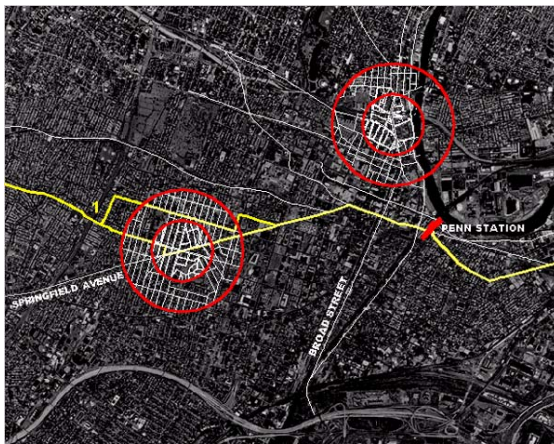


Figure 5 Bus Route #25

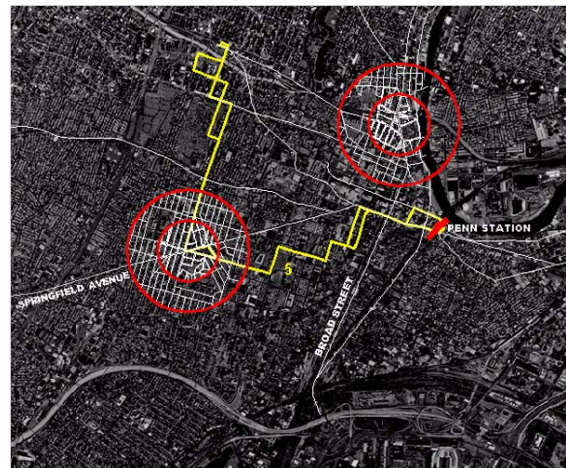


Figure 4 Bus Route #42



Figure 6 Bus Route #70

1.1.1	<u>BUS</u>	<u>TRIPS</u>	<u>RIDERS</u>
	#1	286	16,337
	#5	86	2,760
	#25	301	14,615
	#42	18	352
	#70	101	6,583

According to NJ Transit, approximately 33,092 passengers ride the first three of these buses daily. NJ Transit is currently studying the location for a connecting bus transfer station. The site is also in an area designated for commercial revitalization, including a supermarket. (The choice of this site does not preclude Broad Street or other sites in Newark from being used in the future.)

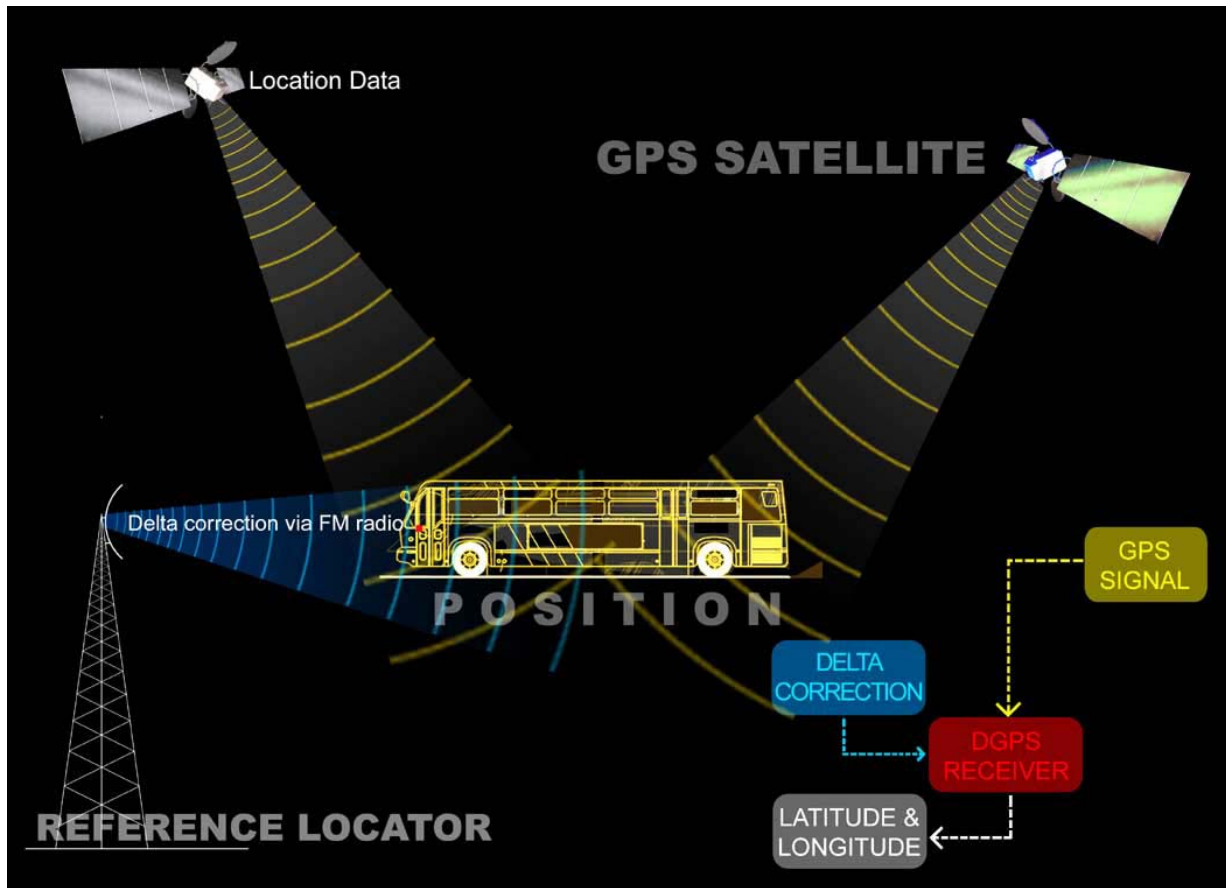


Figure 7 Diagram of GPS enabled bus.

1.2.2 The Transportation Network

For the e-station to function effectively, it will have to become a focus to the community. At the center of activity, full of people, it will project a sense of safety and security. For it to become a success, the community will have to be introduced to the benefits of the e-station. How the e-station improves the familiar transportation network in a new way is an important symbolic first step.

Located in the densest area of the northeast, Newark and its region are challenged by growing traffic congestion. The deployment of an Intelligent Transportation System (ITS) will be critical in resolving this problem. Intelligent transportation systems integrate computer and telecommunication technologies to assist the operation,

development and maintenance of transportation systems. At the e-station, ITS will be able to help users track vehicles, plan their trip and improve the process of buying a ticket. Users will be able to make informed choices about how, where and when they travel based on real time information regarding bus locations, schedules and a multitude of other transit information.

The design team identified three ITS technologies that could be combined to provide real time bus locations to the e-station. The first of these technologies is the existing Automated Vehicle Location (AVL) System that was implemented in Newark in 1994. It uses the city's light poles which equipped with a receiving device, can read transmitters on buses at up to 600 feet. Because the system cannot integrate with newer software, it is currently only used to locate buses in emergencies.

The second technology is the EZ-pass system: an existing regionally deployed, and field-tested ITS technology that can be adapted to determine the location of the bus. Antennas at fixed locations along each route will read electronic tags installed on the bus. However, obstacles like parked vehicles could block the signal. Third is the Global Positioning Systems (GPS), the backbone of any ITS system. GPS tracks signals from satellites and a centralized home location to establish the location of vehicles to an accuracy of fifteen feet. But the signal can be unreliable when interrupted by tall buildings. Ultimately a cost-effective ITS system can be deployed for the purposes of an e-station prototype in Newark by combining GPS with either EZ-pass or the existing AVL system. See Chapter Two.

Another aspect of ITS that can directly affect the user is trip planning. When using paper bus schedules, it is difficult to plan sophisticated trips involving bus transfers and connections to other transit systems. With the help of ITS, the process of planning a trip could be enhanced. Kiosks at the e-station make planning a trip on public transit easy. Instant accessibility to web-based maps, routes and schedules of bus, subway and train allow users to combine several bus lines and find appropriate transfer points to other transit systems. A web based, real time trip planning service is currently under

development by Transcom, a regional transportation organization and will begin to be available in 2001.



Figure 8 Transcom's Kiosk



Figure 9 Transcom's Kiosk

In 2000, the Metro in Washington D.C. implemented a Smart Card system. Smart Card technologies reduce labor-intensive cash handling costs, permit sophisticated fare pricing, allow for automated passenger counts, and link different transportation networks. This is done to better serve the patron in a cost effective way. While New Jersey Transit deployment of a Smart Card system is years away, the technology is becoming widely used and integrated within credit, bank and ID cards. It is always hard to integrate new technology into a system. Smart Cards are perceived, by many, as an unnecessary invasion of their privacy. Therefore, it is crucial to convince users that transportation benefits, like frequent rider discounts, can outweigh any perceived drawbacks.



Figure 10 A Flat monitor touch screen

1.2.3 The Information Network

Exclusion from the digital world is what is meant by the term "the digital divide." The e-station intends to bridge that divide by providing services to less privileged communities in Newark and thereby benefiting those who may not otherwise have access to computers or the Internet. The e-station intends to bridge this divide gradually, by locating information kiosks within its entrance lobby. The kiosk will primarily allow the user to plan a trip and receive real time travel information about current schedules or routes and will be designed for rugged, high volume, short-term use. In addition, the kiosk will provide limited, both in time and content, access to the Internet. For someone who has never used the Internet, the kiosk will provide a first experience in how the Internet can enhance something as everyday as catching the bus.

Additional computers, in a separate, secure location will provide full access to the Internet for those wishing to explore further. This space will also be equipped with telephone, fax and e-mail for members of the community without access to basic telecommunication.

Once initiated to the Internet, a user at an e-station will be able to participate in the world of e-commerce. E-commerce is the fastest growing commercial use on the

Internet with transactions exceeding 37 billion dollars in 2002. At the e-station, with full access to the Internet, residents will be able to shop on-line. As reported in the focus group, residents in the Springfield Avenue neighborhood have limited shopping opportunities nearby; they must travel at least 20 blocks for most shopping and frequently to Hillside, East Orange, West Orange and Kearny. Being able to purchase goods on line will increase their choices and reduce the need for traveling. Residents will also be able to sell their own products on-line. Security issues keep Fed Ex and UPS from delivering packages to certain sections of Newark. To redress this, users will be able to receive goods purchased online at an e-commerce depot within the e-station. Services could be modeled after [empori.com](http://www.empori.com), a Toronto based, e-commerce storage facility.



Figure 11 www.empori.com



Figure 12 www.empori.com

It is a common fear that information stored electronically could be used without authorization. Participants in the focus group reported that privacy is a major concern. Some said they were reluctant to use credit cards, even if they were available and prefer the anonymity of cash. Several group members gave accounts of friends or relatives who received speeding summons because of EZ-Pass. Given that the transportation authorities in the New York/New Jersey Metro area have never authorized police to do

this suggests that this is an “urban myth”. What is important to note is that there is a deep suspicion, especially in the inner city, of any system that can be misused to monitor behavior. Online shopping and e-commerce activities in general are also perceived as threatening privacy. It must be stressed that identity on the Internet is always controlled by the user. Passwords, Smart Cards and firewalls keep a person's information private. Information is only accessible by those who have permission. Thirty-five billion dollars would not have been transacted if fraud were rampant. The benefit of having information stored electronically is that it is always available to authorized users and eliminates the hassle of re-entering lines of information. Given residents' current skepticism about privacy however, it will be necessary to persuade future users of the e-station of the security of personal information.

The e-station will serve to introduce users to the world of the Internet and educate them to its ways. The use of touch screen technology, now standard at the ATM, will be utilized at the kiosk to help initiate the process. Also, technology classes will be taught at the e-station to further develop the community's awareness of developing technologies.

1.2.4 The Social Network

The e-station integrates new technology into the social network of the inner city neighborhood. Nestled within a community, it can become a point of access for social services, now available through the Internet. The One Stop Program is a federally funded program under the Workforce Investment Act of 1998 that seeks to use the Internet to develop New Jersey's workforces. One Stop as the name suggests, connects assessment, job counseling, education, training and employment on local and state levels. Though federally funded through the state government, it is a locally delivered strategy. The One Stop system integrates public and private information systems that provide access to comprehensive employment, training and supportive services, to employers and a population with barriers to employment. The information resource and common meeting ground for this system is the Internet home page called

the Workforce New Jersey Public Information Network, which is accessible to employers, job seekers and facilitators.

One-Stop Career Centers are the delivery points for this system. They are decentralized centers connected electronically, located in social service agencies, community colleges, schools, vocational rehabilitation programs, and employment programs and community based organizations. Currently both Essex County and the Mayor's Office of Employment and Training (MOET) operate One Stop Centers in Newark. Several of the eight operated by MOET are in local communities so that residents can reach them easily. With oversight from the Newark Workforce Investment Board, MOET provides each of its affiliate One Stop Centers with a state-certified vocational counselor, between four and nine computers (depending on the available space) and connection to the Internet and the network. The affiliate partners provide the space and additional part-time space; the One Stop program often complements computer training or employment services that are already in place at that location.

Locating a One Stop Center at an e-station would have clear advantages. It would make the One Stop services very public and easily accessible; it would make using these services extremely convenient. At the moment, the One Stop Centers operated by MOET, open since 2000, are not well known, are not visible to the public and the number of users so far is not as large as anticipated. Having a One Stop Center so visible and so accessible, as it would be in an e-station, could increase its use.

The Families First Card, which replaced food stamps, is a debit card through which Work First New Jersey or welfare recipients receive their benefits electronically. Use of this card has streamlined the welfare benefits process, both for the public agency and the recipient. In the next few years, it is expected that Smart Card technology will integrate the Family First card with the One Stop program. This comprehensive database containing information on benefits, educational qualifications, job readiness,

medical care, accessed through the Smart Card, at any location, will eliminate hassles of maintaining and transporting paperwork, making the system more efficient.

The e-station addresses several effects of the cyber age on cities and its inhabitants. The e-station will help bridge the digital divide by providing access to computers and the Internet. It will reduce the spatial mismatch of suburban location of new jobs and inner-city residents by improving the commute. And, it will reduce the skills mismatch between the skills and educational levels of urban core residents and urban core jobs through the services of the One Stop Program.

1.3 Architectural Program and Design

The four networks provide a conceptual framework for the e-station and indicate the kinds of components that it will comprise. These components and the needs they generate suggest a series of spatial relationships and begin to indicate a physical form for the e-station. Using this programmatic information and the research completed by the fall infrastructure planning studio, students in the architecture studios were able to design an e-station.

Through design research and interaction with the community a diagram of a possible spatial layout was developed. This diagram of spatial relationships does not intend to present a resolved project, but rather the logical interaction of its parts and its relationship to site within the urban context.

The e-station is first and foremost a bus station. The entrance/lobby is open visually, and secure physically while being accessible to everyone. One can wait here for the bus and see the bus display, or under the canopy. Available in the lobby are the ATMs, ticket vending machines, and information kiosks. The information kiosks in the entrance lobby provide high volume, short-term access to the Internet and travel information.

Passing through the lobby the community will have access to the semipublic e-space. Within the e-space one finds the computer and telecommunication center, giving full access to the One Stop center and a variety of social, educational, cultural and commercial services on line, via computer terminals.

The community will be able to order goods on-line. They will be able to pick up deliveries of their Internet purchases at the e-commerce depot. This storage space will be set up much like a P.O. Box center or the aforementioned empori.com.

A concierge will oversee activities in both the entrance lobby and the e-space. The concierge will educate users and will be responsible for management and security of the e-space. The concierge will coordinate the educational seminars but more importantly, the concierge will be able to guide the users through the system from one location. This can be accomplished using current technology, allowing the concierge to enter into any workspace virtually. By scheduling the concierge in two eight hours shifts, the e-station could be open from 6 am to 10 pm, 6 or 7 days a week.

In anticipating of the deployment of a Smart Card by New Jersey Transit, the same Card that benefits users of the transportation network by providing fare discounts, the same card that allows users quick and easy internet access, the same card that affords new employment opportunities, could also enhance the safety and security of e-station. The e-space could be controlled much like today's ATM vestibules. The technology that brought us ATMs twenty years ago was greeted with skepticism. Today they are widely accepted and allow cash withdrawals worldwide. Universal acceptance of Smart Card technology is just around the corner. This will allow the gradual phasing in of the Smart Card as the digital key to the e-space. The Smart Card will enable the concierge to maintain the safety and security of those using the e-station. How much personal information the Smart Card holds is user defined. For those who are still skeptical, a prepaid card like a phone card can be used to provide access, but with certain obvious limitations.

At the focus group, the community stressed the necessity for a security guard, in addition to the concierge, at the e-station. Business owners in Newark have reiterated this point. If the e-station fulfills its promise and becomes a focus for the neighborhood making the community stronger, then the conditions that today necessitate a guard might disappear. The decision as to when and how long a guard is required and what kinds of technology can secure the facility ultimately rests with the community.

1.3.1 Spatial Relationships

Even though the e-station is a relatively small building with a limited set of functions, its design must address a series of complex and often contrasting needs. As conceived, an e-station can be a stand-alone building, placed in an existing storefront, or attached to another building. Whichever option is chosen, it is essential that the computers and other components (such as the ticket vending machines or ATMs) be easily visible and easily accessible from the street. It is important to allow people who are passing by to see for themselves what opportunities the e-station offers and for them to enter and explore for themselves without having to follow a given schedule or to make an appointment. Both transparency and accessibility are key. The activities of the e-station are to be on display. For this reason, designers used glass for the e-station facade and made the computers visible from the street, often locating them directly at the building wall, with computers facing inward to avoid glare on the screens. Insulated glass of standard type and sizes is recommended because it can be replaced quickly and easily if necessary

In its close connection to the street, the e-station becomes a direct extension of the urban network. This urban function is further enhanced when the e-station is adjacent to another kind of outdoor space such as a small plaza or seating area. The adjacency of other services, such as the supermarket, or to day care, further enriches the urban context of the e-station and makes its use even more convenient. While the bus stop must, necessarily, be close to the e-station, it need not be immediately contiguous to

the e-station entry, since bus riders can determine the exact arrival time of buses from the electronic board.

Security is a major concern. Some members of the focus group recommended that a security guard be present at all times when the e-station is open. At the same time, owners of Vartech, formerly located on Springfield Avenue, have had no security problems in their store and feel a security guard would be unnecessary. Nonetheless, the future supermarket at Springfield Avenue and 10th will have a security guard and he could be responsible for the e-station as well. Roll down screens would provide security at night while also being semi-transparent. In some designs on the following pages the concern for security is addressed by making the e-space completely separate from the lobby, requiring a pass, at all times, to enter the e-space. The visibility of activities within the e-station adds to its security, as does its adjacency to the supermarket (which will be policed by a security guard).

1.3.2 Architectural Designs

Designers treated the relationship of the e-station to the supermarket in different ways. In several schemes, it is possible to look into the e-station from the supermarket. These visual connections could be future physical connections between the e-station and the interior of the supermarket to incorporate e-commerce services. In some designs, the e-station shares the supermarket lobby but this does not negate the need for ATMs and the bus arrival display, which are key components of the e-station.

Programmatically, the e-station is akin to a library: you get information and guidance from a knowledgeable person (the concierge) and you go to a specific location to find what you need, or you go to that location directly without any guidance. In either case, the concierge must have a good view of the entire e-station from the concierge space. It is also a place of business, where you buy tickets and, eventually, where you may purchase goods via the Internet and then pick them up. It must serve two kinds of users: those who are just there for a short time, purchasing a ticket, waiting for the bus

and possibly quickly checking their e-mail and those who spend longer periods, possibly a whole day, using a computer. Some designers addressed this difference by having computers at a bar, which are used standing up, and providing computers for longer term use where one sits down. Having two kinds of computers, for shorter and longer term use, also reflects the idea of gradually increasing the involvement of e-station visitors. Initially a person unfamiliar with computers might use the touch-screen on a kiosk; then he or she might try surfing the Internet and eventually could try e-mail and more intensive information searches and production of documents.

At this particular site, the e-station is a small storefront (2,000 sf) attached to a much larger building (50,000 sf). Despite its relatively small size and close relationship to the supermarket, the e-station must have its own presence and its own identity. Some designers achieved this by making it a kind of pavilion, very sculptural (and expensive) in Lenox Brown's design and more modestly but nonetheless with integrity in and Joe DeLucia's. Not only must the e-station have an identity, separate from other adjacent buildings, it must also be welcoming, indicating that anyone who is interested may enter. The intention is to encourage people to come in, to explore the opportunities offered at their leisure and to gain additional expertise as they do so, the e-station should have an informal, relaxed and comfortable atmosphere, allowing people to work alone and to get help from the concierge and from each other. In Nestor Villereal's design, a highly relaxed atmosphere is created by furnishing the e-space with couches, where people can sit, and even lounge around, as they use lap tops anticipating wireless technology. While the e-station should be welcoming and comfortable, it is also a place of business transactions and for activities that require concentration, so it should not be excessively informal or disorganized. As in a library, it is important that people be able to concentrate so all designs incorporate one acoustically absorbent surface.

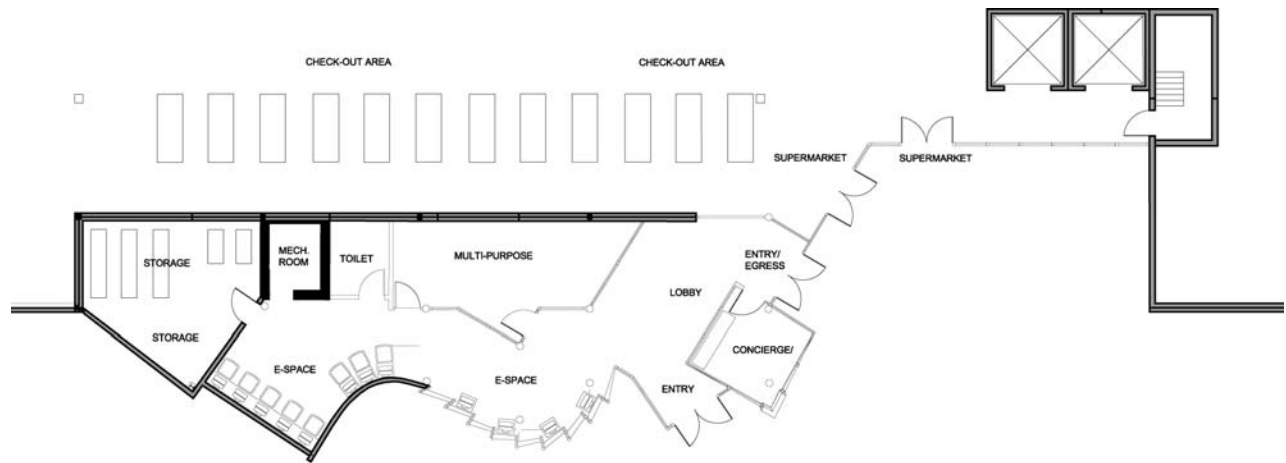


Figure 13 Lennox Brown, Professor Sollohub: Floor Plan



Figure 14 Lennox Brown, Professor Sollohub: View from Springfield Avenue

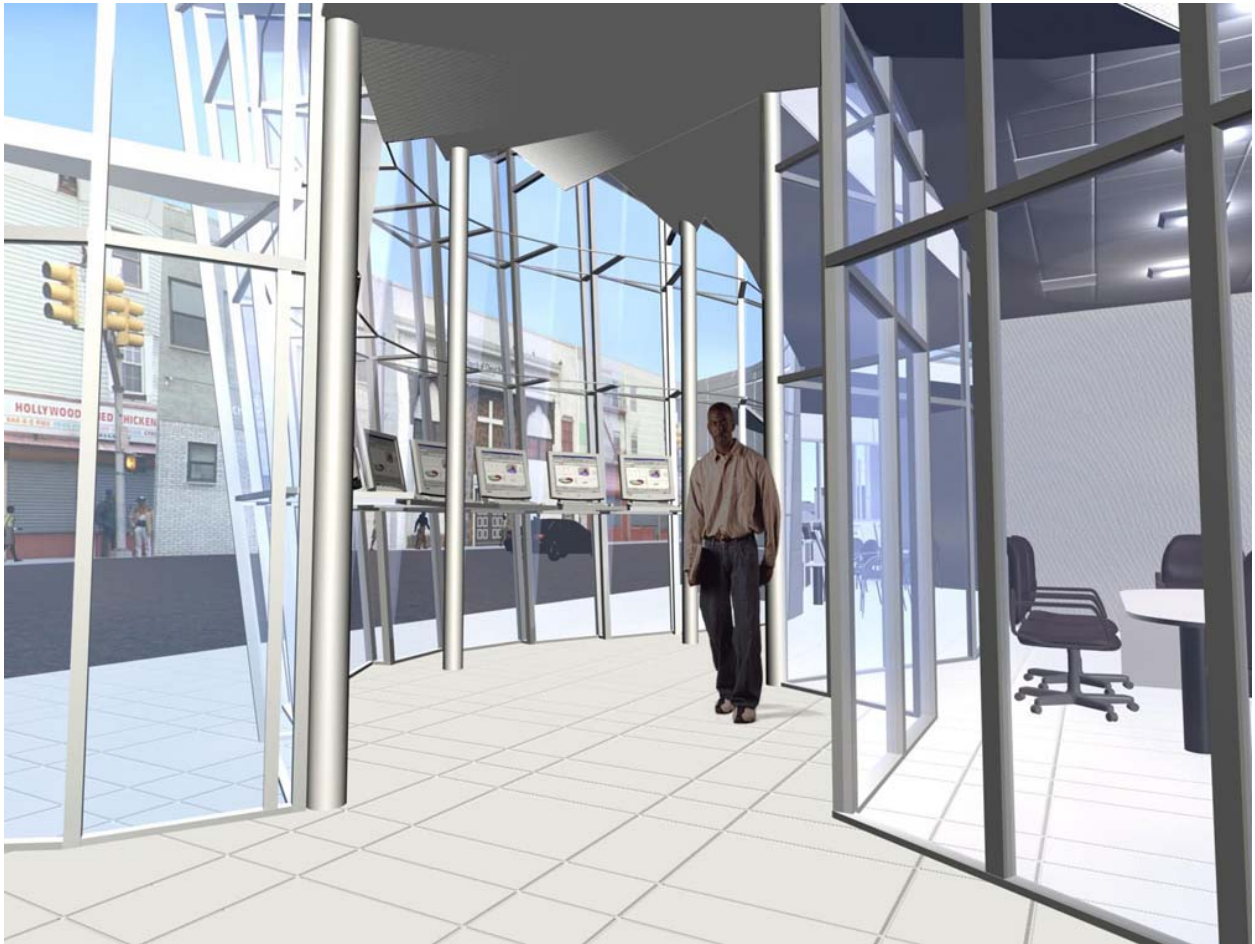


Figure 15 Lennox Brown, Professor Sollohub: Interior view



Figure 16 Lennox Brown, Professor Sollohub: Interior view [right]

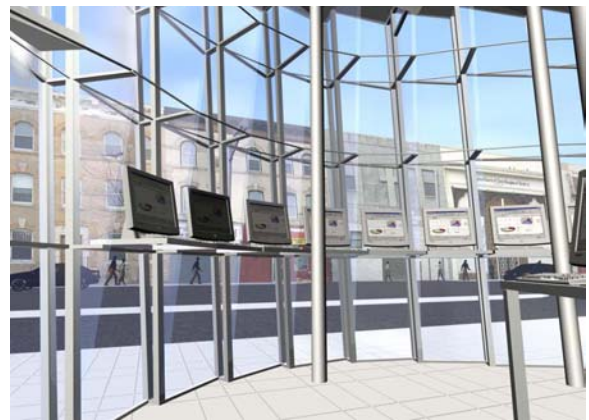


Figure 17 Lennox Brown, Professor Sollohub: Interior view [left]

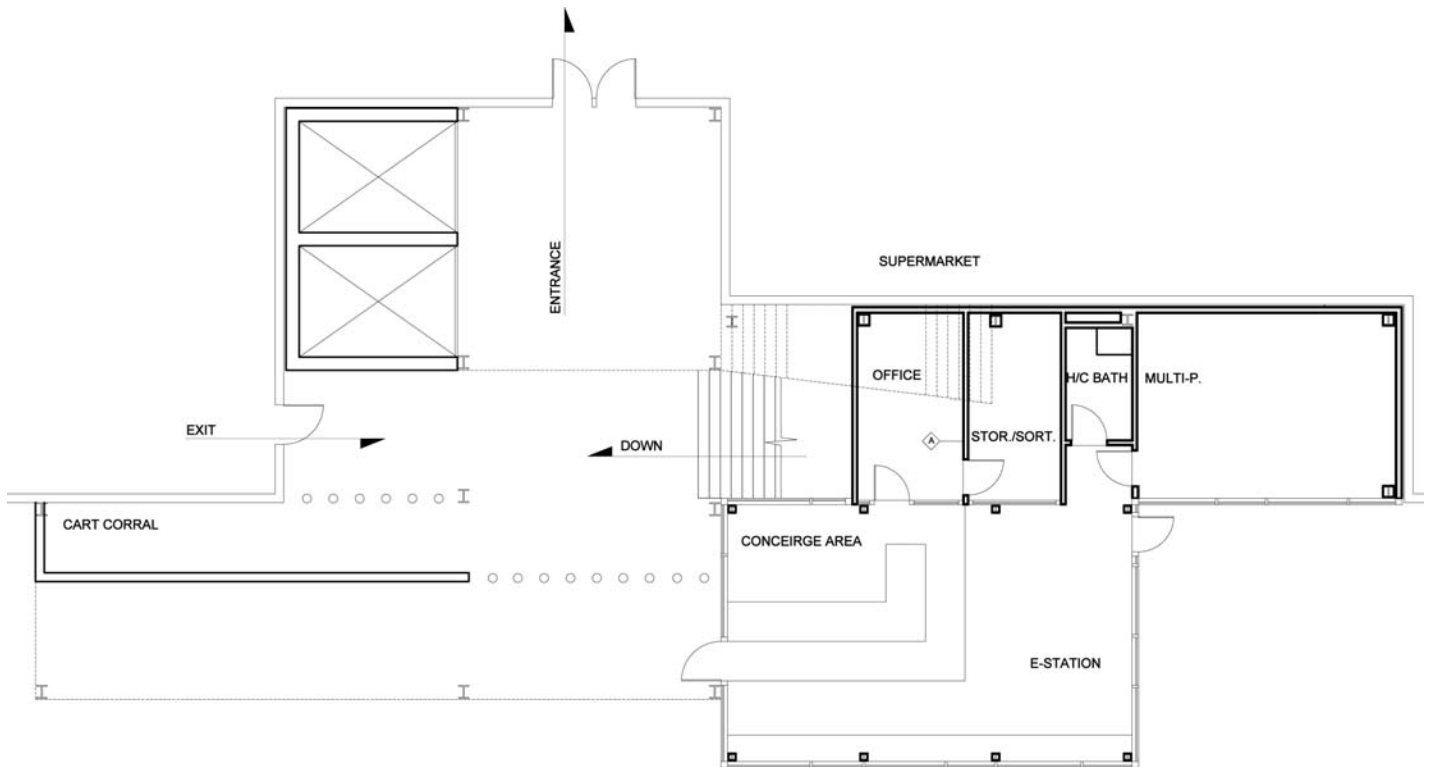


Figure 18 Joseph Delucia, Professor Sollohub: Floor Plan: Scale = 1/8" = 1' - 0"

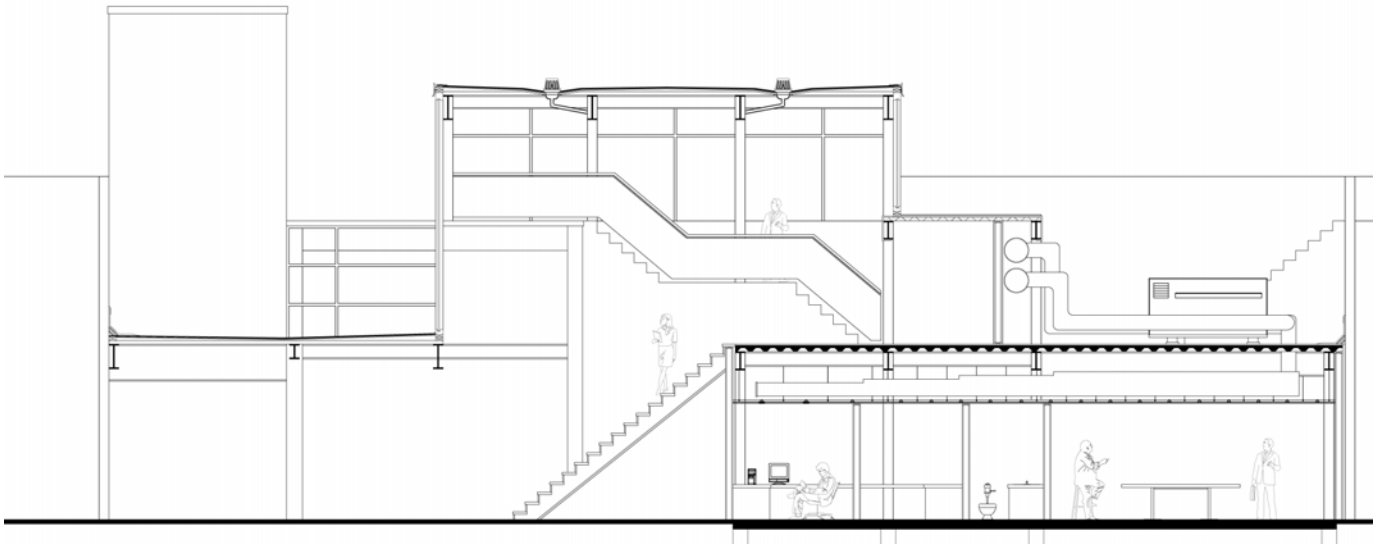
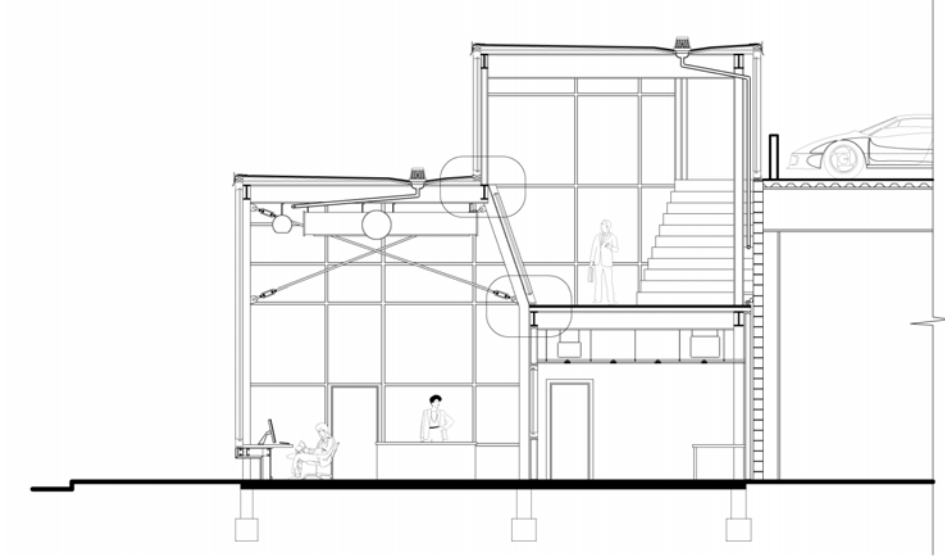


Figure 20 Joseph Delucia, Professor Sollohub: Cross Section: Scale = 1/8" = 1' - 0"

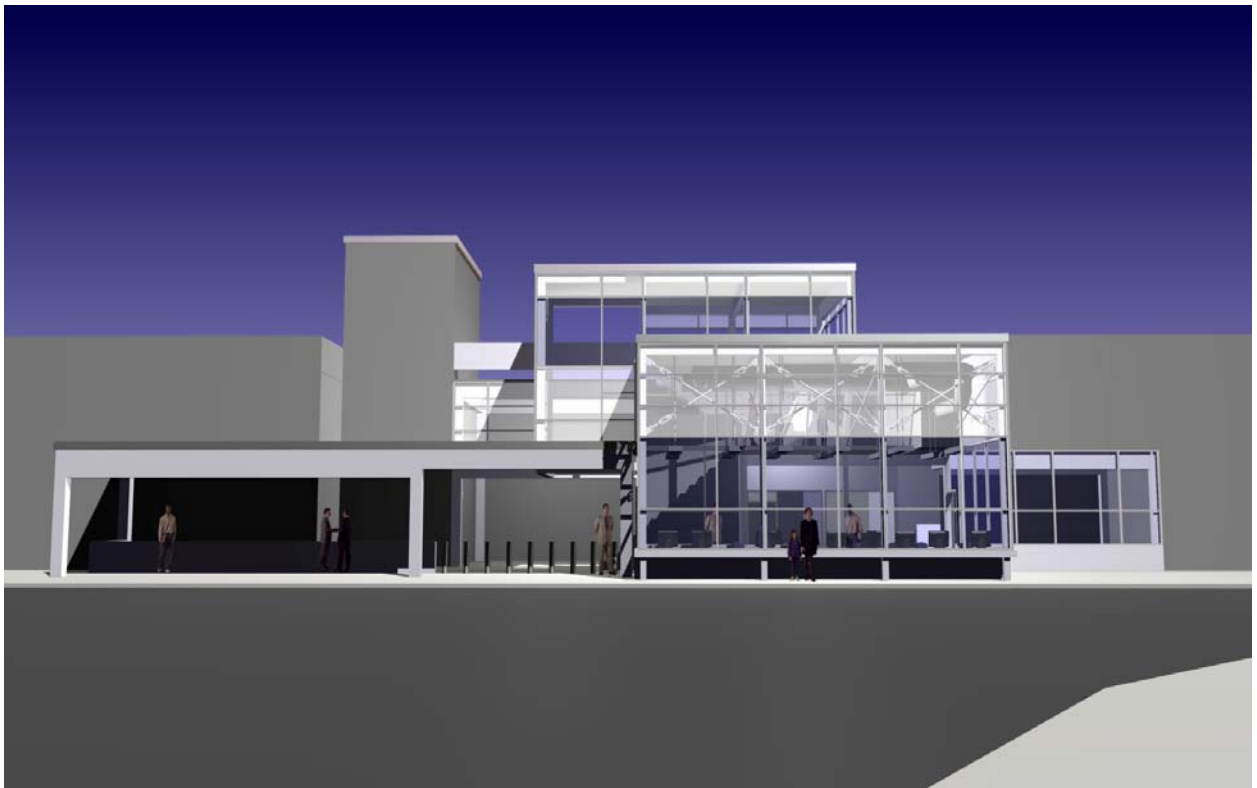
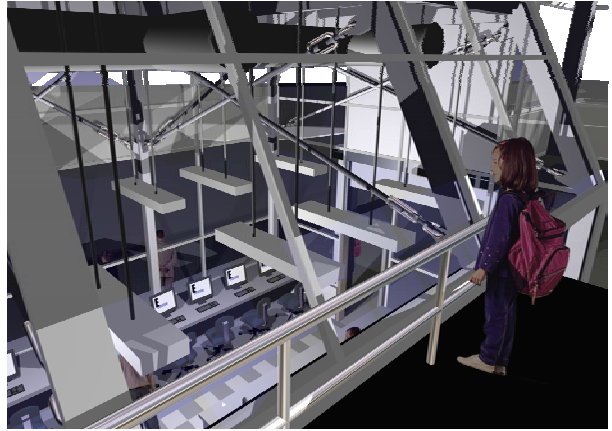


