The History of my Involvement in PRT and how it led to ATRA

J. E. Anderson

In early 1967, my application to spend 10 months in the Soviet Union sponsored jointly by the American Academy of Sciences and the Soviet Academy of Sciences was approved. I left home in early November 1967 and returned home in September 1968. While working in the USSR I spent a considerable amount of time thinking about my career. While at Honeywell I enjoyed more and more the chance to lead groups of up to a couple dozen engineers in projects far beyond the scope of one individual. While we didn't then call what I was doing Systems Engineering that is exactly what it was. Notwithstanding that I enjoyed that work immensely I was pulled to the University by a desire to teach and do academic research, but I was also pushed by certain events that I have felt better left unsaid.

Coming to the University, I plunged enthusiastically into my research work, but I also noted certain negative aspects that caused me to yearn for Systems Engineering work. Frankly, I was having a classical midlife crisis. While the research I was doing in magnetohydrodynamics was most interesting, I began to feel that it was not enough for my entire career. I felt that there may have been at most a dozen scientists in the world deeply interested in electric arcs, and that the effect of that research on society as a whole was if anything tiny. I had just past my 40th birthday and I felt that life was slipping away from me. Then one day, maybe inspired by writing a poem for my mother's 75th Birthday, the following words of Jesus came to me loud and clear:

"Whosoever will lose his life for my sake will find it and find it in abundance."

That was it, I thought! I interpreted "losing one's life for my sake" to mean that if one would get fully involved in a cause beyond one's self, a cause of vital importance to mankind, one would find meaning in one's life and find it in abundance. I had brought many books with me. One was the writings of Thomas Jefferson. What impressed me about Jefferson was that he was always talking about the first-rank problems of his time. The year 1968 was a tumultuous period in the United States. I read an editorial in *Science* by a professor at the University of Michigan who commented on the most important problems of the day, starting with preventing nuclear war. After listing his idea of the ranking of important problems to our society, he concluded that most professors were working on problems that ranked about ninth in order of importance. Why would I want to do that? Why couldn't I work on one of the most important problems? These kinds of thoughts would occupy my mind more and more in my remaining months in the Soviet Union while dutifully finishing the research I promised to do. It was published in Russian in a book called *Magnetogasdynamics of Thermal Plasma*, Moscow: Energia, 1970.

My thoughts while ending my visit to the Soviet Union are best summerized in the following letter that I wrote to my Department Head:

September 1, 1968

Dr. Richard C. Jordan
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University of Minnesota
111 Church St. SE
Minneapolis, MN 55455

Dear Dick:

Since it will be several weeks yet before I will be able to talk to you in person, I thought it would be appropriate for me to write to you now concerning the feelings I have expressed earlier. Perhaps this is a better way to open our discussion anyway, and can form a more concrete basis for further discussion when I see you.

As I mentioned to you over the phone on Sunday, and as you know, my background – somewhat because of circumstances difficult for me to control and sometimes because of my own inclinations – has been more diverse than is usually the case. Before attending M. I. T. I worked on theoretical structures, instrument design, shock and vibration engineering, autopilot analysis, and inertial navigation systems. All of this was oriented to practical engineering problems and involved me in a good mix of theoretical and experimental engineering. Though my role was always that of analyst and synthesis, I worked closely with experimenters, and often spent much time in the laboratory myself. At NACA I helped set up tests and took data to verify a theory of mine; while designing instruments at Honeywell I spent hours in the lab studying the meaning of tests I had ordered; in the autopilot group, I made regular trips to airports to discuss flight tests of Honeywell autopilots and spent many days analyzing aircraft-autopilot systems on the analog computer; etc. In every one of the Honeywell roles, I was soon leading groups – first, I directed a group of 4-6 design engineers in the design of an instrument that was selected as the "Product of the Month" by *Aviation Age* magazine; after a year in the autopilot group, I was put in charge of 15 research engineers working on autopilots for the Airforce's most important fighter aircraft; soon after joining the inertial-navigation group I led a group in advanced design of a system I had invented and several years later led an intersectional group of 20 research engineers on this system. I have never been afraid to get my hands dirty. My brother and I had a shop and worked with tools since we came to the U. S. in 1936. I worked in a machine shop while in high school, in carpentry in the Navy, and in another machine shop even after joining NACA. I loved experimental work, but found gradually that I could make my best contributions in the analytical area. Dr. Eugene Lundquist, Director of the Structures Research Laboratory at NACA, recognized this early by assigning me to theoretical work, and I have had continued evidence that this is true. In Honeywell, I think my work can best be described as a combination of analytical thinking closely related to the real world plus exercise of ability to lead and to persuade others. In particular I pride myself on my ability to adapt myself to various problem situations.

Through this period, I continued to study and longed for the PhD degree both because I felt that only through it could I reach my full potential and because there was a lot of physics and mathematics that I wanted to know. For a while I had resigned myself to the apparent fact that it would not be economically possible for me to quit work and study full time, and that my responsibilities at Honeywell were such that I couldn't discharge them and make much progress on a degree. Sputnik changed things to the point that full-time study became possible. My almost three years at M. I. T. were a wonderful phase of my life, permitting me to study subjects such as general relativity theory and quantum theory, which I longed to know. Upon going there, my purpose was to broaden my knowledge of fundamentals and of systems with the dream of someday managing large system projects. Upon thinking of a field of study and thesis topic, I was led through my studies to choose MHD (magnetohydrodynamics) both because it would require me to learn a lot of physics and math, and because of the glamour of a new large-scale power system.

In returning to Honeywell, I did a broad range of things the first year as an advisor to the Research Director including heading a staff study on high-power lasers. I then became involved in the systems department where I headed a group of 25 engineers in the spacecraft group. This work led directly to acceptance of Honeywell by NASA as a systems house instead of a component supplier – a feat I learned only after deciding to join your department.

For various reasons I reviewed my career quite carefully while in Minsk. The Honeywell part is for the most part characterized by initial periods in which I worked alone and worked out ideas for devices and system, followed by periods in which I led groups in development of these ideas. The systems grew more complex as time progressed and in every case contributed significantly to the organization. In fact, when I left for M. I. T. in June 1959, I was the undisputed top technical man in inertial navigation in the Company. But strangely enough, through this whole period I considered my work as more or less a way to make a living while I strove to attain my educational goals. This is not to say that I didn't enjoy it. Technically, I did even in the face of many frustrations. But in my leisure hours I found myself always trying to dig as deeply as I could into fundamental questions in both physics and religion. (This coupling is to me not at all strange as both relate to understanding of the world – physical and spiritual combined.)

Attending M. I. T. was exciting because it gave me the freedom to pursue these fundamental interests. In the first summer, I learned enough of the calculus of curvilinear tensors so that I could understand how the equations of the general theory of relativity were derived. After two months, I wrote a report in which I traced the derivation of the theory and worked out some problems which explained the time paradox from the view point of general relativity. I also began to dig more deeply than I had into quantum mechanics, fluid mechanics, thermodynamics, statistical mechanics, plasma physics, and electromagnetic theory all of which led me to feel that a program of study in MHD would help combine many of my interests and, as I mentioned above, offered the exciting hope of working on new systems.

I enjoyed my thesis work a great deal and by the time I finished I felt I had found what I wanted to continue to do. But I was obligated to go back to Honeywell and, though I tried, I knew that it would not be possible to pursue problems either of the type or to the depth I desired. Because of an unacceptable working relationship with the Director of Research, I transferred to the only place I could go – the Space Systems Department. Here I quickly got involved with a proposal for a solar-probe spacecraft, was put in charge of the technical part, and because of my enthusiasm for the possibilities worked 100 hours a week for two weeks to get it done. I led the study I mentioned above. I could see that this position was leading me into management responsibility, but in such a position I felt I would be hamstrung by an intolerable relationship with the Research Director – the very department with which I would need great cooperation if we were to accomplish anything. Also, I felt the climate was not right for the company to get started in the space business, and that judgment has subsequently proven correct.

I felt it important to go into this detail to give you a better idea of the background with which I came to the University. I had decided that I wanted to settle down to a research career at least for the foreseeable future. But I had come from positions in which I was the leading technical person, where I had some authority as well as responsibility, and where I was accustomed to great deal of supporting assistance. In this respect I found the transfer to the University somewhat traumatic, but I decided that what had to be had to be and that this would again be one of those think periods before I would really get going again.

Dr. Eckert asked me soon after I arrived if I wanted to do experimental work. From my own experience, I felt that, while I wanted to stay close to experimental work, my talents and skills were now such that it would be more profitable to devote my attention to theory, but theory closely related and coupled to experiments done by others. I felt that this is a world of specialists and that one man can't be effective trying to be all things at once. There was little time enough to do one or the other and still attend to my teaching and advising duties, as well as to consulting for Honeywell for which there was much demand.

