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Application of NASA Technology to a Rapid Transit System

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ABSTRACT

NASA has established a new program in technology utilization. It involves full time, on-site contact with the user and is presently being applied in the development of the Metropolitan Dade County (Florida) Rapid Transit System. The NASA Representative identifies technical problems while participating in daily activities and then draws on the agency's expertise to assist in solutions. This paper presents a report on the results to date and expectations for the future.

BACKGROUND

At Metropolitan Dade County, Florida, an intense effort has been exerted over the past 14 years, especially since 1973, to obtain a rapid transit system to service the dense urban areas. The County includes Miami plus 26 other cities, and the area as a whole has been showing a steady growth. A new transit system is sorely needed since many expressways and urban streets are presently almost saturated with over 1 million autos now registered in the County, plus the largest rental car population in the world. The County now has over 1,500,000 in population and the 1985 projections show it will probably exceed 1,750,000 as a conservative forecast.

Getting to and from work, schools, stores and other normal day-to-day destinations has become a difficult and increasingly expensive task. For example: U.S. Highway I-95 through Dade County was designed to handle a maximum of 96,000 cars a day at Level C Service (Federal Highway Administration rating standards). Today I-95 is carrying nearly twice that volume. The Palmetto Expressway is also handling almost twice its design capacity and U.S. 1 and other arterial streets are equally overloaded. The existing buses, which can only travel an average of 12 m.p.h., are having difficulty trying to hold schedules due to traffic jams and the passengers are not getting the service they need. The bus fleet, now being enlarged from a present level of 550 buses to a future level of more than 900 buses, is physically restricted by both low speed and low capacity. The County has therefore long aimed at providing an alternate form of transportation, so that some of those who do not require autos during the day for their work or other activities can leave their cars at home.

In view of the heavy traffic it is somewhat a paradox that nearly 16% of the County's population is over 65 years of age and more than a third of the entire population of Dade County is too old, too young, too handicapped, or too poor to drive, own and operate autos. In fact, a full 20% of all households in Dade County do not have an automobile of any sort. These people are truly "transit dependents."

The voters demonstrated by a 1972 referendum that they do not want additional expressways built to alleviate the problems of growing congestion. This vote, by a two to one majority, resulted in rejection of proposals to build six new expressways. Such new highways would have required at least 300-foot rights-of-way, while a fixed guideway rapid transit system needs only about a 28-foot width for more than equivalent volumes in terms of people moved per hour. Due to passenger density it would take 23 lanes of expressway to carry the number of people a single rapid transit line can carry in one direction. In terms of money, it costs 88 cents per person per mile to build a suburban highway, and only 20 cents per person per mile for rail rapid transit. Also, the highway has a more significant impact on the urban areas because it forces the relocation of a larger number of people and businesses. In summary, rapid transit is a much more efficient method of moving people than highways and is particularly appropriate to a dense, growing metropolitan area such as Dade County.

Just increasing the size of the bus fleet will not solve the problem. Fundamentally, the present slow speed of the Metro Transit Agency (M.T.A.) buses cannot improve in the years ahead, but become slower with growth in population of both people and autos. Like Mexico City, "bus jams" would inevitably take place in many congested areas and heavily traveled expressways. The substitution of buses for automobiles in a traffic jam does not help the public.

"All-bus" plans are also far more expensive from an operating cost standpoint. Recent experience indicates $100,000 per bus per year is a reasonable 1985 operating cost projection, compared to the present level which exceeds $70,000 per bus, per year. This would cause the cost of a 2,200

bus fleet (approximately the same capacity level as the rapid transit system now being designed) to exceed $220 million per year by 1985, more than twice the estimated operating cost of the currently approved Stage I (combined) bus-rail plan. After years of careful study, the Federal, State and County governments all concurred that the "all-bus" plans should be rejected, and they have been discarded.

The factors covered above, necessitate a fixed rail rapid transit system as a primary element of the total transportation network for 1985. There are other factors, such as needed reduction in pollution and conservation in the use of fuel. Also, a reduction in travel time as compared to alternate means to move people must be achieved and will be realized with the present program, by a factor of approximately one-half, i.e., time of travel on typical trips by 1985 will be reduced by more than one-half compared to today's standards and schedules.

DESCRIPTION OF 1985 SYSTEM

A brief description of the rapid transit system is appropriate since many people are not familiar with this mode of transportation. This will feature a surface level and aerial fixed guideway with two steel running rails. A third rail will supply electrical power to electric motors in the cars (4 motors per car) that will in turn provide traction power. The rapid transit system is to be built as a multiple stage project. The present Stage I is planned to commence at the Dadeland South Station, in the South part of Dade County, and proceed Northeast along the Florida East Coast (FEC) Railway right-of-way to the downtown Miami area; a distance of nearly 10 miles. It then will proceed through the Civic Center in the central part of the County, then generally north and west along N.W. 12th Avenue and N.W. 27th Avenue to N.W. 79th Street, past Hialeah Park along N.W. 74th Street to a West 8th Avenue station in Hialeah, with a Hialeah yard and shop at the Northwest end of the line. There will be 20 stations along this 21-mile long route.