Figure 23 Joseph Delucia, Professor Sollohub: Exterior View, Computer Rendering

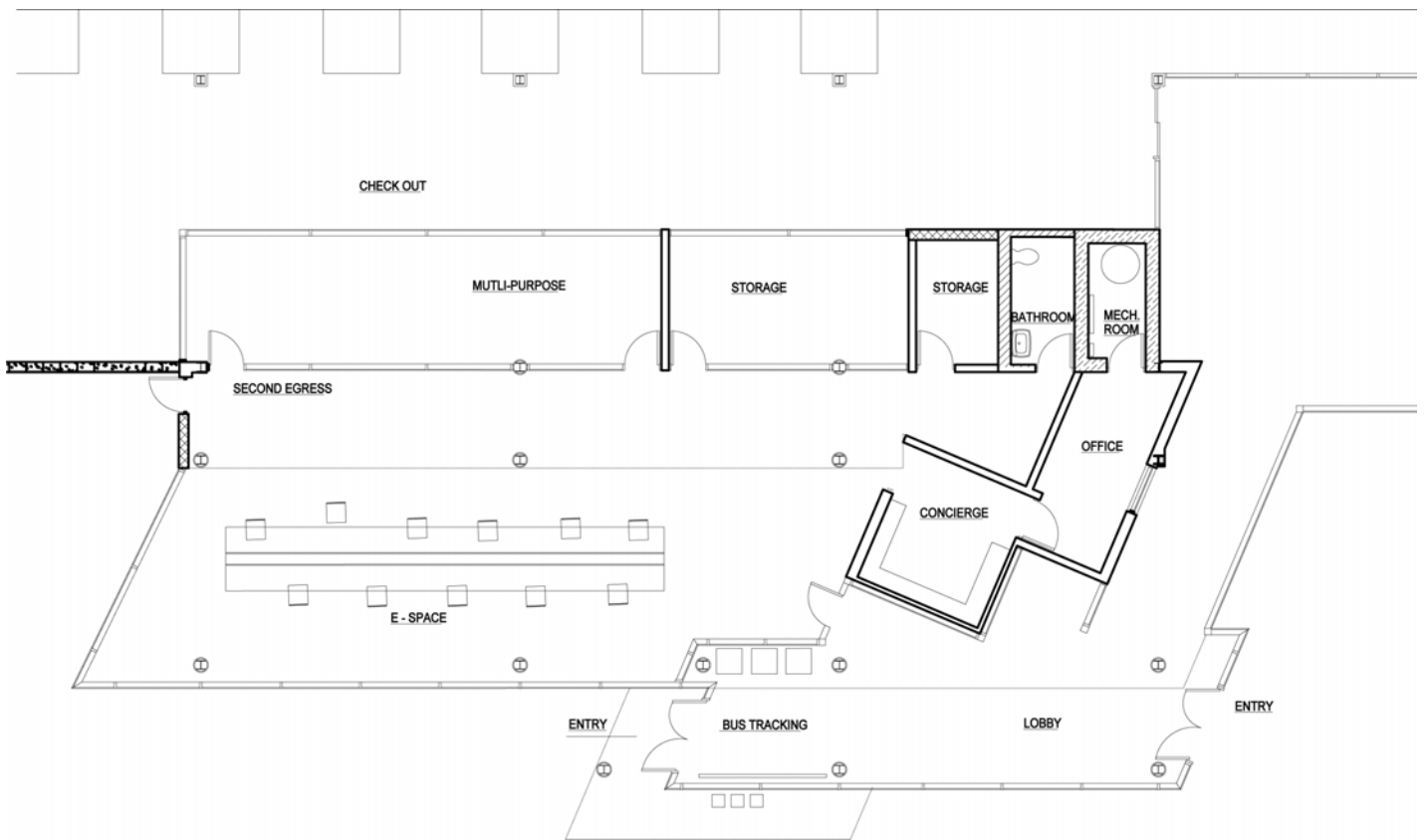


Figure 24 Ersella Kripa, Professor Sollohub: Floor Plan: Scale = 1/8" = 1' - 0"

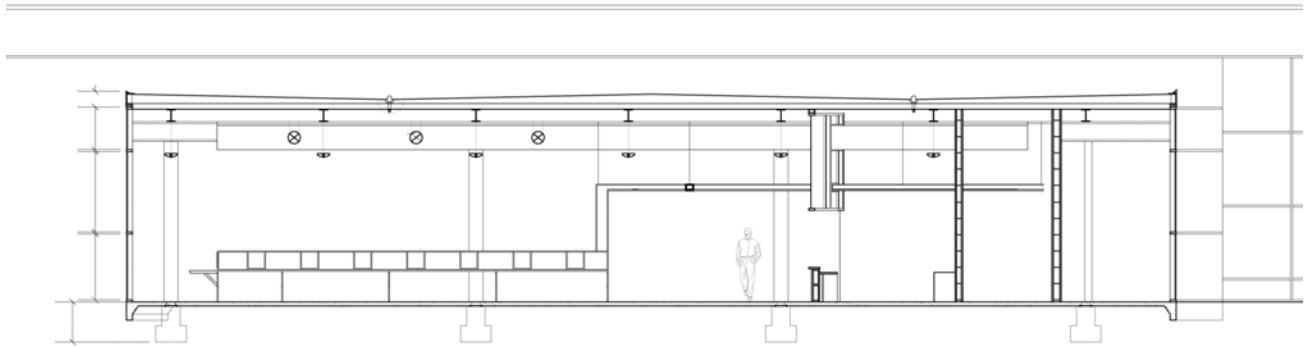


Figure 25 Ersella Kripa, Professor Sollohub: Cross Section: Scale = 1/8" = 1' - 0"

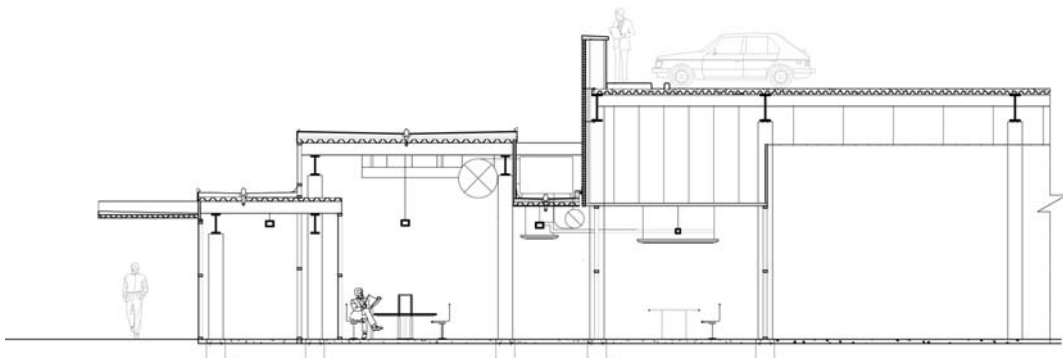


Figure 26 Ersella Kripa, Professor Sollohub: Cross Section: Scale = 1/8" = 1' - 0"

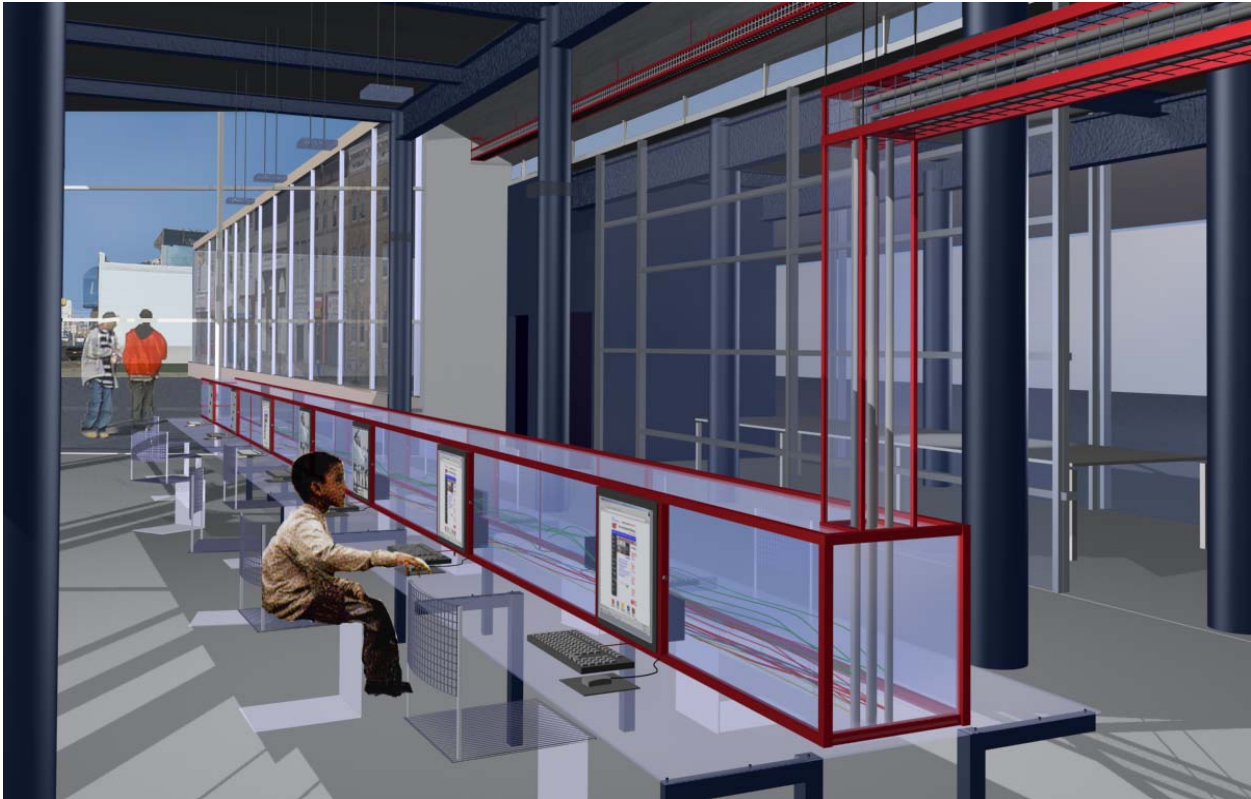


Figure 27 Ersella Kripa, Professor Sollohub: Interior View, Computer Rendering



Figure 28: Ersella Kripa, Professor Sollohub: Exterior View, Computer Rendering

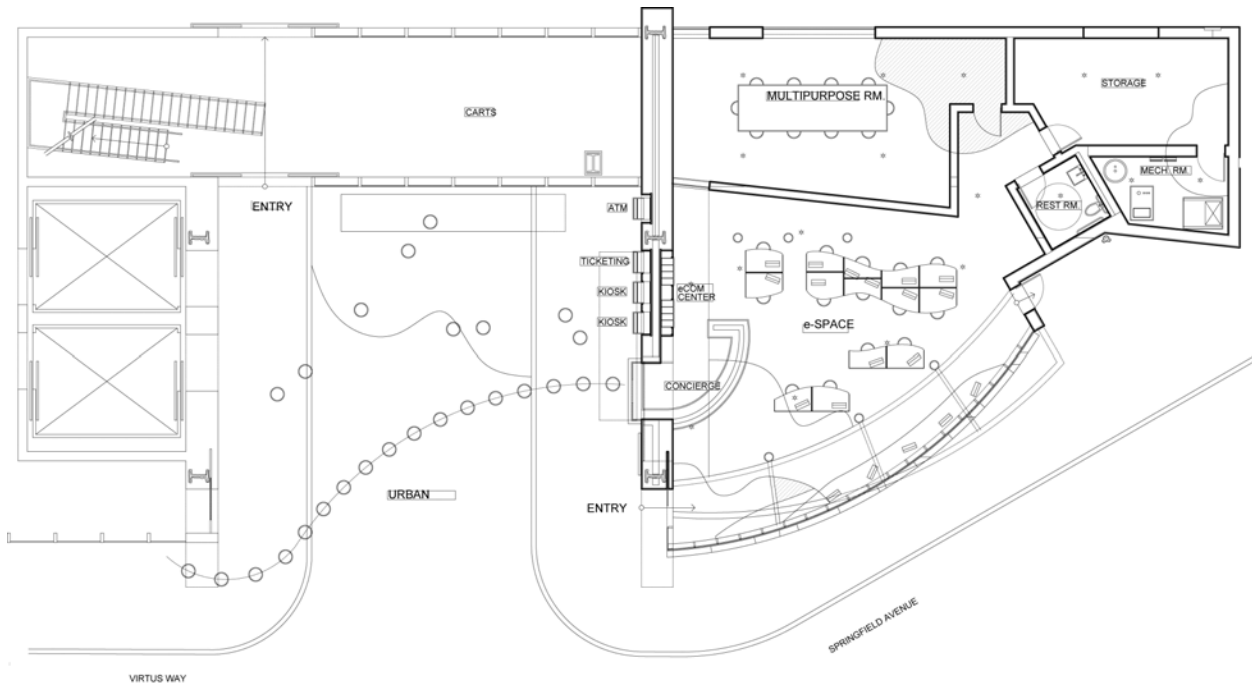


Figure 29: Eric Miller, Professor Sollohub: Floor Plan: Scale = 1/8" = 1' - 0"

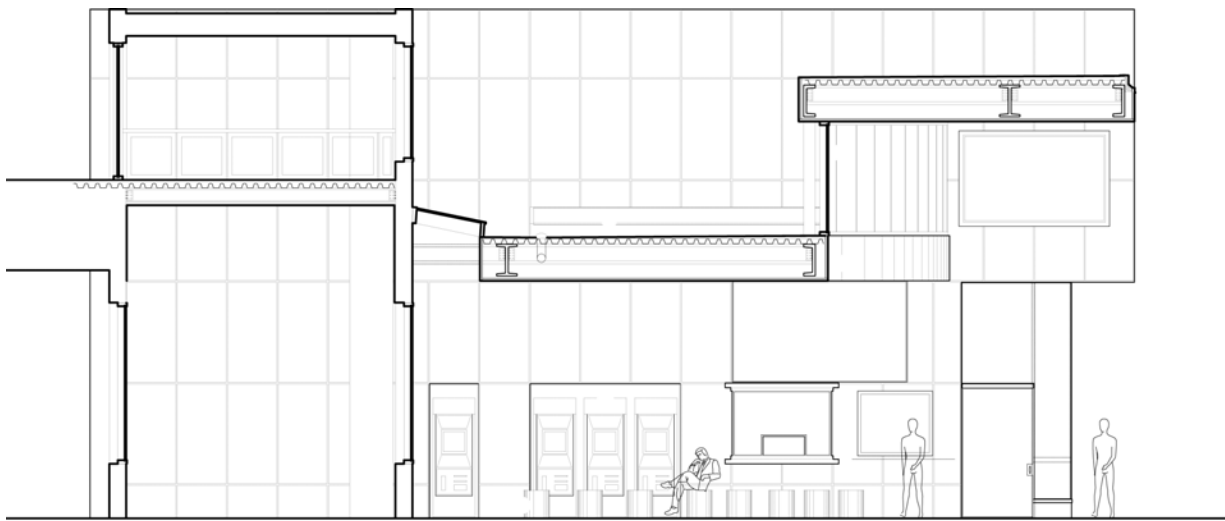


Figure 30: Eric Miller, Professor Sollohub: Cross Section: Scale = 1/8" = 1' - 0"

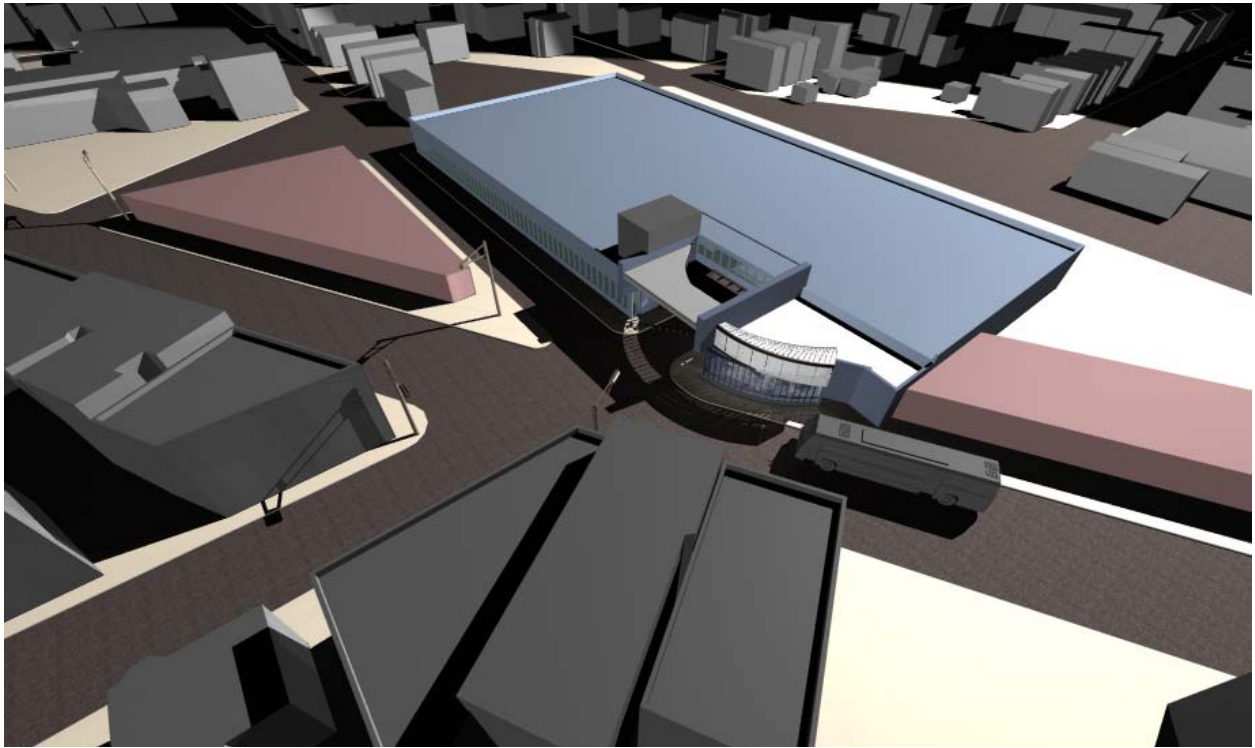


Figure 31 Eric Miller, Professor Sollohub: Exterior View, Computer Rendering



Figure 32 Eric Miller, Professor Sollohub: Exterior View, Computer Rendering



Figure 33 Eric Miller, Professor Sollohub: Interior View, Computer Rendering

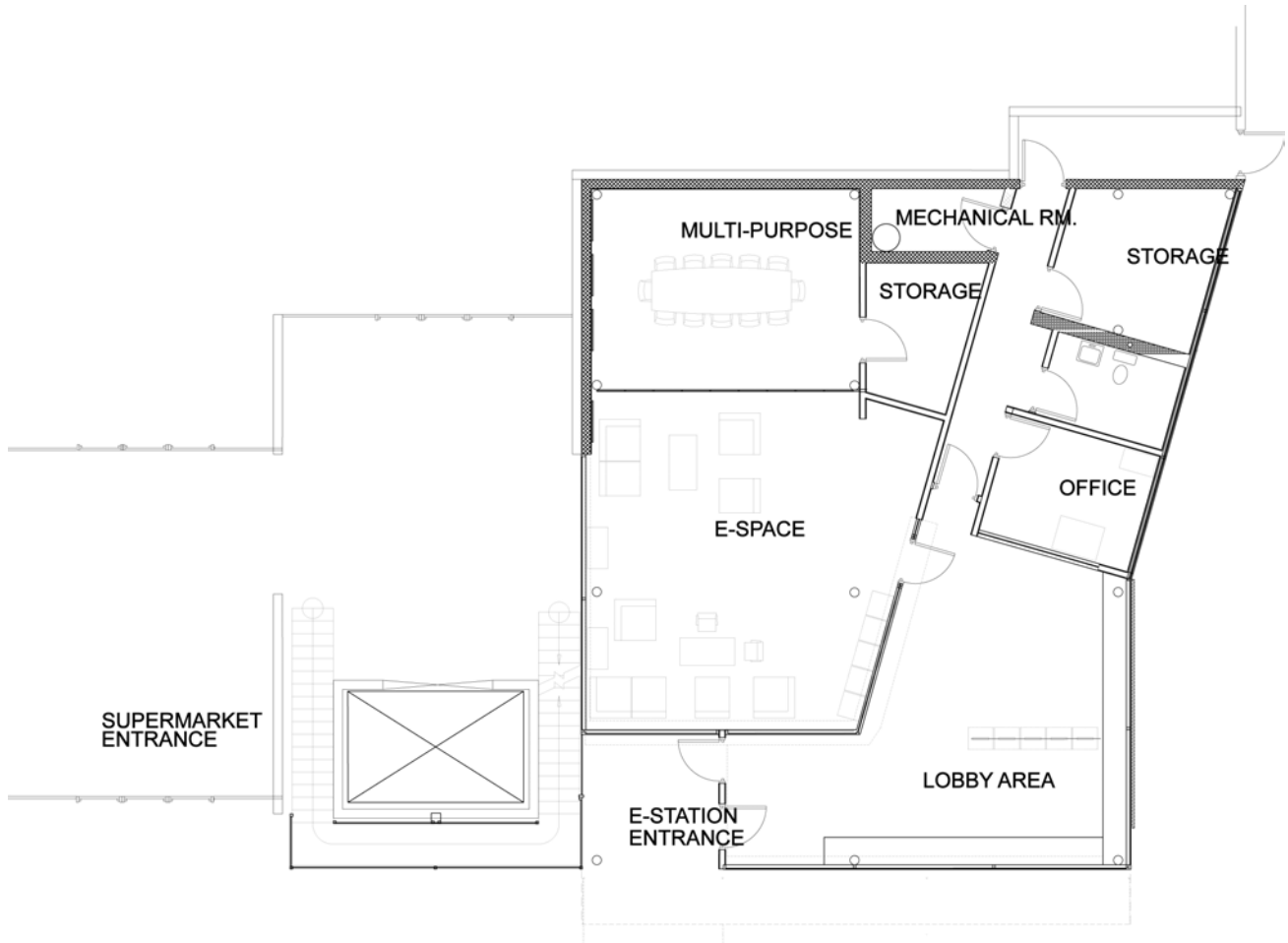


Figure 34 Nestor Villareal, Professor Sollohub: Floor Plan: Scale = 1/8" = 1' - 0"



Figure 35 Nestor Villareal, Professor Sollohub: Cross Section: Scale = 1/8" = 1' - 0"

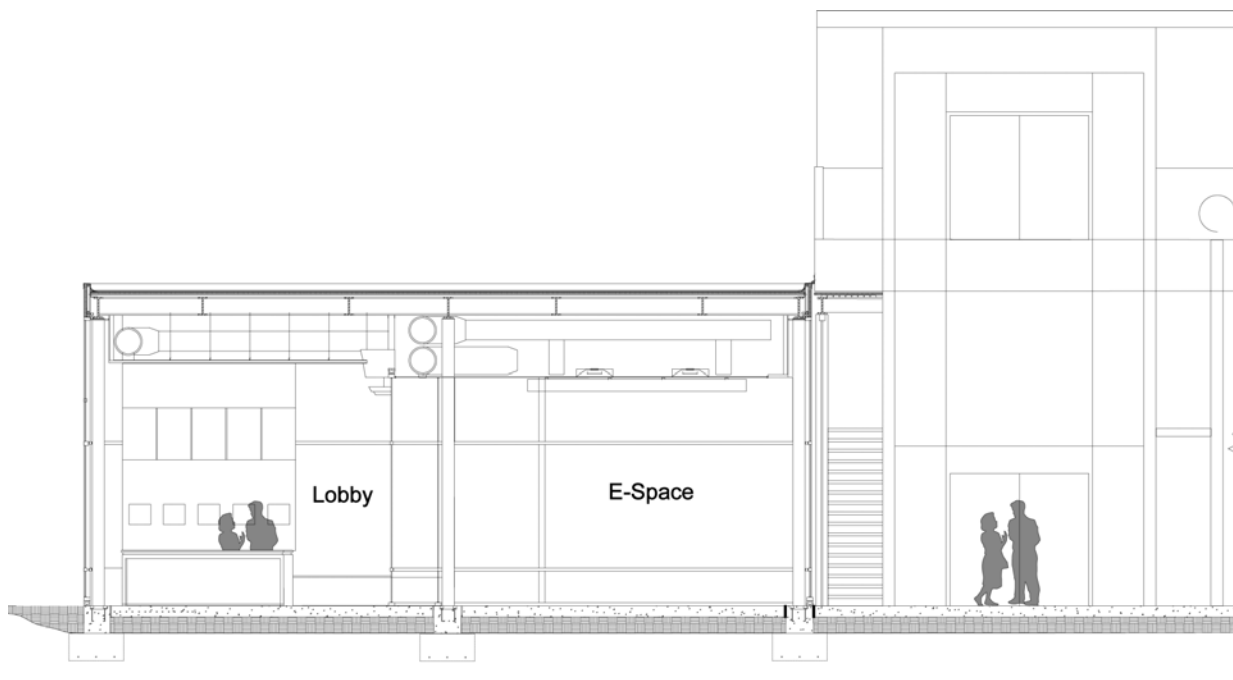


Figure 36 Nestor Villareal, Professor Sollohub: Cross Section: Scale = 1/8" = 1' - 0"



Figure 37 Nestor Villareal, Professor Sollohub: Exterior View, Computer Rendering



Figure 38 Nestor Villareal, Professor Sollohub: Exterior View, Computer Rendering



Figure 39 Nestor Villareal, Professor Sollohub: Interior View, Computer Rendering



Figure 40 Nestor Villareal, Professor Sollohub: Interior View, Computer Rendering

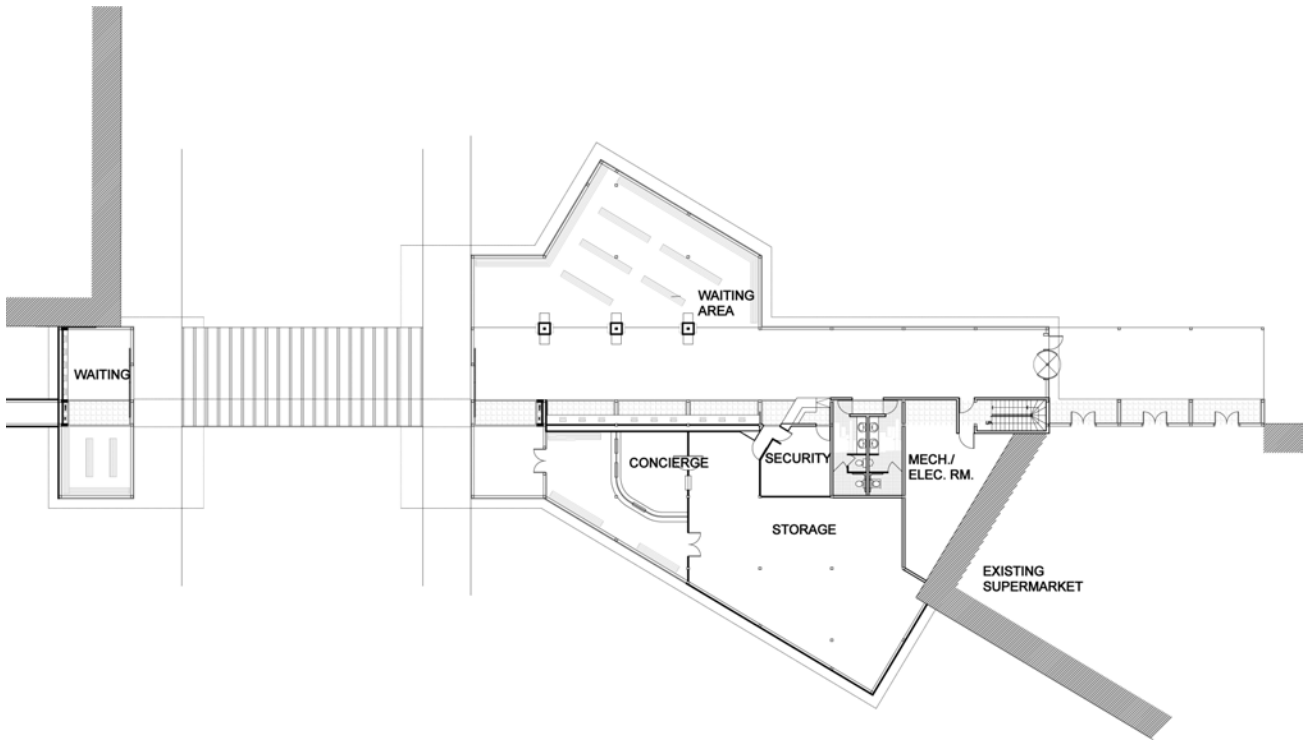


Figure 41 kevin brodber, Professor Sollohub: Floor Plan: Scale = 1/8" = 1' - 0"

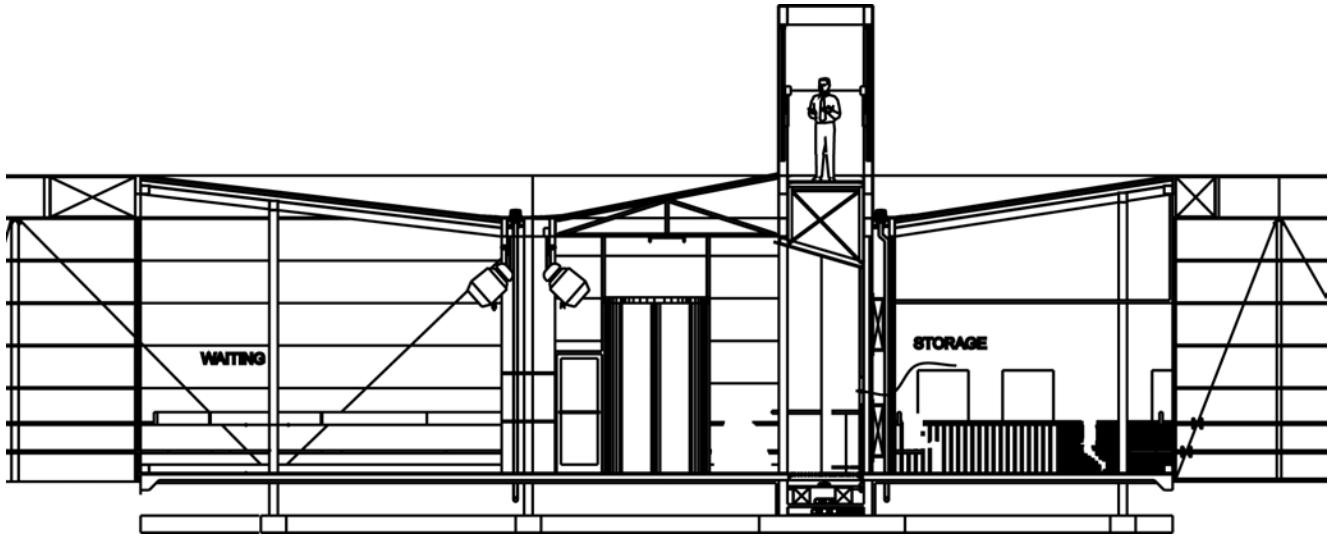


Figure 42 kevin brodber, Professor Sollohub: Section: Scale = 1/8" = 1' - 0"

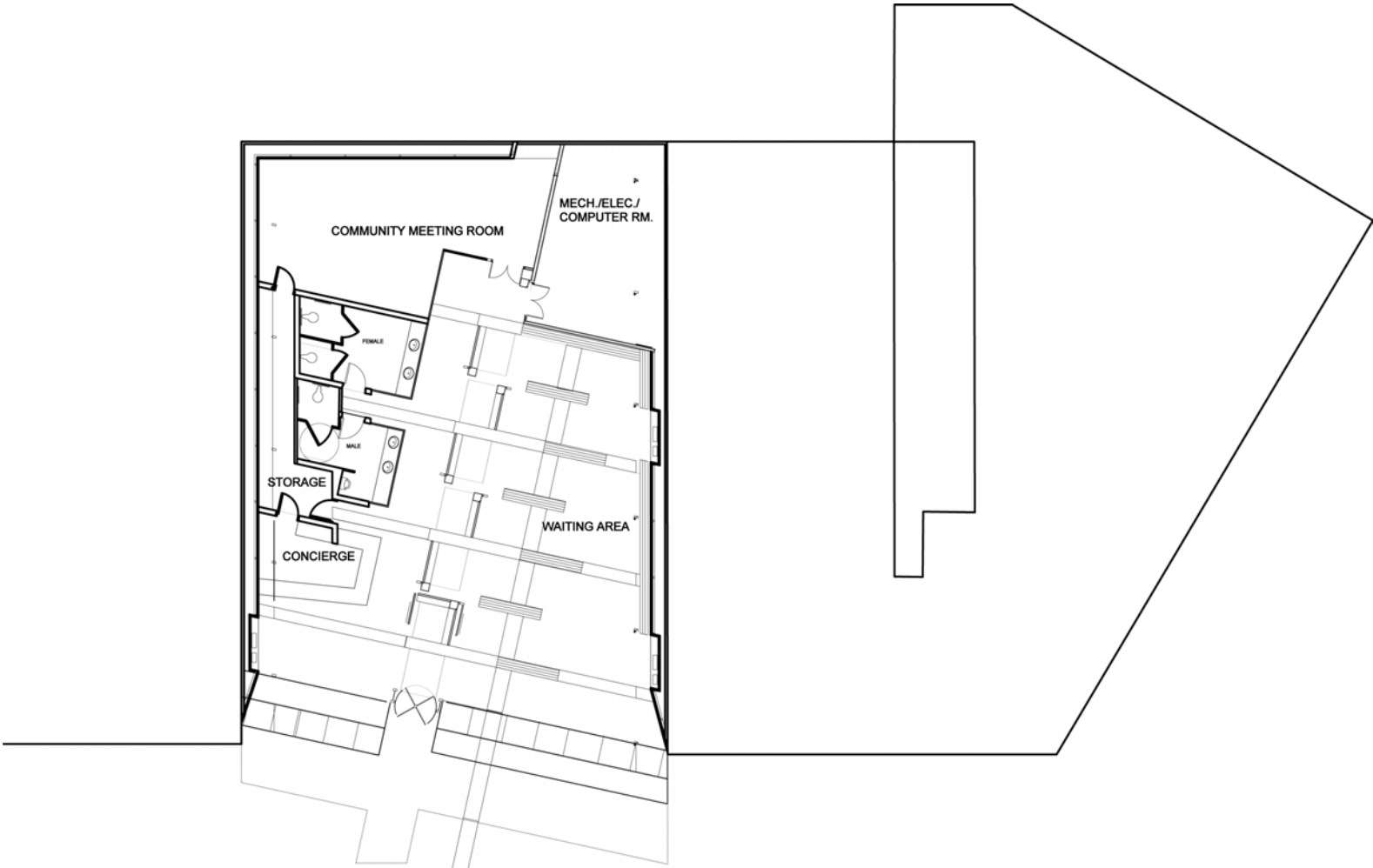


Figure 43 Gregory Minott, Professor Sollohub, Plan 1/8"=1'

gregory minott

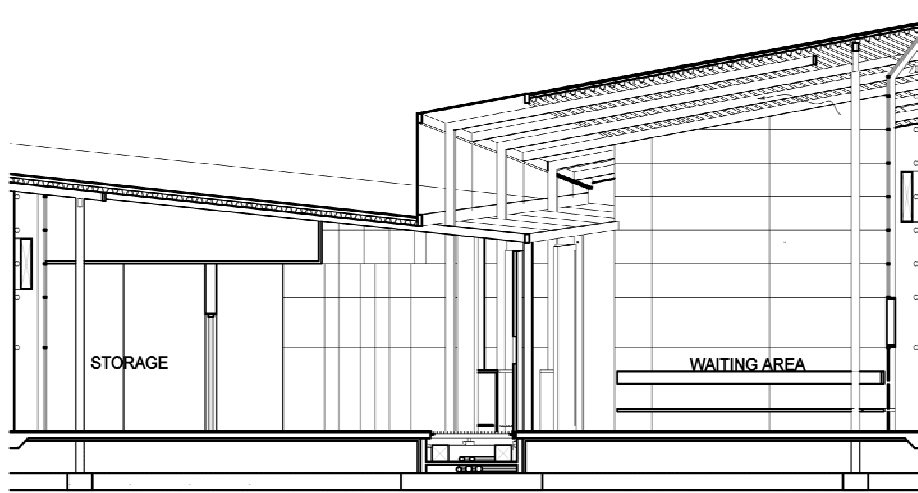


Figure 44 Gregory Minott, Professor Sollohub, Section 1/8"=1'

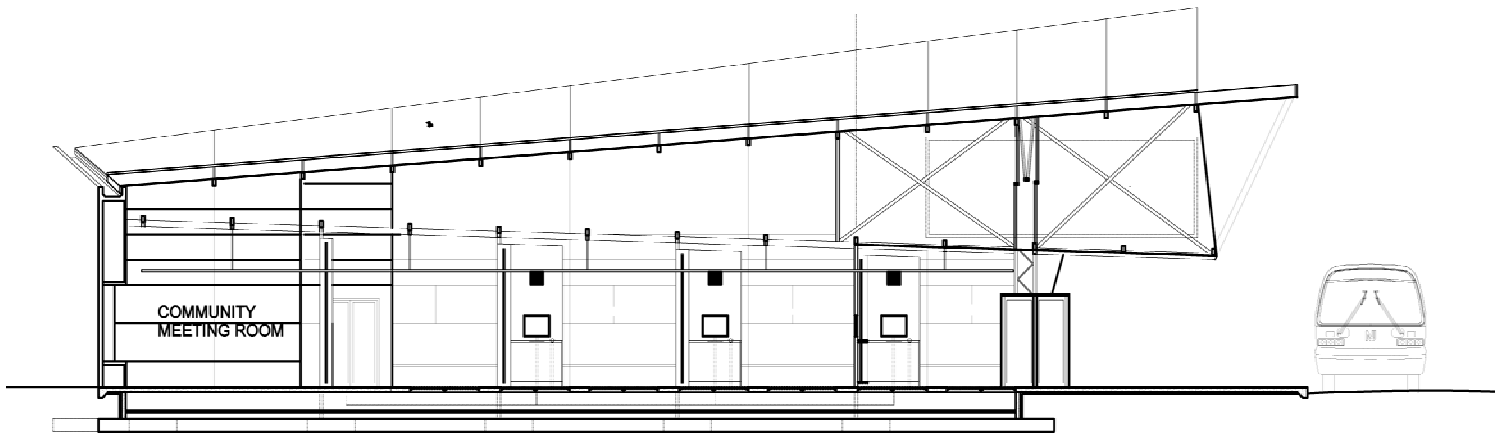


Figure 45 Gregory Minott, Professor Sollohub, Section 1/8"=1'

1.4 Operation and Management

With the research presented in the web-based document and after meetings with the project team and additional research of their own, three students in the Small Business Institute in the NJIT School of Management developed a preliminary business plan for the e-station. Questions raised in this effort and additional review of community technology centers and televillages have raised additional issues concerning the future development and operation of the first e-station.

1.5 Business Plan

As envisioned in the business plan, the e-station will operate as a public-private partnership between the social and community services side of the project and the business side. The business side will act as a catalyst for the development of the e-station and will eventually make the e-station self-sustainable and profitable through producing a steady revenue stream. Under this plan, the e-station would be owned either by an existing non-profit community-based organization or by one established for this purpose. This organization would lease space to one or more businesses occupying the e-station and would receive some percentage of their profit. Additional funding for social services would come from government or private grants to the e-station.

The business services in the e-station would be centered on the Internet and e-commerce. One business could be a cyber cafe, providing Internet access on an hourly fee basis at the long-term terminals with vending machines or a refreshment counter and offering additional workshops and classes. Research suggests that "cyber cafe" as a designation is more successful than "computer resources center" or similar terms. This business would operate its own Internet portal, allowing merchants to operate on the portal's web page for a fee, with purchases made through the e-station portal site. In addition to paying for advertising on the e-station portal, merchants selling online would pay a percentage of total sales to the cyber cafe that would manage the portal. Purchases could be made either by credit card or by a prepaid purchase card. Such a card, like Monneta Prepaid, allows those without credit cards and those who wish to

make anonymous purchases on the Web to shop online. Value can be added to the card with cash paid at the point of purchase with a credit card, check or direct transfer from an e-cash account. In Newark neighborhoods where many residents do not have credit cards and are concerned about privacy and anonymity, prepaid cards are a necessity.