As a consultant, I have gotten involved in problems related to magneto- and electro-hydrodynamics, reentry physics, upper atmosphere physics, spacecraft development, explosion dynamics, and navigation; and because of my personal situation I have had to work harder on this than would otherwise have been desirable.

I have frankly felt as time has gone on that a theoretician is really a second-class citizen in the Heat Transfer Division. I know that the backgrounds of the people here are much different from mine. I have come to feel that this group is really better suited to career heat transfer types, and have come to the conclusion that it would be better for all concerned if I left.

I am sure you felt this problem a few years ago when you asked me if I wanted to head the design division. A lot of the above should clarify why I did not. At the present time I am no closer to being convinced that this is what I should do.

Perhaps I am a frustrated physicist, but I can't take time to dwell on what could have been if I had been able to carry my educational program straight through. As things stand now, I feel I must look for a position in which there is a genuine leadership component as well as opportunity to make use of a broader-than-usual technical background. At Honeywell I worked well with people, found that people sought and accepted my leadership and advice, and at the same time through extensive reading and observation I have felt that I could do a better job than some of those above me in various technical management positions. I am not a narrowly oriented person. I read as widely as I can in history, philosophy, theology, sociology, psychology, current events, and in other areas of science, etc. Particularly as a result of my observations in the USSR, I am most concerned that the U.S. make real headway in its internal problems, that it maintain its military strength, and that it project an image that will convince people everywhere of the superiority of free enterprise to the slavery of Communism. I want to make – yea I must make – what I do relate to the community at large. I feel that at this stage of my life I can make the best contribution by getting involved in a multidisciplinary program in which I can use both my technical background and presently dormant leadership talents. Frankly, at the present time I don't know where I will find such a position. It could be in some branch of the Federal Government such as transportation, environmental science, defense, Air Force; in a non-profit corporation, in industry, or in a university – perhaps this one. I am leaving no stone unturned in this search and have sent resumes to many places. Things are moving very slowly at the present time, and it appears clear that my decision may take months. In the meantime I will be happy to talk to you further and will be open to suggestions. I again wish you a speedy recovery.

Very sincerely yours,

Dr. Jordan responded quickly and said that he had something that he thought would interest me. I reached Minneapolis on September 28th and as soon as I could I met with Dr. Jordan to learn what he "thought would be of interest to me." The "something to show me" was a request he had gotten shortly before from the newly formed Urban Mass Transportation Administration (UMTA) for proposals to establish interdisciplinary research and training programs in universities to study the application of new technology to urban transportation. It is important to note that this was in the declining months of the Johnson Administration. The more I studied the Request for Proposals and read accompanying literature, the more I realized that this was indeed the kind of thing I was looking for. I plunged in with a group of professors led by Professor Dan Gerlough in Civil Engineering. We submitted our proposal and received one of the grants. It gave me some travel money that I used to visit companies developing the new transit systems. I learned that in 1966 UMTA had awarded a series of 17 contracts to various companies and research institutes on this topic. They had all submitted their reports, and an UMTA Associate Administrator Bill Merritt had written a summary document called "Tomorrow's Transportation" extolling the advantages of the new systems. The result was that many companies, both in the USA and abroad, became interested in new forms of urban transportation.

In the 15 years before the summary document, half a dozen inventors had realized that a major problem with rapid-rail systems was the huge cost of their guideways, which were huge because they had to carry large, heavy vehicles. Expansion of urban transportation in this way was all but impossible. Such a system, the plans for which went back to 1949, was almost in service in San Francisco. It was called BART for Bay Area Rapid Transit, but it was much too expensive for most cities. The inventors of the new systems understood that if the cars of a transit system were automated they would not need drivers, which would reduce the operating costs. Automation was a feature of BART; but with everything else conventional. The inventors of the new system noted also that if the passenger-carrying load was broken up into many small driverless units, the load on the guideway would be markedly reduced and hence the guideway could be much smaller and less expensive. The key then was that to obtain sufficient capacity the vehicles could not stop on line, but the guideway would have to be configured so that the vehicles would stop only on by-pass guideways, similar to the way automobiles on freeways leave the main road before stopping. Now, if the vehicles were small enough so that they need carry only people traveling together by choice, seven marked improvements appeared: 1) the guideways need weigh per unit of length only a small fraction of the guideways that supported conventional rapid rail systems, which would proportionately reduce system cost and visual impact, 2) the trips could be nonstop and hence time competitive with automobile trips, 3) the vehicles need run only on demand rather than scheduled, which would substantially reduce the total vehicle movement, 4) service would always be available with little or no waiting, 5) close station spacing would not affect the average speed, which would permit many more access points, 6) the stations could be sized to demand instead of all having to be as long as the longest train, thus lowering capital cost, and 7) each vehicle would carry only passengers riding together by choice, which for the vast majority meant a much more attractive ride. The result would be a system that could be built and operated for much lower cost and the number of people attracted to it would be much greater than in conventional transit mainly because there need be no sacrifice in time in using the system and because the ride was secure. With lower guideway cost a more extensive system could be built with closer spacing between stations, thus providing many more points of access than practical with a conventional rail system. Such a system could become a major alternative transit mode to everyone including those who could not or should not drive a car. Quite clearly many technical problems needed to be solved to make such a system practical, but a seasoned and unbiased engineer could see after some study that these problems were tractable. One could quickly envision much easier movement within a city without the pollution and accidents associated with the auto system.

The more I thought about such ideas, the more I came to see that this was the kind of problem that back in Minsk I had dreamed of working on. I soon learned that the interdisciplinary studies sponsored by UMTA showed that such systems would reduce congestion. On the other hand, if the Nation were to continue to rely only on conventional transit as the population grew, congestion would worsen. I studied these ideas over a period of more than a year before I was fully committed to helping realize them.

This new system was first called “personal transit,” then “personalized rapid transit,” and finally the name that has stuck: “Personal Rapid Transit or PRT.” The inventors that I came to know who had independently invented the PRT concept were Donn Fichter, Ed Haltom, the team of Howard Ross and Al Sobey, Bill Alden, Floyd Berggren, Bob Bartells, and Jerry Kieffer. Fichter and Haltom’s ideas were first described in 1953, Ross and Sobey started in the late 1950s,

Alden and Berggren in the early 1960s, and Bartells and Kieffer later in the 1960s but before the UMTA work was released.

After returning home from the Soviet Union, learning my way around again, and noting the public-policy aspects of my new interests, I joined the Citizens League (CL) and received a notice during the summer of 1969 that they were forming a Transit Facilities Committee and needed volunteers. I volunteered along with about 20 other CL members. The Committee began its work in September 1969, meeting one night a week. One of those who also joined was Dr. Jarold A. Kieffer, a political scientist with substantial experience in the U. S. Government in Washington, D. C. and who had just come to the Twin Cities from the University of Oregon to take a position as assistant to Dr. Arthur Flemming, the new President of Macalester College. The July 1969 issue of *Scientific American* had carried a lead article entitled "Systems Analysis of Urban Transportation" by William F. Hamilton and Dana K. Nance of General Research Corporation (GRC) in Santa Barbara, California. GRC had been awarded one of the above-mentioned UMTA grants and under it formed an interdisciplinary team of about 18 professionals. Their mission was to compare by simulation the growth of cities with or without PRT. They selected Boston as a typical large old city, Houston as a typical large new city, Hartford as a typical small old city, and Tucson as a typical small new city. They laid out PRT networks in all of these cities and estimated both costs and ridership. The main result they reported was that if only conventional transit systems were deployed in these cities congestion would continue to get worse, but if PRT systems were gradually deployed it would be possible to reduce congestion, and with it the many problems of the automobile system.

Jerry Kieffer, Ed Anderson, Tom Floyd[1]

Several of the committee members including Dr. Kieffer and me had read the *Scientific American* article and called for consideration of PRT in the Twin Cities. Jerry Kieffer and I exchanged papers and found that we had both been thinking along the same lines. We began working together and continued to do so for decades. By early 1970 I felt fairly well informed on PRT and also became aware that the Metropolitan Transit Commission (MTC) staff and consultants were suppressing discussion of PRT, and were strongly pushing conventional rail transit. Feeling very strongly that this suppression could result in unfortunate and costly decisions for the Twin Cities, I decided to try to inform the MTC and others of the features of personalized transit through a paper I wrote and called "Personalized Public Transit for the Twin Cities." I distributed the paper to about 600 people in the Twin Cities Area who I thought may have a voice in transit decisions. Even though my paper looks primitive now, it had more impact than I dreamed possible. I received

[1] During the 1980's Tom Floyd was Chairman of ATRA and a major factor in interesting the Chicago RTA in PRT.

requests for it from both coasts, it resulted in many speaking engagements in the Twin Cities (43 by March 1971), it in part caused the MTC to cut back a $1.8 million proposal from their consulting team Daniel Mann Johnson & Mendenhall (DMJM, pronounced Dim Jim) for the preliminary design of a rapid rail system to a $433,000 planning study, and it caused the resignation of the Executive Director of the MTC and two of his staff members. Two members of the MTC, Ted Brouillette and Jim Martineau met with Jerry Kieffer and me in the Campus Club to work out a strategy. We met many times but the MTC staff hung onto their plans first for a subway, then failing at that an elevated system using 100-passenger vehicles, insisting that they could attract 10,000 riders in the peak hour in each direction. This just happened to be the capacity of the system they proposed but would be equivalent to the carrying capacity of almost five freeway lanes of automobiles. The fact that these numbers could be pointed out as nonsense made no dent in the MTC staff opinion.

