

THE ROLE OF FEDERAL GOVERNMENT IN FOSTERING  
TECHNOLOGICAL CHANGE IN PUBLIC TRANSPORTATION:  
A CASE STUDY OF TRANSBUS

by

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ABSTRACT

THE ROLE OF FEDERAL GOVERNMENT IN FOSTERING  
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by

Bizhan Azad

The purpose of this research was to study a case of federal government-initiated technology innovation, namely, the Transbus, and then try to answer several emerging questions concerning the role of federal government in fostering technological change. In 1971, the Urban Mass Transportation of the U.S. Department of Transportation began developing specifications for Transbus--a bus that would standardize vehicle design in the United States. Eight years later in September 1979, a panel under the auspices of the National Research Council reported to the secretary of Transportation that this program had been unsuccessful, and that the piecemeal actions by the federal government agencies in initiating technological innovation in the transit industry were a major reasons for the failure. Transbus was analyzed from the political/administrative as well as the technical perspective. It was discovered that motivation for Transbus was originated from several interacting interests, policies, and other factors, including General Motors Corporation's efforts to market its RTS bus, the antitrust/monopoly policies of the Department of Justice, and the competitive bidding requirements imposed on rolling stock acquired by federal financial assistance. Initially, a standardized design bus was intended, and the specifications were formulated according to the 1967 National Academy of Engineering study on design of new buses. This plan also included a pre-production procurement of 300 Transbuses. Later this plan was abandoned mainly due to a change of outlook in federal policy, i.e., less direct federal involvement in commercial development of transit technology. Instead, a procurement plan was formulated on the basis of existing bus technology for "Advanced Design Buses."

While the issue of mainstreaming the elderly and handicapped gained momentum, i.e., a significant amount of judicial, Congressional, and executive pressure for prompt action, the Transbus was revived as a means of achieving the above objectives via public mass transit. The introduction of the Transbus into transit operations was planned though the new plan did not entail the original pre-production procurement. This policy failed in the end, because of refusal of the manufacturers to bid for production of Transbus. The manufacturers' reasons for not bidding on Transbus were based on commercial "unfeasibility" of the related subsystem components and "stringent" warranty requirements corresponding to these components.

After analyzing the Transbus in the general technology push/technology pull framework, it was concluded that within the current domain of federal government authority, i.e., funding the development of technology, carrying

out the demonstration of technology, and promulgating regulatory standards, the effectiveness of government's actions in deploying the technology is very limited and at best nominal. It was recommended that a more incentive-oriented approach be taken towards the commercial development of technology, and programs be carried out in more direct cooperation with the transit operators and the manufacturers/suppliers. Also, the technological systems which are to be deployed have to be consistent with the technology base and its structure of transit industry.

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## CHAPTER ONE

### INTRODUCTION

#### 1.1 INTRODUCTION

In 1971, the Urban Mass Transportation Administration (UMTA) of the U.S. Department of Transportation (DOT) began developing specifications for the Transbus--a bus that would standardize vehicle design in the United States.<sup>1</sup> Eight years later, in September, 1979, a panel under auspices of the National Research Council reported to the Secretary of Transportation that this program had been unsuccessful, and that the piecemeal actions by the federal government agencies, at initiating technological innovation in the transit industry, were a major reason for the failure.<sup>2</sup> What happened in the eight years between the development of the design specifications and the formal statement of failure? What lessons could be learned about the role that government can play in fostering technological innovation in the private or public sector? What statements can be made about the relationship between technology and policy as evidenced in this case? It is the purpose of this research to examine each of these questions in detail, and to comment on the dynamics between the public and private sectors as they relate to innovation and its diffusion.

This chapter will give a brief overview of the events preceding the federal government involvement in mass transportation. In order to set the context, the evolution of bus technology and the bus market in the U.S. will be described. The changes in the operating environment of the transit industry will be discussed as they had a major impact on the development of national transportation policy and on subsequent federal decisions to become actively involved in the development of transit technology. The methodology

used in this research is described in the last section of this chapter.

Chapter two will describe in greater detail the events surrounding the Transbus program. This would in effect be a case study of a federal government initiated technology innovation.

Chapter three will analyze the decision, and policies which formed the Transbus program. The analysis will address political, economic, and technical issues as regards the Transbus program. Specific attention will be given to the impact of government actions, the influence held by the bus manufacturer(s), and the importance of particular interest groups, such as the elderly/handicapped, as determinants of policies and outcomes.

Chapter four will examine a general framework on the role of federal government in development and deployment of technology, i.e., initiating technological innovation. The framework will be used as a reference to critique the Transbus program.

Chapter five will present several conclusions and recommendations which are to be observed in future formulation and implementation of such technology innovation programs as the Transbus.

## 1.2 EVOLUTION OF BUS TECHNOLOGY IN THE U.S.: OMNIBUS TO TRANSBUS

In order to put the events surrounding the Transbus into perspective, it is first necessary to understand the evolution of bus technology in the U.S. and the market forces that were heavily influencing federal transit policy. The changes in transit technology, beginning with the introduction of public transportation in the United States, will be described below.