E-commerce purchases could also be delivered to a private mail center, such as Mailboxes Etc., operating within the e-station. Both the cyber cafe tenant and the private mail center tenant would rent space with a percentage of their gross income going to the non-profit organization owning the e-station.

In 2001, Newark had two cyber cafes in other areas of the city; each charged \$12 an hour for Internet access. Across the street from the e-station site was a small computer business, Vartech Solutions, which provided computer and Internet access for \$5 an hour. Vartech was a possible candidate for running the e-station cyber cafe and expressed interest in doing so. Unfortunately, Vartech closed in 2002. Research conducted for the business plan indicates that the cyber cafe tenant could fulfill almost all of the responsibilities of the concierge/facilitator and in return would pay a below market rent and would receive 75 percent of the revenue from the portal business.

Funding for the construction of the e-station would be in the form of a grant and construction loans to the non-profit owner of the e-station. The costs of operating and managing the e-station (security guard, electric/gas, telephone, water/sewer, maintenance, insurance, legal and accounting and building management fees) would be covered primarily by base rents received from the two business entrepreneurs in the e-station (cyber cafe and private mail center) and a small percentage of their gross revenue.

Management and operating costs are estimated to be \$125,000 for the first year (2002), with a 3 percent increase each year over a five-year period. For the e-station to be self-sustaining and to cover these costs, after a start up period, would require that revenue

from the cyber cafe, private mail center, and the portal increase significantly over a five-year period. The business plan, under its more aggressive model, projects a 20 percent annual increase in revenue from the tenant businesses, starting at \$82,461 in Year 1, covering operating costs of \$151,561 in Year 5 with revenue of \$170,991. Additional revenue of \$50,000 per year could be provided by advertising, fees from ATM machines and pay telephones and rental from a 24-hour newsstand.

2 CHAPTER TWO: NEWARK E-STATIONS ADVANCED TRANSPORTATION SYSTEM

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2.1 Chapter Summary

This chapter presents a conceptual traveler information system for users of the Newark e-stations. In essence, the e-station is a special transit terminal that is envisioned to serve two roles:

- 1) To become a computer and internet access center to people in disadvantaged areas, and**
- 2) To provide a user-friendly transit access and information to all groups of potential users of the e-station.**

The principal characteristics of the e-station traveler information and access system are:

1. General Web-based Traveler Information System Access and Customized User Interface

The user is expected to have access to the primary traveler information service, **TRIPS**, which will be provided by TRANSCOM by the end of 2002. Associated with the TRIPS service are links to the various transit agencies of the region, New Jersey Transit (NJT), New York City Transit (NYCT), Amtrak, Long Island Railway (LIRR) that provide special web sites offerings schedule and fare information. The user can either query the specific web sites or request trip planning directly from TRIPS. Furthermore, the user will be able to access any other traveler information service that is available through the web.

In order to provide more valuable transit information to the e-station users it is essential that a real-time transit information system be developed to provide the status of trains and buses and the expected arrivals and departures at each station. As such the following systems will need to be implemented by transit authorities:

- **An Automated Vehicle Location (AVL) system based on**
 - **Global Positioning System (GPS) technology or**
 - **Roadside Beacon technology such as TRANSCOM's System for Managing Incidents and Traffic (TRANSMIT) or**
 - **A hybrid technology (GPS plus TRANSMIT readers) that will ensure vehicle positioning in areas where GPS is not functional,**
- **A communication system between the traveler information systems and the New Jersey Transit buses/trains,**
- **Real-Time intermodal algorithms to aid the travelers in planning their trip from point to point seamlessly through any and all available modes of transportation,**
- **Real-time travel time estimation and prediction algorithms,**
- **Real-time expected bus/train arrival time algorithms at each transit stop.**

The web-based traveler information system of the e-stations can be further enhanced to provide **real-time bus/trains arrivals and departures** at the e-station through special web messages and computer auditory messages.

2. e-station Traveler Information User Profile

Each traveler of the e-station will have the option to generate a user traveler information profile that will record **his/her travel characteristics** based on the mode of transportation, time of day and day of the week, frequent bus routes, and preferred transit information (such as the status of special buses, expected arrival times at specific stops etc.). Given the user's profile, related traveler information will be provided to the e-station user through his/her preferred personal communication means (e.g.

internet, e-mail, fax, phone, pager, cell-phone based messaging, other). Within this profile the user will also designate special transit accessibility needs such that the traveler information system to provide him/her with pertinent information and also to inform the specific transit agency of these special needs. **This user profile can be embedded to TRANSCOM's TRIPS web service under the Teletrip option.**

3. e-station transit stop traveler information

The technologies developed to provide transit information to the travelers while waiting at a transit station are also applicable for the e-stations. Technologies that may be implemented include:

- **Variable Message Signs for bus arrivals and departures,**
- **Variable Message Signs to display to bus drivers special requests for users with disabilities and special needs (e.g. kneeling bus needed),**
- **TV monitors for bus arrivals and departures,**
- **Audio messages for bus arrivals and departures,**
- **Informational talking signs for visually impaired.**

4. e-station Terminal Information

- **The e-station's users should receive related real-time traveler information while working in the station.** Aside from the traveler information that users will receive through their computer, a separate general information service will be provided at the terminal through the following technologies:
 - **TV monitors for bus arrivals and departures, as well as other related messages (e.g. major incidents and excessive delays, advertising),**
 - **Audio messages of bus arrivals and departures as well as other related messages (e.g. major incidents and excessive delays).**

- **e-station Information Kiosks**

The e-station kiosks are expected to be an enhanced version of TRANSCOM's SATIN kiosk program, which are envisioned to provide similar information as their TRIPS traveler information web site for the metropolitan area. **An enhancement to SATIN**

kiosks could be a system to aid visually impaired persons to get oriented within the e-station as well as to be able to browse through the computer and the Internet efficiently.

- **e-station Terminal Information for Visually Impaired**

Informational Talking Signs. One of the newest technologies to aid visually impaired people to orient themselves and travel seamlessly without personal guidance is through the installation of informational talking signs that designate the location and services of the station.

5. e-station Smart Card Concept

A special feature of the e-station Smart Card system will be a **user's profile database** that could include the following: personal traveling preferences; access to special web sites; special codes for access to buildings, rooms, and computers; as an electronic purse with the full functionality of a credit card. The users of the e-station will have the option to participate in a Smart Card system that can be used for:

- **Electronic transit fare payment (NJT); participation in a special fare discount program,**
- **Traveler information; customized user traveler profile personalized bus arrivals and departures at/from the e-station, automatic access to the web-based traveler information services such as the TRANSCOM's TRIPS123, NJT, MTA, other**
- **Access to the e-station building and special services (reserved computers, reserved rooms, special classes, e-station discounts, etc.).**
- **Other uses; e-commerce, participation in special forums, etc.**

6. New Jersey Transit Accessibility Services

The available services provided by NJT to senior citizens, paraplegic and visually impaired people can also be provided to the users of the e-stations. These services may include:

NJT Accessible Rail Stations and Train Cars. The trip planner can be enhanced to incorporate information on the availability of accessibility services for people with special needs at rail stations and train cars when they request either route schedule or detailed point to point transit information. E-stations that have access to trains, special service and associated information can be provided to aid people to have easy access to/from the trains.

Lift-equipped and kneeling buses. The NJT's trip planner could incorporate information on lift-equipped and kneeling buses. In the case of kneeling buses, the travelers could also provide this request a priori to the driver through some communication means (e.g. wireless communication, through a variable message sign located at a bus stop or through the internet) that can save boarding time.

NJT's Access Link. It is suggested that the Newark e-stations request service from the NJT's paratransit service for people with disabilities, the Access Link.

County Paratransit. It is suggested that the Newark e-stations request service from the Essex County Paratransit system.

NJT's Reduced Fare Program. An incentive can be provided to the people who use the e-stations by providing a reduced fare fee in a similar manner to senior citizens and people with disabilities.

An added feature to the e-stations can be the installation of telephones next to each computer terminal that will make it easier for people to call NJT or emergency services in case they prefer to use an operator to receive related information. This telephone may be setup to have restrictions that will prevent someone to use it for personal conversations other than reaching transit and emergency agencies.

2.2 Introduction

This report presents a conceptual traveler information system for users of the Newark e-stations. In essence the e-station is a special transit terminal that is envisioned to serve two roles: 1) To become a computer and internet access service to people in disadvantaged areas, and 2) To provide a user-friendly transit access and related traveler information to users of the e-station.

e-station traveler information services. The e-station users should be able to receive transit information while they are in working on the computer terminal or they are waiting at a transit stop in a user-friendly and efficient manner. The primary media for general information to the public is provided through the World Wide Web. The Internet is becoming the communication media of choice for traveler information for people whose work requires the use of computer and their organization has access to the web. Other traditional media include the radio and television, which provide general information on traffic conditions and any related delays on transit. Personalized traveler information is also provided through e-mail, fax, pager and cellular telephony. Various technologies have been applied throughout the world that provide transit information to the users while they are waiting at a transit station, they are within a transit terminal or while they ride a bus or a train.

e-station transit user accessibility. Transit agencies in the US have to conform to special requirements that provide access to people with disabilities. These services include boarding and alighting to/from buses and trains, special ramps and elevators for paraplegic people and technologies that can serve visually impaired people to move around the station. As such the design of the e-stations should adhere to the needs of all potential transit users including senior citizens and persons with disabilities.

This report presents the principal functions that could be provided to the users of the e-stations to receive traveler information with emphasis on transit and some accessibility services that are usually provided by transit agencies. These envisioned functions are:

- Traveler information through the World Wide Web,
- Traveler information kiosks installed at the e-stations,
- Terminal transit traveler information (e.g. through TV and/or computer monitors or electronic boards),
- Bus/train stop traveler information (e.g. Variable message signs, TV monitors, special devices for visually impaired),
- Accessibility services for transit users (senior citizens, paraplegic, visually impaired, other).

2.3 Conceptual Newark e-station Traveler Information System

In this section, we outline a conceptual traveler information system that includes the main functions that a Newark e-station could include as a service to its users.

2.4 Goals and Objectives

Goal: Provide timely traveler information to the users of the e-stations

Objectives

1. Provide transit arrivals and departures to the users at the transit stop of the e-station,
2. Outline the implementation of the user's traveler profile within a Smart Card program.
3. Provide access to web-based traveler information systems at the e-station's computer terminals,
4. Provide transit arrivals and departures to the users while working in the e-station,
5. Provide information to visually impaired people on the services of the e-station and transit information,
6. Develop a user's traveler profile to expedite traveler information requests from the web.

Goal: Provide safe and efficient access to/from and within the e-station

Objectives:

1. Design the e-station building to accommodate seamless access to paraplegic people to all services of the e-station,
2. Design the e-station transit stop to accommodate the needs of paraplegic people as defined by the Disabilities Act,
3. Provide to the users of the e-station access to NJT's and County transit accessibility programs,
4. Outline a Smart Card access program for the users of the e-station.

2.5 Web-based Traveler Information (Static and Dynamic)

The most widely used media to provide transit information to the travelers is the World Wide Web (www). The majority of the transit agencies have now established web sites where travelers can receive information related to the agency and the transit schedules and corresponding fares. Associated with the web-based systems transit agencies have established telephone-based systems that also provide similar information through an operator. We could divide these transit web-based systems into two main categories, *static* and *dynamic*. Static transit traveler information simply provide information on the schedules of buses and trains where dynamic systems also provide real time transit information.

An e-station user is expected to have access to the following traveler information systems specific to the NY/NJ/CT metropolitan area:

2.5.1 The New Jersey Transit (NJT) Traveler Information and Transit Accessibility, Newark, New Jersey

The NJT implemented two systems to provide transit information to travelers, the telephone based Interactive Voice Response (IVR) system and the web based system. The IVR system is accessible through an 800 number that directs the callers to either the automated IVR system or to an operator. The majority of callers prefer to use the operator that puts a significant toll on the available telephone lines causing congestion, inducing busy signals frequently. The introduction of the web-based system has provided relief from the telephone based system as many travelers can receive more

informed information through the NJT's corresponding web site (www.njtransit.com). NJT's transit travel information system currently provides static schedule and fare information with the exception of the alerts through the web site. **The current system cannot provide real time bus location information, which is a desirable function of the e-stations concept.**

The schedules & fare module within NJT's web site provides transit station to transit station route and fare information based on the time of day and day of the week. **The schedules & fare module can be enhanced to include dynamic information of every bus/train route such as bus/train location and expected arrival at a specific transit station.**

The Trip planner module provides itinerary information (from origin to a destination), schedule information, transit service near a user-specified location, corresponding connecting services and accessible services. The travelers can provide the origin and destination to the operator or input the same data in the web-based system and receive "optimal" transit route information including the associated fare cost. Accessible services provide information to people with disabilities and senior citizens such as accessible rail stations and train cars, lift-equipped and kneeling buses, Access Link ADA Paratransit, the corresponding county paratransit and the reduced fare program. **The Trip planner module can be enhanced to provide real time bus/train arrival information to the e-stations. Timely information of expected bus/train arrivals can improve the productivity of the users of the e-stations and the anxiety of when their bus/train will arrive will be reduced.**

NJT Accessible Services

Accessible Rail Stations and Train Cars. These services provide information on the availability of access to/from train platforms such as **E** = Elevator, **R** = Ramp, **PL** = Portable Lift, **MH** = Mini High-Level Platform. NJ TRANSIT has bridge plates available at all accessible high and mini high-level platforms and the user needs to inform the corresponding NJT crew so they could assist them in boarding and alighting. Priority

seating is also available in all buses and trains at designated seats for senior citizens, people with disabilities and people with mobility devices. **The trip planner can be enhanced to incorporate this information when they request either route schedule or detailed point to point transit information. In e-stations that have access to trains, special service can be provided to aid people to have easy access to/from the trains.**

Lift-equipped and kneeling buses. NJT has a fleet of lift-equipped and kneeling buses. Lift-equipped buses are designated in the schedule with a “W”. Travelers can make a reservation for a lift-equipped bus the day before (before 4:00PM) for the specific route that they want to use. **The NJT’s trip planner should incorporate this information and provide all necessary information that is needed to people requesting such a service. In the case of the kneeling bus, the travelers can provide this request a priori to the driver through some communication means (e.g. wireless communication or through a variable message sign located at a bus stop) that will save time. It is therefore advisable to design such a variable message sign to be incorporated with the e-stations concept.**

Access Link is NJ TRANSIT’s Paratransit service required by the Americans with Disabilities Act of 1990. Access Link provides people with disabilities paratransit service comparable to the local bus service. This service is specifically for people whose disability prevents them from using existing local bus service. **It is suggested that the Newark e-stations request service from NJT’s Access Link.**

County Paratransit. Each county in New Jersey provides county-based paratransit service for senior citizens and people with disabilities. NJ TRANSIT assists in the provision of accessible services by the counties and non-profit agencies through the administration of the Casino Revenue Fund Senior Citizens and Disabled Residents Transportation Assistance Program, and Federal Transportation Administration (FTA) Section 5310, 5311, and 5307 Programs. **It is suggested that the Newark e-stations request service from the Essex County Paratransit system.**

NJT's Reduced Fare Program. Reduced fare is available to senior citizens and people with disabilities for specific (off-peak hours during weekdays) hours during the day and during the weekends. A new pricing scheme may be suggested to NJT to provide incentives to people to visit and utilize the services of the e-stations. Such users of the e-stations **can be offered a reduced fare fee in a similar manner to senior citizens and people with disabilities.** The use of a Smart Card will make the administration of such a reduced fare program much easier and reduce the risk for abuse from people who do not use the e-stations.

The travelers who will utilize the e-stations will have access to the web therefore they could obtain general NJT transit schedule information and specific Origin and Destination (O-D) information through NJT's web-based traveler information system.

2.5.2 TRANSCOM's Traveler Itinerary Planning System (TRIPS123)

TRANSCOM, PB Farradyne Inc. and TransCore, Inc. formed a public-private partnership that was awarded a multi-million dollar grant from the USDOT to develop the TRIPS123 multimodal traveler information system. The NY/NJ/CT metropolitan region was one of four metropolitan areas in the country to receive a metropolitan model deployment initiative (MMDI) grant. TRANSCOM is a non-for profit corporation that is primarily sponsored by 14 public agencies in the NY/NJ/CT metropolitan region. The member agencies are: New Jersey Transit, Port Authority Trans-Hudson, Metropolitan Transit Authority, New Jersey DOT, Connecticut DOT, New Jersey Highway Authority, New Jersey Turnpike Authority, New York City DOT, New York State DOT, New York State Police, New York State Thruway Authority, Palisades Interstate Park Commission, Port Authority, and Triborough Bridge and Tunnel Authority. All these member agencies are part of the MMDI together with the private entities mentioned earlier. The New York State DOT is the administrative lead for the public sector team. The principal components of the TRIPS 123 are:

- *Quick Check:* Quick Check is expected to be a free service that will provide traffic conditions in the metropolitan area. Users can receive timely highway and transit

information either through a telephone line or through a specially designed web site, *trips123.com*.

- *Telewarning*: Telewarning is expected to be a subscription-fee-based service that is expected to alert travelers on highway and transit conditions through their choice of communication media. The subscribers will be required to create a user's profile that will include their specific normal commuter routes (highway, transit or combination), the usual times of travel, and the preferred communication media (e-mail, cellular telephone, telephone, fax, and pager).
- *Transit Advisor*: The transit advisor will be linked to all public transit agencies and private transit operators of the NY/NJ/CT metropolitan area, where the user will be able to search for transit schedules, fares and plan his/her trip. It is expected that in the future, users will be able to receive point-to-point intermodal trip planning once the various agencies and private carriers link their bus and train routes to TRIPS123.

In order for the e-station users to receive full benefits from the TRIPS123 program, they should become subscribers to the Telewarning system. Primarily the e-station users should receive timely bus and train arrivals to the e-station such that they will be able to optimize their time and manage their trips. Such a function will attract more users to the e-stations. The Telewarning system will need to be enhanced to provide real time expected bus/trains arrivals at the e-station.

2.5.3 New York Metropolitan Transit Authority (MTA)

MTA Web site

The MTA web site offers information on schedules and fare for New York City Transit (buses and subway), the Long Island Railway, The Long Island Bus, the Metro North Railroad, and Bridges and Tunnels. It also provides service advisories. Currently it does not provide any trip planning from point to point. It is expected that trip-planning information will become available through TRANSCOM's TRIPS web site once it is implemented (expected by the end of 2002).

Long Island Railroad Traveler Information System (Super Teletrip) - Jamaica (Queens), New York (www.mta.nyc.ny.us/mta/phone.htm#lirr)⁽¹⁸⁾

LIRR operates a telephone based traveler information system called Teletrip. The system offers the option to the user to either use an operator or an automated telephone system. Customers can obtain fare, schedule, up-to-date status of station parking lots, directions to stations, hours of station operation, on-time performance of trains, service disruptions, weekly tour availability information, and excursion package and tour information. This system is expected to become accessible also through the TRIPS123 system.

Transportation Information and Decision Engineering Center Transit Schedule Web Publishing (www.njtide.org/reports/index.html)⁽¹⁹⁾

A new methodology, called the Transit Timetable System (T3S), for publishing transit timetables on the web has been developed by the TIDE center. T3S is an online interactive transit timetable information exchange/administration system (5) which uses the Transit Timetable Markup Language (T3ML). T3ML is an XML application for describing transit timetable information. Transit timetable information can be stored as T3ML files, which capture both its content and structure. This methodology provides a universal way for transit travelers in obtaining general as well as personalized (point-to-point) transit schedule information from the web and provides a unified framework for transit operators to also publish, modify and exchange transit information on the web. A description of the T3S is given in appendix B.

The e-station users are expected to have access to the internet; therefore, they would also have access to TRANSCOM's TRIPS program, the NJT's web site, the MTA's web site as well as other traveler information web sites that are of specific interest to them through a specially designed coordinated interface. The TRIPS program through its Teletrip option offers the opportunity for users to become subscribers that will be providing more personalized information to the users. **The Teletrip program can be further enhanced through the establishment of a real-time transit arrival and departure information system that can send timely messages to the users through their specified communication means (web, phone, fax, pager, e-mail, other).**

2.6 In-terminal kiosks

Many traveler information providers are contemplating the use of kiosks that can be installed at places that can be found useful for travelers. These kiosks have access to the web and various traveler information services as well as other yellow page type of information. Various efforts have been undertaken in the country such as: the New York Metropolitan area under TRANSCOM, the EZRider program in the Seattle area under also the StarTrek Metropolitan Model Deployment Initiative (MMDI). Some of the kiosks principal functions are: Itinerary planning using real time and static information, web-based interface, potential for public-private partnerships, advertising. **The kiosk concept may well be adopted by the Newark e-stations regardless of the installation of computers. One or more TRANSCOM kiosks can be installed at the e-stations such that travelers who only want to find some information can quickly search through the kiosk and plan their trip.**

2.6.1 TRANSCOM's SATIN Traveler Information System Kiosk

TRANSCOM is developing a traveler information kiosk program, the Service Area Travelers Interactive Network (SATIN), where specially designed traveler information kiosks are envisioned to be installed at strategic locations throughout the metropolitan area. SATIN is a public-private partnership between TRANSCOM and Golden Screens Interactive Technologies, Inc. SATIN is expected to provide similar traveler information as TRIPS123 and will be directly connected to it. Wherever possible, it will also inform the public about major incidents or schedule changes, via an overhead monitor or LED visible to all passersby. The expected applications to be provided on the kiosks include:

- Transportation incident and construction information,
- Roadway routing,
- Location-specific information, with details of customer services available,
- Transit routing based on options including preferences for fewest transfers, fastest travel time, etc.,
- Transit schedules, locations of stations/stops, fares, details on customer services available at stations, and connecting transit service available at each station/stop.

This includes both site-specific information (information on options at the traveler's

current location) and comprehensive information covering all locations (to allow for planning of other trips or transfers),

- Park-and-ride lot locations, connecting transit schedules and fares listed by park-and-ride lot, and details on customer services available at each location,
- Near-real-time roadway speeds and weather conditions (ice, fog, etc.),
- Weather forecasts for the immediate area,
- Information on special events and other tourist information,
- Information on the impact upcoming special events will have on traffic and transit availability.

2.6.2 LIRR Talking Kiosk Concept for Visually Impaired

An innovative system in the New York area is the talking display system (Talking Directory Display System (TDDS) also called “Talking Kiosk” developed by the Baruch College Computer Center for Visually Impaired People and the LIRR. The system was developed to assist visually impaired persons with locating LIRR facilities throughout the Penn Station in New York City. The system includes an audible beacon that directs the visually impaired people to the talking kiosk. A proximity sensor identifies the presence of a potential user when the person is within two feet from the kiosk. Once the system identifies a user it provides voice directions on the operation of the kiosk terminal. The users can receive information either through a tactile map of the station and/or a standard telephone keypad. The users can receive information on the Penn station orientation, more specific information on the LIRR as well as the NY City subway, NJ Transit, and Amtrak. **The Talking station could also be used as an added feature within a more general traveler information kiosk at the Newark e-stations.**

2.6.3 e-station traveler information kiosks

TRANSCOM’s SATIN kiosks can also be installed at the Newark e-station where their functionality can be further enhanced to produce timely bus/train arrivals and departures. Furthermore, the LIRR Talking kiosk can also be integrated within the SATIN program and provide a more universal traveler information system that will also be accessible by visually impaired people.

2.7 Public Address/Customer Information Signs

Transit agencies provide various ways for informing travelers of various messages that are related primarily on the status of bus/train routes, and specifically arrivals and departures. These messages communicated to the users either through voice communication devices or through displays.

2.7.1 New York City Transit

Information is provided through signs and auditory announcements. The main information provided is the arrival of the next train. It is expected that in the future it will be possible to provide more timely information to the users as to how many stops away is the next train away from the platform. Associated real time information may include: length of the next train (to allow customers to position themselves properly on the platform for long or short trains), and advisories regarding planned service disruptions and detours.

Wayside Information

An FTA funded project for NYCT and MTA is envisioned to install various types of communication media at bus stops to provide real time information to commuters waiting at bus stops such as: variable message signs (VMS), video monitors, and interactive kiosks. The system will become operational once it is integrated with the envisioned NYCT AVL system. The operational test will install 20 bus stops with VMS and 10 with flat screen video monitors providing the following information: Estimated bus arrival times; Bus routes serving a given bus stop and their destinations; Service type available (limited stop or local service); Transfers; Alternate routes; and Service delays.

2.7.2 New Jersey Transit

In 1996, New Jersey Transit received a \$300,000 Planning and Research grant to research the feasibility of providing real-time, in-terminal train information for its passengers. In addition, in 1998 it received a \$250,000 grant to research the type and format of information passengers' desire. It will include study, selection, and procurement of the display technology. The research may also include the purchase

and integration of a radio frequency tag-based automatic train identification system. If successfully integrated, the traveler information would include the train numbers.

The technologies implemented and planned by NYCT and NJT for providing information to the travelers at bus and train stations can also be incorporated within the e-stations design.

2.8 Newark e-stations Conceptual Transit Traveler Services Architecture

The basic elements of the e-stations transit travel information architecture are: The communication and traffic surveillance system, the data processing system, and the user interface.

2.8.1 Communication and Traffic Surveillance System

A communication system will need to be installed in the buses to communicate with TRANSCOM's TRIPS central computer and the corresponding servers at the NJT and NYCT. The buses will be sending primarily location information based on the Automatic Vehicle Location (AVL) technology that will be implemented by the transit agencies. The traffic surveillance system includes the vehicle sensors that are installed at various highways in the metropolitan area, the TRANSMIT system and the envisioned AVL system.

Global Positioning System (GPS)

One of the most popular ways in real time determination of a vehicle's position is through the Global Positioning System (GPS). The GPS system utilizes a set of 21 satellites to provide continuous coverage of the position of moving vehicles around the world. The location of an object is achieved through a GPS receiver that communicates directly with at least four satellites, each one sending the current time and its ID to the receiver. The receiver then computes its geographic location (longitude, latitude and elevation) based on these four pieces of information. The satellites are operated and controlled by the US government and the Defense department. The defense department until recently were scrambling the messages that were sent by the satellites such that the location of an object will not be calculated precisely for security reasons. As such various organizations relied on differential GPS to find the correct location of an

object. The differential GPS utilizes a known location, provided by the US Coast Guard, of an object plus the messages from the satellites, thereby circumventing the errors induced by the defense department. However, recently the US government stopped the scrambling of the satellite messages rendering the DGPS non-necessary for many applications. Currently, it is safe to say that a moving object can obtain its position through GPS within 10 meters while for stationary objects the accuracy can be at the centimeter level.

A very important issue in the use of GPS is the effect of canyons. The location of an object requires line of sight from at least 4 satellites. As such, areas with high rise buildings and trees create the canyon effect rendering the use of GPS problematic or non-feasible such as in some areas in Manhattan.

Another problem in the identification of the location of an object on a digital map is the accuracy of the digital map itself. The original digital maps developed are the TIGER files, which contain a lot of errors on the roadway system of the US. Various companies have developed more accurate digital maps such as the Navigational Technologies, Inc.. One of the primary purposes of the development of these digital maps is for use in traveler information systems such as web-based systems and in-vehicle navigation systems. A tutorial on GPS can be found under the TIDE center's web site:
www.njtide.org/tutorials/gps/GpstheorySiRFv1_1_files/frame.htm ⁽²¹⁾

The NJT and the MTA are contemplating the installation of a GPS system in their buses to improve their operations and to provide more timely transit information to the public. The "canyon" effect is more prominent in the Manhattan area where there are clusters of tall buildings that inhibit direct line of sight with the US GPS satellite constellation. Therefore for the NY area especially buses that operate in Manhattan a hybrid AVL system will be necessary. In NJ only a few areas have tall buildings making it more plausible to use only the GPS as an AVL technology.

Roadside Beacon (Signpost) based positioning.

The signpost technology utilizes fixed locations with beacons that transmit the location and ID of the beacon. Moving objects equipped with appropriate receivers can determine their location by receiving these signals as they pass through these beacons. They can then transmit their location to a central computer for further processing. A similar concept to signpost is the use of roadside beacons that communicate the position of the vehicle through electronic tags such as the E-ZPASS tags. TRANSCOM could install TRANSMIT roadside readers along critical arterials which cover a substantial number of bus routes. These roadside readers can be installed at regular intervals of approximately one mile or if necessary a half mile and their accurate position can be determined. As a bus passes the capture zone of the roadside reader, it sends a message to the roadside reader with the tag's ID. The roadside reader then produces a message containing the bus ID, time and date, and the roadside reader ID that includes its position. Therefore, the bus can continuously be monitored through the coverage area. The TRANSMIT based approach will also produce both link bus travel times, passenger car travel times and truck travel times since now a substantial number of cars in New Jersey is equipped with E-ZPASS tags. These data will then be used to develop link travel time estimates for different classes of vehicles than can then be used to predict the arrival of the buses at the bus stations. A cost-benefit analysis study can be undertaken to determine the cost effectiveness of such an approach over the use of GPS only and on a hybrid system combining the two technologies as an effective means of determining the location of the buses and the associated link travel time estimates. A description of the original TRANSMIT^(23, 24) communication system is presented in appendix A.

Dead Reckoning.

The dead reckoning technology utilizes a gyroscope that measures the vehicle azimuth change, the odometer change and the initial position of the vehicle. The position of the vehicle can then be determined continuously given a well-calibrated system. One of the disadvantages of this approach is that the gyroscope accumulates angular errors as the vehicle moves. As the vehicle moves away from its original known position it needs to be corrected with some other means, such as a GPS system or sign post technology. A study was undertaken for NJ Transit by Dr. Greenfeld⁽²²⁾ to evaluate a hybrid GPS and

dead reckoning technology on various NJT bus routes. The principal conclusion from that study was that the hybrid system did not provide any competitive advantage over a system utilizing differential GPS only. They did recommend it; however, that GPS may not be applicable in areas with high-rise buildings such as in Newark, NJ.

Bus Equipped with E-ZPASS tags to TRANSMIT Roadside Beacons and to Central Computer

Buses equipped with E-ZPASS tags send their tag ID to the TRANSMIT roadside reader.

TRANSMIT Roadside Reader sends a message that includes the roadside reader ID, bus tag ID, time and date through the preferred communication means (currently leased telephone lines) to NJT's central computer, Newark NJ and/or TRANSCOM, Jersey City.

Bus Equipped with GPS to Central Computer

In case that the GPS technology is used then a wireless communication system will be required. Currently in New Jersey, this can be achieved through the Cellular Digital Packet Data (CDPD) transmission utilizing the cellular telephony network. CDPD is a cellular based data transmission technology that is set to deliver data in packets at rates of up to 19.2 Kbps. Data can be transmitted reliably and securely using error correction & encrypting technologies. CDPD has the advantage that it has continuous open connection to the web server, eliminating the need for dial-ups. CDPD modems can be connected to the NJT buses to transmit the data to the central computer server for further processing.

“CDPD is an open packet data service, defined as an autonomous overlay network, specified for the cellular TDMA network. The Ericsson CDPD system is designed for integration with an existing TDMA/AMPS cellular network. By reusing cellular frequency spectrum, cell planning, power equipment, RBS site equipment, transport connection and antenna systems, CDPD can be quickly and economically deployed wherever cellular service is available without implementing a completely new mobile data network.

CDPD is one of the most economical and cost-effective wireless data solutions available today. No other currently deployed technology delivers the always-on, packet-

switched wireless data solution that today's Mobile Internet user's demand.”

<http://www.ericsson.com/technology/CDPD.shtml> ⁽²⁵⁾

Central Computer to e-station user

The central computer will be sending the current geocoded location of the buses to the e-station's users through the NJT's traveler information web site and potentially in the future through TRANSCOM's TRIPS123 (www.trips123.com) web site. The user will then be able to be continuously informed on the location of the buses and the expected arrival at the station.

2.8.2 Data Processing System Enhancements

Development of intermodal route planning algorithms

One of the most valuable functions of transit traveler information systems is route planning that takes into consideration the various modes of transportation that the users are willing to take. The basic characteristics of such an algorithm are: 1) The user specifies his/her origin and destination, 2) time of expected departure or desired time of arrival at the destination, 3) the preferred mode(s) of transportation, 4) maximum walking distance from his origin, destination, transfer to the nearest transit stop, 5) maximum number of transfers, 6) other socioeconomic data. The algorithm should be able to run in real time such that a user can change his/her preferences and be provided with several optional intermodal paths if desired. The intermodal algorithms will be utilizing real-time travel time estimation and prediction algorithms that will have to be developed as future functions of either the TRANSCOM's TRIPS123 and/or the New Jersey Transit web based traveler information services.

Real-time travel time estimation and prediction algorithms

This function is also one of the central elements of transit traveler information systems. The principal difficulty in obtaining accurate link travel time estimation and expected bus arrivals at bus stops is the inexistence of a comprehensive real time traffic surveillance system. The installation of the TRANSMIT system on various roadways in the metropolitan area offers the best opportunity for providing such a real time travel time estimation and prediction system. In the future, while more vehicles will be equipped with GPS systems, they could be used also as traffic probes that would provide a wider coverage of the transportation network where the TRANSMIT system will not be

installed. Supplemental to GPS and the TRANSMIT system is the existence of inductive loop detectors, microwave radar detectors and video image processing detectors at various roadways that primarily estimate traffic flow rates and/or vehicle speeds that can also be transformed into estimates of link travel times. A combination of these data collection systems could be used to provide accurate bus arrivals at the bus stops through various techniques such as statistical prediction models and the use of dynamic traffic assignment.

2.8.3 User Interface

A special user interface will be developed for the e-station users that will have access to all traveler information services of the region such as the TRIPS123, NJT, and MTA.

The users of the e-station that have access to the traveler information services will have the option to subscribe to the web-based traveler information service or to receive information as non-subscribers. The subscribers will have benefits over non-subscribers such as a user's profile that will have personal traveling characteristics.

The user's profile could include the following information:

Subscriber User's Profile

Name: The name of the person

e-station ID and Password: an ID that could be used to access all services of the e-station and corresponding password as well as NJT's web-based system. This account could be used to access an enhanced NJT system that could incorporate user profiles within its database.

Frequent O-D pairs: The subscriber input's the most frequent O-D pairs s/he uses based on the time of day and day of the week. This can be expanded to special days (e.g. holidays). The system will choose as a default for example the O-D based on the time of day and day of the week. The NJT traveler information system can then provide the corresponding transit route based on the current default O-D.

Frequent bus/train routes and bus arrivals at the e-station: The user inputs the most frequent bus/train routes that s/he is interested on based on the time of day and day of

the week. The NJT system can then be enhanced to provide specific information for only these routes to the user on a real time basis such as delays and expected arrivals at the e-station's bus stop. The system can be set up in such a way that it can provide frequent messages to the user based on the status of a specific bus route. For example, it can provide a message to the computer when the bus is 15 minutes away and then another when it is 5 minutes away. Alternatively, the system can provide real-time messages on consecutive buses serving the same route such that the traveler can decide which bus to take based on his/her preference.

Maximum number of transfers: The user inputs the maximum number of transfers s/he is willing to take to reach his/her destination. The NJT's algorithms will need to be modified to take into consideration this user constraint.

Maximum Walking Distance to a transit station: The user specifies the maximum walking distance s/he is willing to cover to go to a bus or train station. This is also a constraint that will require modifications to the current NJT route planning algorithm.

Socio-economic characteristics: Gender, age group, income group, as well as other socioeconomic factors can further be included within the user's traveler profile that will aid in planning studies and future enhancements to the services that can be provided by the e-stations. These entries will be optional to the users.

Special Accessibility Needs: Senior citizens and people with disabilities that need information on accessibility and special services should be able to input their request such through the NJT Trip Planner. Each user can specify a priory his/her special needs in terms of accessibility within its profile. The system should have the capability to request new information and services if different from the default that is embedded within the User's profile. Some of these enhancements to NJT's web service have been outlined earlier.

The same ID and possibly another password could be used by the travelers to request transit information from the NJT's IVR system as well as directly from the operator. The system will have ready the answer based on the user's profile unless the subscriber requests a non-default O-D or bus/train route. Such a subscriber-based service will reduce the communication time needed and provide added value that may attract more users in the system.

Non-Subscriber

Non-subscribers will require inputting their requests into the NJT's web-based system in a similar way as it is done now. The additional features mentioned above could also apply for non-subscribers although they will have to input manually all the necessary information every time they want to use the system.

In Appendix C we provide a conceptual GIS-based Multimodal Traveler Information Systems that was developed by Mouskos et.al. ⁽²⁶⁾

2.9 Automated Electronic Payment and Personal Transaction Systems

The Smart Card technology is attributed to Roland Moreno, a French journalist (1973), who envisioned and patented the concept of embedding a microchip into a bank style plastic card. The first such Smart Card was implemented in France to pay for telephone transactions. The first application of Smart Card technology was also implemented in FRANCE as part of the French transportation system RATP in 1993.

AEPPTS are becoming the future of transit operations. Manual fare collection is being replaced by magnetic fare collection cards and more recently with contact or contactless Smart Cards. A Smart Card differs from magnetic fare collection systems by incorporating a computer chip that allows the card to be read by various types of devices and can act simply as an electronic purse or a global card that can include personal characteristics (medical, travel, etc.), credit and/or debit card, access control as well as other applications. The functionality of a Smart Card will depend on the specific capabilities of the embedded chip such as storage and processing capabilities.

Contactless Smart Cards allow commuters to pay for fares quickly and conveniently by waving their Smart Cards past a reader. This speeds boarding times and supports effortless transfers by eliminating the need for commuters to search for cash at every point of transfer between systems. Smart Cards will also determine the correct fare from a range of variables, including transfers, route, length of trip, time of day, discounts for students, elderly and disabled riders, and different fare structures for each transit operator.

Benefits for operators include lower maintenance expenses (compared to magnetic stripe ticketing systems) and increased availability of information on transit usage and performance. For example, the San Francisco Bay Area's new TransLink® system is expected to provide accurate ridership data to participating transit agencies, supplying them with vital information for assessing routes and schedules. Utilizing this information will enable transit operators to spot bottlenecks, improve service, and use assets more efficiently.

Contactless Smart Cards, which have an analog-digital transceiver in a microchip that sends and receives route and fare data from a fare collection terminal, enable transit passengers to walk through toll gates after simply waving the Smart Card by the fare box. The technology speeds the flow of passengers through transit terminals and simplifies payment for customers by eliminating the need for cash or boarding passes.

Companies developing Smart Cards assert that the approach eventually will replace cash transactions in many types of convenience-oriented business environments.

The use of Smart Card technology has spread throughout the world in various countries such as: Norway (Oslo), Finland (Helsinki), Holland (Amsterdam), United Kingdom (London, Manchester), France (Paris), Spain (Barcelona), United States (Washington DC), Argentina (Buenos Aires), Japan, China (Hong Kong), Singapore, Australia (Sydney, Melbourne), Brazil (Sao Paulo), Canada (Montreal).