The CL Committee met weekly for an entire year, during which time testimony was taken by many individuals from all of the relevant agencies as well as from private citizens and members of the Legislature. Here I got my baptism of fire to an intense controversy over transit modes, a controversy that continued for decades. Many called it the "Transit Wars." The CL Committee was given copies of a report commissioned by the MTC and written by DMJM, a firm strongly committed to development of conventional rapid rail in many U. S. cities. The report presented data on several transit alternatives including a subway between Minneapolis and St. Paul. The system with by far the largest cost per passenger was the subway, but based on weak arguments in the introductory page the consultant with prodding from the MTC recommended that the subway was their preferred alternative. The CL Committee ripped the report to pieces in their final report. DMJM got their funding reduced right after Jerry Kieffer and I made a joint presentation to the Transit Development Committee (TDC) of the MTC. I recalled that one of our friends on the Commission whispered to us after the meeting: "Those guys standing in the back of the room just lost $1,000,000 on your presentation."

Shortly after I returned to Minnesota I began again attending meetings of the Twin Cities Chapter of the American Institute for Aeronautics and Astronautics (AIAA). An election for the officers of the local chapter was coming up and I was elected President for the year 1969-1970, having been Vice President at the time I left for the Soviet Union. A year later an election for Director of the Region serving the Upper Midwest came up. Likely with the publicity I received from having been in the Soviet Union, I was nominated and elected. So for four years I served as a member of the AIAA National Board and was given travel money to attend Board meetings in New York, St. Louis, San Francisco, etc. At that time, many aerospace engineers had been laid off because the main engineering tasks related to the Moon landing program had been finished. As a consequence, a major task of the AIAA and my job as Regional Director was to try to help these laid-off engineers find jobs. With the engineering background these engineers had attained, they were strong candidates to work on PRT. The National AIAA had a Distinguished Lecture Program, and I was soon appointed to be one of them, which provided funds for me to give lectures on PRT in many locations around the United States. The ones I recall most are Indianapolis, Chicago, Denver, Kansas City, Los Angeles, Tampa, and Seattle. Through some of these meetings I found colleagues with whom I worked for many years.

The broadened knowledge I obtained by listening to the other lectures reinforced my conclusion that I should devote a substantial portion of my time to PRT.

The Transit Development Committee (TDC) of the MTC invited me along on a trip they took from March 30th to April 2nd, 1970 to gain information on new transit development projects. We visited development work on PRT and other automated transit systems at Transportation Technology, Inc. (TTI) and Ford Motor Company in Detroit, Westinghouse in Pittsburg, Alden StaRRcar in Bedford, Mass., and M. I. T. At M. I. T. we were invited to the office of Transportation Professor A. Scheffer (Shef) Lang, who in 1964 had coauthored a book *Urban Rail Transit: its Economics and Technology*. I had previously read his book and found that it showed that conventional rail transit in most urban areas in the United States was a serious economic loser. Shef said that he and his colleagues had estimated that if Boston replaced its conventional rail transit system with PRT they could not only handle the traffic but would substantially reduce the annual costs. This was the credible outside evidence needed.

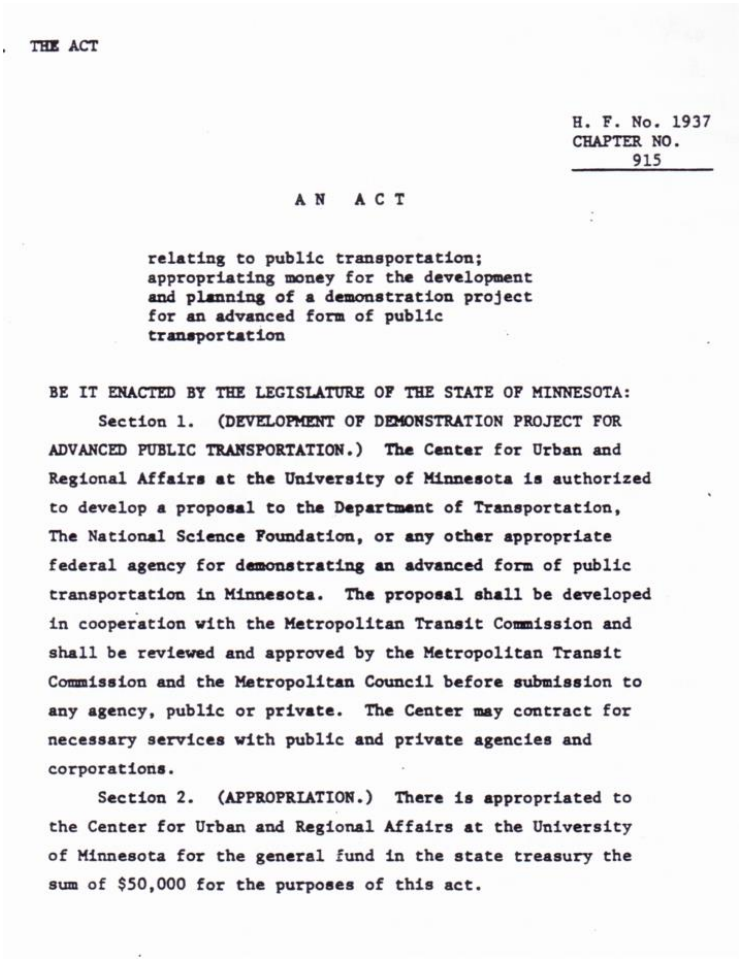
When we returned home, the TDC indicated interest in developing a relationship with my colleagues and me at the University. This interest was the catalyst that caused the University administration to pay me half my salary to work through the Center for Urban and Regional Affairs as the Coordinator of a Task Force on New Concepts in Urban Transportation. Our hopes to receive quick funding from the MTC, however, began to evaporate as we realized that the Commission staff was not interested in such a relationship because they were still convinced, contrary to the Commission view, that conventional rail transit should be developed in the Twin Cities. A July 15th meeting between our Task Force and the Commission was a flop because insufficient time was allotted to discussion and an August meeting flopped because the MTC staff attempted to bog us down in trivia.

We decided that a direct approach to the MTC through the staff was fruitless and that a groundswell of popular support would need to be developed first. We also decided that we could not tolerate a Metro Commission sweeping facts under the rug as vigorously as was happening. Expensive decisions, we felt, should not be made without examining alternatives, but that was exactly what was happening. To pursue funding, we began working on a proposal to the National Science Foundation that we called "A Technology Assessment of Personal Rapid Transit."

The Task Force on New Concepts in Urban Transportation included 16 professors from Engineering, Architecture, Urban Planning, Sociology, and Political Science. During the summer of 1970 my colleagues and I began serious development of PRT planning tools. While continuing to give presentations on PRT, I made several trips to visit the work of PRT developers. In early September 1970 I was invited to give a slide show on PRT with pictures of PRT systems I had taken. It was to a group of entering freshman students. It was a practice of the University radio and television station to send a reporter to such events. This time one of them, Bob Boyle, taped my presentation. Bob was so impressed that he determined to set up a meeting before State Legislators to hear the ideas I presented. During the next few months he wrote letters to every member of the State Legislature and every Member of Congress from Minnesota inviting them to a presentation that was held December 19, 1970. Dr. John Borchert, Geography Professor and Director of the Center for Urban and Regional Affairs, gave a presentation on transportation and land use, following which I gave an updated presentation on the potential of PRT. The result was that one of the attendees, Senator Mel Hanson, suggested that the Legislature give the University $50,000 to develop a proposal to demonstrate PRT. At the beginning of that fall quarter, I had assigned development of a PRT plan for the Twin Cities to my Senior Design Class. Twenty five students

and three faculty members participated, led by then senior Mechanical Engineering student Jay Kiedrowski, who later had a distinguished career in State Finance.

At the above-mentioned December 1970 meeting with Legislators, Senator Hanson invited me to meet with him in January to draft the bill he had in mind. While we walked down a hall in the State Capitol and whispered to each other in the back of a conference room he took notes for the bill shown here.