Most of the system will necessarily be elevated because of the flat terrain, subsurface and water conditions, etc., with approximately 3.0 miles at grade level. A steel wheel/steel rail technology with standard 4'8½" gauge has been adopted.

The total budgeted cost for Stage I of the rapid transit system is $795 million, and includes funds for construction, purchase of rapid transit cars, spare parts, equipment required for tracks, signal and power systems, parking lots at stations, and bus feeder support.

Future stages are being planned, to extend ultimately the 21-mile Stage I to a length of just under 50 miles. The rail system will cover what is now, and expected to remain, the most congested parts of the County and thus serve the heaviest travel demands. The routes will be integrated with the bus system to cover the rest of the area, using these vehicles as a feeder system to the rail stations, as well as normal line haul bus service. The "bus-rail" system will operate as an integrated network to support the needs of the patrons.

APPLICATION OF NASA TECHNOLOGY

The project does not, immediately relate to NASA Technology. There are, however, some similarities with the facilities and equipment at the Kennedy Space Center. Some applications have been identified through coordination with NASA since 1974 and many others are being identified as the project progresses. The space program progressed so fast in recent years that the technology resulting from the NASA program has become much further advanced, in many areas, than such projects as rail transportation. This is, of course, the source of the technology that is to be utilized in a technology transfer effort. The Dade County Project is not, in any way, an R&D type effort and is, fundamentally, utilizing "state-of-the-art" engineering.

Now "state-of-the-art" means different things to different people. Engineers are classified by their field of work and tend to become somewhat specialized within that field. Various factors often limit their absorption of new technology. These can range from devoting all their time and effort to concentration on certain areas of interest to simply not being aware of what is taking place outside his field. This probably applies to all engineering fields to a greater or lesser extent depending on the nature of the individual project and attitudes of the involved individuals. Dade County's management aims are to design and to emplace a working system in a matter of 5 years using, essentially, "state-of-the-art" concepts. This design makes it necessary to carefully seek out opportunities for use of existing technology, if significant product improvements are to be realized over existing rapid transit systems. Management certainly does not want to repeat past mistakes at other locations.

The space program has both accumulated and developed much data. The NASA "data banks" have become a national resource. It therefore has become an important resource for data that can improve the transit system's technical design efforts. That is why NASA became involved in the Dade County rapid transit system project under an agreement with the U.S. Department of Transportation (DOT). The DOT is very interested in the Dade County project because they are responsible for furnishing the major portion of the funding for the system (80%).

The first step has been to establish a means for the transfer of technology from NASA. Dade County's technical people are not familiar with

the extent of the NASA activities nor the functions of their Centers and facilities. NASA technical people, in turn, are not aware of many of the County's problems. Each side was, in the past, not sure of what questions to ask in order to obtain satisfactory results.

NASA has an established nationwide technology transfer system, but the County, as well as other local agencies, has had trouble in effectively utilizing it. The solution for better technology utilization at Dade County came through a variation in the NASA system, in that a full-time engineer, who we refer to as the "on-site NASA Representative," has been provided.

This Representative was selected on the basis of prior engineering experience in the space program, and a good practical knowledge of the NASA organization and their activities. More important, from the County's point of view, is the participation by this representative in the daily design activities, and direct technical contact with the County's general architectural and engineering consultant that is providing facilities design and system engineering support for this project. This provides the NASA Representative the means to obtain first hand a good working knowledge of the County's design problem areas. This insight is provided both by the County and by the representative's own individual initiative in determining which items NASA has already researched and resolved that appear to be applicable to this project.

After a problem is identified, a search is made by the NASA Representative using the existing technology transfer network to find appropriate documentation and obtain advice from NASA experts. Such information is then transmitted by memoranda through the County's Director of Transit System Development to the County's General Consultant - generally the systems engineering group of the General Consultant's organization. These transmittals usually include technical information that will help show how to best utilize the inputs. This organizational relationship allows for free flow between the involved parties on a purely technical basis without encountering contractual or management problems.

The obvious question is what has been gained in this endeavor? It is too early to assess the results. The NASA Representative arrived on October 3, 1977, when the preliminary system definition was well advanced. The County wanted to start sooner, but circumstances prevented it. The timing of his arrival vis-a-vis the status of the design development of the project at that time has restricted the scope of the technology transfer to the detailed design activities, production/construction, and applications of reliability and maintainability factors. These are all very important, so the total input should prove productive.

The exchange of technical data is in progress. Some of the problem areas considered to date include:

1. Corrosion

Miami, like the NASA Kennedy Space Center, has a subtropical, marine climate. Conditions for causing corrosion and mildew are severe, and this can create monumental maintenance problems. The operational experience at KSC regarding this problem is directly applicable to the County's project. The County is, therefore, using that experience to develop designs and to maintain critical components in such manner that we can minimize the corrosion problem, applying NASA's solutions from KSC and elsewhere. This is a critical area because excess maintenance problems escalate costs while reducing the reliability of the system.