2.9.1 Transit Operators Concerns about Fare Media

1. *Throughput/Dwell Time.* The principal concern is the time required for the fare transaction to take place. Transit operators would like to minimize the dwell time for each bus/train at each station, consequently improving the performance of the system as a whole, reducing at the same time the emissions generated by the standing bus or train, and reducing the fuel consumption per bus/train.
2. *Intermodality (Bus, Train, Tramway, Ferry, Other).* One of the most important issues of the fare collection system is the accommodation of different modes within a person's trip from its origin to its destination. The transit operators usually offer discounts for people who use more than one transit vehicle during their trip, which is a means to attract more travelers to use transit. Currently the majority of the transit systems utilize a manual paper type transfer system that is costly and very inconvenient for the travelers. Furthermore, many people who are rare users of the transit system find it difficult to obtain pertinent information regarding the transit system.
3. *Flexible fare structure (Monthly Pass, Stored value ticket, Peak/off peak hour tariff, one time rider).* The fare structure of the majority of the transit systems includes various payment ways that are aimed to capture different types of users such as daily users, occasional users, and time of the day users. Typical fare payments are provided in terms of monthly passes, peak and off-peak hour tariffs, one time tariff, stored value ticket where fares are subtracted per use, daily tickets to use the entire system.
4. *Passenger handling convenience.* Passenger handling is a primary concern for every transit agency. One of the principal concerns arise at the fare collection points and the access/egress to/from the bus/train. At very congested systems travelers may miss their bus or train waiting for the purchase of a ticket or fare card. Consequently, long queues are generated at the fare collection boxes especially during peak hours. In addition, during boarding and alighting, the primary objective is to handle as many passengers as possible in minimum time and minimum loss of revenue.

5. *Total cost over system life.* The principal costs of fare card systems are the capital costs, installation costs, and maintenance costs.
6. **Two additional issues that are of major concern to transit operators are high data accounting accuracy and revenue security.** The use of a coin and token system requires an elaborate system of data accounting accuracy and revenue security that ensures that the transactions recorded by the fare boxes match the money that are collected. Furthermore, the coins and/or tokens collected require a high level of security for their entire route from the fare box collection points to the accounting office and then to the bank. The use of magnetic cards and Smart Cards eliminates the security associated with the protection of physical money however it requires security for the protection of electronic transactions and card counterfeiting.

2.9.2 Potential benefits of Smart Cards:

- Lower maintenance costs for transit operators,
- Faster boarding time and seamless transfers between various transportation modes,
- Universal payment transactions covering practically all credit card type of payments over multiple jurisdictions, eliminating the need for a public agency or private company to establish a separate fee/money collection system,
- Automated transit trip data collection such as bus/train/ferry ridership, Origin-Destination and transfer. Transit agencies can use this information to evaluate the functionality of certain routes and provide for better service either in real-time or by planning the schedules and the bus/train routes more efficiently.
- Potential revenue source: rent space on the Smart Card for specific applications, card logo,
- Access to specific web sites over the internet,
- Automated downloading and uploading of selected information/data from a computer and internet based on the user's preferences.

2.10 Functionality of the Newark e-stations Smart Card

2.10.1 Travel Personal Management

Traveler Information Service. The Smart Card could be used to provide personalized traveler information by activating a web-based service that could immediately notify the user on a number of different items that are embedded into his/her personal travel profile:

- Notify the user when the next bus will arrive to his/her default destination for the specific travel time period of the day that he/she enters the e-station,
- Produce the travel itinerary for the default trip based on the time period of the day and day of the week or a new trip as specified by the user once he/she enters the traveler information service,
- Provide information on any potential transit problems that may affect his/her trip,
- Provide information on any potential incidents on his/her common route if he/she is using a private automobile,
- Provide other general type of traveler information such as yellow page information (e.g. movie theater times) that are specific to the Smart Card user,
- Provide immediate access to his/her personal travel profile for changes to the default travel attributes and entries as well as personal characteristics.

Transit payment. The Smart Card could be used for purchasing transit tickets throughout the New Jersey Transit (NJT) and the PATH system. NJT and PATH currently do not have any form of electronic payment through Smart Card technology. However we expect that in the future an electronic payment system through Smart Card technology may become a reality. The Smart Card payment function could include the following services:

1. *Payment of NJT bus or train tickets based on the existing ticketing system.* In this fashion, the smart will be used like a credit card that is already being accepted by the existing ticket machines of NJT.
2. *Electronic payment using the Smart Card.* The system will require the installation of Smart Card readers at transit stop stations and/or each bus and train and the setup of a payment call center, which will be able to handle various queries. Such a system will provide much more flexibility to the users rather than the existing ticketing system. The principal characteristics of such a system are:
 - The transit traveler either inserts the Smart Card through a magnetic reader or waives the card close to a wireless reader. The payment call center is immediately notified and records the number of the user. The traveler upon reaching the desired destination swipes the card again through a reader, the payment call center is

notified and the correct amount is deducted from the user's account. The system will automatically deduct the correct amount in cases of transfers and it will have the capability to differentiate between different user categories (e.g. monthly, transit employees, paraplegic, seniors etc.)

- The Smart Card can have a storage where the traveler's trip is being recorded and it could be downloaded into a computer. For example, the user will be able to download his/her trips being undertaken over the previous day, week or month. The data could then be used for various purposes such as taxes and personal trip management. The traveler can verify transit fares paid for certain trips and can also review the associated trip travel time that he/she can then use for personal trip management. In addition, the traveler can compare trips taken by car, bus train or intermodal (car plus train or bus) more efficiently and improve his/her trip decision-making process having more accurate results.
- Furthermore, individual trip data can be easily entered into transportation and transit planning software by various research institutions, public agencies and private companies for further calibration and improvement of the models currently used, as well as serve into the development of future generation software.

2.10.2 Other general use of Smart Cards

Building access. The Smart Card could be used to provide access to the building either by its self or in combination with a password for added security. In addition, different people may have access to certain areas of the building while others will be restricted from entering terminals

Computer access. The Smart Card could also be used to provide access to specific computer terminals. In combination with the embedded travel management functionality the smart will be able to be used for other purposes such as:

- **Web access.** Each user can have a web profile where all favorable web addresses are stored and activated upon accessing the computer system. Furthermore, based on the specific Smart Card the system can block a user from accessing certain web sites (e.g. minors under 12 or under 18 year old).

- **E-mail access.** The user can activate his/her e-mail service only with the use of the Smart Card and personal account, providing an added security level.
- **Electronic bank transactions.** The use of a Smart Card can provide added security for any type of bank transactions and payments through the internet. For example while it may be somewhat easy for someone to steal the account number and password through the internet, access to the account may not be authorized unless the user inserts the Smart Card into a special slot on the computer, making it difficult for unauthorized users to access a person's personal account.
- **Access to specific computer programs.** The user will be able to access specific computer programs that may not be accessible to other users such as games, professional programs (e.g. finance, engineering, other) that require a special license.

Advertising. The Smart Card could be used as an advertising tool by various companies.

- **The Smart Card logo could be used by a specific company to promote their product.** Companies can advertise based on the information that is stored in the card. Each web site that is accessed through the Smart Card can have one or more advertisements of different companies and their associated products upon the opening of the specific web site. Furthermore, companies can provide various incentives to the Smart Card users for opening their web sites that are stored in the Smart Card. The Smart Card will be able to upload automatically update the advertisements once the user enters the computer system and connects to the web.

3 CHAPTER THREE: A BUSINESSPLAN FOR THE E-STATION

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3.1 Chapter Summary

This chapter is written in the form of a business plan for the purpose of introducing the new building concept of an e-station. Our task is to develop a model for operating and managing the e-station. The focus of this chapter is to propose a business plan for the e-station that would promote a public-private business relationship. It is important that this chapter presents a business model for operating and managing the e-station and incorporates opportunities for private entrepreneurs to work in partnership with community organizations towards the goal of making the e-station a self-sufficient entity. This documentation will become the foundation for further development and fundraising for the e-station.

The chapter is organized in sections. We start with the executive summary, a brief introduction followed by an analytical description of the project. We continue with the proposed businesses that will be encompassed in the e-station followed by a descriptive analysis of the project. In the proposed businesses industry analysis, we discuss Porter's five forces that affect the project environment. We broke our proposed services into two categories: community and business services. We then assess the environment of the project for each proposed service. In our analysis, we also present the characteristics of the community we are planning to serve.

Ending the chapter, we present some of the costs for operating and maintaining an e-station and the financial projections of possible revenues. We conclude by defining some of the risk factors involved and our recommendations for the project.

3.2 Project Site

The proposed site of the e-station is located on Springfield Avenue and 10th Street in the Westside Park Neighborhood in Newark, NJ. The Westside Park community is a 116-block neighborhood affected by unemployment; abandoned housing and other poverty related issues. However, the area is in the process of redevelopment. Springfield

Avenue extends centrally through the community and is the prime commercial corridor. Currently, this neighborhood is part of a revitalization initiative and the plans include a restoration of Springfield Avenue as a major shopping corridor. The 2,000 square foot e-station is to be constructed adjacent to a two-block long strip mall that is currently the site of a proposed restoration and expansion project.

Thirty years ago, Springfield Avenue was Newark's main commercial street, full of social and urban interactions. After the upheaval during the late 1960s, the inner city began its deterioration and desertion of some of its residents and most of the commercial facilities. Today, the people who form this community are low-income families who have always lived in the neighborhood. There are also an increasing number of new people who have come with residential development. Even now, the community has a tremendous need for public and private facilities to supply urban and social needs. Most families rely on the mass transit to go to work, school and shopping. However, there are no bus stations in the area. The ordinary act of waiting for the bus has a different meaning for this community, implying lack of security, limited availability of service and unreliable schedules.

3.3 Proposed Community Services

Transportation – The goal of the e-station is to improve the public bus transportation. The e-station is fundamentally a state of the art bus stop. It will provide a sheltered bus stop that will incorporate real time bus locations utilizing ITS technologies and ticket vending machines. Currently, New Jersey Transit (NJT) operates four bus lines that travel by or near the proposed location of the e-station.

Social Services and Education – The e-station would function as part of the existing One Stop Program that incorporates the Workforce New Jersey Public Information Network and The Families First Card Program. Instruction in the use of computers and access to the Internet will be provided. A multi-purpose/conference room is planned to be part of the e-station to facilitate the presentation of training and/or educational programs.

3.4 Proposed Business Services

The proposed business of the e-station would be a type of e-commerce depot. The business model that we have identified through our research is called Empori.com, Inc. This is an e-commerce depot that has set up partnerships with various e-commerce retailers and facilitates e-commerce purchases. Empori.com, Inc. is a Canadian based company and although it does not seem to be very successful at this time, we feel that the basic model of an e-commerce depot is sound. In our analysis, we have identified the essence of an e-commerce depot. It is a 'bricks and mortar' facility that has access to and a presence on the Internet; it has alliances with e-retailers; and it maintains a 'clicks and mortar' philosophy.

A business model that we have identified and we feel is more appropriate to the e-station project is Mail Boxes Etc. (MBE). This is a franchise company that offers FedEx, USPS and UPS services in addition to mailbox, fax and packaging services. An MBE franchise fulfills a large portion of the e-commerce depot model. It is possible that the e-station would house a franchise operation of MBE. The primary service that the business would provide is the shipping and receiving of packages. If a customer wanted to order merchandise from the Internet they could have it shipped directly to the e-station. Since it is difficult to have merchandise shipped to any home in Newark, this would provide community members with an opportunity to buy via catalog or Internet and receive the purchase at a nearby facility. Internet access will be provided at the e-station. There might be sufficient space available so that additional business opportunities can be added to the MBE franchise and the e-station could offer the complete e-commerce model. For example, a Cyber Café could be added that would charge a patron to surf the web. It is proposed that the e-station will also offer instruction on introductory computer skills. Future considerations to teach more advanced instruction like programming courses and web design courses may be implemented if the deployment of the first classes proves to be successful and additional business opportunities could be realized.

3.5 Project Analysis

The e-station project analysis is directly related to an analysis of the community of the proposed site of the e-station. The Springfield Avenue site is located near but not at a major transportation hub. For this reason, the majority of people who will use the e-station will be people who live in the community. To be successful, it is a must that the e-station advertises to the community and promotes participation and involvement in the project.

As described in the project description, there are two types of services that will be offered at the e-station. The first is community services and the second is business services. To generate a cash flow for the businesses in the e-station, it is necessary to evaluate what services the community is lacking and to offer those services that would have value to the residents of the community. We will need to determine how much value these services have and what the residents are willing to pay for them.

In our analysis of the project, we have applied Porter's five forces analytical technique to each industry involved in the e-station environment. In our analysis, we have followed a format used to analyze an industry that was outlined and defined by the Harvard economist Michael Porter. Porter's research is based on the research done by the Harvard Economics Department in the 1950's that resulted in the development of a new sub field of economics called industrial organization. This new sub field explored the structural reasons why some industries were more profitable than others. Published in his first book in 1980, *Competitive Strategy*, Porter's five forces framework sought to relate the average profitability of the participants in an industry to five competitive forces.

Force 1 – degree of rivalry – helps determine the extent to which the value created by an industry will be dissipated through competition, including the number and relative size of competitors.

Force 2 – threat of entry – average industry profitability is influenced by both potential and existing competitors and how easily new competitors can enter the industry.

Force 3 – threat of substitutes – an industry's profitability depends on the relative price-to-performance ratios of the different types of products or services to which customers can turn to satisfy the same basic need, it is affected by the cost the buyer will incur if changing suppliers.

Force 4 – buyer power – force that influences relative value created by an industry, it allows customers to squeeze industry margins by compelling competitors to either reduce prices or increase the level of service offered without recompense.

Force 5 – supplier power – typically focuses on the relative size and concentration of suppliers and the degree of differentiation in the inputs supplied in an industry.

3.6 Community Services

The community services to be offered at the e-station are envisioned to work within the existing framework of services already offered in the city of Newark. The value that the e-station will add to the existing framework is improved access for the residents of the community to these services. In addition to providing transportation and social services, the e-station will function also as a community center. A 200 square foot multi-purpose room is part of the programmatic space diagram that is being used in the architectural models. This multi-purpose room will be for community-based functions like meetings, lectures and educational programs.

3.6.1 Transportation

The primary and most important goal of the e-station is to improve the quality of public bus transportation. The e-station is fundamentally a state of the art bus station. It will

provide an enclosed bus stop that will incorporate an enhanced transportation system to inform people of real time bus locations utilizing Intelligent Transportation Systems (ITS) technologies. The e-station will ultimately increase the safety and comfort of waiting for the bus.

Currently, New Jersey Transit (NJT) is the sole mass transportation provider operating four bus lines (#1, #5, #25, and #42) that travel by or near the proposed location of the e-station. Bus line #25 traverses Springfield Avenue in length. According to NJT statistics, approximately 33,092 passengers ride these buses daily, not including bus line #42.

Since the majority of the people living in the area do not own a car, they heavily depend on mass transportation. Although, not the most convenient medium of transportation, it is the most economical. Cabs are not an option for most residents, so dependable public transportation is particularly important to them. Low-cost public transportation will address the community need for access to other communities and resources.

3.6.2 Social Services and Education

The e-station will integrate social networks with information networks. It will be a point of access and administration of services for career planning, labor exchange, social services, and workforce readiness activities available through the Internet. The e-station will include computer access for the One Stop Program and will have a One Stop social worker available for counseling. One Stop is a single access point to connect residents with information on employment, education, welfare benefits, medical care and training services on local, state and national levels. Another social service program is Families First, which provides welfare recipients with a debit card that is issued by Work First New Jersey (WFNJ). This debit card allows recipients to purchase food and access cash benefits. It is based on the Electronic Benefits Transfer (EBT) System.

There are many social service locations available to the Newark residents. However, the e-station will be unique because of its integration with the transportation services in the community. The social service programs are funded and administered by local, state and federal government agencies. In the research that has already been done to formulate the concept of the e-station, a need has been identified in the community. This need is currently being supported by the government agencies that control the supply of funding for these programs.

The e-station will be a part of the existing social service structure of the city. In order for the e-station project to be successful, it is of utmost importance to involve the community and make this project valuable to them. It is possible that residents will prefer to go to a social service center that they are already familiar with, however, the e-station plans to integrate itself within the existing framework of services already available and make them more readily accessible to the residents. Integration of transportation services combined with access to the information network of social services that currently exists on the Internet will add value to the social services offered at the e-station. The e-station is proposed to fulfill a real need in the community. However, it will be up to the community to acknowledge its value. The project is completely dependent upon its acceptance by the community.

3.7 Business Services

The business services are centered on the Internet and e-commerce. The Internet provides access to goods and services that are lacking in the community. There are three main components for e-commerce: the ability to access the Internet, the ability to purchase goods from e-retailers and the ability to receive packages. The business service models that we have researched facilitate all three of these components while providing opportunities for cash streams for the e-station. In addition, a service to facilitate online purchases, which would function similarly to prepaid phone cards, could

be initiated. This would maintain a high level of anonymity that is a major concern of the community.

3.7.1 Access to the Internet – The Cyber Cafe

Statistics have shown that the "digital divide" is increasing. During the past two years, Internet access rose from 26 percent to 42 percent, a change of 16 percent, in all households in America. However, the change in African–American households rose from 11 percent to 23 percent, a change of only 12 percent. To generate a cash stream for the e-station, Internet access could be provided on a fee basis at the long-term terminals. In addition, vending machines or a refreshment counter could be implemented for additional revenues.

In the city of Newark, there will be several factors that need to be considered when discussing the idea of implementing a cyber café in the e-station model. Currently, Newark has two existing cyber cafés. The first café is Alexis Place A Cyber Café and it is located at 260 Washington Street. It charges its customers \$12.00 an hour for Internet access on the seven computers provided. Some of the services provided by Alexis Place include website and network development as well as computer repair for your home computer. In the tradition of a typical cyber café, its clientele can also purchase coffee. The second cyber-café is Urbansource Cyber Center and it is located at 46 Branford Place. It also charges customers \$12.00 an hour for surfing the web. Urbansource offers their clients eight computers, video conferencing, website development and DSL connections.

Currently, located on Central Avenue across the street from the proposed e-station site is a cyber café, Vartech Solutions, which would be considered the main competition for the e-station. Vartech provides its customers with 16 computers that cost \$5.00 an hour to surf the Web. Vartech has a philosophy that incorporates three factors: 1) the children need to be included, 2) they need to provide their customers with information and 3) people need to understand why their business is beneficial to the neighborhood.

In order to support their philosophy, Vartech has started the idea that would be “Geeks in the Hood”. This is an enrichment program aimed at giving minority children in the neighborhood training in computer languages and Web design. Vartech would like to show children how to start and operate a business on the Internet. The profits would be used for operating costs with the remainder going to a trust fund for the children that would pay for college when they graduate from high school. Currently, the operating costs for Vartech Solutions are \$1200 a month for rent, \$650 a month for insurance, \$400 a month for utilities, and \$500 a month for their phone bill. Their computers cost \$225 to build and run directly off their VMware GSX server that is a Linux based solution, which provides optimal computer performance.

Education is considered to be very important in the community and is nurtured through a number of opportunities. Currently, children are acquiring computer skills at schools, libraries and churches. Since the services are provided free of charge to the community, the likelihood that they will be chosen over the e-station's cyber café greatly increases. Furthermore, people that are from the community manage the school, library and church and will be trusted by family members to teach their children about computers. Since all of the institutions mentioned provide Internet services for free, the e-station will have to provide a unique service that will attract patrons. Furthermore, some corporate programs are also in the process of providing Newark's youth with access to the Internet. For example, Lucent Technologies is investing money in their program called the Lucent Foundation, as well as Project GRAD. Former Newark native Shaquille O'Neil has provided funds to bring new technology centers to the Boys and Girls Clubs. Four technology centers are also in the process of opening in the Westside Park neighborhood. The city of Newark is receiving extensive help in providing free technology solutions that would be the main threat for substitution.

The e-station needs to provide the community with services that their patrons will find valuable. It can offer classes that teach their customers how to use computers on an elementary level as well as an understanding of the Microsoft Office Suite. This service

will allow the community members to acquire the skills that are necessary to secure a job in a corporate environment and will serve as a bridge to a new career. Furthermore, it will allow the community to experience e-commerce by accessing the web in order to make purchases over the Internet. When you view all the services that the e-station is going to provide together with the untapped potential of the market share, which is currently being under utilized it has an attraction that will appeal to the community members.

3.7.2 Purchase Goods – Internet Portal

There are a very limited number of competitive retailers in this neighborhood so residents must travel out of the neighborhood to buy many needed items. Access to the Internet and e-commerce would help alleviate this problem. To generate a cash stream for the e-station, a shopping portal could be initiated. Alliances with e-retailers could also provide discounts for people using the portal to make purchases.

In the pursuit of generating revenues for the e-station, we recommend the establishment of a portal Web interface. This feature will allow merchants to advertise on the portal's web page for a fee. In our case, a portal would serve two purposes. One will be the generation of cash flow for the e-station and the second will be the convenience of providing electronic shopping to the users of the e-station. Providing accessibility to online shopping can be advantageous and profitable. We can have local merchants advertise on our site in addition to having partnerships with retailers who are currently selling through e-commerce. Local merchants can buy space on our web page for a determined monthly fee. There are also some online shops that pay a percentage of the total purchase to the owner of the host page where the sale originated (ex. Amazon), as long as they have signed up as partners in their program.

Portal is the term to describe very highly frequented Web pages. Portals were conceived as entry pages to the WWW and are intended to be a navigational aid to users. Web portals are often the first page the web browser loads when someone starts up the web browser (Netscape Navigator, Microsoft Internet Explorer, etc.). The term "web portal" began to be used to describe mega-sites such as Yahoo, Excite, Microsoft (MSN), Netscape Netcenter, and America Online (AOL) because many users used them as a "starting point" or "entry point" for their web surfing. The term "search engine" has become inadequate to describe the breadth of the offerings of these leading Internet destinations, although search and navigation are still pivotal to most people's online experience. AOL is a little different; it has always been an Internet access provider in addition to being a network of proprietary Internet content and services.

The major consumer web portals are still the most heavily visited sites on the Internet. Yahoo, AOL and MSN are the giants but the next seven or eight after that are significant, as well. All command stock valuations in the billions. AOL Time Warner is worth several hundred billion dollars. Portals offer a wide range of customization options and functionality including: Internet search and navigation; email; customized news, weather, sports, and horoscopes; planners, calendars, and contact managers; bookmark managers to save favorite web sites; real-time chat; message boards; original content on every imaginable topic; shopping; free home pages; "clubs" which function as makeshift intranets; small business services; and much more. Increasingly, major portals are seeing to it that vital content such as news, stock prices, and messages can be accessed with wireless devices and phones.

Today, the term "portal" is going strong. The rapid growth of new ways of leveraging the Internet for communal and corporate purposes has spawned at least four common types of portals. In addition to (a) major consumer web portals like Yahoo, we're witnessing a blistering pace of growth in (b) corporate portals or Enterprise Resource Portals; (c) vertical, affinity, or niche portals; and (d) industry or Business-to-Business

(B2B) portals. For the purpose of the e-station, we are going to concentrate on the vertical and horizontal portals.

- ***Vertical portals (vortals)***

A vertical portal is a major web resource or industry site focused on a specific topic, niche, or industry. Vertical or niche portals are what we might have called websites in the past. The term vertical portal was coined to distinguish from more comprehensive (horizontal) consumer portals such as Yahoo!, Excite and Lycos. Today, certain category leading web sites in a given topical category, or catering to a given demographic, are called portals. The list of very popular and economically significant vertical portals is growing rapidly. Examples include ivillage.com (aimed at women), guru.com (for independent professionals) and Boatscape.com (for boat enthusiasts). Demographically focused portals (portals being launched to cater to specific ethnic groups, specific age groups, alternative lifestyles, religions, and other groups that are perceived to form a community or market) are now being called affinity portals. "Vertical" content, community, and commerce seem to enjoy increasing favor in the marketplace.

- ***Horizontal portals***

By contrast, horizontal portals are general interest portals covering a wide range of topics and features, such as Yahoo! or Lycos. Combinations of Internet access and access to a wide range of information, as with AOL, Excite@Home, Freeserve, Sympatico, and Earthlink might also be called horizontal portals. The distinction between vertical and horizontal portals was necessary to distinguish the mega-portals from the more topically focused portals. It is generally acknowledged that there can only be a few major horizontal portals. Most new entrants today will seek to establish themselves in a "vertical area".

Portal Industry Analysis

There are several suppliers who offer portals. Among the most popular are America Online (AOL), Microsoft (MSN), Yahoo!, Netscape, Lycos, AltaVista, Excite, and Go.com. The leading portals by far are Yahoo!, AOL and MSN. The rest of the pack does not have the means or the brand to compete. The remaining portals are dwindling away and getting behind or just dropped out of the race.

The leading portals are enjoying popularity due to their number of subscribers. In addition to their portal offering, they provide free email accounts and search engines. These products attract users to their website. Each of the Web giants has millions of surfers passing their websites daily. Carrying such a traffic volume, it makes them all that more attractive to merchants who are interested in having electronic storefronts and high visibility. The pricing is pretty much set by the three top leading portal providers, AOL, MSN and Yahoo!. They have similar price structures.

Portals try to compete on the number of subscribers they attract and by offering products that will result in higher Internet traffic. They try to accommodate the information needs of a user by offering categories of interest to just about everyone. The categories range from financials to health, to auto, even to horoscopes.

In the portal market, we do not see a barrier to entry. Anyone can create and market a portal on the Web as long as they have the infrastructure to support it. Entering the portal business is not restricted. The problem is not entering the market; the problem is succeeding in it. The portals that have succeeded and have become strong in a volatile electronic marketplace are those who have other offerings, such as, search engines and free email. Strong partnerships and alliances are also beneficial to the survival and expansion of portals.

In a sense, every portal could be the substitute of each other. Most portals feature the same major categories of interest to users. They will need to keep up with the likes and

dislikes of users in order to remain competitive. Users are not tied in to anyone portal in particular. User preferences can change over time. Some surfers use the services of more than one portal depending on their needs. Loyalty could be an issue in the threat of substitutes. Portal providers try to capture the loyalty of users by allowing a high degree of customization. If the portal contents and features are not to the liking of the user, then the portal will not be successful in attracting that user.

The buyer of the portal service is the Internet user. Another buyer of the portal service is the merchant who buys advertising space on the portal website or the merchant who sets an electronic storefront. The portal user's surfing habits and demographics can drive the portal market to a degree. Users in a way, dictate what the contents of the portal are. Both of these buyers have a degree of buying power by using or not the portal offerings. Portal providers try hard to please their customers because they know their existence depends on their loyalty and patronage.

Comparing the various portals, we find that they differ in their service offerings and in pricing. These portals give surfers the ability to personalize their browser start page. For example, they can customize the news feature to give them local news by providing their zip code. They can customize the personal finance section to display the stock prices of their own stock picks. Other categories included on the start pages are advertising and electronic commerce sites for their shopping convenience.

In our analysis, we will consider the top leading portals and we will examine their services and pricing structure. In the table below (see table 1), the portals mentioned above are presented along with their features.

Feature	AltaVista	AOL	Excite	Go	Lycos	MSN	Netscape	Yahoo
Personalization	x	x	x	x	x	x	x	x
Free e-mail	x	x	x	x	x	x	x	x
Directory	x	x	x	x	x	x	x	x
Stock Quotes	x		x	x	x	x	x	x
Chat		x	x	x	x	x	x	x
Maps/Directions	x		x	x	x	x	x	x
People Search	x	x	x	x	x	x	x	x
Yellow Pages	x	x	x	x	x	x	x	x
Games			x	x	x	x		x
Free Home Pages	x	x		x	x	x	x	x
Communities/Clubs			x		x	x		x
Classifieds		x	x		x		x	x
Auctions			x	x	x	x		x
Contact Manager/ Address Book			x		x	x	x	x
Free Software	x	x	x	x	x	x	x	x
Specialty Searches	x			x	x	x		
Free Net Access	x		x					x
Calendar		x	x	x	x		x	x
Instant Messaging		x			x	x	x	x
Radio			x		x	x	x	x
Shopping	x	x	x	x	x	x	x	x
Custom IE 5.0	x		x	x	x			
Feature	AltaVista	AOL	Excite	Go	Lycos	MSN	Netscape	Yahoo

Figure 46 Portal Comparison Table

Payment for e-commerce Purchases

Purchases made through the e-station portal site can be paid by either a credit card or by a prepaid purchase card. Since the majority of the population living in the area surrounding the proposed site of the e-station do not have a credit card, the second option is most likely to be chosen. When it comes to any retail transaction, anonymity and privacy are major concerns of the community. There are several companies that offer such prepaid cards for online purchases. For the purpose of this project, we will describe the advantages and benefits of the Monneta Prepaid card.

Monneta Prepaid is a cash equivalent electronic payment method, which uses a stored value approach. A Monneta Prepaid card allows consumers to purchase over the Internet without a credit card, or even without a bank account. Consumers can load a virtual prepaid card quickly and conveniently, allowing them to shop and make

purchases at participating merchant sites. Monneta Prepaid makes online purchasing possible for consumers without credit cards and for those who simply prefer to pay with cash. Consumers concerned with security and privacy can use Monneta Prepaid to make secure, anonymous purchases on the Web. A Monneta Prepaid card can be designed as a one-time use card or a rechargeable card. Value can be added in a variety of convenient ways, including cash at point of purchase, credit card, check, or direct transfer from an eCash account.

Portal Operating Costs and Revenues

The operating costs involved in the portal service offering are associated with the setup, hosting and maintaining of the website. The costs of setting up a portal depend on the size and contents of the portal. For a small portal design we estimate \$75,000, for a medium approximately \$125,000-\$150,000 and for a larger on \$200,000 and above. We recommend that the management and maintenance of the portal be the task of the Cyber Café business entity. The original capital required for the setup of the portal should be included in the e-station's capital improvement budget. We proposed splitting the revenues generated by the portal with 25 percent going to the e-station and 75 percent going to the Cyber Café as a subsidy.

For the purpose of the e-station, we will use the Yahoo! portal model for determination of revenues derived from renting e-commerce space for online stores. Among the large portal/community sites to offer cyber shop is Web giant Yahoo! The Yahoo! Shopping offers a high traffic location in the Internet. It is the most-visited independent site on the Internet. It allows for online catalog building, which allows web shop owners to include their sites in their popular search engine. Yahoo! Store merchants pay a flat rate depending on the size of the site. There is no per-transaction fee, no startup cost, and no minimum time commitment. The pricing ranges are as following:

1. ***Small Store \$100/month***

For \$100/month you can have up to 50 items for sale (plus as many

additional information pages as you want). Upgrading to a larger store at any time.

2. **Large Store** \$300/month

For \$300/month you can have a store with up to 1000 items.

3. **Larger Stores** \$300/month

For \$300/month you can have a store with up to 1000 items, plus \$100/month for each additional 1000 items. Ex., a 5000-item store would cost \$700/month.

4. **Domain Names**

New Domain Registration (com/net/org) \$35/year

We will also be charging a percentage of total sales to our online store merchants. This will be a supplemental revenue source for the e-station. For the purposes of this chapter, we will be projecting a revenue of 10 percent of the total sales based on capturing 1 percent of expenditures in the primary trade area. (see financial projections section).

An additional source of income derived from the portal would be banner advertising. We propose a charge for advertising on the portal. Banners will be setup on a rotation basis of ninety days minimum for a fee of \$250. Other pricing options could be setup, as seen more profitable, by the operating business of the portal.

3.7.3 Receive Packages – Private Mail Center

Currently, because of the threat of package theft, it is difficult to have packages shipped to homes in Newark. Merchandise ordered through the portal from e-retailers could be shipped directly to the e-station. A cash stream for the e-station would be generated from fees for this service. According to the US Census Bureau, private mail centers are described as:

Private Mail Centers (SIC 7389) (NAICS 561431)

This US industry comprises (1) establishments primarily engaged in providing mailbox rental and other postal and mailing (except direct mail advertising) services or (2) establishments engaged in providing these mailing services along with one or more other office support services, such as facsimile services, word processing services, on-site PC rental services, and office product sales.

The business model that we have researched is Mail Boxes, Etc. (MBE), which is the world's largest franchiser of postal/shipping, business, and communications services. The services that MBE offers are: packaging, parcel shipping, 24-hour mailbox access, copying, printing, faxing, paging, office supplies, and other related postal and business products and services. MBE is an authorized outlet for FedEx, UPS, DHL and USPS. MBE opened its first location in 1980 and has grown to have 4300 worldwide locations, with 3400 in the US alone. Total sales at MBE locations have grown to \$1.4 billion for the fiscal year ending 1999 from \$1.2 billion in 1996. The franchise fee for a MBE location is \$29,950.

MBE has developed relationships and alliances with online businesses. To facilitate these relationships MBE has invested aggressively in technology infrastructure. Last year it developed its first customer database, and now it is installing a system wide private network that links each store to suppliers and MBE headquarters via satellite. Some of the strategic alliances that MBE is currently involved in are:

- eBay and iShip.com

MBE has a five-year agreement with eBay to provide their members with an integrated system for e-commerce shipping. The alliance will provide a seamless solution for shipping and delivery services that will bridge the Internet commerce world with real world infrastructure.

- Return.com

MBE owns a 40% interest in Return.com in a joint venture with Innotrac, a technology marketing and support company. However, this does not appear to be a very successful venture. Currently, there are only four companies that have signed on to Return.com.

- EncrypTix

MBE has invested in this venture that is developing a system to let consumers purchase event tickets online with pickup at a MBE location.

- National Interbank and Juniper Bank

MBE serves as a branch depository for these online financial institutions.

US Office Products, the parent company of MBE, has signed an agreement with UPS to acquire Mail Boxes, Etc. in March 2001. The transaction will be conducted in cash and is expected to close within the next few months. MBE business will be conducted through a unit of UPS. It is unclear how this will affect the business model of MBE franchises.

Mail Boxes Etc. Industry Analysis

Currently, there are two MBE franchises in Newark. One is located at 131-185 Bergen Street in the Pathmark Plaza across from the UMDNJ hospital; the other is located at 909 Broad Street across from City Hall. The franchise license agreement provides for a protected territory that is based upon the demographics of the community. There does not appear to be a conflict or threat if a franchise were to be located in the e-station on Springfield Avenue. The two biggest competitors for MBE are PakMail Services of America (franchise fee \$27,950) and PostNet Postal & Business Services (franchise fee \$26,900). Neither of these other franchises have locations in Newark. However, there is a US Post Office on Springfield Avenue. Although this may offer some degree of rivalry, the additional services offered by MBE through strategic alliances should counteract their presence. The strategic alliances that MBE has formed with eBay.com, iShip.com and Return.com are examples of proprietary differences that MBE offers to

their customers. Other competitors are Kinko's, Staples, OfficeMax and Office Depot, which are large stores that offer similar services but do not have a strong presence in the Newark area.

The protected territory agreement in the MBE franchise license agreement will counteract any entrants in the e-station territory. There does not appear to be any barriers for another type of franchise opening. However, the strong brand identity and proprietary product differences that are a result of strategic alliances of MBE give an advantage to MBE. The integration between the three business services offered at the e-station will also give an advantage to customers using use the e-station to receive/ship packages from e-commerce activity. In essence, there will not be any substitutes.

In order to purchase goods online, you need to be able to receive the package and, if you are unsatisfied, you need to be able to ship the package back to the vendor. Currently, the residents of the community have difficulty doing this. The e-station, by providing this service, will be offering a service to the community that will be very valuable. By integrating the business services offered at the e-station, the buyer will be inclined to utilize this advantage and not use their inherent power. The lack of substitutes will in essence give almost all of the power to the supplier. It will have to be determined how much value does this service give to the community and what are the residents willing to pay for it.

3.8 Customer Markets

A demographic analysis was performed on the data provided from the 1990 U.S. Census to better understand the anticipated customers in the e-station trade area. Five categories were identified in this analysis: population, income, age, employment status and educational attainment. The trade area of the proposed e-station has been broken

down into three areas: primary, secondary and fringe. In order to show statistical trends, all of the trade areas will be analyzed when discussing the five categories.

Trade Area Description

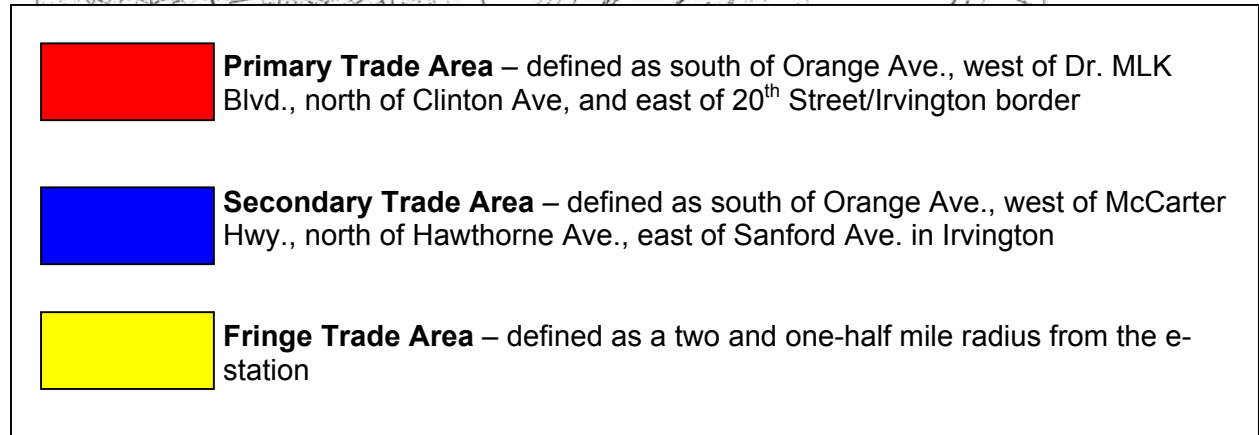
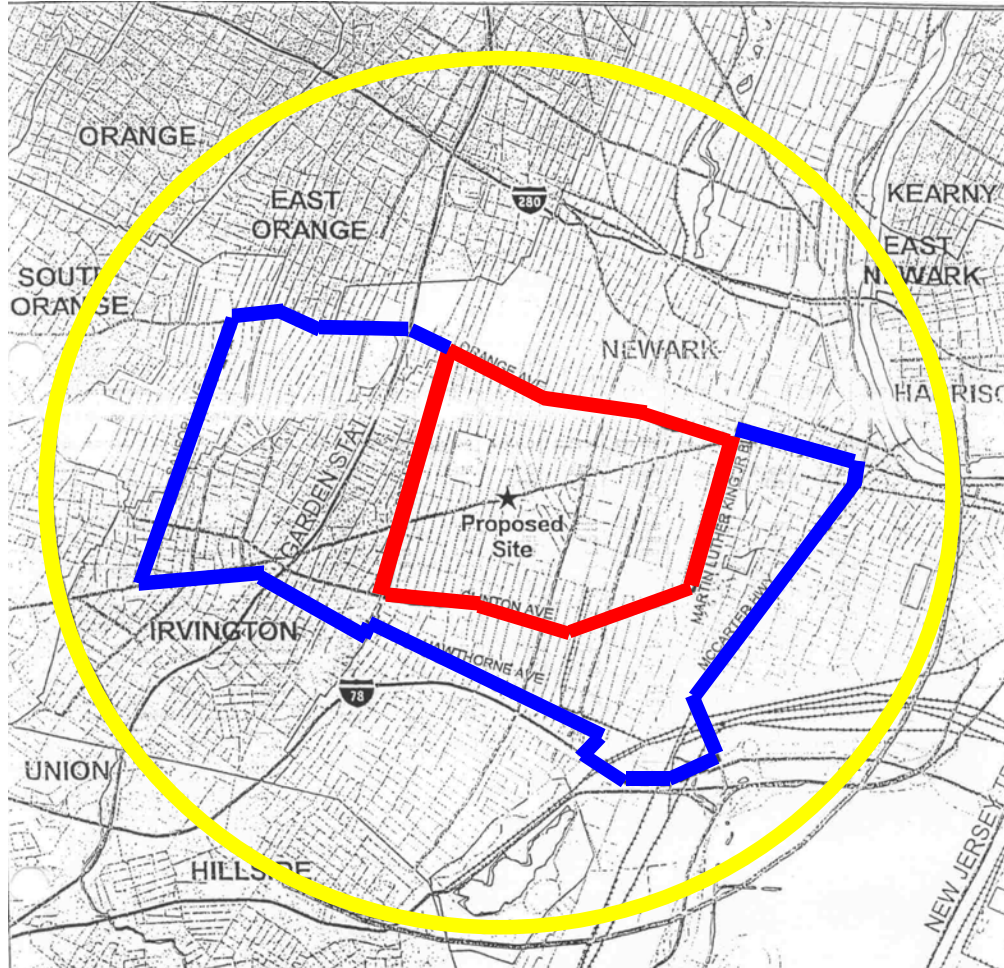


Figure 47 Trade Area descriptions

The total population of the trade area is 355,276 people with 120,152 households and an average household size of 2.96. The primary trade area accounts for 13 percent of the population as well as 13 percent of the households and an average household size of 2.99. The secondary trade area accounts for 20 percent of the population and dwellings with an average household size of 2.88. Furthermore, the fringe trade area accounts for 67 percent of the population and housing with an average household size of 2.97.