THE ACT

H. F. No. 1937
CHAPTER NO.
915

AN ACT

relating to public transportation; appropriating money for the development and planning of a demonstration project for an advanced form of public transportation

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF MINNESOTA:

Section 1. (DEVELOPMENT OF DEMONSTRATION PROJECT FOR ADVANCED PUBLIC TRANSPORTATION.) The Center for Urban and Regional Affairs at the University of Minnesota is authorized to develop a proposal to the Department of Transportation, The National Science Foundation, or any other appropriate federal agency for demonstrating an advanced form of public transportation in Minnesota. The proposal shall be developed in cooperation with the Metropolitan Transit Commission and shall be reviewed and approved by the Metropolitan Transit Commission and the Metropolitan Council before submission to any agency, public or private. The Center may contract for necessary services with public and private agencies and corporations.

Section 2. (APPROPRIATION.) There is appropriated to the Center for Urban and Regional Affairs at the University of Minnesota for the general fund in the state treasury the sum of $50,000 for the purposes of this act.

In fall 1970 Jerry Kieffer went to Washington D. C. to interview for a position in the federal government worthy of his considerable talent and experience. A taxi in which he was riding was hit almost head-on and he was severely injured. He was confined to a hospital in the Washington, D. C. area for almost a year. It took him a long time to fully recover. However, the injury did not diminish his interest in helping PRT. We talked on the telephone many times while he was recovering. We of course discussed the bill Senator Hanson had introduced and felt that it was an extremely long shot to think it could be passed by an authorization committee and an appropriations committee in each house, then be passed by both the House and the Senate, and finally signed by the governor. Besides my own lobbying activities, we had a two-pronged strategy. The first was that one of my undergraduate students, Roger Peterson, took leave during the winter quarter of 1971 to work as an intern in the House Research Office. He took as his major task lobbying the bill through both the House and Senate. He wrote up his own materials and visited almost every member of the Legislature. The second prong was that the University television station had begun in fall 1970 to plan 10 two-hour programs on a sequence of Friday evenings on various aspects of PRT. The first hour of each program was a presentation, several of which were by PRT developers such as Ed Haltom of Monocab, Howard Ross of TTI, Bill Alden of Alden StaRRcar, and Niel Shear of Honeywell. Others were by local agency officials, State Legislators, and one evening was devoted to the results of the senior-design project previously mentioned. The second hour each week was devoted to answering questions on the radio by people who watched the television programs. To our amazement the bill picked up endorsements as the Legislative session wore on. The Bill passed both houses and was signed into law on the last day of the session, which was in late May of 1971.

Totally independent of us, a University of West Virginia Professor Samy Elias had followed PRT development. He noted that the site of his University in Morgantown, West Virginia, while a town of only 29,000 residents, was subject to traffic jams typical of large cities. Because of its mountainous terrain much traffic was confined to one highway and the students suffered long and unpredictable delays in moving from one campus to another. He had applied to UMTA for a grant to hire Barton Aschman & Associates[2] to study the application of PRT and had compared the characteristics of three automated transit systems: the Alden StaRRcar, Ed Haltom's Monocab, and Dashaveyor. The first two had the characteristics of PRT but the third used larger vehicles and in-track switching, which made one wonder why it was included. Barton-Aschman, recommended that the StaRRcar be demonstrated in Morgantown. John Volpe, Secretary of Transportation at that time, saw this as an opportunity to develop a national PRT demonstration. Members of his staff visited StaRRcar headquarters in Bedford, Massachusetts, and noted that they were a small company with only six employees. They believed that a major federally sponsored demonstration of a new mode of transportation required large, recognized companies, so in December 1970, the same month we were meeting with members of the Minnesota State Legislature, they contracted with Jet Propulsion Laboratory (JPL) in Pasadena, California, to be the systems manager; Boeing in Seattle to design and build the vehicles; Bendix in Ann Arbor, Michigan, to design and build the control system; and Frederick R. Harris, Inc. in Stamford, Connecticut, to design and build the guideway, stations and maintenance facility. The requirement was that the system had to be operational by October 1972 to help reelect President Nixon. The word had gone down in the Nixon Administration that no program be undertaken that would have a deadline beyond the next election. Showing UMTA's lack of understanding of the PRT concept, the Administrator Carlos Villarreal declared that six-passenger vehicles would be much too small for the general public and ordered that the vehicles accommodate 20 passengers, 8 seated and the rest standees. Serious systems engineering would have resulted in a different conclusion, but none was involved.

In my role as Coordinator of our Task Force on New Concepts in Urban Transportation I objected to such a hurried program with a completely new technology, but it was explained to me that the only important fact was the hard, political deadline. I became acquainted with all four of the companies involved in the Morgantown PRT program and visited them all. In particular, in August 1971 I visited JPL in Pasadena, California, two weeks after they had resigned from the program, stating that they could not maintain their reputation for technical excellence while being involved with such a program. Having been given the role of systems manager, they had understood that they would receive a budget for the kind of systems engineering they had done for space programs before hardware was built, but they learned that UMTA only wanted them to be the agency through which funds would be distributed to the other contractors. So eight months into a 22-month program Boeing was asked to take over the role of systems manager. I got particularly acquainted with J. P. Cunliffe, a vice president of F. R. Harris, who later came to Minneapolis and gave a presentation in my transit class. He said that when he asked UMTA what vehicle weight his company should assume in designing the guideways, he was told to assume that they might be as heavy as heavy rail cars, which totally negated the basic advantages of PRT, i.e., that the vehicles must be small and light to minimize the weight and cost of the guideway. To meet the time deadline, they had to rush to finish their design and then begin constructing the fixed facilities. Before they did so they told UMTA that they would need funds to make borings at each of the planned guideway support posts, but to save money the UMTA managers, mostly former aerospace

[2] Barton Aschman Vice President Mike Powells became the first Chairman of ATRA.

engineers with no experience in civil engineering, responded that they need only make borings at every fifth post. F. R. Harris, a competent civil engineering company, retorted that the ground conditions in a mountainous area were such that they needed borings at every post site to be able to design foundations sufficiently solid for the posts. Finally, F. R. Harris demanded written confirmation from UMTA that they would take responsibility for any posts that sank. Only then did F. R. Harris proceed. The posts and guideways were built; some of them sank and had to be removed. Borings were then done and proper foundations were built, all at great cost.

Once the guideway was too far along to make changes, Boeing discovered that the vehicles they were designing couldn't negotiate curves with radii as small as F. R. Harris had designed and built into the guideway. As a consequence, Boeing had to add back-wheel steering, which added further to the costs. Then, somewhere in the design process, the team realized that it snows quite frequently in Morgantown and that under such conditions sufficient traction could not be guaranteed. Thus the UMTA managers decided to embed pipes in the guideway that would in the winter carry heated ethylene glycol. A student of mine, Gary Brod, got a job with Boeing in the late 1970s and showed me data indicating that the cost for energy to heat the guideway each year was about four times the annual energy required to propel the vehicles, which indicated that an important requirement for PRT is that the system not require guideway heating.

The system was up and running in October 1972 and President Nixon's daughter Tricia rode in one of the vehicles. To prevent crashes, the vehicles had been equipped with a number of failure sensors, one of which failed during Tricia's trip, which caused the vehicle to stop in between stations. The press made hay with this and, coupled with the major cost overruns that resulted from such a hurried program, the Morgantown system gave PRT a serious black eye and discouraged Congressional interest in the PRT concept. Notwithstanding all of the above, the Morgantown system still operates every day and has had an almost perfect record of no accidents. I have ridden on it on several occasions and find that the people in Morgantown have nothing but praise for their PRT system.

During the summer of 1970 our Task Force on New Concepts in Urban Transportation began, as I have mentioned, developing planning tools for PRT. To put focus into our efforts, we decided to aim the above-mentioned proposal to the National Science Foundation program entitled "Research Applied to National Needs." We discussed our interest in submitting a proposal with officials in both the NSF and the Department of Transportation and were assured that, because funds were short in the DOT, a proposal to the NSF related to PRT was appropriate. The proposal, comprised of 170 pages of text, was to involve 14 faculty members and was signed off by the heads of 11 units of the University. It was released on May 21, 1971 under the title "*A Technology Assessment of Personal Rapid Transit: Interdisciplinary Analysis and Optimization of PRT in Terms of its Potential for Assisting in the Revitalization of Urban Society*," and was introduced by a three-page letter from the Vice President for Academic Affairs, Dr. William G. Sheppard. It is not surprising that the NSF sent a copy of the proposal to the DOT for their review, but it was surprising that the DOT not only rejected it but indicated great displeasure that we had sent the proposal to the NSF even though we had previously discussed the proposal with officials of UMTA and were assured that they had no problem with our plan. I thus became much aware of jurisdictional problems in the U. S. Government, which interfere with the needs of the citizenry.