The omnibus and the horsecar were among the first transit vehicles used on a large scale in the U.S., which made their debut appearances in New York City during early 1830's and 1840's.<sup>3</sup> The major characteristics of

the early mass transit service included limited vehicle capacity, low speeds, and passenger discomfort on poor road surfaces.<sup>4</sup> In the late 1860's and early 1870's, the use of the cable car was the first major departure from this conventional technology. Among the pioneering cities using the cable car were Chicago and San Francisco. The innovative aspects of the cable car were its grip system, and the constantly moving cable underneath the road surface.<sup>5</sup> Although this meant that vehicles could be run at shorter headways and significantly lower operating costs (than horsecars), the (initial) capital costs were quite high, close to \$100,000 per route-mile.<sup>6</sup> These high capital costs made it extremely unattractive to the smaller transit companies serving less densely populated areas. The advent of commercial operation of the electric streetcar (henceforth streetcar), the next in line of transit innovations, was in the 1880's. At the beginning, the design of the streetcar consisted of a horsecar with an appended electric motor. During the following decade the technology was improved and along with this improvement came greater usage of streetcars in transit operations. By the mid 1890's, there were almost 1,200 miles of electrified street railway in the country.<sup>7</sup>

The streetcar was more attractive than its competitors, the capital costs were lower than the cable car, the operating costs were lower than the horsecar, and the average speed could reach 10 mph.<sup>8</sup> Although the capital costs of the streetcar were lower than the cable car, they still represented a significant increase in the financing requirement. So much so that, a large number of smaller transit companies were forced to merge with the larger ones in order to reduce the financial burden.<sup>9</sup> The experimentation with streetcar went as far back as 1850's, and there probably were other reasons for its phenomenal development/diffusion beyond the above advan-

tages. For instance, an epidemic in 1872 caused the deaths of a great number of horses used by the transit companies which created severe operational problems.<sup>10</sup> In some cities as much as half of the horsecar and omnibus fleets were out of operation for a long period of time. The prospects for such epidemic re-occurring could have been one of the motivating forces for finding a new mass transit technology. Whatever the reasons for the adoption of the streetcar, its success in the 19th century is only comparable to that of its successor, the motorbus in the following century.

#### STREETCAR TO MOTORBUS

The basic technology of the streetcar remained unchanged until the early 1930's when a new type of streetcar, called PCC, was developed.<sup>11</sup> The PCC (Electric Railway Presidents Conference Committee) car was the result of a co-ordinated effort by the operators and manufacturers to revive the much neglected streetcar technology, and to reverse the trend of its decline.<sup>12</sup> This effort, however, was unsuccessful for several reasons, most important of which was the increased competition from the motorbus (henceforth bus). That the bus has won this competition is well illustrated in Table 1.1 and Figure 1.1 which show that from 1925 to 1975 the share of bus rides as a percentage of total mass transit rides has grown from 9% to 72% (total patronage less than halved from 16.7 billion to 7.0 billion).<sup>13</sup>

The bus operations in the U.S. first began in New York City in 1905 when the Fifth Avenue Coach Company replaced some of its omnibuses with (double deck) buses imported from England.<sup>14</sup> The early buses suffered from a major problem associated with most new technology, namely, unreliability. By the 1920's, however, the bus technology had improved a great deal. The major improved feature of this generation of buses was

the lower step which provided easier access.<sup>15</sup> The subsequent technological improvements came with the use of light alloys in body construction which permitted the size of the bus to be increased.<sup>16</sup> Another major change occurred when the diesel engine was introduced into the bus design.<sup>17</sup> The major advantage of using the diesel engine was the resulting lower operating costs due to higher efficiency and lower fuel costs.<sup>18</sup> All of these innovations represented improvements in subsystem components, and were making the bus a much more desirable means of providing service than could be provided with the streetcar mass transit technology. Still other advantages of bus were low initial costs and high operational flexibility compared to fixed right-of-way rapid transit.<sup>19</sup> It should be noted that any fixed right-of-way transit bears a higher fixed costs burden than bus transit mainly due to higher route maintenance costs of the former.<sup>20</sup>

In addition to inherent advantages of bus over streetcar there were other forces behind the promotion of bus as a means of providing transit service. For instance, it has been argued that the "rise" of the bus was because of the entry of General Motors Corporation (GMC) into the bus market.<sup>21</sup> Further, it has been claimed that if it were not for aggressive marketing strategies of GMC and a number of other companies to promote the bus during the earlier period of this century, the transit industry would have collapsed sooner than it did (late 1950's, and early 1960's).<sup>22</sup> In order to familiarize the reader with the events surrounding these arguments, a short account of the events will be given below.