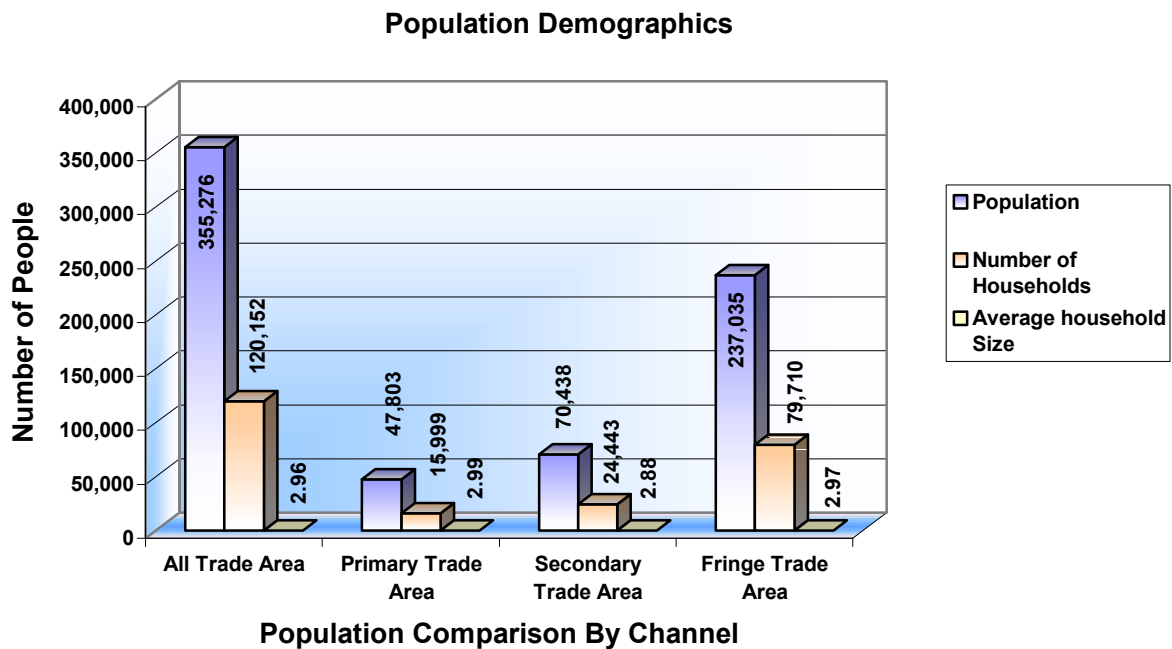


Figure 48 Population Demographics

The median income for the entire trade area is \$24,843 with a per capita income of \$10,135. The primary trade area has a median household income of \$17,304 with a per capita income of \$7,883. The secondary trade area has a median household income of \$24,937 and the fringe trade area is \$26,522. The primary trade area where the proposed site of the E-Station is located is the lowest median household income of all three trade areas.

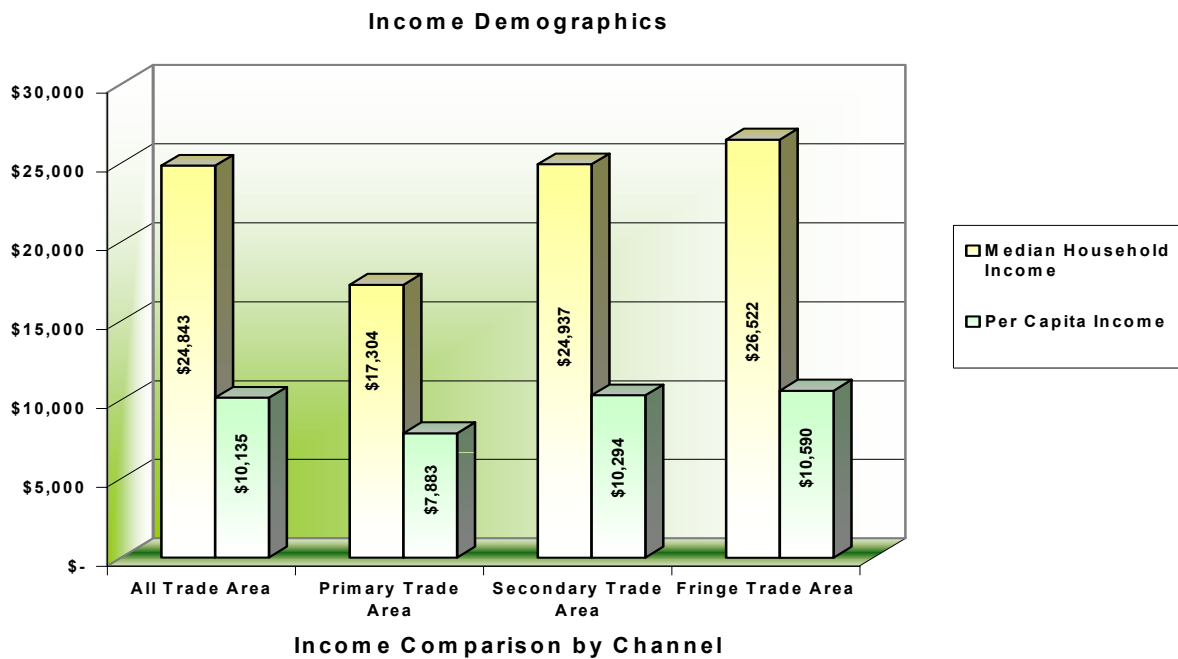


Figure 49 Income Demographics

The employment demographics was analyzed by using three categories employed, unemployed and below poverty level vs. the actual population of the trade area. In the primary trade area there is an employment rate of 30 percent an unemployment rate of 7.2 percent and 38.6 percent of the population is below poverty level. In the secondary trade area, 43 percent of the population is employed, 6.7 percent of the population is unemployed and 20.2 percent of the people live in poverty. Finally, in the fringe trade area 35.9 percent of the people are employed, 5.3 percent of the people are unemployed and 16.7 percent of the people are impoverished. As you move further away from the primary trade area the level of poverty and unemployment decrease significantly.

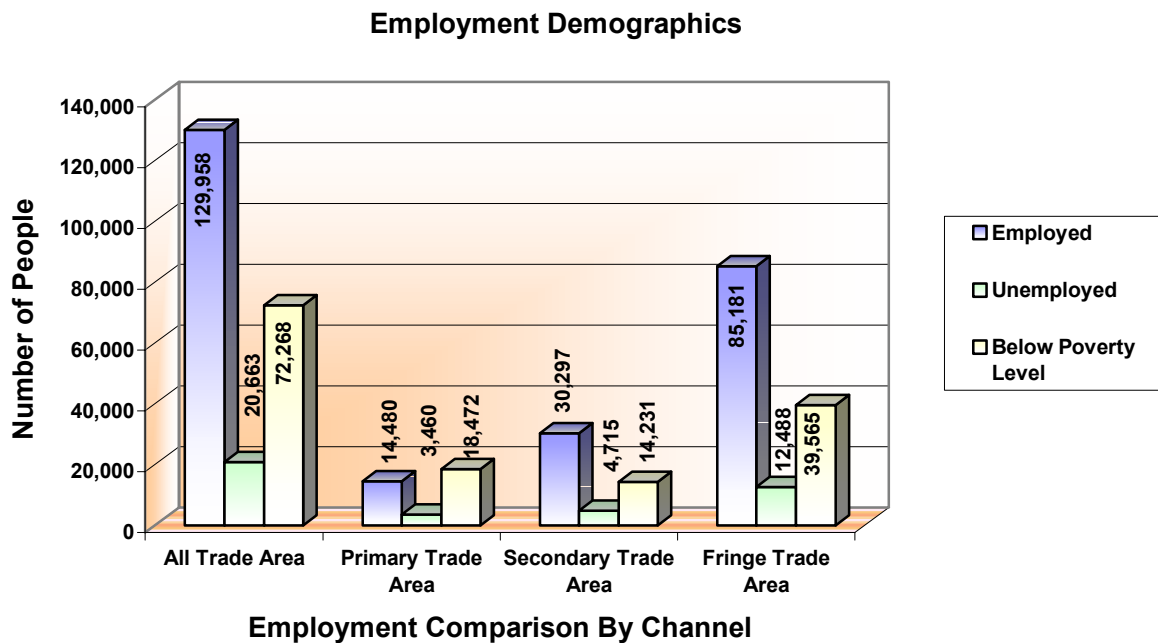


Figure 50 Employment Demographics

The educational demographics have four categories high school graduate, associate graduate, bachelor degree and graduate degree. In the primary trade area 1.6 percent of the people have an associates degree, 1.9 percent has a bachelors degree and 1 percent has graduate degrees. In the secondary trade area 2.6 percent has associates degrees, 3.9 percent has a bachelor degree and 1.9 percent has a graduate degree. Finally, in the fringe trade area 1.9 percent has an associates degree, 3.8 percent has a bachelors degree and 1.7 percent has a graduate level degree. The statistics show that the farther away from the primary trade area the higher percentage of people who have attained secondary degrees.

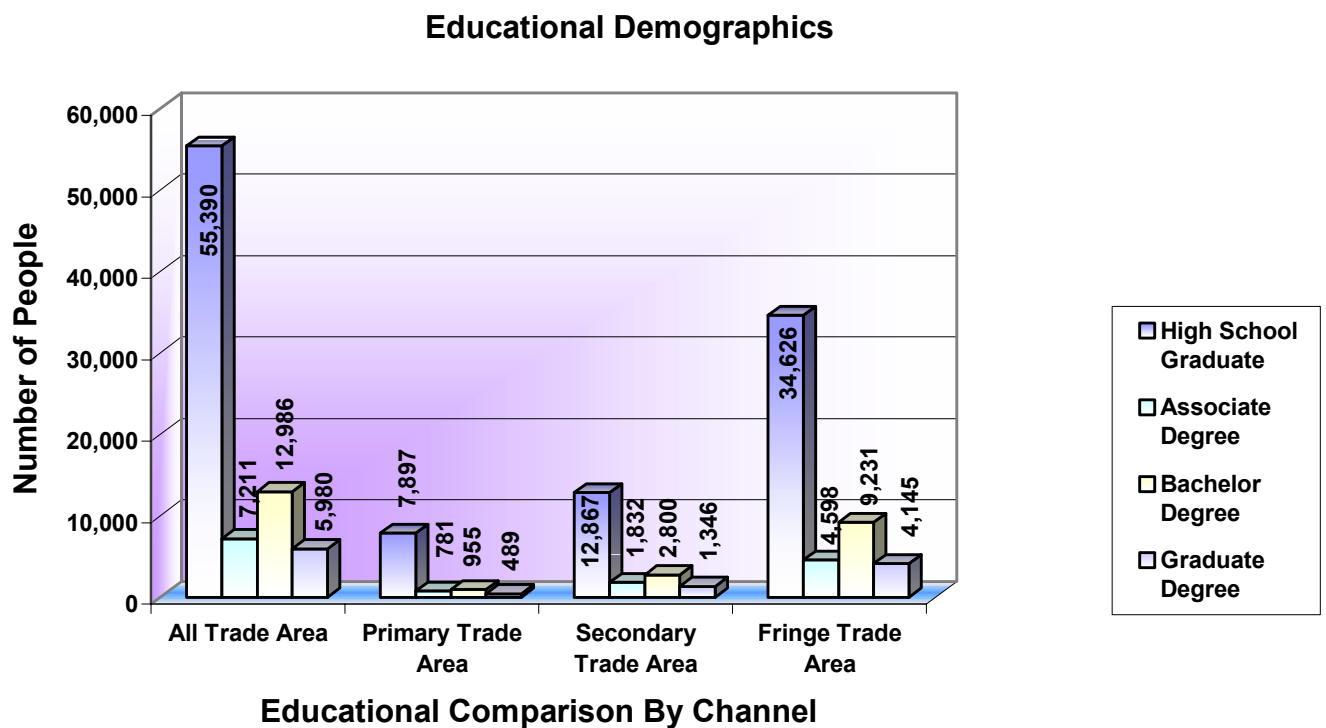


Figure 51 Educational Demographics

The age demographics graph has six categories; under 5 years of age, 5 to 17, 18 to 29, 30 to 49, 50 to 64 and 65 and up. The population is distributed consistently throughout the entire trade area and can form a bell curve with the 30 to 49 category being the median. In the under 5 years of age 8 percent of the population is distributed

followed by 20 percent for the 5 to 17 years of age, 22 percent for the 18 to 29 years of age, 29 percent for the 30 to 49 years of age, 12 percent for the 50 to 64 years of age and 9 percent for the 65 and up. The even distribution of the population will help to bring many different consumers to the e-station to use its services.

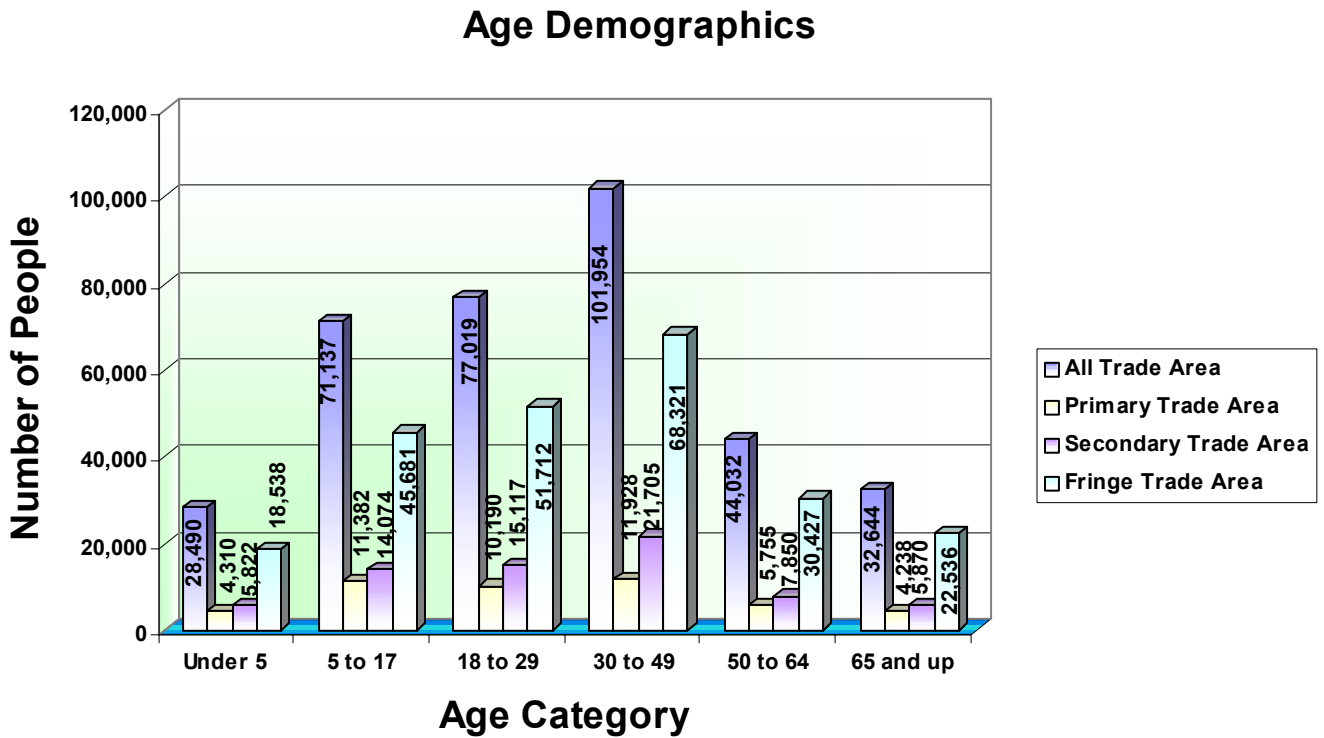


Figure 52 Age Demographics

3.9 Operation and Management Costs

For the purposes of this chapter, we will assume a gross lease agreement with the tenants. The following estimates are based on maintaining the entire 2,000 square foot e-station. In our financial analysis, we have projected the cost of operations of the e-station to increase 3 percent per year for a five-year period.

The following operation and maintenance cost analysis is based on anticipated maximum costs for services outlined. It is possible that one or more of the tasks can be provided by combining them into one service contract. For example, maintenance cleaning and security could be a combined task and the cost for this combined service would be less than the two individual estimates.

In addition, we have not included any salaries to be part of the e-station's operating budget, including a salary for the proposed concierge/facilitator. It is our recommendation that independent contractors provide all services required to maintain and operate the e-station. This includes a fee for a building management company to oversee the facility and to provide the necessary administration of all operating tasks. Furthermore, our research shows that the tenants of the e-station can assume many of the responsibilities attributed to the concierge. As compensation for performing these duties, the tenant receives below market rate rent for the space they will occupy. It is anticipated that the Cyber Café tenant will provide almost all of the responsibilities attributed to the concierge and in addition to the below market rate rent we recommend that the Cyber Café manage the portal business and 75 percent of the revenues generated from the portal business will go to the Cyber Café. This will in effect subsidize the Cyber Café business and compensate them for the free services that they will provide.

The following outline of anticipated operating and maintenance costs for the e-station are based on budget numbers from Mr. Craig Sawyer of the Housing and Community Development Network of New Jersey and Mr. Vincent Olsen and Mr. Hossein Goodarz of New Jersey Transit.

These estimates are on the high side because of dramatic increase in fuel costs and unknown situation regarding the building assemblies.

\$600/month @ 7 months = \$4,200.

\$1000/month during winter season for heat, @ 5 months = \$5,000.

Total Electric/Gas \$9,200

Telephone

This number will be an allowance in the amount of \$150/month. In addition, we have assumed that the tenants will pay to operate and maintain their own phone lines.

Total Telephone \$1,800

Sewer/Water

\$450/year

Total Sewer/Water \$450

Maintenance – cleaning

For a company to come in and clean the facility including supplying all the necessary equipment and supplies, we are budgeting \$2000/month. A rough hourly number for this service is \$28/hour. This means that we have allowed for approximately 2.5 hours of cleaning per day, seven days a week.

\$2000/month @ 12 = \$24000

Total Maintenance/cleaning \$24,000

Maintenance – repairs/replacements

Because this is a new construction, warranties/guarantees for major building components (i.e. roof, windows, furnace, etc) would be covered for approximately 15 years. Depending on the assemblies of construction, including type of interior finishes, minor repairs/replacements (i.e. re-painting, flooring replacement, etc.) would not occur for approximately three years. We recommend having a reserve fund that is added to annually in the amount of \$8000/year.

Total Maintenance/repairs \$8,000

Insurance

When considering an amount for insurance costs, we have estimated a high number because of the uncertainties regarding the actual physical building, the extent of the value of the equipment that will be part of the e-station and the high probability of vandalism in the neighborhood.

Property and liability \$10000/year

Total Insurance \$10,000

Legal and Accounting

\$2000/year

Total Legal/Accounting \$2,000

Building Management Fees

Management of facility

\$5000/year

Total Management Fees \$5,000

Operating and Management Costs	Fiscal Year 2001	Fiscal Year 2002	Fiscal Year 2003	Fiscal Year 2004	Fiscal Year 2005
Security	\$ 64,240	\$ 66,810	\$ 69,482	\$ 72,261	\$ 75,152
Electric/Gas	\$ 9,200	\$ 9,568	\$ 9,951	\$ 10,349	\$ 10,763
Telephone	\$ 1,800	\$ 1,872	\$ 1,947	\$ 2,025	\$ 2,106
Sewer/Water	\$ 450	\$ 468	\$ 487	\$ 506	\$ 526
Maintenance-Cleaning	\$ 24,000	\$ 24,960	\$ 25,958	\$ 26,997	\$ 28,077
Maintenance-Repairs/Replacements	\$ 8,000	\$ 8,320	\$ 8,653	\$ 8,999	\$ 9,359
Insurance	\$ 10,000	\$ 10,400	\$ 10,816	\$ 11,249	\$ 11,699
Legal and Accounting	\$ 2,000	\$ 2,080	\$ 2,163	\$ 2,250	\$ 2,340
Building Management Fees	\$ 5,000	\$ 5,200	\$ 5,408	\$ 5,624	\$ 5,849
Total Operating Costs	\$ 124,690	\$ 129,678	\$ 134,865	\$ 140,259	\$ 145,870

Figure 53 Operating and Management Cost Projection

3.10 Financial Projections of Revenues

Our assumption is that the revenue generated by the e-station is basically rent receipts. To simplify the analysis and to attract entrepreneurs to the project as tenants we propose a gross lease agreement with below market rate rents. To stimulate reciprocal participation towards the success of the project by the e-station and the tenants we also propose an additional rent receipt in the form of a percentage of gross income for each tenant.

3.10.1 Assumptions for Rent Receipts for Year 1

Rentable square foot receipts in neighborhood:

Most leases for commercial/retail space in the neighborhood are in some form of a net lease in which the tenant pays a square foot number and in the case of multi-tenant space pays a percentage of common space and also pays for their own utilities and maintenance.

Low range is \$9 - \$12 per square foot

Medium range is \$13 - \$15 per square foot

High range is \$16 - \$19 per square foot

Lease agreement

Following is an explanation of common lease agreements:

gross lease – tenant pays rent only and the landlord pays all the expenses normally associated with the ownership of the property

net lease – tenant pays rent plus utilities and real estate taxes

net net lease – tenant pays rent plus utilities, real estate taxes, insurance and some maintenance

triple net lease – tenant pays rent plus the taxes, insurance, and all the maintenance expenses

For the purposes of this chapter, we will assume that the lease agreement will be a gross lease that is based on a rentable square foot number for each tenant. In addition, we recommend a type of lease that is similar to leases that are used for merchants in a shopping mall. This type of lease is one in which the tenant pays a base rent per square foot number plus a small percentage of their gross income. This type of lease arrangement benefits both the tenant and the landlord. It encourages the landlord to market the facility to bring in customers. The tenant benefits by having a larger customer base and increased sale revenues; the landlord benefits by increased rent receipts as a result of the tenant's increased sale revenues.

Tenants

For the purposes of our chapter, we have used the programmatic space breakdown diagram that was given to the architecture studio as a guide. For a new construction and a gross lease agreement, an estimated rent range in the neighborhood would be at least \$25 per square foot. This is an estimate because there are not any comparable examples in the neighborhood. To interest entrepreneurs in the project we propose a low base rent of \$18/square foot and a low gross income percentage of 2 percent to start. This assumption enables the possibility to increase the rent depending on the success of the project and can be negotiated in the lease agreements with the proposed tenants. In addition, as previously mentioned, we propose that the Cyber Café tenant manage the portal business. The anticipated revenues generated by the portal will in effect subsidize the Cyber Café business. Since the portal business does not lend itself to a space allocation, we propose to charge 25 percent of gross income to start and the remaining 75 percent of the projected portal income will be the subsidy that the Cyber Café will receive.

Rent Receipts

Proposed of Tenant	Program Space	Square Feet	Base Rent per square foot	Percentage of Gross Income
Cyber Café	E-Space	450		
	Concierge	100		
		550	\$18	2%
Portal				
	Part of Cyber Café	n/a	n/a	25%
Mail Box Etc.				
	Storage	300		
	Office	100		
		400	\$18	2%

Proposed Tenant	Proposed Rent Per Square Foot	Proposed Square Footage	Monthly Rent	Total Per Year Rent	Percentage of Gross Income
Cyber Café	\$ 18.00	550	\$825	\$9,900	2%
MailBox Etc.	\$ 18.00	400	\$600	\$7,200	2%
Portal	N/A	N/A	N/A	N/A	25%
Totals	N/A	950	\$1,425	\$17,100	N/A

Figure 54 Rent Receipts

3.10.2 Assumptions for Gross Incomes for Tenants for Year 1

To compute the percentage of gross income to be paid by the tenants to the e-station, we must first make assumptions regarding the first year gross income of each tenant.

3.10.3 Assumptions for Cyber Café

The financial projections for the Cyber Café are based on the financials of easyEverything Internet Café that has 20 cafes located across Europe with 1 café in New York City at 234 West 42nd Street between 7th and 8th Avenue. The average traffic a month for an easyEverything Internet café is 110,000 customers per a location. The 2000 Census reported a total population for midtown Manhattan of 985,000 people. Therefore, easyEverything was able to get 11 percent of the mid-town Manhattan population to use their Internet café.

Following the same trend for easyEverything Internet Café, it would appear that the potential base population within the entire trade area would be 39,080 customers. If the proposed Cyber Café was to offer 16 terminals at \$6.00 an hour for their use and the hours of operation for the Cyber Café was from 8:00am to 9:00 p.m. from Monday to Friday that would give the potential of 1456 hours of terminal usage. If the cyber café were able to rent their terminals at a conservative 35 percent of the time the realized gross income per a month would be \$16,307 a month with a first year revenue of \$195,684. A conservative projection of five percent per year is assumed.

Business	Fiscal Year 2001	Fiscal Year 2002	Fiscal Year 2003	Fiscal Year 2004	Fiscal Year 2005
Cyber Café	\$195,684	\$205,468	\$215,742	\$226,529	\$237,855

Figure 55 Cyber Café Five year projection at 5 percent

3.10.4 Assumptions for Portal

In order to get a projection of the revenue potential that the portal business may realize we used data from the US Census Bureau, 1998 Average Annual Expenditure report. In the primary trade area of the e-station annual expenditures for apparel and services,

drugs and medical supplies, personal care products and housekeeping supplies was \$35,167,110. Our assumption is that because of the variety of goods offered through e-commerce, the portal business will capture a conservative one percent of the total expenditures for these categories in the amount of \$351,671. A portal service typically receives approximately five to fifteen percent of sales in revenues from the merchants/vendors. We will assume a conservative 10 percent of sales in revenues for the portal business.

Business	Fiscal Year 2001	Fiscal Year 2002	Fiscal Year 2003	Fiscal Year 2004	Fiscal Year 2005
Portal	\$35,167	\$36,925	\$38,772	\$40,710	\$42,746

Figure 56 Portal Five year projections at 5 percent

3.10.5 Assumptions for Mail Boxes Etc.

Several factors were used to determine the potential earnings of a Mail Box Etc franchise in the e-station. The US Census Bureau, 1997 Economic Census reported that there were 4,350 Private Mail Center establishments with total revenues of (in \$1,000) \$1,659,348. This data yields average revenue per establishment of \$381,459. There are 3,400 MBE locations in the United States with total reported sales of \$1.4 billion in 1999. This data yields average revenue per establishment of \$4,117,647. In addition, total sales at US MBE locations rose from \$1.2 billion in 1996 to \$1.4 billion in 1999, which is an increase in sales of 16.67 percent over three-year period, which is an average of 5 percent per year.

The US Census Bureau, 1998 Average Annual Expenditure reported that in the primary trade area of the e-station, there are 17,470 households with a median household income

of \$17,304. The Average Annual Expenditure on postage and stationary for the median household income is \$76/household, for a total of \$1,327,720.

For the purpose of this report, our assumption is extremely conservative and based on capturing 10 percent of the annual consumer expenditure for postage and stationary in the primary trade area. Based on our assumptions, the first year gross revenues for the MBE is \$132,772. This assumption is only approximately one-third of the average revenue per establishment for Private Mail Centers as reported in the US Census Bureau, 1997 Economic Census and is only 3 percent of the average sales per location in 1999 for MBE locations. Although we are using such a conservative year one sales, we will assume the average growth of five percent per year.

Business	Fiscal Year 2001	Fiscal Year 2002	Fiscal Year 2003	Fiscal Year 2004	Fiscal Year 2005
Mail Boxes Etc	\$132,772	\$139,411	\$146,381	\$153,700	\$161,385

Figure 57 Mail Box Etc. five year projection at 5 percent

3.10.6 Assumptions for Projected Revenue for the e-station

1 – Base Rent

We have used a 4 percent increase per year for five years. This is a conservative assumption that covers the 3 percent increase in operating costs plus 1 percent. At the end of five years the rent is still below market rate at \$21/square foot.

2 – Percent of Gross Income

The original percent of gross income remained constant for the five year period, Cyber Café 2 percent, Mail Box Etc. 2 percent, and portal 25 percent. The increase in revenue is due to the projected increase in the individual businesses' incomes.

Business	Price Per Square Foot	Fiscal Year 2001	Fiscal Year 2002	Fiscal Year 2003	Fiscal Year 2004	Fiscal Year 2005
Mail Box Etc	\$18.00	\$7,200	\$7,488	\$7,788	\$8,099	\$8,423
Percentage of Gross	N/A	\$2,655	\$2,788	\$2,928	\$3,074	\$3,228
Cyber Café	\$18.00	\$9,900	\$10,296	\$10,708	\$11,136	\$11,582
Percentage of Gross	N/A	\$3,914	\$4,109	\$4,315	\$4,531	\$4,757
Portal	N/A	N/A	N/A	N/A	N/A	N/A
Percentage of gross	N/A	\$8,792	\$9,231	\$9,693	\$10,178	\$10,686
Totals	\$18.00	\$32,461	\$33,913	\$35,431	\$37,017	\$38,676

Figure 58 Percentage of Gross Income

Graphical Analysis of Operating Cost vs Projected Revenues

When the projected revenue is compared to the operating costs of the e-station there is clearly a large differential. The e-station will most likely need to look to additional sources to provide funds to help subsidize the operating costs of the center.

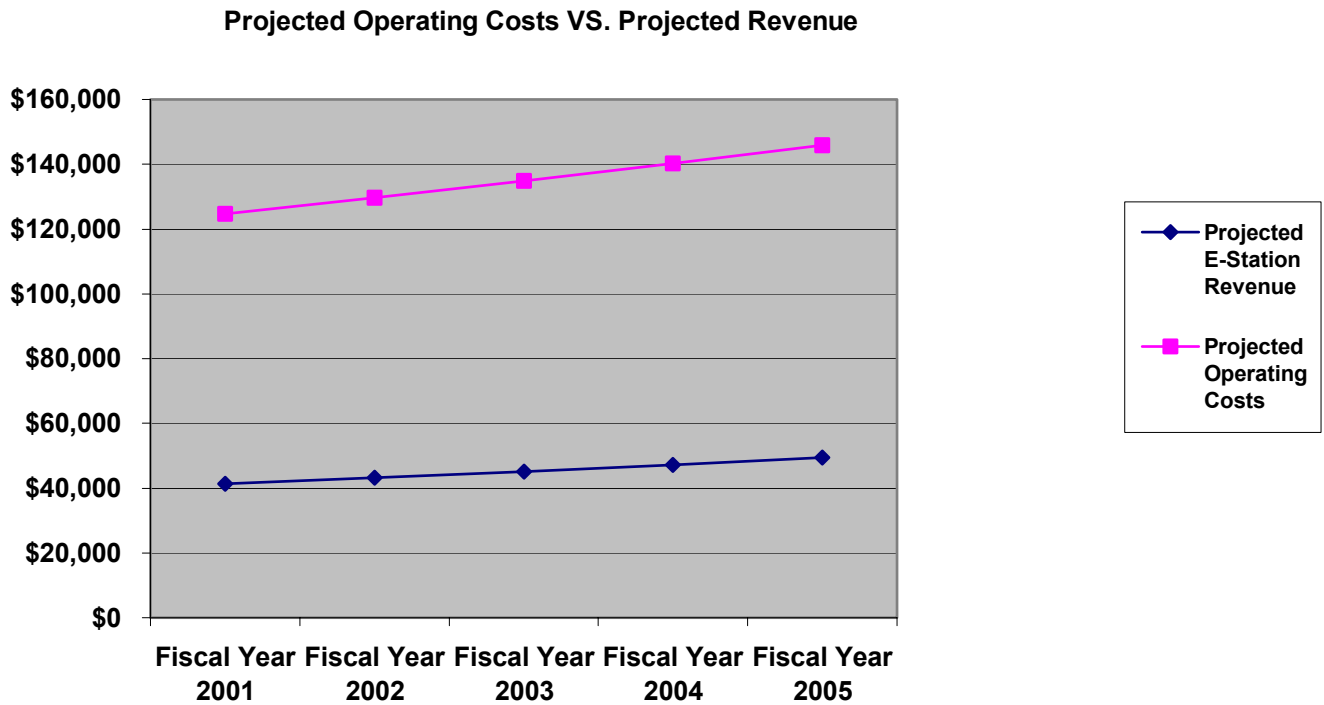


Figure 59 Operating cost Vs. Projected Revenues

The preceding analysis of e-station revenues is based on extremely conservative assumptions. In addition to the conservative analysis we have outlined, we would also like to outline a more optimistic and aggressive revenue projection and analysis.

For Year 1, we will keep our initial conservative assumptions for the three tenant businesses in the e-station. (Cyber Café, portal and Mail Box Etc.) However, to this initial assumption for Year 1 revenues, we will project a more aggressive growth rate of 20 percent. This assumption is based upon the e-station project being accepted by the community. This assumption is realistic in so far as the fact that Year 1 is so conservative, the growth rate would theoretically be higher than average to bring the businesses closer to an average income level. Furthermore, following is an outline of additional anticipated revenues that we have identified and have added these anticipated revenues, in the amount of \$50,000, to Year 1 income.

3.10.7 Additional Anticipated Revenues

Although we do not include these revenues in the original conservative financial revenue projections for the e-station, as outlined below, the e-station could easily realize at least an additional \$30,000 - \$50,000 in revenues per year.

Advertising

Portal – banner advertising \$250 for 90 days minimum rotation.

Traditional Train Station – MetroVision and TDI are two companies that NJ Transit currently has contracts with in their train stations. The revenue paid to NJ Transit is 55 percent of 85 percent of total revenues received by MetroVision and/or TDI. Based on the size of the e-station, there could be approximately 30 panels of advertising that could yield approximately \$1000/month for the e-station.

ATM Machine

The fee paid by a bank to place an ATM machine in a train station is approximately \$1000/month.

Pay Telephones

The fee paid by a telephone company to place pay phones in a train station is 7 percent - 10 percent of gross income received from the site.

24 Hour News Stand

It is the recommendation of Mr. Olsen and Mr. Goodarz of NJ Transit that an additional tenant, a 24-hour newsstand, be explored. The typical agreement between NJ Transit and a 24-hour newsstand tenant is rent in the form of 10 percent - 15 percent of gross income. A 24-hour newsstand in a small train station typically realizes \$250,000/year in gross income. This type of arrangement could yield approximately \$25,000/year for the e-station. In addition to providing additional revenues for the e-station, the placement of a 24-hour newsstand offers the opportunity to reduce the security cost of the e-station and lessen the probability for vandalism.

3.10.8 Assumptions for Aggressive Projected Revenue for the e-station

1 – Base Rent

We have not increased the base rent from the conservative assumptions. We feel that it will be important for the e-station to offer below market rate rent to interest entrepreneurs.

2 – Percent of Gross Income

This is also the same as the conservative assumptions. Cyber Café 2 percent, Mail Box Etc. 2 percent, and portal 25 percent.

3 – Tenant Revenues

Year 1 assumptions remain the same but projection of incomes is 20 percent.

4 – Additional Revenues

To the Year 1 revenues for the e-station (base rent plus percent of gross incomes from tenants) we have added \$50,000/year

Business	Fiscal Year 2001	Fiscal Year 2002	Fiscal Year 2003	Fiscal Year 2004	Fiscal Year 2005
Projected E-Station Revenue Conservative	\$32,461	\$33,913	\$35,431	\$37,017	\$38,676
Projected Operating Costs	\$124,690	\$130,925	\$137,471	\$144,344	\$151,561
Projected E-Station Revenue	\$82,461	\$98,953	\$118,744	\$142,493	\$170,991

Aggressive

Figure 60 Additional Revenues

The following graph shows that acceptance by the community to support a 20% growth of the tenant businesses and identifying and utilizing as many possible additional revenue sources, many that are found in typical train stations, the e-station can obtain its goal of becoming self-sustainable.

Projected Operating Costs VS. Projected Revenue

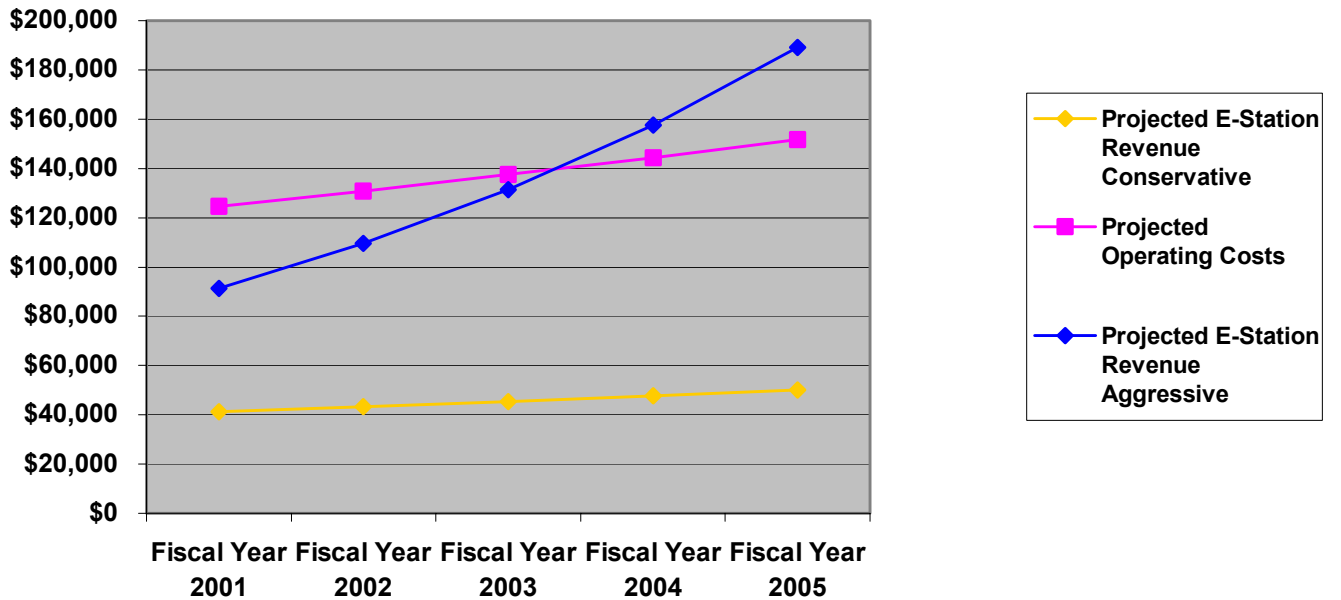


Figure 61 Projected Cost vs. Projected Revenue

3.11 Risk Factors

When starting any business there are certain risk factors that need to be taken into consideration. The proposed site for the e-station is located in a neighborhood that 38.6 percent of the population in the primary trade area lives below the poverty level as reported by the 1990 census. The measure used by the 1990 census for poverty level

intended for a family three persons was \$10,530. Therefore, the market where the e-station would reside may not have enough customers with money in the neighborhood to sustain a non-public subsidized business. Furthermore, if the businesses that reside in the e-station do not prosper the potential revenue from percentage of gross profits would never be realized and would be detrimental to the survival of the business.