At about the time we released the NSF proposal, we decided that we should plan a conference on PRT. We decided to call it the "National Conference on Personal Rapid Transit" and

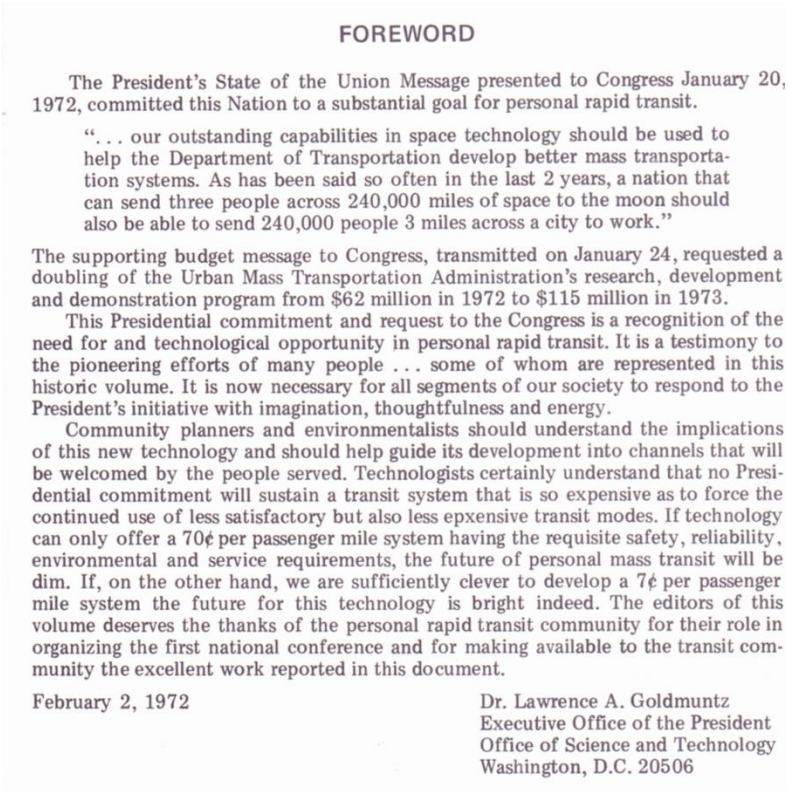
the University's Department of Conferences enthusiastically agreed to manage it and front the costs. Gordon Amundsen, a senior conference coordinator, was the lead person we dealt with. We developed a call for papers, and mailed it out to a list we had developed. The response was much greater than we had any reason to expect and we began getting calls from Europe, Canada, and many parts of the United States.

In June 1971, my colleague Professor Jack Dais and I gave a paper on our work on PRT at a three-day Civil Engineering Conference in Seattle. At the conference Jack and I described the kind of PRT system we had in mind. Near the end of our presentation a man in the back of the room got up and said excitedly that he and his company were working on a very similar system. That man was Dr. Jack Irving, Vice President of The Aerospace Corporation in El Segundo, California. He let us know about their work on PRT. We told him about our planned conference and he enthusiastically said that he would participate. He did and he and his group presented three papers on PRT technology. The more we studied the work Dr. Irving and his team had done on PRT the more we realized that it was head and shoulders above any of the other half dozen systems then being developed. The Aerospace Corporation had been established in 1960 by the Air Force to manage ballistic missile programs, and as a result had recruited some of the best systems engineers in the country. Their work on PRT showed it.

Upon returning home, I soon learned that the importance of our forthcoming PRT conference had kept growing to the point that we felt that we should invite someone from the UMTA to give a luncheon speech. In discussing who to invite, we thought that the appropriate person would be the UMTA Associate Administration for Research and Development, Robert Hemmes. To our surprise not only was our invitation declined but the UMTA Administrator directed that no one from UMTA could attend. He scheduled a conference for the same week. UMTA was deep into the Morgantown project and understandably didn't like the idea that anyone was stealing their thunder. One UMTA staff member even commented that conferences should be on all modes of transportation, not just one, thinking apparently that the federal government had some kind of veto power over the actions of a State University. To figure out what was going on and what to do, I flew to Washington to have a conversation with M. I. T. Professor Herb Richardson, who had been appointed Chief Scientist to the Secretary of Transportation. He told me that there was a PRT project in the White House headed by Dr. Larry Goldmuntz and that I should invite him. I called Dr. Goldmuntz and found that he was delighted to accept, that he had been thinking of organizing a conference on PRT, and was pleased that someone was doing it. What a difference in attitude!

Dr. Goldmuntz gave the keynote address and wrote the forward (see next page) to the volume of papers that were edited and published as a book in April 1972. The most important immediate fallout of the conference was that I was invited by Dr. Goldmuntz to join Dr. Irving in

a presentation to the President's Science Advisory Council in Washington, D. C. on December 16, 1971. The Council recommended to the President that the United States should embark on the development of high-capacity PRT along the lines recommended by The Aerospace Corporation.



FOREWORD

The President's State of the Union Message presented to Congress January 20, 1972, committed this Nation to a substantial goal for personal rapid transit.

"... our outstanding capabilities in space technology should be used to help the Department of Transportation develop better mass transportation systems. As has been said so often in the last 2 years, a nation that can send three people across 240,000 miles of space to the moon should also be able to send 240,000 people 3 miles across a city to work."

The supporting budget message to Congress, transmitted on January 24, requested a doubling of the Urban Mass Transportation Administration's research, development and demonstration program from $62 million in 1972 to $115 million in 1973.

This Presidential commitment and request to the Congress is a recognition of the need for and technological opportunity in personal rapid transit. It is a testimony to the pioneering efforts of many people ... some of whom are represented in this historic volume. It is now necessary for all segments of our society to respond to the President's initiative with imagination, thoughtfulness and energy.

Community planners and environmentalists should understand the implications of this new technology and should help guide its development into channels that will be welcomed by the people served. Technologists certainly understand that no Presidential commitment will sustain a transit system that is so expensive as to force the continued use of less satisfactory but also less epxensive transit modes. If technology can only offer a 70¢ per passenger mile system having the requisite safety, reliability, environmental and service requirements, the future of personal mass transit will be dim. If, on the other hand, we are sufficiently clever to develop a 7¢ per passenger mile system the future for this technology is bright indeed. The editors of this volume deserves the thanks of the personal rapid transit community for their role in organizing the first national conference and for making available to the transit community the excellent work reported in this document.

February 2, 1972

Dr. Lawrence A. Goldmuntz
Executive Office of the President
Office of Science and Technology
Washington, D.C. 20506

The front page of the January 21, 1972 issue of the *New York Times* carried an article about President Nixon's State of the Union Address. It featured a proposed new technologies opportunities program, the leading element of which was "The development of a system of small vehicles running at close spacing in a network of guideways to carry people nonstop from origin to destination in cities." We felt that that statement was a major victory and presumed that a strong program to develop high-capacity PRT would follow. During detailed negotiations, the program was more highly refined and UMTA was directed to double its program as stated in Dr. Goldmuntz's forward and to initiate the development of high-capacity PRT. The UMTA Administrator, however, fumed. He of course had endorsed the Morgantown system and now was being upstaged. He didn't even mention the White House program in his budget message to Congress. Following a great deal of negotiation, the White House staff under Dr. Goldmuntz decided that if UMTA did not want the new program, NASA should be directed to take it on. NASA at the time was enthusiastic about entering into new areas because they had many engineers employed and decreasing budgets. Thus, the NASA Advanced PRT Program was outlined. I gave a presentation at NASA headquarters on September 21, 1972 after getting acquainted with the UMTA R&D staff the day before. By early fall 1972 all of the important people in the DOT had committed themselves to the NASA program – even the UMTA Administrator.

What happened next was astonishing! Following the November 1972 election, President Nixon directed all of his presidential appointees to resign. New people were appointed that had no knowledge of the high-capacity PRT program and that resulted in further delay. NASA Huntsville was to have housed the PRT program and they had negotiated a Memorandum of Understanding (MOU) with UMTA. They even held an MOU party in December 1972 and I was called to ask if I would Chair a National Committee to oversee the new program.

Here are some of my other 1972 activities:

- My colleagues in the Department of Aerospace and Engineering Mechanics Jack L. Dais, William L. Garrard, Alain L. Kornhauser, and Harold York; and I edited the 28 papers given at our conference into a volume we called *Personal Rapid Transit*. It was published in April 1972 and 1000 copies were printed, many given away free, but also many sold to individuals and libraries in the United States and abroad.

- With support from the University Department of Conferences, particularly Gordon Amundson, we began planning for a second PRT Conference, this time it would be called "The 1973 International Conference on Personal Rapid Transit." Out of the first conference, we recruited a Steering Committee of 28 professionals from research institutes, universities, and private companies around the United States, and one from England. The conference was to be divided into 10 sessions, and we found a competent professional to chair each one.