One example of what has been done to date includes NASA providing the County a test sample of a zinc rich coating for exposed carbon steel or aluminum that resists corrosion. The sample came from the Goddard Space Flight Center and represents the type of coating now in use at the KSC; especially on Launch Complex 39 that will soon be used to support the space shuttle operations.

2. Solar Energy

The County has plans to use the rapid transit station to be located at the University of Miami as a pilot project, to utilize solar energy for station lighting and equipment room cooling. The NASA Lewis Research Center and Marshall Space Flight Center have provided considerable data on the state-of-the-art for solar energy applications. This is a big asset for establishing the technical definitions, and developing cost estimates for this effort. This is another direct, technical application from NASA to Dade County, utilizing the on-site NASA Representative.

3. Quality Assurance (QA)

NASA has made inputs to the rapid transit system's QA plans, particularly with regards to facility construction. Here the County has used QA plans for two of the KSC Space Shuttle facilities as a model for application to the transit project.

Failure data on transit vehicles was obtained from Stanford Research Center, which is one of the NASA Technology Application Teams. This group is also setting up a reliability engineering program for rapid transit systems, that will be secured in the near future.

4. Fire Retardation

Experience has shown that in transportation accidents people are often killed by the products of subsequent fires rather than injuries due to the crash. Reports on the work at the Ames Research Center and Johnson Space Center has been obtained to show what materials are best for vehicle interiors to eliminate excessive smoke and other toxic vapors. Also data has been obtained on design concepts in this area, such as type of materials to place behind metal panels or inside sandwich structures in the transportation vehicles.

Other inputs cover a wide range of details. The ultimate assessment of the value of these inputs will not be known until after the rapid transit system starts into revenue operations, by 1983. In the meantime, the Project will be starting into construction and manufacturing. This is always a very busy period. New areas of technology transfer are being identified each day, and as construction proceeds it is evident this will continue.

TECHNOLOGY TRANSFER FUNDAMENTALS

It is appropriate to comment on some fundamental factors that have to be satisfied to properly identify and handle the transfer of technical data between two independent organizations. These are not new concepts and many of you have heard them before but they are worth repeating. There is an onus on management on both sides, the "provider" and the "receiver," not to take a passive role. Management needs to favor the technology utilization (TU) concept and help by insuring that their organizations provide the needed support on the "provider" side and use the inputs on the "receiver" side. This is considered vital to obtain an effective exchange of information. It calls for direction and guidelines if there is to be good, or in some cases any, utilization of the technical information that is made available.

Management also has to help overcome the "we already know how to do it" syndrome. Some people have resisted using new inputs (which are to them new "ideas") as a matter of pride, or the fear that there will be a new face behind their desk in the near future. Thus there is a management role of helping to bridge the area between the point of origin and the intended use. Part of this role is to assure people that use of new ideas is a plus, not a threat, nor meant to imply that the user's capability is being questioned. It is expedient to point out that technology has become too complicated for one person, or group, to know all the answers and getting help is an excellent solution. This is the management approach at Dade County and we're sure it is shared by NASA generally and NASA-TU Office specifically.

Management also helps by understanding that the transfer of technology provides a means for obtaining a better piece of hardware, better techniques, and/or becomes a base to improve the skills of the technical groups within the receiving organization.

Note the emphasis on the word "help." It is felt that just providing a large quantity of literature would, for the most part, be non-productive. Mere access is not enough. The disseminator must play a more important role than just effecting the transfer. The receiver needs to have the support of someone familiar with the general scope of available knowledge and how to find it. The provider, in turn, must also be familiar with the user's needs and tailor the technology inputs to the right users. Another important service is, therefore, to translate many of the things from the NASA files (or should I say interpret or scale down) into a form that is more suitable to the user's needs. Generally the user cannot, or does not want, to go through some type of "R&D," or expensive training effort. Frankly, some of the NASA developments are so extensive that they tend to overwhelm the potential user. It is not uncommon to hear "we just don't have the resources to handle such a big concept." The provider must therefore insure that the receiver be given the needed visibility and assistance to keep what is needed and eliminate the excess to carefully match the degree of need, schedules, objectives, and resources.

In the Metropolitan Dade County rapid transit project we look to the on-site NASA Representative to bridge, in cooperation with management, this gap between the source and the user. That is the key to our TU as we see it. This can be summed up by declaring that technology transfer requires going through and working with people. Both sides at the technical levels have to take active participation with management encouragement, or management direction if necessary.

This is the first time that a full-time on-site NASA Representative has been assigned to a rapid transit project. In view of the above listed needs this seems to be the most feasible means for NASA to achieve a practical technology transfer to this type program.