1 – Implementation of technology based assumptions

ITS Bus Service

Ability to purchase goods by a pre-paid card system that can be integrated with portal

2 – Community acceptance and use

The success of the project depends on the community acceptance and support of the e-station. The community has to see the e-station as a value-added to residence life.

3 – Locating and obtaining funding for the project

The original capital for construction and for purchasing of equipment.
Future funding for operations and management.

4 – Political factors

Political factors will play an important role. They can affect the location of the e-station.

5 – Population shift

Population shift will affect the e-station. A decrease in population in the surrounding area will have an impact on the traffic and use of the e-station services. Hopefully, the revitalization plans of Newark will attract new businesses and residents.

6 – The ability to interest local entrepreneurs in the project

To make the e-station self-sustainable, participation by local entrepreneurs is required.

3.12 Recommendations

Following are recommendations regarding the implementation of the e-station as currently planned.

3.12.1 Ownership Structure

We propose the formation of a non-profit organization (e-station Inc.) that would serve as an umbrella corporation to the e-station. In our analysis, we have not included any capital improvement costs for the construction of the e-station. Nor have we included any equipment costs that are necessary to implement the technology associated with this project. We propose that this non-profit organization receives anticipated cash streams from the proposed businesses and any needed public funding. To simplify the responsibilities of e-station Inc. we also recommend retaining a professional property management company to take care of the operation and management of the facility. A cost for this service has been included in our cost analysis. Furthermore, we recommend that all the services offered at the e-station, all the services required to maintain the e-station be in the form of private businesses and e-station Inc. does not have any employees.

An alternative to the e-station 'owning' the physical building and property, Mr. Craig Sawyer of the Housing and Community Development Network of New Jersey, who prepared a market analysis for the proposed supermarket development, recommends that there might be a possibility for the e-station to lease space from the supermarket development. The e-station could then sub-lease space to the proposed business that we have recommended to be part of the e-station.

3.12.2 Tenants

The goal of the e-station, in addition to offering the community improved access to public transportation and social services, is to enable the members of the community to access the large variety of goods and services that are available on the Internet through e-commerce. In our analysis we defined three services required for e-commerce: ability access to the Internet, ability to purchase goods and the ability to receive/ship packages. We have proposed businesses to be placed in the e-station to provide the services we have identified that are required for e-commerce. In addition, we recommend that these businesses be independent from the e-station. In effect, the e-station will house these services, and local entrepreneurs will run and own the businesses. Revenues coming into the e-station will be in the form of rent. The success of the businesses and the success of the e-station have a reciprocal relationship.

Mail Boxes Etc. Franchise

Our research shows that a Mail Boxes Etc. franchise solves many of the shipping and receiving of packages problem that exists in the neighborhood. MBE has an existing infrastructure to facilitate this service and has strategic alliances already in place regarding e-commerce. We recommend that the entrepreneur for this business be encouraged to participate by the initial low rent offering and the potential for additional business opportunities that may be realized as a result of the success of the project.

Portal

We chose a portal as a revenue-generating proposed business for the e-station. The portal revenues will be derived from electronic banner advertising and a percentage of sales from e-commerce activities. We recommend that the portal be managed by the cyber café business entity of the e-station. This will be more cost effective and will eliminate duplication of service offerings. We recommend dedicating a number of workstations for e-commerce usage. This will allow for better management and control.

Cyber Café

A "cyber café" designation has proven to be more successful than 'computer resource center' and we feel that additional revenues can be generated by the sale of refreshments. It is also recommended that a partnership be formed with Vartech Solutions to run the cyber café in the e-station. The advantage of having Vartech run the proposed cyber café is the likelihood that the people in the neighborhood would support a business that is run by a local resident over a non-resident. It is suggested that Vartech be allowed to use the portal at a reduced cost and in return would give the professional management company 3 percent of gross profit for the service provided. It is also suggested that the cyber café forms a working relationship with Mailboxes Etc. in order to provide a complete shopping experience that will include the shipping of their web purchased items.

Cooperation between the Businesses

We recommend that the three proposed business entities cooperate with each other and work together to create more business opportunities. Because of the relationship between the three businesses regarding e-commerce, through cooperation and integration of services, all three businesses will benefit by creating a competitive advantage.

3.12.3 Marketing

We must stress the importance of marketing the e-station. The success of the e-station is its acceptance by the community. A significant budget should be allotted for marketing to local news media and to community organizations. The marketing should focus on the advantages and benefits that the e-station will bring to the local residents.

3.12.4 Security

We recommend the elimination of the concierge function. Instead, we propose the hiring of a full time security service. We recommend two 8-hour shifts to cover the e-station operating hours. The security person can be trained to provide typical information regarding the use of the e-station.

3.12.5 Site

The original e-station project included the analysis of two different sites in Newark, the Springfield Avenue site and the Broad Street site. In our original research into the project, we came to the conclusion that because Springfield Avenue is not a major transportation hub, as is Broad Street, and there is much less foot traffic, the e-station would function more like a community center. A factor that would improve the feasibility of the project is that NJ Transit is assessing the feasibility of establishing a connecting bus transfer station on the lot of the proposed supermarket development connected to the e-station site on Springfield Avenue.

3.13 Conclusions

Ending this report, we conclude that the success of the e-station project depends heavily on its acceptance by the community. In addition, the proposed businesses need to cooperate and form alliances in order to create new business opportunities and to make the e-station a viable and self-sustainable entity. Given the right environment, the e-station can prove to be an essential part of the Westside Park neighborhood revitalization. This report can be considered the basis for further research and development of the e-station concept.

4 CHAPTER FOUR: ISSUES AND NEXT STEPS

The idea of e-stations is an innovative one, combining elements that are currently available and in use in some places but that have not been brought together in this manner before. The web-based document, the architectural proposals and the business plan all suggest how these elements could come together. Actually doing so in order to finance, build and operate a real e-station that becomes self-sustaining, requires additional research planning, and fund raising.

The best site determined so far for the first e-station is at Springfield Avenue and west 10th street in the West Side Park neighborhood. This location is the site of a previous

supermarket and is slated for redevelopment as a future supermarket under the auspices of CREST, a local community development corporation who will work in partnership with a for-profit developer. Since the completion of the program and several of the architectural designs of the e-station, CREST has expressed strong interest in developing an e-station at this site, possibly as a storefront adjacent to the supermarket. In November 2002 CREST received a \$400,000 business development grant and remains committed to incorporating an e-station into the development of the supermarket. The feasibility of this and the exact nature of the redevelopment and the legal and financial arrangements have not yet been determined and probably cannot be until arrangements between CREST and a developer for the supermarket are completed.

It makes sense to have the e-station developed and owned by a local non-profit organization which could establish partnerships with for-profit organizations to generate revenue. This is the recommendation in the business plan and is supported by the planner of the Blue Line Televillage in Compton, California, Walter Siembab, who feels that one factor in the lack of full success of the televillage was that, counter to his recommendation, the televillage was owned and operated by the municipal government and not by a community non-profit. It would also be possible for the eventual sponsor not to own the premises of the e-station but to lease space from another entity -- such as the new supermarket. Whether the organization owning the e-station should be a community organization or one created for this purpose and how that decision should be made are questions yet to be answered. A very serious issue to be addressed is the need to assess and possibly to develop the organizational capacity of any group to oversee the e-station.

The business plan recommends that all services offered at the e-station and all services required to maintain the e-station be in the form of private businesses. Thus the organization owning the e-station would not need to employ any staff. Whether the latter would actually be feasible, particularly during the start-up period of several years, is highly questionable. Again, Walter Siembab suggests that one of the largest problems

he encountered relative to the Blue Line Televillage was finding and training staff to run the facility.

The idea of the e-station and the research and design completed so far are all the work of faculty and students at NJIT. Other organizations have expressed strong support and contributed ideas and information but to date the driving force is from within the university community. It seems clear that at some point in the near future more initiative and responsibility will need to be assumed by someone or group of persons within the community. Who these people will be and whether and how they can be compensated are additional issues. The guidelines for creating a community technology center (published by ctcnet) recommend that a Steering Committee be formed and that it include a "prime mover organizer" as well as community representatives, business community representatives, professionals and educational community representatives. While the person whose idea it is to establish the e-station is a faculty member at NJIT, it would make more sense for the responsibility of developing the e-station to be shared with a community representative.

As outlined in the e-station business plan, the success of the e-station as an eventually self-sustaining operation depends upon the presence, cooperation and financial viability of a cyber cafe, a private mail center and possibly a newsstand. In the spring of 2001 the research team began discussions with an existing computer business on Springfield Avenue, Vartech, to determine if Vartech could be the owner and manager of the cyber café, fulfilling the role of the private partner in the development of the e-station. However in May 2002 Vartech closed. Other possible entrepreneurs who could be candidates for operating the e-station and other possible tenant businesses or revenue-producing ventures need to be located. Further study is also required to determine the best legal and financial arrangements behind the public/private partnership that would constitute the e-station.

The intention is to make the e-station a self-sustaining operation with revenue generated from the cyber cafe, a private mail center, ATM fees, payphone fees,

advertising and other sources. But this will take time and at least three years of outside funding from grants and foundations is needed to support the e-station during its initial start-up period. Also, while the generation of revenue is important, so is the provision of social services such as the One Stop Program. The One Stop Centers managed by the Mayor's Office of Education and Training have been in operation since 1999 and attendance at these centers is not as high as expected. While the advantage of a One Stop Center in the e-station that is so visible and accessible from the street is an advantage, more research and discussion are needed to determine the feasibility of incorporating a One Stop Center into the first e-station.

Funds are needed to pay for the construction of the first e-station. In November 2000 the Executive Director of the Casino Reinvestment Development Authority, in response to a proposal submitted by the urban lab at NJIT, expressed strong interest in the e-station and supported the possibility of CRDA funding part of its construction, possibly \$240,000. Since then CRDA has concentrated their efforts elsewhere. While CRDA is committed to funding redevelopment efforts in Newark; whether this can include the e-station remains to be seen. With this report, funding organizations in the private sector can also be approached.

NJIT architecture students developed valuable design proposals for the first e-station and ideas are being drawn from this work for explaining the e-station and for fund raising. The final design, however, can only be completed when the location is certain, when the relationship to other possible new buildings is established and once the budget for construction is determined. The research team will have to be expanded to include specialists in environmental engineering, structure and life safety. The design will be completed by a professional architect who, once the necessary agency reviews are complete, will prepare the construction documents.

The success of the e-station depends fully on its acceptance and use by local community residents. Residents young and old have to see and experience, quite quickly, the benefits of the e-station services to their lives and to take frequent

advantage of those services. Such acceptance and use requires an intense and well designed marketing campaign both before and after the e-station is open. The need for education about the e-station and marketing its benefits was raised by residents in the focus group and stressed in the business plan. A significant amount of money should be allocated for marketing with careful research concerning marketing content and methods.

Clearly there is much to be done before the first e-station can be built; the tasks to be completed and partnerships to be formed are somewhat daunting. At the same time there are many encouraging signs that indicate the value of the e-station concept and the recognition of its merit. The cyberdistrict plan developed in fall 2002 by Hudson County was based in part on the e-station research reported here. CREST, the community development corporation engaged in developing the site of Springfield Avenue and 10th Street, remains committed to the idea of incorporating an e-station into the planned supermarket. As part of its master plan study New Jersey Transit reviewed the e-station concept for the Broad Street Station and will consider incorporating it when design for the station is developed.

The e-station is part of the broader transportation strategy of bus rapid transit, which seeks to improve the frequency, capacity, efficiency, comfort and image of bus service. In Lane County, Oregon, bus rapid transit will serve the Eugene/Springfield Metropolitan area by employing: vehicles that resemble rail cars, transit only lanes, an intelligent transportation system, off-board fare collection, and safe and attractive stations that may also include cafes, newsstands and other commercial facilities.

Newark, a city that developed along trolley lines and has a consistently high bus ridership is an excellent candidate for bus rapid transit. In fact, a study conducted in Newark in the 1950s by General Motors to research running buses underground was used by Mercedes Benz to develop the first bus rapid transit system in Essen, Germany. In 2003, Richard Roberts, the new Planning Director of New Jersey Transit expressed his interest in developing bus rapid transit in Newark. The e-station would be an excellent component of such an initiative.

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6 APPENDICES

6.1 Appendix A: Survey of Advanced Public Traveler Information Systems

Riderlink (<http://www.riderlink.gen.wa.us/>), Seattle, Washington ⁽¹⁾

Rider link features a web site that provides information on Metro Transit Information for the Seattle area. Travelers can obtain information on transit schedules, van and carpooling, HOV lanes, ferry, and park and ride facilities. Riderlink offers links to corresponding transit web sites of the central Puget Sound region: Metro Transit (King County) Kitsap Transit (Kitsap County), Pierce Transit (Pierce County), Community Transit (Snohomish County), Everett Transit (Snohomish County) and Sound Transit (Regional Transit Service). The Metro Transit web site includes a trip planner that provides the “optimal” transit trip from an origin to a destination. Users can request the fastest route, one with fewer transfers, one involving the minimal walking distance and they can also require an accessible trip if necessary.

BusView (www.smarttrek.org/html/busview.html) ⁽²⁾

The University of Washington developed a real time web based system that displays the location of the buses on a GIS map. The buses are monitored through the bus AVL system that communicates the bus location to a central location in real time. BusView also produces alerts based on user input on specific bus routes that aid the traveler in their decision as to which bus to catch. This is also a desirable feature for the Newark e-stations.

The AVL system includes: (1) computers and the radio system on-board each bus, (2) signpost transmitters distributed throughout King County that broadcast a signal, (3) displays in the Control Center in downtown Seattle and (4) servers that process the data stream and determine the location of each bus.

In addition, the Spokane Transit Authority has installed an in-terminal traveler information system through television monitors. The information provided includes the scheduled bus arrivals and the actual departure time of the next bus in each route from the terminal, including the bay from which the bus will depart from.

EZRider (Puget Sound Region – Washington) (www.riderlink.gen.wa.us) ⁽³⁾

The EZRider kiosk traveler information project provides the same information as the Riderlink. Five kiosks have been installed at the Boeing complex, providing valuable information to the employees that can plan their transit trips more effectively. An additional three kiosks were expected to be provided to users of the Washington State Ferries - two in ferry terminals and another on a newly constructed ferry that can be used en-route.

Orange County, California (www.octa.net/busrail/secguide.asp) ⁽⁴⁾

A federally funded operational test (\$3 million - The California DOT (Caltrans) and the Federal Highway Administration) is the implementation of the Transit Probe and TravelTIP. The Transit Probe project is a multi-jurisdictional transit demonstration project that utilizes buses equipped with GPS that are also used as traffic probes.

The operational test also includes the use of traveler information kiosks that are located at various terminals throughout in the Orange County. The system also incorporates a transit trip planner in a similar manner with the other systems. It is envisioned that up to 750 fixed-route and paratransit vehicles will be equipped with GPS receivers throughout Orange County Transportation Authority routes on a completed system.

San Francisco Bay Area, California – TravInfo (www.travinfo.org) ⁽⁵⁾

TravInfo is a traveler information system developed for the San Francisco bay area by the Metropolitan Transportation Commission (MTC). It provides both traffic and transit information through a toll free number as well as the web. It provides a web link to transit information (www.transitinfo.org), which can be accessed by commuters to receive information on transit schedules and trip planning. Their web based trip planner, The [TakeTransitSM Trip Planner](#)⁽⁶⁾ can produce the “optimal” trip based on either the departure time or the required arrival time. The user can also specify his/her preferences such as fastest, fewest transfers, minimal walking and minimum fare. Furthermore, the users can provide the fare category as well as the maximum walking distance. Users can also receive traveler information through a toll free number.

Honolulu, Hawaii (www.thebus.org) ⁽⁷⁾

In Hawaii they developed a telephone and web-based transit traveler information system. The telephone system is a pre-recorded system (TheBUS) that provides information on bus routes and schedules as well as expected trip duration. Information

is provided either in English or Japanese. The system is geared towards two categories of users, locals or tourists. Locals can select the Express-Time option and tourists the Visiting-on-TheBUS option. The latter provides specialized information on transit routes and schedules that service 52 tourist destinations. It also includes information on hotels and senior citizen centers.

Ann Arbor, Michigan (theride.org) ⁽⁸⁾

The transit traveler information system in Ann Arbor, Michigan operated by the Ann Arbor Transportation Authority offers a free e-mail subscription service that allows the users to receive timely transit information based on their specific travel profile. E-mail alerts are sent to the users on the status of their bus. Users can also access the web site (theride.org) that provides real time information on the status of the buses. The web site offers comprehensive related transit information such as map, schedules and fares, trip planning, ride share, park and ride, accessible services, senior services, football ride, and art fair ride. It also provides weather-related information that may affect bus routes as well as updated fixed-route changes either through telephone or through the web.

The AATA has also installed an in-terminal traveler information system that provides real-time bus data on expected arrival times, delays and departure times. This is accomplished through real-time communication between the bus AVL system and the terminal information system. The information is delivered to the passengers through video monitors.

The Winston, Salem Transit Authority (WSTA - www.ci.winston-salem.nc.us/DOT/wsta.html) ⁽⁹⁾ APTS Mobility manager project was funded by the FTA also features an integrated transit traveler information and transit dispatching and scheduling system. The transit and paratransit information is provided through the telephone, cable TV, and strategically located kiosks.

Canada

Two transit information systems in Canada offer similar services as their US counterparts such as a web site and telephone service. The one is the British Columbia Transit (www.translink.bc.ca) ⁽¹⁰⁾ in Vancouver and the other one is the London, Ontario.

The London, Ontario system (www.city.london.on.ca/Transportation/ltc.htm)⁽¹¹⁾ provides real time monitoring of buses through signposts that are located throughout the area. This information is used both by the transit agency for better transit management as well as by the users that they can project the arrival of their bus at the desired bus station. It offers also an automated telephone system that provides information on real time bus arrivals (up to the next three) for specific bus stops. The bus stops are coded in four digits that the user punches on the telephone when the appropriate prompt is heard.

AZTech Metropolitan Model Deployment Initiative, Phoenix, Arizona
(www.aztech.org)⁽¹²⁾

One of the components of the MMDI in Phoenix, Arizona is the implementation of real-time and static transit information to the travelers through their strategically located kiosks. Real time information on bus location and expected arrival information at each bus stop will be achieved through an AVL system. In addition, this information will be available through an automated telephone system and the AZTech web site through the bus book link.

Talking Signs for Visually Impaired www.ski.org/rehab/WCrandall/General/intro^(13, 14)

Visually impaired people have the disadvantage that they cannot read the messages printed on the information at bus/train stops and bus/train terminals. A rather new technology has been developed which is comprised of a receiver that the user carries with him/her and an infrared transmitter that produces an audible signal. While the user moves forward to the transmitter the signal becomes stronger hence the user knows that he/she is moving closer to the source and the signal fades once the user moves in the opposite direction. These messages contain the same information as the printed signs such as women's restroom, computer terminal, bus stop, etc. The talking sign technology could also be used at the e-stations to provide orientation to the visually impaired people to the services provided by the station. This technology has been applied in San Francisco, California by the Municipal Railway and the Bay Area Transit District at the Powell Street station.

6.2 Appendix B: Smart Card Implementation Projects around the World

Some of the efforts around the world involving the use of Smart Cards for public transportation are briefly summarized below:

Motorola Inc. (www.motorola.com) ⁽²⁷⁾

San Francisco Bay Area TransLink®

The San Francisco Bay Area Metropolitan Transportation Commission (MTC) has awarded a ten-year, \$114 million - \$157 million contract (depending on usage) contract to the ERG Motorola Alliance to install and operate the TransLink® Smart Card AFC system. The Smart Card system will provide an integrated payment service that will cover train, light rail, bus and ferry, to over 1 million TransLink® users estimated by the year 2002. The TransLink® system incorporates 9 counties and 26 different transportation agencies. The Alliance will design, supply and implement the system; provide infrastructure for Smart Card and back office operations; manage operations of the entire system; and provide customized support services. The Alliance's back office technical support will provide detailed information and revenue distribution to the participating transit companies. As such, the system could be used to improve continuously the overall transit system given that the various operators will have more accurate and timely knowledge of the demand and transit trips of the users of the system. The system is expected to be fully operational in 2002.

Basic Functions:

Contactless fare transactions. Public transport fares and transfers between modes such as buses, trains and ferries that are run by 26 different transit agencies are achieved with a single Smart Card where the user waves the card at check in/checkout readers.

Integrated fare payment. The fare payment structure involves trip length, transfers, route, time of day, discounts for students, elderly and disabled riders.

Universal payment card. The card can easily transfer money to the public transport account of the user from their bank accounts or credit cards. In addition, the card's functionality can include various actions such as access either to buildings, parking lots, as well as computers, restricted *web sites or other specialized accounts*.

Stationary and mobile value-loading devices. Special ATM like devices have been installed at various convenient places where transit users can load their Smart Cards with additional money as well as check their account balances.

Smart kiosks providing route and fare information. Smart kiosks have been installed that can provide route and fare information that cover all 26 transit agencies of the San Francisco Bay area.

Basic Equipment. M-Smart Venus™ dual interface and contactless Smart Cards, Contactless Check-in/Check-out Card Interface Devices, Stationary and mobile value-loading devices, Balance readers, Smart kiosks providing route and fare information, System and sub-system operating equipment.

Transport Authority of Berlin (BVG)

The Transport Authority of Berlin (BVG) awarded an \$8.2 million contract to conduct a field trial for a Smart Card automated fare collection system covering Berlin and the surrounding Brandenburg area, which includes two subway lines, two bus routes and one tram line. The S-Bahn Berlin GmbH (Rapid Transit System of Berlin) and the VBB (Transport Authority of Berlin-Brandenburg) are also participating in the field trial that began in October 1999 and will continue through April 2000.

Approximately 25,000 participants will test the system, expecting up to 150,000 transactions per including transfers between stations and modes of transport. The BVG expects full system implementation and general public availability by 2002.

Technical University of Berlin

Motorola will develop and implement a multi-application Smart Card solution for the Technical University of Berlin (TU Berlin). The Motorola system will provide a university

identification card and application platform that includes the capability to access university services over the Internet. It is based on a contacted/contactless dual interface Smart Card compatible with the transit automated fare collection (AFC) system presently installed in Berlin. Motorola will provide Smart Cards, card acceptance devices, system integration, and consulting for the TU Berlin CampusCard system.

Nanjing Public Transit

Motorola was awarded a Smart Card project in Nanjing, China to design and implement a Smart Card system for Nanjing's public network of buses, ferries and the Metro subway system. During Phase I of the project, Motorola will design and implement a Smart Card system for Nanjing's three bus companies. Motorola will provide more than 2,000 card readers and issue 400,000 M-Smart Mercury™ contactless Smart Cards to riders. A system field trial was scheduled to begin in March 2000 with Phase 1 fully operational by July 2000.

Netherlands Tripperpas: System Profile

The Ministry of Transport, Public Works and Water Management in the Netherlands has awarded in July 1999 a contract to Motorola for approximately 14 million guilders (US\$6.6 million) to enhance bus service in the city of Groningen by implementing a field trial of an integrated Smart Card automated fare collection system called Tripperpas. The Ministry is funding the project as a preliminary step to replace eventually the Strippenkaart paper ticketing system for all public transport within the Netherlands.

ARRIVA Netherlands is part of ARRIVA Passenger Services, the third largest bus operator in the UK and an operator in Denmark. ARRIVA Netherlands provides all public transport by bus in the 3 northern provinces of the Netherlands, and in part of Limburg, the most southern province. ARRIVA Netherlands also provides train services through NoordNed, a jointly owned company with NS (Dutch Railways). ARRIVA Netherlands has a fleet-size of about 1250 vehicles (bus, mini-bus, taxi) and 4000 personnel. It is expected that the Tripperpas Smart Card system will be

expanded to include electronic payments over the rail, taxi, disabled transport and bus system through a centralized back office transaction system.

Rome Metrebus: System Profile

In 1999, the ERG Motorola Alliance won a contract to design, install, manage and maintain an integrated contact/contactless Smart Card ticketing system in Rome and the surrounding Lazio region. In March 2001, ERG assumed full responsibility for the implementation of this project. The projection calls for up to 500,000 Smart Cards to be issued by the end of 2001 that will process more than 4 million transactions. The Metrebus Integrated Smart Card Fare Collection project includes 5,000 buses, three light rail lines and 76 rail stations in Rome and the surrounding region of Lazio.

ERG will operate the system for a period of nine years on behalf of the ATAC (Azienda Tramvie e Autobus del Comune di Roma). ERG will provide and operate call centers, security, ticket sales, data collection Smart Card issuing and reload equipment and a reporting system utilizing the clearing house system. The clearinghouse is also capable of processing non-transit related transactions, providing added value to other potential uses of the Smart Card in the future.

Principal characteristics:

- Smart Cards containing cardholder's photograph, name and date of birth,
- 4000 point of sale terminals (Smart Card purchases and reloading) at the Tabaccai & Giornalai outlets throughout Rome and Lazio,
- 9700 ticket validators,
- 200 portable Smart Card readers
- card personalization equipment,
- ERG's BackOffice processing system.

Land Transport Authority of Singapore: System Profile

The Land Transport Authority of Singapore awarded Motorola a \$78 million contract for an integrated Smart Card automated fare collection system to serve

five public transport operators, including approximately 3,750 buses, mass rapid transit and light rapid transit operations. This Smart Card AFC system will incorporate 22,000 readers and an initial 5 million Smart Cards. Singapore's system will support a reload facility where value can be added to the card directly from the cardholder's bank account. Full implementation is expected in 2002.

Bunbury City Transit, Australia: System Profile

In April 1999, Bunbury City Transit (BCT) launched the first ISO 14443 Type-B commercial implementation of a single-chip, dual-interface contacted/contactless Smart Card solution in Western Australia's sixth largest city.

Amtrak

Motorola was awarded a \$24 million contract, to develop and implement a computerized on-board fare collection system as well as test two Smart Card applications for e-ticketing and meal tracking. Implementation of the fare collection system will begin by the spring of 2000 with a pilot on Amtrak's new Acela Express high-speed rail service between Boston, New York and Washington. The pilot will conclude by fall of 2000, with full system implementation expected in October 2000.

MASTERCARD SMART CARD (www.mastercard.com) ⁽²⁸⁾

Korea – The Kookmin Trade Pass Smart Card. MasterCard International and Kookmin Card Co. is offering a multifunctional payment card in Korea. The Smart Card utilizes the Mondex electronic cash and the MasterCard M/Chip chip-based credit/debit application and will be operating on the MULTOS Smart Card platform.

In addition, these cards are envisioned to have radio frequency capabilities that could be utilized for transit fare transactions on Korea's bus and train network. These cards are expected to be fully functional credit cards and will be able to be used anywhere in the world that Mastercard is available.

Toll Collection (China) Smart Card application. Joint venture between -Smart System, Inc., a joint venture of On Track Innovations Ltd. (OTI) and Cheung Kong Infrastructure Holdings Ltd. (CKI) that utilizes Smart Card technology for toll collection. Travelers that want to cross the Beidou Bridge in Panyu, Guandong, China, can utilize contact/contactless Smart Cards. A field test involving 5,000 OTI cards was conducted on 10 toll collection stations. Card users pay tolls automatically by presenting a contactless Smart Card to a reader installed at each toll station. The fare is then automatically deducted from the account, which is preloaded from a user's bank account. Users can add money into the account at various recharging stations.

Cubic Transportation Systems (www.cubic.com/cts/)⁽²⁹⁾ – Cubic Corporation Washington DC, Maryland and Virginia Smart Card system (Cubic Transportation Systems – Cubic Corporation).

Cubic Transportation systems is developing an integrated Smart Card bus fare system for Virginia, Maryland and Washington DC. Users of Washington Metropolitan Area Transportation Authority (WMATA) Metrorail and parking facilities already utilize Cubic's GO CARD® Smart Card technology for their fare transactions under the SmarTrip system, which was developed in 1999. As of March 2001 the system registered more than 160,000 Smart Card users. The SmarTrip system will soon be expanded to include the bus system in Washington DC. The regional transit Smart Card based integrated fare system is expected to be operational by mid-2003.

The regional Smart Card system includes bus companies in Maryland (Annapolis Transit, Corridor Transit Corporation, Frederick Transit, Hartford County Transit, Howard County Transportation System, Montgomery County Ride-On, Ocean City Transit and Prince Georges County Transit) and Virginia (Arlington Crystal City Trolley [ART], Alexandria Transit Company [DASH], PRTC Omni-Ride, Fairfax County Connector and City of Fairfax CUE Bus).

The transit systems developed by Cubic are incorporated under Cubic's Nextfare™ Solution Suite that includes the following technologies:

Cubic's Nextfare™ Web Services.

- Order and register new Smart Cards on line, reload the Smart Cards, verify purchases and get account history.
- Transit agencies can Nextfare™ to sell and add value to tickets, provide customer service, reconcile payment when multiple transit authorities use the same Smart Card system and offer Internet links to other products and services.

Cubic Tri-Reader®, is Cubic's technology developed to ensure compatibility among all the participating agencies. It has been designed to plug into new and existing mass transit systems. This technology provides an open architecture environment, ensuring that a variety of Smart Cards from various vendors can be easily integrated into the ***Cubic's GO CARD® contactless Smart Card*** technology characteristics:

- Embedded computer chip,
- Embedded antenna that communicates (wireless) with compatible Smart Card readers,
- Smart Card readers at faregates, ticket vending machines and parking exit processors, bus check in/check validators,
- SmartBenefits; transit benefits for participating federal and private sector employees.

Chicago Transit Authority (CTA) – (Cubic Transportation Systems – Cubic Corporation)

CTA started an integrated Smart Card system on the summer of 2000 involving 3,500 cards that were issued to full-fare customers as a pilot test. The users could use their Smart Cards on CTA's bus and rail operations and neighboring suburban bus operator Pace. In 2001 CTA awarded Cubic a contract to expand the number of Smart Cards issued to customers to 300,000.

Shanghai Metro Corporation–(Cubic Transportation Systems – Cubic Corporation)

Cubic Transportation Systems installed in 1999 a dual transit fare system for the Shanghai Metro Corporation in China. The system accepts both magnetic cards and

contactless Smart Cards. The contactless Smart Card will be used initially by daily commuters but the system is designed to eventually include intermodal applications such as bus-to-commute train or commute train-to-railway travel.

In addition, a pilot study on the introduction of Smart Card technology based on Cubic's GO CARD system was conducted in Guangzhou's Metro (China) in 1999.

6.3 Appendix C: TRANSMIT System

Introduction

TRANSCOM's System for Managing Incidents and Traffic (TRANSMIT) represents a unique approach for traffic surveillance and incident detection ^(1, 2). The TRANSMIT system utilizes Electronic Toll and Traffic Management (ETTM) equipment, which is compatible with the E-ZPass system. The MARK IV ETTM equipment was installed during the Fall of 1995 and January 1996 was the first month that it became fully operational. E-ZPass is an electronic toll collection system, currently in operation along the New York State Thruway (NYST) as well as at other facilities in the NY/NJ/CT metropolitan area, serving over 4 million vehicles equipped with E-ZPass tags. The number of vehicles equipped with electronic tags is expected to rise significantly in the metropolitan area over the next few years as more facilities are expected to install the E-ZPass system. The original TRANSMIT system has been installed along the GSP in New Jersey and NYST in New York. It stretches out north from the Hillsdale Toll Plaza on the GSP to the NYST, and along the NYST it extends west from the Tarrytown Toll Plaza (Tappan Zee Bridge) to the Spring Valley Toll Plaza. On these routes, tag readers compatible with the TRANSMIT system were installed at intervals of 0.5 to 2.1 miles as shown schematic. Currently the TRANSMIT system has been expended to approximately 200 highway miles in the metropolitan area and it covers some of the major crossings into the Manhattan Borough such as the George Washington Bridge and Lincoln Tunnel. It is expected that in the next few years it will be installed along the New Jersey Turnpike and the entire length of Garden State Parkway as well as other major roadways in New York and New Jersey.

Each time an E-ZPass tag equipped vehicle passes a RoadSide Terminal (RST) location, the reader antenna radiates a signal to interrogate the tag in the vehicle. The vehicle equipped with a tag responds by sending its tag identification number (tag ID). At this RST, the recorded data containing tag ID, detection time, location and lane position is then forwarded to the Operations Information Center (OIC) at Jersey City, NJ. The tag ID is encoded immediately at the RST into a random number to ensure the anonymity of the motorist. Such surveillance data is acquired continuously on a 24-hour

basis at 22 RST locations. The vehicle travel times between successive readers are then determined from the acquired real time data at the OIC. The incident detection algorithm is based on statistical comparison of real time estimated travel times with continuously updated historical travel times for the same time period of the day and type of day (weekday, Saturday, Sunday, or holiday). When the algorithm detects multiple successive vehicles arriving late at a downstream reader of a specific link of the system, an alarm is triggered to indicate the occurrence of a possible incident. A detailed description on the various components of the TRANSMIT system can be found in (1, 2, 3, 4, 5)

The performance of the TRANSMIT system depends on the accurate and reliable collection, transmission and processing of the probe data in real time. All these functions are carried out by various components of its communication system.

TRANSMIT Communication System

The major function of the TRANSMIT communication system is to detect E-ZPass tag equipped vehicle probes at the RSTs and to transmit this data to the OIC.

The major components of this system are:

- E-ZPass tags (transponder) placed in a vehicle,
- Roadcheck™¹ Basic Reader System (at the RST),
- Leased telephone lines,
- Radio link across the Tappan Zee Bridge,
- Multiplexers specific to certain sites,
- OIC computer and related peripherals.

E-ZPass Tag: The E-ZPass tag is a vehicle's electronic identification device. Physically it consists of an antenna and electronic circuitry designed to carry out the transaction for paying tolls. The TRANSMIT system uses this tag for identification purposes only. RSTs radiate interrogation pulses continuously to "wake up" the tags mounted in the vehicles. As a tag equipped vehicle approaches the capture zone of the RST, it

¹ Roadcheck™ reader is a trademark of the MARK IV Industries, Inc.

responds back to the interrogation pulse by transmitting specific data to the RST including its identification data, ID. The tag transmits data at 500 kbps in the 915 MHz band.

Roadcheck™ Basic Reader System: Installed at the RST, the *Roadcheck™ Basic Reader* is an autonomous stationary unit linked through a telephone line to a computer at the OIC. A description of the geographic locations of the RSTs and corresponding antenna types are given in table 1. The reader system consists of:

Antenna(s): single/multi lane or side fire,
CPU board,
RF Control board,
Communication Boards,
Power Module.

Telephone Line and Multiplexers: The point-to-point modems (9.6 kbps, 8-N-1) at the OIC are connected to the field modems in NJ locations via full duplex, analog, leased telephone lines. The current rate of 9.6 kbps can easily be increased to 28.8 kbps with commercially available modems. These connections in the TRANSMIT system are accomplished using 7 FDDA circuits for the NJ locations, and using 13 FDDA circuits for the NY locations. There is a dedicated leased phone line (digital point-to-point link) between the head and location 9 and the OIC. Data compression techniques are utilized during transmission of this multiplexed data at the rate of 56 kbps. All these lines operate according to RS-232C standards.

Data collected at New York field sites (locations 10-28) is multiplexed at location 9. The input of the statistical multiplexer consists of 13 FDDA circuits, which provide data transmission from various locations at the rate of 9.6 kbps. The compressed output data rate of this multiplexer is 56 kbps and is transmitted through a dedicated leased telephone line to the OIC.

Data collected at locations 27 and 28 is multiplexed at the multiplexer housed at location 28 and further transmitted to location 9. At location 9, data received from locations 10-28 are multiplexed and further re-transmitted to the OIC via a digital point-to-point leased telephone line. At the OIC, data received from location 9 is demultiplexed before it is processed.

The Spread Spectrum Radio Link at Tappan Zee Bridge: The radio link operates at 920 MHz and has a maximum data transmission capacity of 56 kbps. Presently, it only utilizes 38.4 kbps and provides a direct connection from location 27 on the Tappan Zee Bridge to location 28 at the toll plaza. Data collected at locations 27 and 28 is multiplexed and transmitted over the shared leased telephone line to location 9. At location 9 data received from locations 10-28 is multiplexed and further re-transmitted to the OIC via a digital point-to-point leased telephone line.

Operations Information Center (OIC), Jersey City, NJ: The data at the OIC is received through 7 FDDA links from NJ locations (GSP) and one 56 kbps link from location 9 (headend location) in NY (NYST). The multiplexed data from NY locations is channeled through the Digital Service Unit/Channel Service Unit (DSU/CSU) to the demultiplexer. The demultiplexed data from NY locations together with NJ data is fed into a communications server (Sun Sparc 5 workstation). Then, it is pre-processed and forwarded to a data server (Sun Sparc 10 workstation) for further processing. The outcome of this processing is being monitored by stand-by operators on a 24 hour basis.

Data Flow in the TRANSMIT System: Data acquisition is initiated at the roadside terminal where the system software is used to configure demands of each particular site and to update information as required, as well as to monitor and ensure the proper operation of the system. The RST can be reconfigured via the diagnostic port using a laptop computer.

- Tag Message: The data entry is generated at the roadside terminal upon the detection of an E-ZPass tag in a passing vehicle. Such transponder messages can be viewed at the RST using a laptop computer connected through the diagnostic port to the CPU board. A typical message generated at the roadside terminal has the following format:

Time	Lane #	Function	Transaction #	Agency ID	Tag ID	Tag ID	Port
>LANE<07:05:04 >-A	Lane 2	PF	Txn:61756	Ag: 4	Sn: 156199	TA2RFxxxx	>CO M1

Figure 62 Example of a typical message

- COM Port Link Data: The data received by the RST from the transponder is converted into the proper format to be forwarded through the COM port of the reader to the OIC. Communication mode is serial, asynchronous, and full duplex and ASCII based. Data is sent in packets framed by ASCII 'STX' and 'ETX' codes and may not exceed 139 bytes in length (128 bytes of data and 11 bytes of framing, header and trailer). Data transparency is assured by conversion of any binary data within a packet to ASCII code in the printable range.