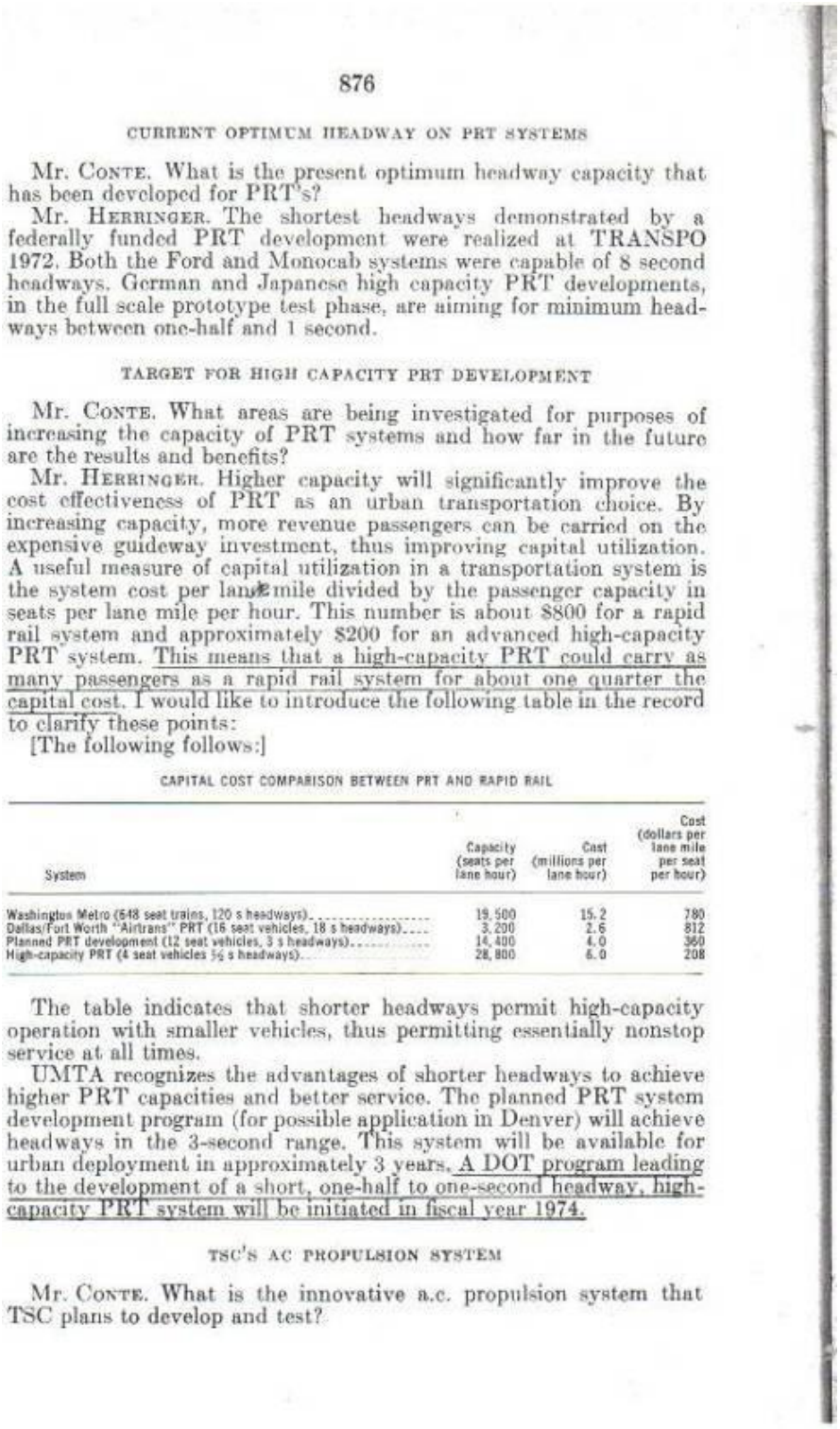
- On March 16, 1972 I testified before the United States Senate Committee on Commerce on bills relating to improving national transportation programs including research and development. My written testimony occupies pages 148-150 of a hearings document entitled "National Transportation Act of 1971."

- On May 31to June 1, 1972 UMTA held an exhibition they called Transpo 72. They invited four companies then developing automated transit systems to exhibit. To do so they allotted $6,000,000 to be divided four ways. The companies selected were Monocab, TTI, Dashaveyor, and Ford. The first two were PRT systems. The third was a system that used clumsy in-track switching and could not possibly be useful for PRT. To accompany the fourth, Henry Ford II, then President of Ford Motor Company, gave a luncheon speech saying with great fanfare that Ford was entering the PRT field. His offering was called ACT for Automatically Controlled Transportation. It was a 24-passenger vehicle supported by a standard truck chassis and running on a wide concrete-trough guideway. Subsequently Ford built a small demonstration of ACT to serve a shopping center in Dearborn, Michigan. Its operating costs per passenger were an order of magnitude above that of most other systems. Later Ford installed the ACT guideway at the Hartford, Connecticut airport. The governor of Connecticut refused to pay the operating deficit and Ford eventually was forced with great embarrassment to remove their system.

  > It is always a serious problem when the head of a company assigns a group of his engineers to do something they have never done before. The team of engineers is given too short a deadline, relatively loose specifications, and insufficient time to understand the benefits. As they have no particular interest in something different from the systems they have been working on they take the easy way out by doing no serious systems engineering. The result is inevitably a disaster.

- In mid-1972 I was contacted by the Overseas Speakers Bureau of the U. S. Information Agency (USIA), a unit of the United States Department of State, telling me that if I ever got an invitation to speak overseas, they would arrange a series of lectures for me to give in various countries. Soon afterwards I got an invitation to speak at a conference in Coventry, England, in March 1973 so I contacted the USIA and they began to arrange lectures for me in France, Germany, Switzerland, and Sweden.

- On January 16, 1973 two of my colleagues and I were invited to NASA Huntsville to develop plans to work together. It was a time of great optimism, but it was not long before we learned that UMTA would not tolerate having NASA involved in their designated area and in March 1973 the new UMTA Administrator Frank Harringer announced to Congress that UMTA would initiate a program to develop High-Capacity PRT. The page of the Congressional Record on which this promise was made is shown here.



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CURRENT OPTIMUM HEADWAY ON PRT SYSTEMS

Mr. CONTE. What is the present optimum headway capacity that has been developed for PRT's?

Mr. HERRINGER. The shortest headways demonstrated by a federally funded PRT development were realized at TRANSPO 1972. Both the Ford and Monocab systems were capable of 8 second headways. German and Japanese high capacity PRT developments, in the full scale prototype test phase, are aiming for minimum headways between one-half and 1 second.

TARGET FOR HIGH CAPACITY PRT DEVELOPMENT

Mr. CONTE. What areas are being investigated for purposes of increasing the capacity of PRT systems and how far in the future are the results and benefits?

Mr. HERRINGER. Higher capacity will significantly improve the cost effectiveness of PRT as an urban transportation choice. By increasing capacity, more revenue passengers can be carried on the expensive guideway investment, thus improving capital utilization. A useful measure of capital utilization in a transportation system is the system cost per lane mile divided by the passenger capacity in seats per lane mile per hour. This number is about $800 for a rapid rail system and approximately $200 for an advanced high-capacity PRT system. This means that a high-capacity PRT could carry as many passengers as a rapid rail system for about one quarter the capital cost. I would like to introduce the following table in the record to clarify these points:

[The following follows:]

CAPITAL COST COMPARISON BETWEEN PRT AND RAPID RAIL

System	Capacity (seats per lane hour)	Cost (millions per lane hour)	Cost (dollars per lane mile per seat per hour)
Washington Metro (548 seat trains, 120 s headways)	19,500	15.2	780
Dallas/Fort Worth "Airtrans" PRT (16 seat vehicles, 18 s headways)	3,200	2.6	812
Planned PRT development (12 seat vehicles, 3 s headways)	14,400	4.0	360
High-capacity PRT (4 seat vehicles ½ s headways)	28,800	6.0	208

The table indicates that shorter headways permit high-capacity operation with smaller vehicles, thus permitting essentially nonstop service at all times.

UMTA recognizes the advantages of shorter headways to achieve higher PRT capacities and better service. The planned PRT system development program (for possible application in Denver) will achieve headways in the 3-second range. This system will be available for urban deployment in approximately 3 years. A DOT program leading to the development of a short, one-half to one-second headway, high-capacity PRT system will be initiated in fiscal year 1974.

TSC'S AC PROPULSION SYSTEM

Mr. CONTE. What is the innovative a.c. propulsion system that TSC plans to develop and test?

- On March 7, 1973 I was invited to testify before the Transportation Subcommitee of the U. S. House Appropriations Committee, Chaired by Congressman John J. McFall of California. My testimony can be found on pages 267 through 292 of a hearing document entitled "Department of Transportation and related Agencies Appropriations for 1975. Part 1, DEPARTMENT OF TRANSPORTATION, National Transportation Policy," U. S. Government Printing Office, Washington, D. C. 1974. While it was a useful exercise

to describe in some detail the potential benefits of PRT widly deployed in American cities, I am not aware of any positive result of the work that went into that testimony.

- In early 1973 the USIA called to ask if I would be willing to take a "side trip." "Where to?" I asked. "Singapore," they responded. There was to be a transportation conference in Singapore two weeks before my lecture in Coventry on new technologies sponsored by our State Department. I responded positively, and now it was better to think of a round-the-world trip. I would head west to Japan, then Hong Kong, then Bangkok, and on to Singapore before heading to Western Europe. Barely a week before I was to leave, USIA called again and asked if I would mind stopping for 24 hours in New Delhi. "Sure, why not?" I replied. I thought of my friend Kumar, with whom I had had many walks and many dinners while in Minsk. I wrote to him, gave him the exact date, which was a Saturday, and the name of the hotel where I would stay, with no time left to get a response.

In New Delhi with Mrs. Kumar and their children.

- The Singapore conference lasted five days.

- After a most interesting week in Singapore, I was off to New Delhi, and then to Europe.

- The flight to Frankfurt was uneventful and I was glad to be back into more familiar territory. From Frankfurt I flew to Zurich, Switzerland, where I drove half way across Switzerland to visit Bernhard Huber, the Chief Development Engineer at the Swiss Industrial Company. He had invented a PRT system he called ELAN-SIG and I wanted to talk to every PRT inventor in the world. From there I flew to London, and took a train to Coventry in time for the Transport Conference at the University of Warwick that had made the trip possible.

- After the conference, I was off on March 23rd to Sweden where I spent the weekend with my cousin and family in Linkoping. I was then off to Gothenburg where I gave a lecture at Chalmers University and met with the City Commissioner. On Wednesday, March 28th I gave a lecture in Stockholm (See next page).

- From Stockholm I flew to Paris where I gave a lecture at the Institute of Transit and visited people at OEDC who were monitoring the French PRT system called Aramis, which was under development by the French aerospace company Matra. From Paris I travelled to Hagen, West Germany, where I met with Dr. Klaus Becker, the lead developer of the Cabintaxi PRT system, at which time their test system was under construction. I got home on April 1st.

UNCLASSIFIED AIR POUCH

OPERATIONS MEMORANDUM

TO: USIA WASHINGTON FOR: ICS/S DATE: April 19, 1973

FROM: USIS STOCKHOLM

SUBJECT: Volunteer Speaker J. Edward Anderson

REF: -

Stockholm seems recently to have had more than its fair share of speakers who fell below the grade. Some of these were gotten through the Volunteer Speaker Service and we have duly reported on them. Having been assiduous in writing up the negative, we feel it only fair now to write up the positive: Mr. J. Edward Anderson, Professor of Mechanical Engineering, University of Minnesota.

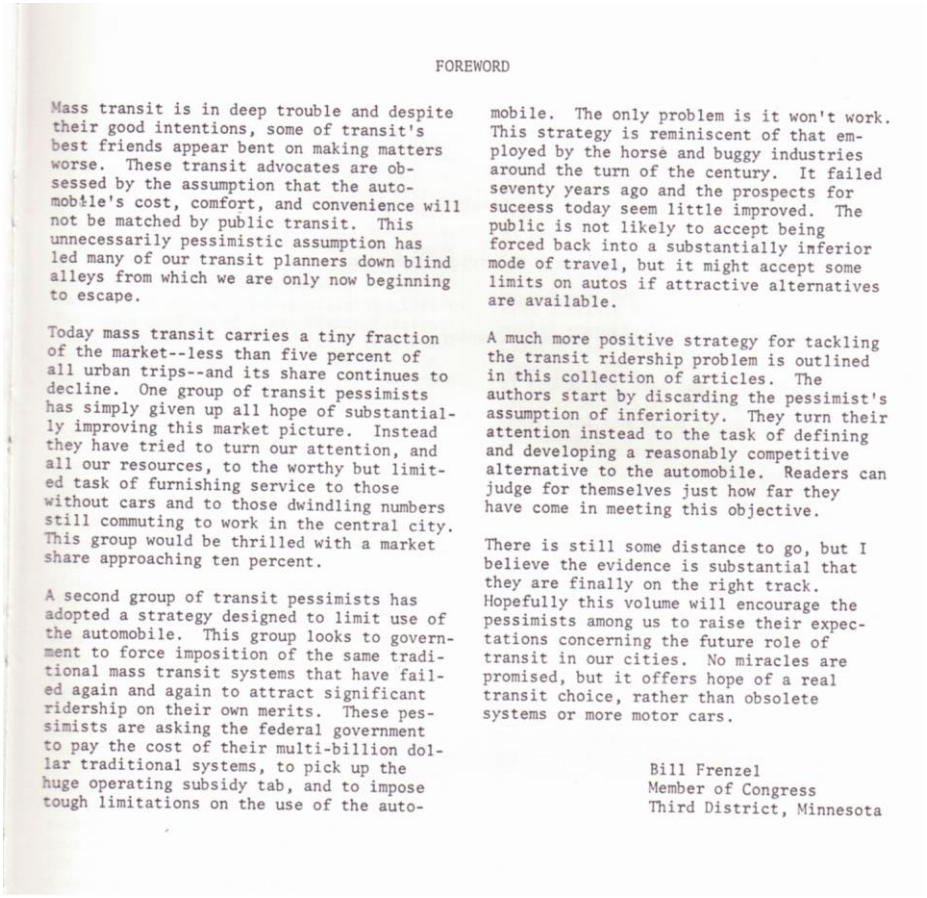
Mr. Anderson was practically a model speaker. His topic was personal rapid transit systems and he came extremely well prepared with slides, a film and his own printed material for distribution to members of the audience. A relaxed style accentuated his total expertise on his subject, and his presentation was both lucid and absorbing. In the discussion which followed, Mr. Anderson proved more than capable of handling all questions.

In sum, a speaker who was nearly perfect. We wish all speakers could match his standard of excellence and recommend him most highly to all posts.

USIS:CD:JHJohnson:WGPetty:abs

UNCLASSIFIED

I continued preparing for the 1973 International Conference on PRT, which was held on May 2-4. This conference, with 76 papers, was almost three times the size of the first. We were endorsed by the American Institute of Planners, the American Society of Civil Engineers, the Industrial Designers Society of America, and the American Society of Planning Officials. The Conference was run by a committee of 29 professional people from many parts of the USA and Wallace Russell from England. I took on the problem of editing the proceedings with the support of a $10,000 grant from the General Electric Foundation and smaller grants from IBM Corporation, Otis Elevator Company, and Honeywell, Inc. The book was a major means of informing the world of the work underway on PRT. Over 1000 copies were sold all over the industrialized world. Congressman Bill Frenzel, representing the 3rd Congressional District in Minnesota, wrote the following Forward to the volume of papers called *Personal Rapid Transit II: Progress-Problems-Potential.*



FOREWORD

Mass transit is in deep trouble and despite their good intentions, some of transit's best friends appear bent on making matters worse. These transit advocates are obsessed by the assumption that the automobile's cost, comfort, and convenience will not be matched by public transit. This unnecessarily pessimistic assumption has led many of our transit planners down blind alleys from which we are only now beginning to escape.

Today mass transit carries a tiny fraction of the market--less than five percent of all urban trips--and its share continues to decline. One group of transit pessimists has simply given up all hope of substantially improving this market picture. Instead they have tried to turn our attention, and all our resources, to the worthy but limited task of furnishing service to those without cars and to those dwindling numbers still commuting to work in the central city. This group would be thrilled with a market share approaching ten percent.

A second group of transit pessimists has adopted a strategy designed to limit use of the automobile. This group looks to government to force imposition of the same traditional mass transit systems that have failed again and again to attract significant ridership on their own merits. These pessimists are asking the federal government to pay the cost of their multi-billion dollar traditional systems, to pick up the huge operating subsidy tab, and to impose tough limitations on the use of the automobile. The only problem is it won't work. This strategy is reminiscent of that employed by the horse and buggy industries around the turn of the century. It failed seventy years ago and the prospects for suceess today seem little improved. The public is not likely to accept being forced back into a substantially inferior mode of travel, but it might accept some limits on autos if attractive alternatives are available.

A much more positive strategy for tackling the transit ridership problem is outlined in this collection of articles. The authors start by discarding the pessimist's assumption of inferiority. They turn their attention instead to the task of defining and developing a reasonably competitive alternative to the automobile. Readers can judge for themselves just how far they have come in meeting this objective.