- Data Received at the OIC: Data received from the RSTs is immediately processed at the OIC. As soon as a data package is received, acknowledgment is sent and the tag ID is converted into a random number. The allocation of the random number depends on the tag ID so that duplication or multi-assignment of random numbers is avoided within the system. The stored form of the data has the following format:

Tag ID	Date	Time	Reader ID
E0C10803E9CA1200 0000	Tue Mar 26 1996	18:47:0 2	reader 27

Figure 63 Format of stored form

References

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LOCATIO N	DESCRIPTION	PHYSICAL LOCATION of ANTENNA	Reg / SF	SL/ ML	DIRECTION BEING READ
1	Hillsdale Plaza	Under pass	Reg	ML	NB/SB
2	Washington Ave.	Under pass	Reg	ML	NB/SB
3	MP 168.4	Under pass	Reg	ML	NB/SB
4	MP 170.1	Metal post	SF	ML	NB/SB
5	Food/ service station entrance	Under sign	Reg	SL	NB exit
6	Food/ service station entrance	Under sign	Reg	SL	SB exit
7	MP 171.5, North of Exit #172	Metal post	SF	ML	NB/SB
8	Eliminated				
9	MP GS2	Metal post; headend location	SF	ML	NB/SB
10	MP GSP 04 Pkwy/Thruway split	Under pass	Reg	ML	NB/SB
11	"Pay Toll" sign; MP 24	Under sign	Reg	ML	NB/SB
12	Eliminated				
13	Exit #14, "Rte 59, Spring Valley Nanuet"; MP 22.8	Under sign	Reg	ML	SB
14	Exit #14, "Rte 59, Spring Valley	Under sign & off ramp	Reg	ML	NB main line & Off ramp

	Nanuet"; MP 22.5				
15	Eliminated				
16	Exit #13S; Exit #13N; MP 21.3	Under pass & Under sign & Off-ramp	Reg	SL	NB/SB
17	Exit #13N	Under sign	Reg	SL	NB exit reader
18	ConRail Bridge; MP 19.5	Under pass	Reg	ML	NB/SB
19	Eliminated				
20	Unlabeled under pass; MP 17.9	Under pass	Reg	ML	NB/SB
21	Exit "9W"	Under sign	Reg	SL	NB exit reader
22	Eliminated				
23	"Tappan Zee Bridge" sign; MP 16.9;	Under sign	Reg	ML	SB
24	Exit #10, "9W Nyack, So. Nyack"; MP 16.4;	Under sign	Reg	ML	NB
25	VMS before bridge	Under VMS	Reg	ML	SB
26	Eliminated				
27	On Tappan Zee Bridge	Second cross member from west	Reg	SL/ ML	NB/SB
28	VMS before bridge	Under VMS	Reg	ML	NB

Figure 64 . Description of Roadside Terminals and Antenna Locations

Reg- Regular Antenna SL- Single Lane Read MP- Milepost
SF- Side Fire Antenna ML- Multi - Lane Read VMS - Variable Message Sign

6.4 Appendix D: TIDE: An XML-Based Transit Timetable System

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Abstract

The Internet and World Wide Web (WWW) are now being used for a wide variety of transportation applications. Most of these applications make use of static Hypertext Markup Language (HTML) documents. However, outside of transportation, considerably more attention is being given to dynamic content and the Extensible Markup Language (XML). The purpose of this paper is to explore one way in which these technologies can be used to provide transit timetable information on the WWW. Specifically, this paper describes the Transit Timetable System (T3S), an online interactive transit timetable information exchange/administration system which uses Java Server Pages and the Transit Timetable Markup Language (T3ML).

Introduction

The Internet and World Wide Web (WWW) are now being used for a wide variety of transportation applications (1). Although most of these applications make use of static Hypertext Markup Language (HTML) documents, there are some transportation applications make use of Extensible Markup Language (XML). World Wide Web Consortium (W3C) published a Note on Navigation Markup Language(NVML). NVML is a common data format for describing navigation information such as locations of points and route information (2). MTML.org released the Marine Trading Markup Language (MTML), an XML-based standard for electronic exchange of purchasing information in the marine industry (3). Transentric proposed TranXML as the new industry standard for e-commerce related activities between shippers and carriers (4). Outside of transportation, considerably more attention is being given to dynamic content and the Extensible Markup Language (XML).

The purpose of this paper is to explore one way in which these technologies can be used to provide transit timetable information on the WWW. Specifically, this paper describes the Transit Timetable System (T3S), an online interactive transit timetable information exchange/administration system (5) which uses the Transit Timetable Markup Language (T3ML).

The Transit Timetable System is designed to:

Provide travelers better access to transit timetable information provided by different transit authorities; and

Help operators/administrators to publish, modify, and exchange timetable information online.

Travelers can use T3S to display the desired timetables, or to get a personalized timetable by giving his/her origin, destination and transfer information. Transit operators/administrators can use T3S to update changes to a timetable, such as delay at a stop, cancellation of trains/buses, or closure of a station.

The T3S makes use of the Transit Timetable Markup Language (T3ML). T3ML is an XML application for describing transit timetable information. Transit timetable information can be stored as T3ML files, which capture both its content and structure. The T3S supports two different kinds of transit systems. These systems are modeled after New Jersey Transit buses and trains and PATH trains. PATH schedules are based on frequencies. That is, the only information provided to the system is how often the trains depart from the starting station during a particular period. The other kinds of schedules include arrival/departure times at every stop. The T3S can convert from one

“format” to another to provide integration across different systems. As an example, if a traveler wants a personalized timetable, and he/she needs to transfer from a NJ Transit train to a PATH train, then the time matching of this transfer requires consistent “formats”.

The T3S provides the following functions to travelers:

Display a timetable.

Display all timetables.

Create a personalized timetable. (A personalized timetable may be composed of timetables from different transit properties.)

For example, figures 1 and 2 shows sample NJ Transit train and bus timetables as they are rendered in a WWW browser. As another example, figure 3 shows a personalized timetable for a person that wants to travel from the Briarwood Shopping Village in White Horse to New Brunswick at 6:00 am in the morning on a weekday, including the transfer at Hamilton Railroad Station from a NJ Transit bus to a NJ Transit train.

Functions provided to transit administrators/operators include:

Display a timetable.

Display all timetables.

Cancel a vehicle. (When a vehicle is cancelled all time information for the selected vehicle will be replaced by “cancelled”.)

Close a station. (When a station is closed all vehicle stops at the selected station will be replaced by “cancelled”.)

Cancel/Update a stop.

Update a delay.

For example, figure 4 shows how the schedule will be rendered in a WWW browser after vehicle No.3844 is canceled.

Representing Transit Timetables

HTML is one of many document description languages that can be used to represent multi-media content. The value of HTML is that it allows developers to separate the form (i.e., appearance) of the pieces of a document from their function. For example, the developer can first organize a document into paragraphs, lists and tables and then specifies how these components look (e.g., justification, margins, etc...).

While HTML is very useful for describing documents, it is not as useful for describing other kinds of data. This is not to say that it can't be used for describing other kinds of data (since many kinds of data ultimately find their way into documents), but that it's usefulness is limited.

XML and Hierarchical Data

XML is simply a way of describing hierarchical data. Unlike HTML which can only be used to describe documents (which are hierarchical in nature), it can be used to describe hierarchical data of any kind.

Hierarchical data are described using parent-child relationships. Hence, each piece of data only takes on its full significance when seen in context. In general, to describe data using the hierarchical model we define *classes* (sometimes called *segments*), their *attributes* (sometimes called *fields*), and the relationship between classes. For example, data about trains are naturally hierarchical. A train consist of (which is a

group of locomotives), one or more cars, one or more cabooses, and a crew (which is a group of employees).

Most XML elements have the following syntax:

```
<tag [attribute ="value"...] [component...] </tag>
```

In the following example:

```
<Employee job="Engineer">John Smith</Employee>
```

The tag is Employee, the single attribute is job, the value of the job attribute is set to "Engineer", and the component is the string "John Smith".

For elements that have no components, you can also use the following abbreviated syntax:

```
<tag[attribute ="value"...!/>
```

For example:

```
<Caboose id="857-931" type="limited"/>
```

If you are familiar with HTML then these examples probably look somewhat familiar to you. This is because HTML can actually be thought of as an application of XML. That is, it can be thought of as a set of valid XML elements and attributes. This kind of structure can be imposed on XML documents using a schema or a document type definition (DTD) which contains a list of valid element types and attribute types. Proponents of XML argue that it has several benefits over HTML (6). First, it adds structure to the data. The inherent structure of XML documents is very important when it comes to manipulation and interaction between a programming language and XML data. Second, XML documents can be validated which guarantees data uniformity. Transit timetables can be delivered on the WWW using either HTML or XML. When using HTML, the timetable is conceptualized as a document containing, perhaps, a header (e.g., an <H1> element), some paragraphs (i.e., some <P> elements) and a table (i.e., a <TABLE> element). The table itself then consists of one or more row elements (i.e., <TR> elements) and column/data elements (i.e., <TD> elements). When using XML, the timetable can be conceptualized in a number of different ways. One approach is to have as a set of trains, each of which arrives at and departs from a variety of stations.

The Transit Timetable Markup Language

T3ML is an XML application for describing transit timetable information. T3ML uses a hierarchical representation of timetables rather than a relational representation. At present, methods of publishing transit timetable online differ according to the country, region, and organization. T3ML is intended to provide capability of standardizing the structure and publication of these timetables.

Both a DTD and a schema have been developed for T3ML. In fact, because T3ML currently covers two different types of timetables, there are actually two DTDs and schemas. For simplicity, we will only discuss the NJ Transit/Amtrak schema here. T3ML is the root element, which include one and only one timetable element. Attribute group of T3ML is named as T3MLAtt, which includes attributes version, date, author and type. Attribute version represents T3ML version with default value set to 1.0. Attribute date represents the date a T3ML file is created, and is restricted in the form of "mm/dd/yy". Attribute author represents the name of the person who created the T3ML file. Finally, attribute type represents T3ML file type. Its value is either "b", or "t", or "a",

or “p”, representing bus, train, Amtrak, and PATH respectively. All the above attributes are required, meaning no empty attribute is allowed.

Element timetable has at least one day element. Attribute group of timetable is named as timetableAtt, which includes attributes title, subtitle, and timetablecode. Attribute title represents timetable name which also serves as T3ML file name. Attribute subtitle provides further information about the timetable. Attribute timetablecode represents timetable code, and is restricted in the form of “[b,t,a,p]{1}d{3}[i,o]{1}”. This format starts with either “b”, or “t”, or “a”, or “p” which represents transit type, and is followed by a 3-digit number representing timetable serial number, and finally ends with either “i” or “o” which respectively represents “incoming” or “outgoing”. Elements title and timetablecode are required, while element subtitle is optional.

Element days could have any number of vehicle elements. Attribute group of days is named as daysAtt, which includes attributes day, willalsooperate, and willnotoperate. Attribute day represents the operating day, which is chosen from a selection of “Weekdays”, “Weekends”, “Daily”, “Saturdays”, and “Sundays”, with a default value of “Weekdays”. Attribute willalsooperate represents additional operating days other than those already indicated in attribute day. Attribute willnotoperate represents exceptional days which won’t operate even if they are among those days indicated in attribute day. Attribute day is required, while attributes willalsooperate and willnotoperate are optional.

Element vehicle could have any number of stop elements. Attribute group of vehicle is named as vehicleAtt, which includes attributes number, type, ssh, excursion, reservation, and businessclass. Attribute number represents the serial number of the vehicle. Attribute type indicates if the vehicle is accessible to the handicapped, with “u” and “w” representing “accessible” and “not accessible” respectively. Attribute ssh indicates the operating status of a vehicle during weekends, with default value of “SatSun”. The value of ssh is chosen from a selection of “Sat”, “Sun”, and “SatSun”, representing “Saturday”, “Sunday”, and “Saturday and Sunday” respectively. Attribute excursion indicates the availability of excursions. Attribute reservation indicates if reservation is available. Attribute businessclass represents if business class is available. All the above attributes are required.

Element stop has one and only one station element as well as one and only one time element. Attribute group of stop is named as stopAtt, which includes one attribute type. Attribute type indicates if a stop is accessible to the handicapped, and it is a required attribute.

Element station has one and only one stationname element. Attribute group of station is named as stationAtt, which includes attributes stationcode and connection. Attribute stationcode represents the code of a station, and is restricted in the form of “s[b,t,a,p]{1}d{5}”. This format starts with “s”, and is followed by a character chosen from “b”, “t”, “a” or “p”, and finally ends with a 5-digit number. Attribute connection represents connecting transits at this station, and it is restricted in the form of “[b,t,a,p]{1}d{3}[i,o]{1}” which has the same meaning as it is in the timetablecode attribute of the timetable element. Attribute stationcode is required, while attribute connection is optional.

Element time has one and only one timevalue element. Attribute group of time is named as timeAtt, which includes attributes status and apm. Attribute status indicates the status of the time, either arrival time or departure time, represented by “Ar.” and

“Lv.” respectively. The default value is “Ar.”. Attribute apm indicates if the time is “am” or “pm”, with default value set to “am”. Both these two attributes are required. The following section is the schema designed for NJ Transit/Amtrak trains and NJ Transit buses.

```
<?xml version="1.0" encoding="UTF-8"?>
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema"
targetNamespace="http://www.njtide.org/xmIs/schema1">

<xsd:element name="T3ML" type="T3MLType"/>

<xsd:complexType name="T3MLType">
<xsd:sequence>
<xsd:element name="timetable" type="timetableType" minOccurs="1" maxOccurs="1"/>
</xsd:sequence>
<xsd:attributeGroup ref="T3MLAtt"/>
</xsd:complexType>

<xsd:complexType name="timetableType">
<xsd:sequence>
<xsd:element name="days" type="daysType" minOccurs="1"
maxOccurs="unbounded"/>
</xsd:sequence>
<xsd:attributeGroup ref="timetableAtt"/>
</xsd:complexType>

<xsd:complexType name="daysType">
<xsd:sequence>
<xsd:element name="vehicle" type="vehicleType" minOccurs="0"
maxOccurs="unbounded"/>
</xsd:sequence>
<xsd:attributeGroup ref="daysAtt"/>
</xsd:complexType>

<xsd:complexType name="vehicleType">
<xsd:sequence>
<xsd:element name="stop" type="stopType" minOccurs="0" maxOccurs="unbounded"/>
</xsd:sequence>
<xsd:attributeGroup ref="vehicleAtt"/>
</xsd:complexType>

<xsd:complexType name="stopType">
<xsd:all>
<xsd:element name="station" type="stationType" minOccurs="1" maxOccurs="1"/>
<xsd:element name="time" type="timeType" minOccurs="1" maxOccurs="1"/>
</xsd:all>
```

```

<xsd:attributeGroup ref="stopAtt"/>
</xsd:complexType>

<xsd:complexType name="stationType">
<xsd:sequence>
<xsd:element name="stationname" type="xsd:string" minOccurs="1" maxOccurs="1"/>
</xsd:sequence>
<xsd:attributeGroup ref="stationAtt"/>
</xsd:complexType>

<xsd:complexType name="timeType">
<xsd:sequence>
<xsd:element name="timevalue" type="xsd:string" minOccurs="1" maxOccurs="1"/>
</xsd:sequence>
<xsd:attributeGroup ref="timeAtt"/>
</xsd:complexType>

<xsd:attributeGroup name="T3MLAtt">
<xsd:attribute name="version" use="required" default="1.0">
<xsd:simpleType>
<xsd:restriction base="xsd:string">
<xsd:enumeration value="1.0"/>
</xsd:restriction>
</xsd:simpleType>
</xsd:attribute>

<xsd:attribute name="date" use="required">
<xsd:simpleType>
<xsd:restriction base="xsd:string">
<xsd:pattern value="d{2}\d{2}\d{2}"/>
</xsd:restriction>
</xsd:simpleType>
</xsd:attribute>

<xsd:attribute name="author" type="xsd:string" use="required"/>
</xsd:attributeGroup>

<xsd:attributeGroup name="timetableAtt">
<xsd:attribute name="title" type="xsd:string" use="required"/>
<xsd:attribute name="subtitle" type="xsd:string" use="optional"/>
<xsd:attribute name="timetablecode" use="required">
<xsd:simpleType>
<xsd:restriction base="xsd:string">
<xsd:pattern value="[b,t,a,p]{1}d{3}[i,o]{1}"/>
</xsd:restriction>
</xsd:simpleType>

```

```
</xsd:attribute>
```

```
<xsd:attribute name="type" use="required" default="b">  
<xsd:simpleType>  
<xsd:restriction base="xsd:string">  
<xsd:enumeration value="b"/>  
<xsd:enumeration value="t"/>  
<xsd:enumeration value="a"/>  
<xsd:enumeration value="p"/>  
</xsd:restriction>  
</xsd:simpleType>  
</xsd:attribute>  
</xsd:attributeGroup>
```

```
<xsd:attributeGroup name="daysAtt">  
<xsd:attribute name="day" use="required" default="Weekdays">  
<xsd:simpleType>  
<xsd:restriction base="xsd:string">  
<xsd:enumeration value="Weekdays"/>  
<xsd:enumeration value="Weekends"/>  
<xsd:enumeration value="Daily"/>  
<xsd:enumeration value="Saturdays"/>  
<xsd:enumeration value="Sundays"/>  
</xsd:restriction>  
</xsd:simpleType>  
</xsd:attribute>  
<xsd:attribute name="willalsooperate" type="xsd:string" use="optional" default="n/a"/>  
<xsd:attribute name="willnotoperate" type="xsd:string" use="optional" default="n/a"/>  
</xsd:attributeGroup>
```

```
<xsd:attributeGroup name="stopAtt">  
<xsd:attribute name="type" use="required" default="w">  
<xsd:simpleType>  
<xsd:restriction base="xsd:string">  
<xsd:enumeration value="u"/>  
<xsd:enumeration value="w"/>  
</xsd:restriction>  
</xsd:simpleType>  
</xsd:attribute>  
</xsd:attributeGroup>
```

```
<xsd:attributeGroup name="vehicleAtt">  
<xsd:attribute name="number" type="xsd:string" use="required"/>  
<xsd:attribute name="type" use="required" default="u">  
<xsd:simpleType>  
<xsd:restriction base="xsd:string">
```

```

<xsd:enumeration value="u"/>
<xsd:enumeration value="w"/>
</xsd:restriction>
</xsd:simpleType>
</xsd:attribute>
<xsd:attribute name="excursion" use="required" default="y">
<xsd:simpleType>
<xsd:restriction base="xsd:string">
<xsd:enumeration value="y"/>
<xsd:enumeration value="n"/>
</xsd:restriction>
</xsd:simpleType>
</xsd:attribute>
<xsd:attribute name="ssh" use="required" default="SatSun">
<xsd:simpleType>
<xsd:restriction base="xsd:string">
<xsd:enumeration value="Sat"/>
<xsd:enumeration value="Sun"/>
<xsd:enumeration value="SatSun"/>
</xsd:restriction>
</xsd:simpleType>
</xsd:attribute>
<xsd:attribute name="reservations" use="required" default="y">
<xsd:simpleType>
<xsd:restriction base="xsd:string">
<xsd:enumeration value="y"/>
<xsd:enumeration value="n"/>
</xsd:restriction>
</xsd:simpleType>
</xsd:attribute>
<xsd:attribute name="businessclass" use="required" default="y">
<xsd:simpleType>
<xsd:restriction base="xsd:string">
<xsd:enumeration value="y"/>
<xsd:enumeration value="n"/>
</xsd:restriction>
</xsd:simpleType>
</xsd:attribute>
</xsd:attributeGroup>

<xsd:attributeGroup name="stationAtt">
<xsd:attribute name="stationcode" use="required">
<xsd:simpleType>
<xsd:restriction base="xsd:string">
<xsd:pattern value="s[b,t,a,p]{1}d{5}"/>
</xsd:restriction>

```

```

</xsd:simpleType>
</xsd:attribute>
<xsd:attribute name="connection" use="optional">
<xsd:simpleType>
<xsd:restriction base="xsd:string">
<xsd:pattern value="[b,t,a,p]{1}d{3}[i,o]{1}"/>
</xsd:restriction>
</xsd:simpleType>
</xsd:attribute>
</xsd:attributeGroup>

<xsd:attributeGroup name="timeAtt">
<xsd:attribute name="status" use="required" default="Ar.">
<xsd:simpleType>
<xsd:restriction base="xsd:string">
<xsd:enumeration value="Ar."/>
<xsd:enumeration value="Lv."/>
</xsd:restriction>
</xsd:simpleType>
</xsd:attribute>
<xsd:attribute name="apm" use="required" default="am">
<xsd:simpleType>
<xsd:restriction base="xsd:string">
<xsd:enumeration value="am"/>
<xsd:enumeration value="pm"/>
</xsd:restriction>
</xsd:simpleType>
</xsd:attribute>
</xsd:attributeGroup>
</xsd:schema>

```

Content Servers

Most WWW servers use the Hypertext Transfer Protocol (HTTP). An HTTP transaction proceeds as follows:

The client opens a connection.

The client sends a request and waits for a response.

The server processes the request.

The server sends a response.

The server closes the connection.

In other words, HTTP is a simple *stateless* protocol for accessing hypermedia documents.

Static and Dynamic Content

HTTP is perfectly suited for delivering static content like, for example, a transit property's "mission statement". It is tempting to also use this approach for delivering quasi-static content (i.e., content that changes infrequently) like transit timetables.

However, this severely limits the functionality of the system. For example, it makes it impossible to provide customized timetables of any kind. As a result, one often wants to have a variety of tasks performed by the server before it sends a response.

The Common Gateway Interface (CGI) provides a means for a client to request that the server run an external application. It is nothing more than a standard that describes how this process takes place. Information from the client is sent to the server which passes it through to the external application (through *standard input*). The output from this external application is then passed back to the client through the server (i.e., *standard output* is redirected or piped to the server).

A fundamental problem with this approach is that each time the server executes an external application, a separate instance is started. This can be very resource intensive (if many copies of an application are being executed) and can be very slow (because each time the application is executed it must initialize itself which might include reading a large data file).

An alternative to this approach is *server-side scripting* in which the server can execute scripts written in an interpreted language. This is completely analogous to what happens in client-side scripting except that the script is “executed” by the server rather than the client.

The Document Object Model

Server-side scripts often query relational database management systems. The T3S, instead, needs to process T3ML files. The API for “serial access” to XML is called the Simple API for XML (SAX) and was defined by XML-DEV. The API for “random access” to XML is called the Document Object Model (DOM) and was defined by the W3C. Perhaps the simplest way to provide access to the elements of an XML document is to expose all of the elements of a particular type as an ordered set (e.g., an array). This is the approach used by the Level.0 DOM.

A better approach is to view the XML document can be thought of as a set of trees, each of which consists of one or more Node objects. This is the approach that is used in the DOM Level 2.0

T3S uses the Level 2.0 DOM to access the different elements of a T3ML file. More specifically, methods of TimeTableRepository class use Level 2.0 DOM to access timetable information stored in T3ML files.

Method initXML() is used to create a T3ML file. Method appendXML() is used to append information to an existing T3ML file. Methods deleteVehicle(), deleteStation(), deleteCell() and updateDelay() are used to update timetable information in T3ML files. Method displayXML() extracts desired timetable information and create a temporary T3ML file for display purpose. Similarly, method personalizedTimeTable() extracts information from different transit types, and combines them together as a temporary T3ML file.

Accessing T3ML files through above methods requires some common operations. These basic operations are implemented as private methods in TimeTableRepository class, namely makeXML(), loadXML(), writeXML(), getElement(), getArrivingTime(), and getAttrValue().

Given transit type, makeXML() is used to create a T3ML file. First, a DocumentBuilderFactory object is obtained. Then, a DocumentBuilder object is created from this factory. Later, a Document object is obtained using this DocumentBuilder object. Next, we set its root element to "t3ml", its processing instruction and document type to their appropriate values. Finally, root element is appended to the Document object, and an empty T3ML file with appropriate processing instruction and document type has been created.

Similarly, in loadXML(), DocumentBuilderFactory and DocumentBuilder objects need to be obtained first. Then, rather than create a Document object, a File object is created using the path of an existing T3ML file, and this File object is then parsed. Finally, method loadXML() returns a parsed Document object.

In method writeXML(), we open a FileWriter using a File object created from a given path. Then, the Document object, an argument of writeXML() method, is written to the File object using the write() method of the Document object.

The three other methods, getElement(), getArrivingTime() and getAttrValue(), utilize the tree structure of a Document object to traverse from top down to search for the desired element, arrival time, or attribute values.

Implementation Issues

This section discusses some of the implementation issues that were encountered while T3S was being developed. **The three-tier architecture of T3S is discussed first, followed by a brief introduction of JavaServer Pages, which incorporates dynamic elements into T3S web pages. Then, Java API for XML Parsing and how a database is accessed from a Servlet are discussed. Other issues included in this section are session tracking which maintains states between T3S web requests, Jakarta-tomcat Servlet container which processes requests forwarded from T3S web server-IIS, and the packaging hierarchy of a T3S as a web application.**

Architecture

T3S was implemented using the three-tier architecture shown in Figure 5. The front-end is the client tier. The middle tier handles business logic, data manipulation to/from the back-end tier and communicates with front-end and back-end resources. The back-end tier is composed of XML files, which are accessed by means of standard APIs. Central to this architecture is the notion of containers. Containers are standardized runtime environments that provide specific component services. Containers also provide standardized access to information system, for example, providing database access through the JDBC API (7).

The front-end pages are a group of interfaces for T3S travelers and transit administrators/operators. The organization of these interfaces is presented in figure 6. There are two sub-tiers in the middle tier, the Servlet sub-tier that is composed of a group of Servlets, and the application sub-tier that has two types of Java classes, JavaBean classes and a TimeTableRepository class. JavaBeans enforces the use of HTML-like tags in JSP pages, while TimeTableRepository handles the data retrieval and manipulation to/from the back-end XML files. Rather than using relational databases to store data, XML files are used in T3S to store transit timetable information.

Data communications from the front-end tier to Servlets in the middle tier are presented in table 1. Data communications from Servlets in the middle tier to the front-end tier are presented in table 2. The middle tier Servlets access the back-end XML files through a TimeTableRepository class, which provides a group of accessing methods. The data communication and accessing methods are presented in table 3. In T3S, there is no data flow from the back-end XML files to the middle tier Servlets. What the middle tier Servlets do is to redirect requests to back-end XML files, which are updated or created using the TimeTableRepository methods.

Java Server Pages

T3S uses JavaServer Pages (JSP), implemented using Servlet technology. JSP is a Java-based technology that simplifies the process of developing dynamic web sites. With JSP, web designers and developers can quickly incorporate dynamic elements into web pages using embedded Java and a few markup tags (8). JSP supports two different styles for adding dynamic content to web pages, scripts embedded in JSP and HTML-like tags that interact with Java objects on the server. To add JSP functionality to existing web servers, third-party products or containers are often required. Some of the most popular containers include JRun from Live Software, ServletExec from New Atlanta, and Jakarta Tomcat from Sun Microsystems and the Apache Software Foundation. Jakarta Tomcat, is used in T3S. JSP was chosen for several reasons (8). First, JSP provides improved performance. JSP is typically implemented via Servlets. When multiple requests arrived for a given Servlet at the same time, it is accomplished via Java thread, rather than full-fledged process. Conventional CGI, spawns one new process for each request to execute the CGI code. Second, JSP allows for the development of reusable components. JSP supports tags for interacting with Java objects residing on the server. These tags are designed for creating, querying, and modifying server-side reusable JavaBeans. Finally, JSP allows for the division of labor. Separation of presentation and implementation is achieved by leveraging JSP's HTML-like tags.

The Java API for XML Parsing

The Java API for XML parsing (JAXP) provides a common interface for creating and using standard SAX and DOM APIs in Java. In order to use DOM APIs, a Java program needs to include two packages: org.w3c.dom, which defines the DOM programming interfaces for XML, and javax.xml.parsers, which defines the DocumentBuilderFactory class and the DocumentBuilder class. A Document object is created using DocumentBuilder. A Document object provides a tree structure manipulated by DOM APIs.

Once a Document object is constructed, often we want to save it as a XML file. At the time of writing the programs for T3S, a Document object need to be casted as a XmlDocument, in order to use the writer() method of the XmlDocument object. The latest version of JAXP APIs include a javax.xml.transform package, which provides an easier way to save an object as an XML file.

Database Access from a Servlet

Although, T3S doesn't use a relational database as the main data storage at the backend, it does have a user database which stores registered user information. The middle tier of T3S includes an authentication servlet (AuthenticationServlet.java) which is used to check if a user is a registered user. AuthenticationServlet uses JDBC API to communicate with the backend user database.

Connection to a database is established in the init(), and this connection persists for the lifetime of the Servlet. The advantage of using a persistent connection is to reduce overhead of establishing and closing a connection for each Servlet request. However, if transactions are involved, synchronize has to be used to guarantee thread-safety. In the authentication Servlet of T3S, the request only involves simple queries; therefore, thread-safety is not an issue for consideration. The connection is closed in a destroy() method.

The doGet() and the doPost() methods both call processRequest() method, which sends a SQL query to the database and check if the user is valid. If the user is valid, user information obtained from the database is output to a user bean. Later, this user bean can be accessed in a JSP page, as long as the id matches the bean's name in the Servlet and the scope is set as "request".

Session Tracking

Internet Communication protocols are divided into two categories: stateless and stateful. Stateful protocols, such as Telnet and FTP, refers to communication through which server associates all requests from clients together, and a state is assigned to the communication. Stateless protocols, such as HTTP, refers to a communication format that requests and responses are treated as isolated transactions. Sometimes, it is necessary for applications using stateless protocols to associate request together, and to "remember" user state on the server. The idea of maintaining state between requests, when the protocol is stateless, is known as session tracking (6).

Creating hidden form fields and Servlet API session tracking tools are the two technologies used in T3S to handle session tracking. In T3S, JSP pages are glued together through Servlets. Although session tracking mostly happens during data transactions between a JSP page and a Servlet, data transactions between two JSP pages also exist.

The Java Servlet API provides a HttpSession object, which is used to store session data in the current Servlet context. To write data to a session, use setAttribute("SessionItem", ItemValue) method. To retrieve data from a session, use getAttribute("SessionItem") method.

In a JSP page, session attribute items are retrieved as following:

```
<%  
String timetable_title=(String)session.getAttribute("timetable_title");  
%>
```

Servlet Container-Jakarta Tomcat

The web server of T3S runs IIS, which normally can't execute Servlets and JSPs. When a web server receives a request for a JSP page, it forwards it to a special process, which is often referred as the Servlet container. In T3S, we use Jakarta Tomcat as the Servlet container. Tomcat, an out-of-process Servlet container redirector

plugin, isapi_redirect.dll, will let IIS send Servlet and JSP requests to Tomcat, and serve them to clients.

Packaging

A web application is defined as a hierarchy of directories and files in a standard layout. The hierarchy is shown in figure 7.

The XML file web.xml is the Web Application Deployment Descriptor for the application. It describes the Servlets and other components that make up the application. All Java class files, including Servlet and non-Servlet classes, are in the classes directory. The lib directory contains JAR files that contain Java class files required for the application, such as third party class libraries. In T3S, we place Servlet API (servlet-2_2b) class files and JDBC driver package Jdata1_2.jar in here.

Conclusions and directions for future Research

The objective of this project was to create a system that is able to assist travelers to access transit time information online and to assist transit operator/administrators manage transit time information stored as XML files. This system was implemented using Java technologies, including Servlets, and JSP pages. **T3S facilitates exchange of transit timetable information among different transit authorities, provides travelers a friendly comprehensive access to timetables of all transit types, and reduces transit operators' workload of maintaining timetables.**

T3S has been tested on a small sample transit network, using Penn Station in Newark, NJ as the "hub". The reason Newark Penn Station was chosen is because it covers all the transit types discussed in T3ML, namely NJ Transit trains and buses, Amtrak and PATH. **The test network includes five NJ Transit bus lines, four NJ Transit train lines, two PATH train lines, and Amtrak. All T3S functions work successfully in the test.** Part of the test results are presented as examples in this paper (see figures 1 to 4).

One planned extension is the integration of a route planning algorithm like that discussed in (9). **To make T3S more useful to travelers, GIS will be integrated to T3S to provide travelers graphic interfaces of transit lines and stations.**

Another planned extension is the use of the Extensible Stylesheet Language Transformations (XSLT) on the server to process the XML files. XSLT is a declarative language. It contains a set of template rules, each of which describes how a particular element type should be processed. In other words, an XSLT program is a set of rules each of which describe what output should be produced when a particular "pattern" is encountered. The purpose of this will be to offload processing requirements from the server to the clients.

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Front-End	Middle	Data Flow
transit_type.jsp	functionServlet	user type, function choice, transit type
traveler_personalized5.jsp	traveler_personalizedServlet	user type, origin information, transfer information, destination information
operator_cancel_vehicle.jsp	operator_cancel_vehicleServlet	transit type, transit line, travel day, canceled vehicle information
operator_cancel_station.jsp	Operator_cancel_stationServlet	transit type, transit line, travel day, canceled station information
operator_cancel_cell.jsp	operator_cancel_cellServlet	transit type, transit line, travel day, updated cells (stops) of a time table
operator_update_delay	operator_update_delayServlet	transit type, transit line, travel day, delay information
operator_create_xmls10.jsp	sessionServlet	timetable title, timetable code, timetable type, form name
operator_create_xmls11.jsp	sessionServlet	number of stations, form name
operator_create_xmls12.jsp	sessionServlet	station information, form name
operator_create_xmls13.jsp	sessionServlet	days information, number of vehicles, form name
operator_create_xmls14.jsp	sessionServlet	vehicle information, form name
operator_create_xml15.jsp	sessionServlet	a collection of information of an XML record, form name
operator_create_xmls11p.jsp	sessionServlet	run time, number of frequencies, form name
operator_create_xml12p.jsp	sessionServlet	a collection of information of an XML record for PATH train, form name
finish_xml.jsp	finishServlet	timetable title, timetable type
finish_update.jsp	finishServlet	timetable type, timetable title

TABLE 2 From Middle Tier to Front-End Tier

Front-End	Middle	Data Flow
AuthenticationServlet	login.jsp	error
functionServlet	function_switch.jsp	function choice, transit type
functionServlet	operator_create_xml10.jsp	user type, function choice, transit type
sessionServlet	operator_create_xml10.jsp	error message, session object (including XML file information collected so far)
sessionServlet	operator_create_xml11.jsp	session object (including XML file information collected so far)
sessionServlet	operator_create_xml12.jsp	session object (including XML file information collected so far)
sessionServlet	operator_create_xml13.jsp	session object (including XML file information collected so far)
sessionServlet	operator_create_xml14.jsp	session object (including XML file information collected so far)
sessionServlet	operator_create_xml15.jsp	session object (including XML file information collected so far)
sessionServlet	operator_create_xml11p.jsp	session object (including XML file information collected so far)
sessionServlet	operator_create_xml12p.jsp	session object (including XML file information collected so far)
sessionServlet	finish_xml.jsp	timetable title, timetable type
Operator_cancel_vehicleServlet	finish_update.jsp	transit line, transit type
Operator_cancel_stationServlet	finish_update.jsp	transit line, transit type
Operator_cancel_cellsServlet	finish_update.jsp	transit line, transit type
Operator_update_delayServlet	finish_update.jsp	transit line, transit type

Figure 65 From Front-end Tier to Middle Tier

Middle	Back-End	Access Methods in TimeTableRepository Class	Data Flow
traveler_personalizedServlet	XML file	personalizedTimeTable()	user type, transit type, transit line, travel day, origin station name, morning, time, transfer station, transfer type, transfer lines, destination station, transfer travel day
operator_cancel_vehicleServlet	XML file	deleteVehicle()	transit type, transit line, travel day, vehicle number
operator_cancel_stationServlet	XML file	deleteStation()	transit type, transit line, travel day, station name
operator_cancel_cellServlet	XML file	deleteCell()	transit type, transit line, travel day, cells (stops) of a time table
operator_update_delayServlet	XML file	updateDelay()	transit type, transit line, travel day, vehicle number, station name, delay time
sessionServlet	XML file	appendXML()	run time, start time, end time, increment, timetable title, timetable type, days, frequency type, frequency date, increment type, submit type
sesssionServlet	XML file	initXML()	T3ML version, T3ML date, author, timetable title, timetable, timetable code, timetable type
functionServlet	XML file	displayXML()	transit type

Figure 66 From Middle Tier to Back-End Tier

TRENTON TO NEWARK-NEW YORK (PARTIAL)

Weekdays

Inbound Vehicle No.		3204	3700	3810	3702	3812	3814	3244	3844
		am	am	am	am	am	am	pm	am
Suburban Sta. Phila.	Lv.						5.00		11.00
30th Street Station	Lv.						5.04		11.04
North Philadelphia	Lv.						5.14		11.14
Trenton(SEPTA)	Lv.						5.54		11.55
Trenton	Lv.			5.26		5.46	6.03		12.10
Hamilton	Lv.			5.32		5.52	6.09		12.16
Princeton	Lv.					5.43	6.01		12.01
Princeton Jct. (Shuttle)	Ar.					5.47	6.05		12.05
Princeton Junction	Lv.			5.38		5.59	6.17		12.22
Jersey Avenue	Lv.		5.20		5.55				
New Brunswick	Lv.		5.25	5.52	6.00	6.13	6.32		12.36

Figure 67 A NJ Transit Train Timetable

601-To College of New Jersey (Partial)

Weekdays

	WHITE HORSE: Briarwood Shopping Village	WHITE HORSE: Hempstead & Arena	WHITE HORSE: K-Mart	HAMILTON Central & Arena	HAMILTON So. Clinton & Park	TRENTON Roebling & Chambers	HAMILTON Railroad Station	TRENTON E.State & N.Broad	TRENTON W.State & Prospect	EWING Prospect & No.Olden	EWING Green & Ewingville	EWING College of New Jersey
am	5.45	5.50		5.56	5.58	6.03	6.09	6.14	6.19	6.24	6.29	6.34
am	6.15	6.20		6.26	6.28	6.33	6.39	6.44	6.49	6.54	6.59	7.04
am	6.45	6.50		6.56	6.58	7.03	7.09	7.14	7.19	7.24	7.29	7.34

Figure 68 A NJ Transit Bus Timetable

601-To College of New Jersey (Partial)

Weekdays

	WHITE HORSE: Briarwood Shopping Village	WHITE HORSE: Hempstead & Arena	WHITE HORSE: K-Mart	HAMILTON Central & Arena	HAMILTON So. Clinton & Park	TRENTON Roebling & Chambers	HAMILTON Railroad Station
am	5.45	5.50		5.56	5.58	6.03	6.09
am	6.15	6.20		6.26	6.28	6.33	6.39
am	6.45	6.50		6.56	6.58	7.03	7.09

*Blue rows: trip accessible to mobility impaired

TRENTON TO NEWARK-NEW YORK (PARTIAL)

Weekdays

	Hamilton	Princeton	Princeton Jct. (Shuttle)	Princeton Junction	Jersey Avenue	New Brunswick
am	6.09	6.01	6.05	6.17		6.32

Figure 69 A Personalized Timetable

TRENTON TO NEWARK-NEW YORK (PARTIAL)

Weekdays

Inbound Vehicle No.		3204	3700	3810	3702	3812	3814	3244	3844
		am	am	am	am	am	am	pm	am
Suburban Sta. Phila.	Lv.						5.00		canceled
30th Street Station	Lv.						5.04		canceled
North Philadelphia	Lv.						5.14		canceled
Trenton(SEPTA)	Lv.						5.54		canceled
Trenton	Lv.			5.26		5.46	6.03		canceled
Hamilton	Lv.			5.32		5.52	6.09		canceled
Princeton	Lv.					5.43	6.01		canceled
Princeton Jct. (Shuttle)	Ar.					5.47	6.05		canceled
Princeton Junction	Lv.			5.38		5.59	6.17		canceled
Jersey Avenue	Lv.		5.20		5.55				
New Brunswick	Lv.		5.25	5.52	6.00	6.13	6.32		canceled

Figure 70 An NJ Transit Train Timetable with a Canceled Vehicle

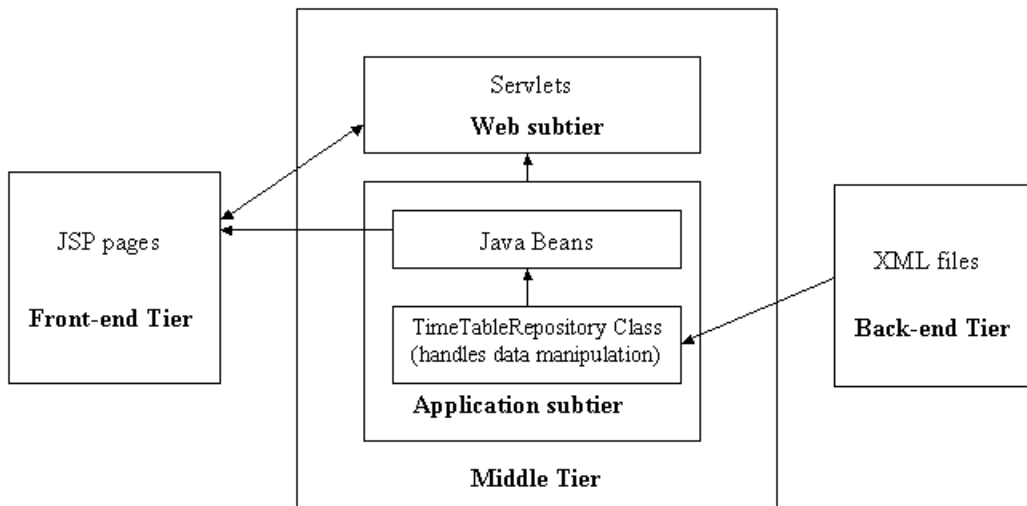


Figure 71 System Structure

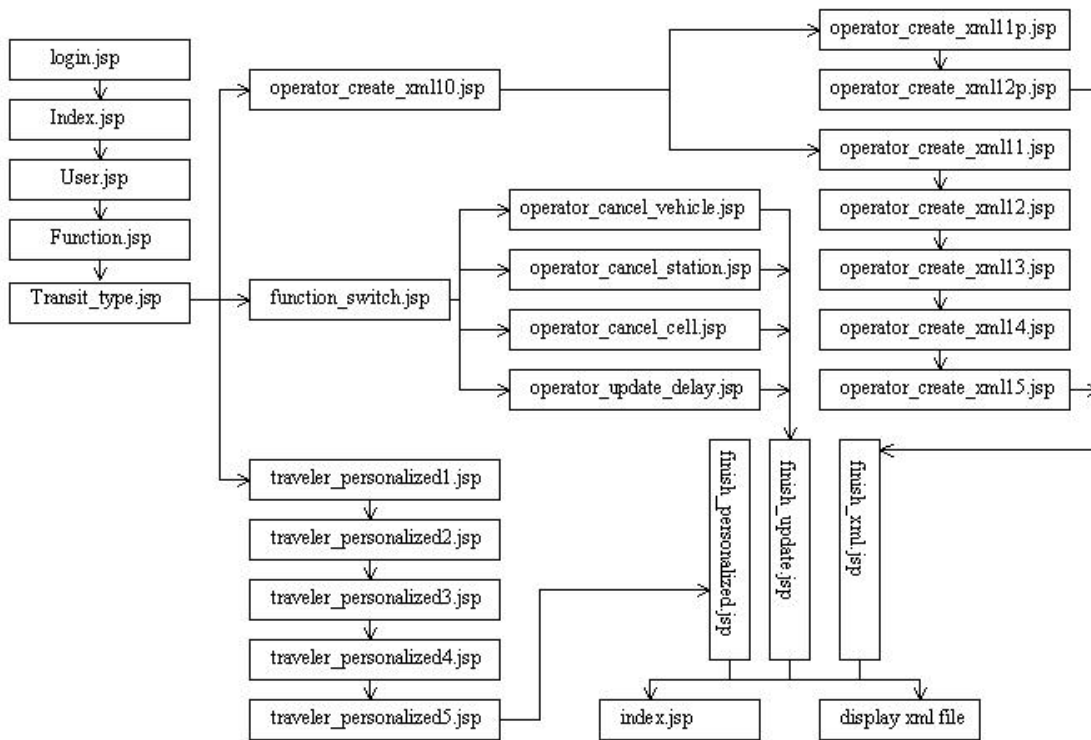


Figure 72 T3S Interfaces

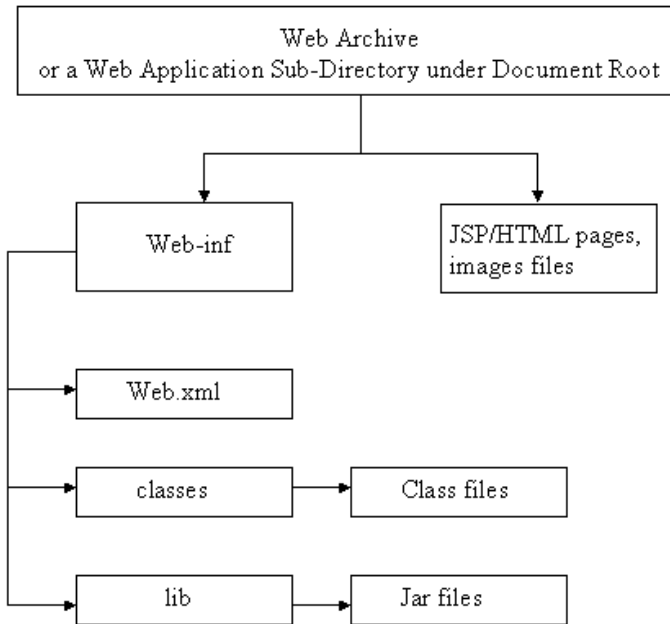


Figure 73 Organization of a Web Application

6.5 Appendix E: A GIS-based Multi-modal Advanced Traveler Information System (MATIS)

by

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Abstract

A conceptual Multi-modal Advanced Traveler Information System (MATIS) was developed on a Sun SPARC 10 workstation using the ARC/INFO GIS software platform. The primary components of MATIS are the MATIS databases, the data processing algorithms and the user interface. The data processing algorithms include route planning for private automobile, transit and ride sharing. These algorithms are executed independently of each other at the present version of the system. The user interface allows the users to enter their input through customized menus which were developed using the ARC/INFO capabilities. The system can accept both subscribers who have their individual profile in the system containing their travel characteristics for one or more of each subsystems as well as non-subscribers who can enter at any time into the system and receive travel information from any of the subsystems. Any user can subscribe or unsubscribe to/from the system at any time. The design and the required input/output of MATIS are outlined and future enhancements of the model are suggested.