There is still some distance to go, but I believe the evidence is substantial that they are finally on the right track. Hopefully this volume will encourage the pessimists among us to raise their expectations concerning the future role of transit in our cities. No miracles are promised, but it offers hope of a real transit choice, rather than obsolete systems or more motor cars.

Bill Frenzel
Member of Congress
Third District, Minnesota

On about the 1st of June 1973 I received a phone call from Mr. Kramel, President of the Motor Vehicle Manufacturers Association, headquartered in Detroit. He invited me to breakfast with him at the St. Paul Hotel on the morning of June 4th. His message was that the auto industry was very much interested in PRT and was considering investing some funds in its planning. If this offer had proceeded, we at the University of Minnesota would have become involved, but for reasons that will become apparent, that was not to be.

During the fall of 1973, the Minnesota Senate Transit Subcommittee, headed by Senator Robert North, held a series of hearings on transit issues. He invited spokesmen for the Metropolitan Council, the Metropolitan Transit Commission (MTC), and me as Coordinator of the University of Minnesota Task Force that had been chartered to develop a proposal under the Act shown earlier in this chapter. He asked each of us to respond to exactly the same set of questions. Fortunately I had been well briefed by The Aerospace Corporation and in December 1973 we delivered our plan for a demonstration of the Aerospace PRT system at the Minnesota State Fair Grounds.

Following the hearings, the Transit Subcommittee planned a trip to Denver to see the TTI PRT system, which by then had moved from the Detroit Airport to a site near Denver with the promise from UMTA that they would be funded to build a full-scale test system. The Senators then flew to Los Angeles to visit The Aerospace Corporation, and finally to Seattle to inspect the underground people mover at the airport. Upon returning from their trip, the Senators drafted a bill "relating to metropolitan public transit; directing the Metropolitan Transit Commission to plan an automated small vehicle fixed guideway system; authorizing tax levies upon property within the metropolitan transit taxing district." It was signed into law on April 12, 1974. For reference the Act is S. F. No. 2703, Chapter No. 573.

The problem with the forthcoming act was that by law the Legislature had no choice but to put the fox in charge of the chicken coop. The MTC received two proposals under this Act, one from The Aerospace Corporation and the other from DeLeuw Cather, an engineering company that had little knowledge of PRT and had opposed it in previous years. The Aerospace Corporation proposal was solid and detailed – a marked contrast to the thin DeLeuw proposal. There were hearings on the proposals but in the end the MTC selected DeLeuw to the astonishment of several members of the Metropolitan Council with whom I had had discussions. DeLew Cather developed a plan using the overdesigned Morgantown system as the basis for size and cost, thus showing that "PRT" was too expensive. This view prevailed in Twin Cities politics for a long time.

Also in the fall of 1973 I met in Minneapolis with Dr. Robert Hemmes, UMTA Associate Administrator for R&D. He said that his organization wished to fund some of my work and invited me to look over a list of possible projects. I responded and on January 22, 1974 received a letter from Dr. Duncan MacKinnon, Chief of the Advanced Development Branch in UMTA. In the letter he approved projects under my direction on the Visual Impact of PRT systems and on Collision Dynamics between PRT vehicles. So now we had succeeded in developing a cooperative relationship with UMTA.

The remainder of this academic year was for me full of meetings, visitors, and trips, besides meeting all of my classes. On May 16, 1974 Richard (Dick) F. Daly, Manager of Government Marketing at Raytheon came to our Mechanical Engineering Department and visited with both me and Dr. Jordan, the Department Head. Daly had been looking for civilian technology that could be manufactured at Raytheon and had concluded that PRT was by far the most promising. He was familiar with the work of The Aerospace Corporation and was impressed with that system. I indicated my interest, but there was no offer at that moment. Dick's trip was apparently an information-gathering venture.

In July 1974 we began planning for the 1975 International PRT Conference, which this time was to be held in Denver, pretty much in recognition that a PRT demonstration was being

planned for Broomfield, CO. That summer, I got a call from the Colorado Regional Transit District (RTD). The previous September, as a result of the longest lines for gasoline in the United States, the Denver citizens were asked to vote on a half-cent gasoline tax to support the development of a fixed-guideway transit system said by the RTD to be a PRT system. The Denver papers had previously included long articles about PRT and its benefits. Indeed, one of my articles had appeared in the *Denver Post*. The citizens of Denver approved the tax increase, as a result of which the RTD hired a new executive director, John Simson, a West Point Graduate, and began staffing up for the largest study of transit alternatives ever undertaken in the United States. The man from the RTD who called me (I don't know how he found out where I was) asked if I knew of any engineers who would be interested in working on the project, indicating that PRT was likely the preferred system.

By that time I had the choice of staying in the Twin Cities trying to fight a transit commission that was locked into conventional transit or to go to a place where PRT seemed to have a chance. I allowed as how I might be interested, whereupon I soon had a plane ticket to visit the RTD, which I did on July 19th. Getting off the plane into the low-humidity air of Denver was a breath of fresh air compared with the high humidity we had been experiencing. The offer to work positively was too attractive to pass up, so I accepted, and immediately asked for a leave from the University of Minnesota. I visited the RTD again on August 14th. Then Dick Daly invited me to Boston for a discussion with the staff of a Transportation Group at the Raytheon Missile Systems Division. Suddenly I had two groups interested in my services. But by then I had committed to the RTD, so for the time being I would work there for a yet undetermined period, and then maybe would be available for consulting to Raytheon. On the 21st of August I got into my Volvo and drove to a new job in Denver, where I quickly found a satisfactory apartment. After working at the RTD for several months, I got a call from Dick Daly offering me a consulting job in the Raytheon Missile Systems Division.

On Monday, April 28, 1975, I reported to work at MSD. It is located in a huge building in Bedford, Massachusetts that houses several thousand engineers working on missiles and radar systems. My first order of business was a tour of the lab, following which I was introduced to the Transportation Group, which was formed to get Raytheon into the business of manufacturing PRT systems. It was headed by Art Slater and included Art Dickson, Senior Systems Engineer; Ira Smith, Senior Electrical Engineer; and Frank Lane, Manager of Marketing. We reported to Vice President F. T. Wimberly.

<u>Systems Engineering.</u> When I got to MSD, I got to work immediately and within a month had released one memo entitled "Criteria for Design of a Transit System," and shortly thereafter "Morphological Development of Transit Characteristics." These memos were inspired very much by the work of California Institute of Technology Professor Fritz Zwicky, who during World War II was involved in the design of jet engines from scratch. He wrote up his ideas in a book he called *Morphology of Propulsive Power*. I was fortunate enough to hear one of his lectures at the University of Minnesota, and although I had engaged in such activities well before his lecture, he strongly stimulated the way we taught design engineering. Since I also had had experience in design at Honeywell (both instrument design and spacecraft design) I was very much ready for Professor Zwicky's ideas. They are now called *Systems Engineering!* The basics are simple, but all too often ignored:

1. Thoroughly understand the *Problem* and the *Requirements* for solution.
2. Let the System Requirements dictate the technologies.
3. Diagram all combinations of potential solutions without prejudice and with absolute objectivity – no pet solutions.
4. Thoroughly analyze analytically and experimentally all reasonable alternatives in each combination until it is clear which best meets all technical, social, and environmental requirements.

The 1975 International Conference on PRT. After a trip to Japan, Germany and France to look at PRT systems under development, I spent much of my time coordinating various activities related to our forthcoming Conference on PRT, which was to be held in Denver on September 16-19. My operating philosophy in chairing a conference was "Anything I don't think of will be done wrong." The conference organization is shown on the next page. There were 49 papers presented, which did not match the 76 papers given in the 1973 conference, likely because UMTA had canceled its High-Capacity PRT program a year before.

I spent a great deal of time right after the conference writing letters of thanks to the various people involved and arranging for publication of the conference proceedings in a volume we called *Personal Rapid Transit III*. This time I did not have to be involved in editing the proceedings. The job was taken over by Dennis Gary of the University of Colorado as General Editor; with Bill Garrard, University of Minnesota; and Al Kornhauser, Princeton University; as the Associate Editors. *PRT III* was published at the University of Minnesota, and released in June 1976. Several thousand copies were sold.

An AGT Society. A major outcome of the 1975 International Conference on Personal Rapid Transit was a decision to form what we called an AGT (Automated Guideway Transit) Society. In his lecture, Dr. Larry Goldmuntz introduced the idea. This led to the formation of the Advanced Transit Association (ATRA). ATRA was founded on May 19, 1976 with 25 people prominent in transportation in governments, universities, and consulting firms elected to the Board of Directors.

Here I am as I looked at ATRA's founding. It bares no resemblance to how I look now.

1975 INTERNATIONAL CONFERENCE ON PERSONAL RAPID TRANSIT

Denver, Colorado, USA
September 16-19, 1975

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