Introduction

Advanced Traveler Information Systems (ATIS) are becoming popular in the US, Europe, Japan, Australia, Canada, as well as other countries around the world. Traveler information is provided to the users through various means such as, radio, television, telephone, fax, or through the computer. A recent popular development is the availability of traveler information through the INTERNET. The primary services that are provided through ATIS are traffic conditions, bus and train schedules including arrivals and departures from stations, and route planning information between an origin and a destination. The principal components of such systems include: the communication system, the traffic surveillance system and the data processing system. The majority of the current systems provide information that is targeted to the general public; however, they do not provide information that is personalized to the needs of the individual user. A limited number of systems provide individual route planning information that is usually based on historical traffic information or simply the shortest distance from an origin to the destination. Route planning applications are primarily targeted to in-vehicle

navigation systems, which is envisioned to become a standard feature in many vehicles in the next decade. Internet-based systems also provide route planning which is embedded to GIS type of services. The majority of the present systems are targeted to users who utilize only one mode of travel such as private automobile, transit or commercial vehicle. However there is a large portion of the population who would like to have access to systems that provide integrated multi-modal traveler information so they may select their travel mode in a more informative and intelligent way.

This paper presents the development of a Multi-modal Advanced Traveler Information System (MATIS) under a UNIX based Geographic Information System (GIS) platform, using a Sun SPARC 10 workstation and the ARC/INFO GIS software. The users of MATIS are distinguished as *subscribers* and *non-subscribers*. Subscribers to the system have a build-in user's profile database which contains personal and travel attribute characteristics, providing added flexibility to the users to request frequently needed traveler information in a timely fashion. Users have the option to access any one or all of three subsystems under MATIS: *i) Route Planning Advanced Traveler Information System (RPATIS)*; *ii) Transit Advanced Traveler Information System (TATIS)*; and *iii) Ride-Sharing Advanced Traveler Information System (RSATIS)*. The present MATIS considered the three subsystems as independent of each. However, a true MATIS should have the capability to provide integrated information to the users in order for them to make their travel choices more intelligently. An example of an intelligent decision making is, to provide the best route from an origin to a destination based on the preferences of the individual traveler, which may be a combination of different modes (intermodal travel), and/or two alternatives. The system would then be more complete in providing an integrated travel decision mechanism not only on a multi-modal basis but on intermodal basis as well. This study concentrated primarily on the development of the data processing components of a full scale MATIS, rather than the communication and the traffic surveillance technologies that are necessary for the successful implementation of a functional MATIS. A survey of some ATIS systems either in operation or under testing is presented in the following section.

Advanced Traveler Information Systems

The objective of an ATIS is to aid travelers in making more intelligent traveling decisions, either prior to their trip or en-route. The primary information that can be provided under an ATIS may include the following: traffic conditions on the selected Origin Destination (O-D) pair; the shortest path from an origin to a destination based on users' selected criteria (shortest, fastest, scenic, other); the shortest tour from an origin to a destination, which is particularly useful for delivery services; weather information; pavement condition; and other, "yellow pages," type of information.

The principal components of an ATIS system may include:

- i) Types of Users and their Needs,
- ii) Transportation Network Surveillance,
- iii) Communications,
- iv) Data Processing.

The users and their traveling needs is a pivotal component to an ATIS because it is used to determine the services to be provided by the system. The functionality and effectiveness of an ATIS system depends on the level of surveillance of the transportation network under consideration. The primary scope of network surveillance is to detect incidents, to provide information on the condition of the roadway system (e.g. icy, flood, potholes, other), construction and maintenance activities and to provide traffic flow information (flow, speed, travel time, occupancy). ATIS requires communication links between the Traffic Information Center (TIC), the traffic surveillance system and the users of the system. The communication media available and their functionality dictate the level of ATIS services that can be provided to the users. The ATIS requires an efficient data processing system to provide timely and accurate responses to the queries of the users. Data processing may include some or all of the following algorithms and processes: data reduction from the traffic surveillance system, data fusion, travel time estimation, travel time prediction, traffic assignment, route planning, automatic vehicle location/identification, ridesharing algorithm, incident detection algorithm and user interface (input/output). The principal databases envisioned for an ATIS are the following: i) the users' profile database which includes

their personal traveler characteristics and preferences; ii) a static database which may include the roadway network, historical traffic information, other; iii) a dynamic database which may include real time data of traffic conditions and other traveler services (e.g. restaurant menus and promotions, movie theaters and playing times, gas station promotions).

One of the most comprehensive ATIS system in the U.S.A. is the Caltrans Smart Traveler in Los Angeles, which provides freeway traffic conditions, bus/rail schedule information and carpooling. The users can access the system through "smart traveler" kiosks which are located in supermarkets, shopping malls and major businesses ⁽¹⁾. The Trip Reduction Information Management System (TRiMS) in Menlo Park, California provides the following: transit routes schedules and fares, bicycle routes, ride matching services, personal vehicle routing services (including Park and Ride) ⁽²⁾. The Bellevue Smart Traveler (BST) in Washington, provides dynamic ride matching information, real time traffic congestion reports and transit schedule information ⁽³⁾. The travel showcase which was implemented in Atlanta, Georgia during the 1996 Olympic Games is the first large scale ATIS demonstration which included real time traffic information, route planning for transit and automobile, as well as the demonstration of various types of technologies for providing the information to the users such as, personal digital assistants, kiosks and telephone services. The Atlanta showcase also provided the first test in the US that included feedback on various technologies from users, the importance of the information provided, timeliness and quality of the information, and the human factors associated with each different technology. The private sector has embraced traveler information as a commercial viability which is evidenced through the information provided from radio and television stations across the country as well as more personalized information such as the AT&T wireless traveler information services and the SMART ROUTE traveler information services in the Boston area. Furthermore, Microsoft and Intel corporations have recently announced that they will jointly develop what is called the Auto PC whose central feature is traveler information and in-vehicle navigation.

One of the ATIS operational tests undertaken in Europe, is the ROMANSE ⁽⁴⁾ project in Southampton, United Kingdom, which is sponsored under the DRIVE program of the European Community. ROMANSE was developed using the ARC/INFO GIS software platform and its main functions include: display of status details from on-street traffic equipment through automatic links; facilities to display incidents (either received automatically via traffic monitoring systems or input manually following reports from various sources); graphical display of HCC roadworks database; automatic display of parking availability status and variable message signs; display of highway network (OSCAR) with associated details such as traffic orders, bus stops and routes, car park locations, attractions and other static information; various input, output and maintenance facilities. Under ROMANSE, the Automatic Vehicle Location (AVL) and passenger information at bus stops (STOPWATCH) project was also developed. STOPWATCH provides real time information on bus services through a network of variable message signs. In addition, the TRIPPlanner system is developed under ROMANSE, which utilizes kiosks (computer terminals) at various locations to provide trip planning information for all modes of transportation to the users. Information is also provided to the users through radio or television, telephone service (STORACALL), RDS-TMC Radio, and in home teletext services (Teletext/CEEFAX). Another ATIS system in Europe is PLEIADES ⁽⁵⁾ which is implemented in the Paris-London corridor. PLEIADES is an intergrated driver information and traffic management system. It provides traveler information through terminals, radio via RDS-TMC, paging, cellular phones and in-vehicle navigation.

In vehicle navigation operational tests conducted in the U.S. include TravTek in Orlando, Florida ⁽⁶⁾, the ADVANCE in Chicago, Illinois ⁽⁷⁾ and FAST TRAC in Oakland County, Michigan ⁽⁸⁾. TravTek and ADVANCE are based on a similar concept where the route planning algorithm calculations take place in the vehicle. The vehicles are also used as traffic probes, by sending link travel times through Radio Frequency communications to the Traffic Operations Center, which in turn fuses the data with historical data and other sources, and sends updated link travel time estimates back to the vehicles. In contrast, FAST TRAC calculates the best paths at the TOC and sends

to the vehicles the updated paths through roadside beacons. FAST TRAC also optimizes the traffic signals using the SCATS™ adaptive traffic control system. The video image processing Autoscope™ system is used for traffic surveillance, and the navigation system is based on the ALI-SCOUT™ system. It is worthwhile to mention that the most advanced in-vehicle navigation system in operation is currently in Japan which is operated under the Vehicle Information & Communication System (VICS) program^(9,10). Under VICS it is estimated that currently more than 700,000 vehicles are equipped with in vehicle navigation systems. Communication is provided to the users through radio beacons located at regular intervals along the expressways in Japan's Highway system. Route planning is undertaken centrally and is disseminated to the vehicle through the radio beacons. An innovative application in VICS is the bird's eye view to the driver developed by NISSAN which provides the route to be followed on an LCD screen and shows the traffic conditions in different colors as well as the locations of incidents along the route (if any).

Development And Principal Components Of MATIS

The system architecture of a universal MATIS is depicted in figure 1. The principal components of MATIS include the travelers and the Traveler Information Center (TIC) receiving and response media, the communication system, the user interface embedded into the TIC data processing and the users data processing platform, the data processing components of TIC which includes the databases (user profile database, static and dynamic transportation network databases) and the algorithms (RPATIS, TATIS, and RSATIS). The dynamic database was not developed at the present phase of the MATIS. Furthermore, an MATIS should be connected to a traffic surveillance system through a communication system, however for simplicity it is not depicted on the diagram since the present MATIS developed concentrated only on the data processing components of a full-scale MATIS.

The MATIS developed at NJIT uses the ARC/INFO GIS as a platform for data storage, user interface, computations, analysis and display of results. Spatial data on map is often comprised of several layers, each representing a class of geographic data such as

roads, rivers, or county boundaries. In ARC/INFO each of these layers is called a coverage. A coverage contains data representing the geographic and non-geographic attributes of spatial features. The non-spatial data is stored in attribute tables in INFO, a proprietary, quasi-relational database of ARC/INFO. The user can easily manipulate the contents and the structure of these tables. A coverage can have one or more types of topological structure, or spatial feature types associated with it. Coverages contain points, arcs (or lines), or polygons. Each of these features is stored in a different attribute file. Polygon coverages contain arcs and are represented by Polygon Attribute (PAT) files, where arcs are defined by nodes at each end. Arcs are represented by Arc Attribute (AAT) files. Points are similar to nodes, but are dissociated for any lines and are stored independently as Point Attribute (PAT) files. Similarly, nodes are stored as Node Attribute (NAT) files. The most important coverage contained in MATIS is the network base map which is contained in a line coverage called MASTER.

The user's point coverage is created by means of geocoding, using the following procedure:

Building the address data with INFO,
formatting address in an INFO data file,
creating address coverage. The address coverage, stores all of the address data associated with coverage features. The Address Database File (ADF) always contains the address, zone and side items.

The address coverage is created as follows:

- Step 1. Check the INFO item (or field) names of each address component that is to be included in the ADDRESS item,
- Step 2. Execute the ARC/INFO command ADDRESSCREATE to create the template for address coverage,
- Step 3. Execute the ARC/INFO command ADDRESSBUILD to create the matching index. ADDRESSBUILD performs several functions that are important for geocoding, one of which is to produce an internal file called a match index that identifies all features with similar addresses.

Address matching compares two addresses to determine whether they are within a certain distance from each other. The ARC/INFO command ADDRESSMATCH is used to match an address coverage with an INFO data file containing addresses. The result is a point coverage with a geographic location for each address and the associated attributes from the address file.

The route planning procedure requires the use of point coverages to identify bus stops, train stops, intersections, and origins and destinations that were used by the different sub-systems of MATIS. The network base map was constructed by converting the Union county of New Jersey TIGER/Line files into a temporary coverage and then extracting the road features into a final coverage. TIGER stands for Topologically Integrated Geographic Encoding and Referencing system and was developed by the US Bureau of Census. In using the TIGER files, several limiting factors were recognized, such as: missing data values of attributes such as address ranges and zip codes which are essential for MATIS, missing address ranges in arcs, incorrect spelling of street names, zip codes missing. Due to reliability concerns of the TIGER files in its original form is therefore not recommended for actual applications, however, since MATIS was only a model, the discrepancies found were not that severe for its development.

MATIS Databases

User Profile Database

The user's personal and travel attribute information are stored in the user's profile database which can be updated when the user accesses the system. The user profile database contains the following information: 1) name of the user; 2) home address; 3) work-place address; 4) phone number of home and work locations; 5) preferred departure time to work; 6) preferred arrival time to work; 7) age; 8) gender; 9) smoking habits; 10) frequently visited addresses. Additionally, each user may input his or her personal and travel preferences for each mode of transportation they choose.

Static Network Database

The network database is based on the TIGER files database system of the Union County of New Jersey and contains the following databases: 1) The transportation roadway network and its attributes containing a geographic representation of the roadway network in terms of links and nodes. Nodes represent either roadway intersections or origins and destinations. The link characteristics include both physical characteristics (length, number of lanes, parking, etc.) and historical travel times. 2) The transit network and its attributes which includes, in addition to the roadway network, the transit links distinguishing between the bus and train individual routes, as well as walking links to transit, and bus stops. It is noted that the same physical link may contain several transit links representing several transit routes. The transit network database was created using a sample of the New Jersey Transit bus and train schedule information for Union County.

User Interface

The user interface of MATIS is intended to serve users directly at kiosks, through computers at home or the workplace or the operators of an ATIS service. Users can provide their input and receive the output through a menu driven interface which was developed using ARC/INFO programmable tools. The input/output interface uses the X-windows platform of the SUN SPARC station. The user interface is a series of menus logically tied together allowing the user to navigate through the program and input information. The interface is developed using the ARC/INFO's Arc Macro Language (AML). AML is a high level, algorithmic language that provides full programming capabilities and a set of tools for building Menus to tailor user interfaces for specific applications.

In order to run the several menus and output options at the same time, ARC/INFO threads were used. A thread carries input from an AML program, keyboard, or an AML menu to the AML processor. Input from these sources stack on the thread with the most current at the top of the stack. With a single thread, the user can interact with only one input source at a time. Multiple threads can be created to allow for multiple input sources.

One can create seven types of menus with AML such as: i) pull down, ii) sidebar, iii) matrix, iv) key, v) tablet, vi) digitizer and vii) form menus. Form menus are the most powerful of the menu types and are widely used in this application. They enable the user to make choices, accept input from the user and can incorporate scrolling lists within the menus themselves. Apart from these, pull down, sidebar and matrix menus are also used and a general description of these menus can be found in the AML Self-Study Workbook ⁽²⁶⁾. The primary components of the interface menus are the following:

- i. Welcome Menu. Welcomes the users into the system and checking if the user is a subscriber or not;
- ii. Registration Checking Menu. User indicates if he or she wants to register, using the registration menu for subscribers or the Travel Particulars menu for non-subscribers.
- iii. User Profile Menu. The user profile contains the first and last name, work and home phone number, gender, smoking habits, profession, and age of the user, which are primarily used by the RSATIS sub-system. Other information combined in the user profile is home and work addresses (street, city/town, state, zip) of the user which are the default origin and destinations of the users. In addition, the departure time from home or work is also included in the user profile menu. Origin and destination information is used by all three subsystems of MATIS.
- iv. Travel Particulars Menu for Subscribers. This menu displays two scrolling lists of addresses, one for the Origin and the other for the Destination. These addresses are the ones used more frequently by the subscriber, and are stored in the user's personal database. The two scrolling lists can be easily updated by the user online. If no origin or destination is selected, then MATIS uses the default O-D pair of the user for the specific time period of the day. In addition, the user may update his or hers departure time, for the specific trip without scrolling it as a new default. Permanent changes to the departure time can take only in the user profile menu. Similarly, the user may change the "Desired Arrival Time" at the destination. A user may select either a departure time or desired arrival time but not both. If the user selects both then the departure time will be used by the subsystems as a

default. The desired arrival time is intended only for transit users at the present version of the system.

- v. Registration Menu. Allows the users to subscribe and contains the same input as the user profile menu.
- vi. Travel Particulars Menu for Non-Subscribers. Contains the same information as the travel particulars menu but for non-subscribers, who will have to input all the necessary information whereas a subscriber will need only to input only changes to the existing information contained in his or hers personal profile.
- vii. MATIS Menu. Allows the user to select any of the three subsystems, the RPATIS, TATIS, RSATIS. It is linked to the travel particulars Menu to enable subscribers to modify their travel profile, if they wish to do so.
- viii. New Address Menu. User can add a new address to his or herss user profile. The address includes the name of the street (or intersection address), town/city, state and zip code.
- ix. Delete Address Menu. User can delete an address from his or herss user profile;
- x. Modify Address Menu. User may modify an address at his or herss user profile; and
- xi. Exit Menu. The user may select to exit from or return to the system.

In addition, other sub-menus exist for each sub-system which are described below under the MATIS sub-systems.

MATIS Sub-systems

The three sub-systems of MATIS are the following:

Route Planning ATIS (RPATIS)

The route planning algorithms used for route guidance may be divided into static and time dependent. Static algorithms use historical travel cost information, such as the path's travel time or the path's length. Time dependent algorithms take into consideration the path travel cost variability. Other considerations include the estimation of a number of alternative paths form an origin to a destination, different

modes of transport and the intermodal aspects of route planning. A comprehensive study of recent advancements in route planning algorithms can be found in ⁽¹¹⁾

Another important component in route planning is the link or path travel cost estimation and prediction which is a non-trivial task. Not only the algorithm must be reasonably accurate but it should be fast enough in order to be useful for the traveler to make timely decisions. The difficulty of travel cost estimation lies in the following factors: the high variance of link travel costs, the user behavior, the different classes of users and the variety of objectives, the unpredictability of incidents in the time horizon, the traffic surveillance/communication system in place and the efficiency of the data processing algorithms used. Using the all-or-nothing approach will lead to erroneous estimates of the path travel costs, once there are enough travelers who have access to the same information. In the past decade, considerable advancements in dynamic traffic assignment have been presented in the literature which in the near future they may produce more robust path travel time estimation taking into consideration the principal factors that are outlined above. However, the necessary data for providing real time travel time (cost) estimates will not be available any time soon. The most recent application for static link travel time estimation using a traffic assignment technique is found in ADVANCE ⁽⁷⁾ in the US, the RG CONTRAM under the ROMANSE ⁽⁴⁾ project and the MCONTRM traffic assignment model under the PLEIADES program ⁽⁵⁾ in Europe. Recent work in travel time estimation and traffic assignment techniques may be found in references ^(12, 13, 14, 15, 16, 17, 18, 19, and 20). The principal characteristics of the RPATIS sub-system are described below.

RPATIS provides route planning to the users with private automobiles for an origin-destination pair based on their personal criteria. The RPATIS utilizes the User's Profile database (if a subscriber) and the static roadway network database to respond to the queries of the users. The present route planning procedure used is the one embedded into the ARC/INFO software which utilizes fixed link travel time impedances. The user may input the historical link travel times for different time periods of the day (e.g. 15-minute intervals) and the route planning algorithm will use the appropriate ones based

on the time of the day. An operational real time RPATIS will need to incorporate a time dependent route planning algorithm and ultimately a dynamic traffic assignment to take into consideration the dynamic behavior of traffic as well as the user route choice characteristics. The specific input and output requirements of RPATIS are presented below:

Input Requirements

The principal input data required by the RPATIS input-menu are as follows:

- i) the user selects the preferred facilities to be used, such as: all roads (default), no freeways, or no tollways. These options are targeted to users who would like to avoid freeways for safety reasons and others who prefer not to use toll facilities.
- ii) the user selects the preferred travel cost criteria, such as: fastest (default) or the shortest distance. The fastest route is always calculated regardless of the user's preference, providing an opportunity to the users to compare their selected preference and the most commonly used preference. This feature may be useful in cases where the differences in travel time for the same trip are significant, such as, in cases of severe accidents which may cause considerable delays.
- iii) the user has the option to specify intermediate visit points between O-D for tour type trips. The user may input as many addresses as he or she wants to the intermediate point database. Tour type trips are especially useful for commercial vehicles as well as for regular commuters who need to make one or more stops on their way to work or from work to home, as well as for other applications.
- iv) the user is requested to provide two preferred routes for each O-D. This feature is used to provide the user with the opportunity to examine the present travel cost for his or hers preferred route. This feature is particularly useful in cases of severe incidents that may occur on the preferred route, and it also provides a continuous comparison of the preferred route's travel time versus the fastest travel time (default).
- v) A very important component of RPATIS is to provide the option for the user to specify the preferred arrival to the destination and the system to provide the best route and departure time from the origin. This option was implemented for the

TATIS subsystem only and is expected to be included for the RPATIS as well. This feature is very useful for many types of trips, such as, arrival time to work, arrival time to a specific appointment, arrival time to an airport, etc.

Output Requirements and Capabilities

- i) viewing the shortest path graphically or with text based directions or both,
- ii) viewing the time based shortest path and/or the user's choice if it is different,
- iii) option to printing either the text based directions, the shortest route graphic only or the area map with the shortest route highlighted in a different color,
- iv) the system provides also zooming capabilities to the user to provide more map detail.

Transit ATIS (TATIS)

TATIS provides to transit users route planning information from an origin to a destination. A primary contribution of this study was the development of a transit route planning algorithm which takes into consideration user-specified criteria usually not being considered in current TATIS systems. A special feature that was embedded into the TATIS is the option for the user to specify preferred arrival time and the system then provides the best route as well as the necessary departure time. This is a significant component of any ATIS system and especially useful in transit systems which have scheduled arrival times at bus or train stations.

Of special importance is the coding of the transit network (transit schedule and stops) into the GIS, which was accomplished using dynamic segmentation. The transit time schedules were represented as INFO tables with the same route identifier used to describe the route and stops but with a different file extension identifier. A single route is described by two text files, the path file and the stop file. The routes are categorized by a mode number, base route number, a variation number, a direction, and time of operation. The location of the transit stops are listed in the stop file. Fare policies were not incorporated into the present system, however, they should be included into a future system since fare is a determining factor that users place in selecting their routes or

their mode of travel. The transit route planning considers up to two transfers for each origin and destination pair that a user may request information on.

TATIS was developed as follows: i) Transit network data preparation for Union county, NJ; ii) development of the transit network analysis algorithm and its implementation, iii) determination of the travel time along an O-D path, iv) development of the O-D path schedule and a graphic display of the path, and v) the input output menu driven interface. The TATIS system and the transit route planning algorithm developed is described in detail in Koncz⁽²¹⁾. The specific input and output requirements of TATIS are presented below:

Input Characteristics

- i) the user specifies his or hers maximum number of transfers. A maximum of two transfers is set for the current TATIS route planning algorithm,
- ii) maximum acceptable time for transfer locations,
- iii) maximum acceptable walking to make a transfer,
- iv) origin and time of departure, and the destination and preferred time of arrival.

Output Characteristics

The output provides the path to be followed which includes the bus stops, transfer points, bus/train arrivals and departures at each station, en-route travel time, and waiting time at each transfer station.

Three additional routes based on the users' criteria as alternatives to the user has the option to see graphically the path chosen or in text based directions format.

Ridesharing ATIS (RSATIS)

Ridesharing systems provide travelers the option to share a ride with someone else from their origin to their destination. The principal characteristics of ridesharing systems are the following: i) spatial relationships, ii) trip schedule relationships, iii) personal preferences of ride-sharers (passenger and drivers). Passengers are matched with

drivers according to the specific characteristics of the drivers and passengers. Spatial matching characteristics include the trip length, radii of pick-up and drop-off, and deviation from the driver's direct route ^(22, 23, and 24). Time schedule relationships include the departure and arrival time tolerance, and the time notification of a guaranteed ride. Sociodemographical characteristics (personal preferences) of the drivers and passengers dictate the willingness to rideshare with other people ⁽²⁵⁾. Ridesharing operational tests in the U.S. include a real time ridesharing matching operational test in Sacramento, and the "Smart Commuter" in Houston.

The principal characteristics of RSATIS are the following:

- i) Drivers and passengers ridematching, which includes both trip schedule and personal characteristics matching. Trip schedule ridematching selects drivers and passengers whose origin and destination are within a user specific radius and/or a portion of their trip overlap, and within the user's departure and arrival times. Personal characteristics matching considers the users personal rideship preferences such as gender, age, smoking habits, and profession;
- ii) Ride sharing confirmation/cancellation. The drivers and the passengers must inform the system once (confirmation) a match is made or if they have to cancel (cancellation) their ridesharing request. The system reallocates passengers once a driver or passenger cancel their trip;
- iii) Similarly to RPATIS and TATIS, the users can use a menu driven interface to register or input their queries and receive the output in an efficient and user friendly manner. The algorithm developed for RSATIS is described in Zheng et. al. ^(27, 28). The principal components of the system are the following:

User profile databases: contains user registration information such as address, attributes, and preferences, which are stored in the INFO table,

Network attribute coverage: contains network attribute information such as streets and links,

Users' point and address coverage: geocoding users' address information and forming users' home and work place point coverages.

Potential users of RSATIS are divided into two groups; drivers and passengers. To enable the system to match drivers to passengers, three types of user profile databases (INFO) tables were build:

- i) The user profile database includes the following entries: user ID number which is provided by the system, origin and destination address, origin and destination zip code and city, home and work telephone number.
- ii) The user's attributes database includes the following (some of them optional) entries: user ID number; user name; gender; age; profession; smoker or non-smoker; preferred departure and arrival time from an origin to a destination, respectively; days wishing to participate in the ridesharing program; user is or isn't a registered driver.
- iii) The user's preference database includes the following entries: user ID number; ridesharing gender preference such as male female or any; preferred ridesharing age group; ridesharer's profession; whether user prefers to ride in smoke-free vehicle or not; the maximum waiting tolerance time to depart.

The main functions of RSATIS (input, task inquiry and output) are accessed through a set of menus accessed from the RSATIS main menu:

Input: Ridesharing registration checking for determining whether the user is registered to the RSATIS; the update ridesharing menu where the users may update their ridesharing personal information and the ridesharing confirmation menu where the users need to confirm their participation in the RSATIS program once they were matched with others for a specific trip; ride cancellation menu where the user needs to inform the system on canceling their participation for a specific trip.

Output: The output, which is selected from the ridematching information menu, presents a list of matched ridesharers that includes the telephone number and location (address) of each one as well as the identification of the driver. The output also provides a map showing the location of each matched user for the specific trip and the route to be followed from the origin to the destination. This information is rather useful for the driver

who can select the sequence that is best for him/her to pick up each passenger. A zoom option can be used to enable the driver to locate the passenger easily. A future system should include a tour type algorithm that can be provided to the driver, as well as the estimated arrival time at each's passenger's departure locations, and the estimated arrival time at each's destination.

Sample Test Case

A user with and ID 13 is taken as a sample test case. Her travel attributes and preferences are presented below:

Input

User's category: Subscriber
User-ID: 13
Travel Attributes:
Address of Origin: Springfield Ave. / Westfield Ave, Union, NJ 07030
Address of Destination: Gordon St. / Westfield Ave., Roselle Park, NJ 07024
Normal time of eaving home: 7:00 AM
Normal time leaving work: 5:00 PM

User Preferences:

a) For RPATIS:

Road Choice: Include all classes of roads
Route choice: fastest route
Number of intermediate points: 1
Adress of Intermediate point(s): 328 Faxwood Road
Preferred path: via 462 Kelinworth Blvd

In this example, the user wishes to make an intermediate stop and then continue to the destination. In addition, the user prefers to pass through Kelinworth Blvd. The algorithm that is embedded in ARC/INFO utilizes this information to produce the fastest

path that passes through Kelinworth Blvd. The intermediate point option and the preferred route is available only for the RPATIS.

b) For TATIS:

Transportation mode:	bus
Maximum number of transfers:	2
Maximum walking time:	15 minutes
Maximum waiting time:	> 20 minutes

In this example, the user's origin and destination are the bus stops, excluding the walking distance to-from the bus stop.

c) For RSATIS

Driver/passenger:	Driver
Pick-up radius:	at home - 1 mile
	At work place: 1 mile
	Enroute - 0.5 mile
Number of seats available:	3
Ride with a smoker?:	Yes
Gender preference:	Both
Age group preference:	30-50
Name:	Jonh Brand
Profession:	Business
Age:	33
Gender:	Male
Home telephone number:	(201) 474-7574
Work telephone number:	(201) 535-4555
Off-days:	Saturday and Sunday

The above input information is stored into the user's profile database and the user does not have to input anything once he or she enters MATIS. The most usual input required would be his or her origin and destination as well as the time of departure. However if this is the default for this user, then the only input required would be his/her ID number. The subscriber can change at any time his/her profile once he/she enters the system.

Output

RPATIS: A summary of the results for the RPATIS option are presented below:

Option	Travel Cost
Shortest Route	4.4 miles
Fastest Route	11 minutes
Passing through one intermediate point	12 minutes
Preferred route	13 minutes

Figure 74 RPATIS

TATIS: A summary of the MATIS results for user ID 13 taking the bus are presented below:

Option #	Journey Time (minutes)	Waiting Time (minutes)	Total Travel Time (minutes)
1	30	52	82
2	71	31	102

Figure 75 TATIS

RSATIS: The user ID 13 is matched to three passengers who have common attributes and travel characteristics.

Summary And Conclusions

The MATIS system was developed under a GIS UNIX platform using the ARC/INFO software where the users can access three subsystems, personal Route Planning ATIS (RPATIS), Transit ATIS (TATIS), and Ride Sharing ATIS (RSATIS). The use of the off-the-shelf ARC/INFO GIS software was found to be very helpful since many functions are integrated into the software and do not require programming new software code for any specific routine, with the exception of the transit route planning algorithm.

Especially useful features are the address matching, geocoding and dynamic segmentation capabilities, as well as the availability of route planning procedures and programming tools to easily develop menus and graphical interfaces. The principal characteristics of the developed system include the following: a unified approach of integrating different modes of travel providing the flexibility to the users, to select information on any mode of travel which may have an impact on travel behavior once implemented. The system may be used for off-line studies of a transportation network and as an ATIS platform where travelers may be surveyed to examine the different components of the system. Furthermore, a large scale implementation of MATIS will enable transportation planners to develop more accurate traffic assignment techniques by studying the travel behavior of the users, enhancing the transportation planning process.

A critical component that was not embedded into the system was the intermodalism aspect of route planning, which should be addressed in the future. Furthermore, the system should provide the best route planning based on a combination of all different travel modes available. The universal route planning algorithm is non-trivial if the user's preferences and attributes are taken into consideration. The problem is exacerbated by the virtual non-existence of sufficient traffic surveillance systems as well as real time origin destination data that are necessary for route choice models. Dynamic traffic assignment techniques will be found very useful in the future for route planning as well as traffic management and transportation planning once the pertinent transportation data will be readily available. The present prototype cannot be used for real time

operations due to the rather slow execution of the algorithms of the three sub-systems. Implementation of MATIS into real time operations will also require the development of the interfaces with the traffic surveillance system, the communication system, and the development of fast travel time algorithms, route planning algorithms and an efficient design of a traffic operations center which will be able to handle a large volume of users at the same time. Furthermore, a future MATIS should be accessible through the INTERNET, which is becoming a standard information platform for many people throughout the country as well as around the world. Future systems will need to customize their data processing algorithms and use GIS software mainly for map displaying. These graphical interfaces will need to be modified to accept the output of the data processing algorithms and display it in a sufficiently short period of time that will be acceptable to the users. Ideally, MATIS systems should be available in portable PCs such as laptop or smaller (palm PCs) with embedded wireless communications. Some initial products are readily available especially in INTERNET based GIS applications.

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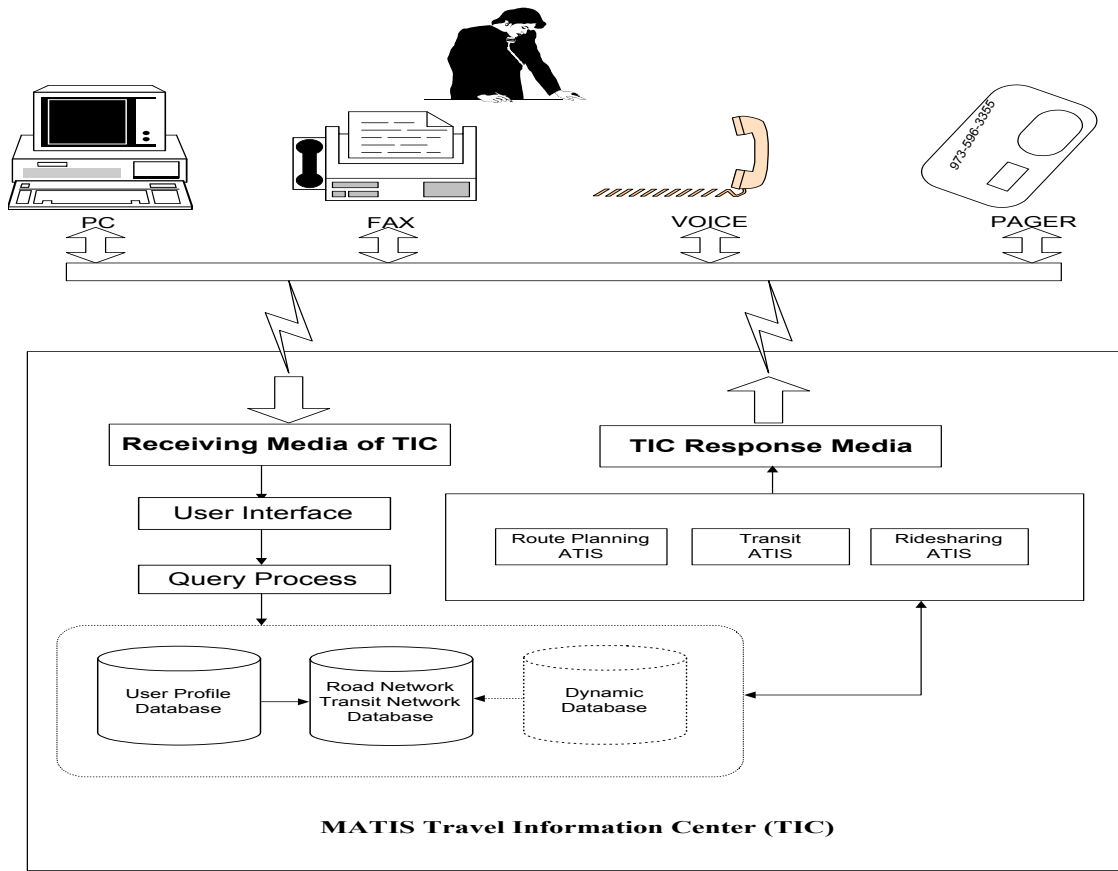


Figure 76 MATIS Conceptual Architecture