In 1925, GMC acquired control over the Yellow Cab Manufacturing Company (YCMC), which at the time was the largest manufacturer of buses in the United States.<sup>23</sup> At the time of the initial take-over there were four other major bus manufacturing companies in the U.S. market--Twin Coach,

Division.<sup>24</sup> By the 1950's, the market share of the GMC alone had increased to almost 80%.<sup>25</sup> The dominance of the bus market by GMC is still true today, but to a lesser extent. In 1965, as a result of a suit filed by the Department of Justice (DOJ) under the antitrust laws, GMC had signed a consent decree which bound it to sell bus component parts to other manufacturers at its interdivisional prices until 1975.<sup>26</sup>

The above suit was filed and finalized in 1965, although the DOJ and several Congressional Committees had been conducting investigations into practices of GMC in the bus market as far back as 1947.<sup>27</sup> For example, in 1949, GMC, as co-defendants with National City Lines, Inc. (NCL) in an anti-trust suit filed by the DOJ, was ordered to divest from NCL, and thus disengaging herself from monopoly operations.<sup>28</sup> In 1936, NCL was organized as a holding company (a company which owns sufficient stock in certain companies to have effective control of them) to acquire and operate local transit companies.<sup>29</sup> In 1938, NCL "conceived the idea of purchasing transportation systems in cities where street cars were no longer practicable and supplanting the latter with passenger buses."<sup>30</sup> Indeed, as of April 9, 1947, NCL owned and operated 46 companies in 45 states.<sup>31</sup> GMC's involvement in the process had been in the form of a long-term contract. In exchange for liberal financing from GMC, NCL would purchase (85%) of its buses from GMC.<sup>32</sup> NCL had in effect offered a portion of its stock to GMC in exchange for \$3,000,000.<sup>33</sup> The deal, however, entailed the above purchasing arrangement, allegedly because the NCL's offer for its stock was above the market value.<sup>34</sup> It is obvious that, these arrangements were conducive to adoption of bus as the major transit vehicle, and further the rise of the GMC's market share. Even after the divestment GMC continued to have the lion's share of the market, though, GMC's strategies in promoting the bus was not limited

to the above.

From the beginning, GMC had embarked on a calculated strategy for marketing its buses. For example, in 1932, GMC had acquired two transit companies in the cities of Kalamazoo (Michigan), and Saingow (Ohio), and then converted their streetcar systems into buses, thereby it had demonstrated the operational feasibility and economic advantages of buses.<sup>35</sup> Another GMC policy was to offer financial incentives to operators for purchase of its buses.<sup>36</sup> This was particularly important to the transit companies, since they usually operated on low profit margins. For instance, if a company were offered GMC's product which it could take (say) seven years to pay and a competitor's product that it could take four years to pay (with equal interest and product quality), it would obviously opt for GMC's product. Other factors contributing to GMC's preeminent position in the market included: establishment of a Transportation Engineering Team responsible for dissemination of information, and demonstration of buses to operators; the reputation and credibility of GMC so that there was little fear of bankruptcy and lack of spare parts; the tendency of transit companies to standardize their equipment from one manufacturer, for easier operation and maintenance; and GMC's power in terms of "differential pricing," selling components to competitors at higher prices than to its internal divisions.<sup>37</sup>

In summary, one of the major causes of the streetcar's downfall was the introduction into market of a new technology that required far less initial capital, and was very flexible from an operational point of view. The adoption, and diffusion of this new technology was further catalyzed by the active promotion (and perhaps illegal monopolistic strategies) of the major provider of that technology, i.e., GMC.

The dominance of GMC in the market is reflected in the pattern of bus

innovations since the 1920's. For instance, those improvements in subsystem technology described earlier and a variety of others were initiated by GMC. It should also be observed that no new manufacturer has entered the bus market since 1946 (except American Motors General, in 1971), and the number of suppliers in the market has decreased since 1925.<sup>38</sup> On the other hand, the volume of sales in this market has been stable and limited to under five thousand units per year (except the immediate post-World War II years), which is illustrated in Table 1.2.<sup>39</sup> Therefore, one may conclude that the small volume of sales, or in other words relatively low demand for buses has contributed to reduction in the number of competitors. Further, the market leader, i.e., GMC, has also had effective control over innovations in bus technology. Indeed, the most recent changes in the bus technology, namely, introduction of the "New Look" bus in 1959, and "RTS-2" bus in 1975, have both been initiated by GMC.<sup>40</sup> Also Figure 1.2 shows the product life cycles for both streetcars and buses.

### 1.3 CHANGE IN THE TRANSIT INDUSTRY: OPERATING ENVIRONMENT

In order to better understand the government's decision to become actively involved in the development and deployment of transit technology, one must understand the operating environment of transit industry. It is also important to understand what factors contributed to the present situation.

Since the late 1920's, ridership trend in the transit industry has been on the decline except for the World War II period. The various periods, however, have been distinguished according to ridership trend as follows: initial rapid growth (1900-1919); stabilization (1920-1939); war induced growth (1940-45); and length decline (1946-1976).<sup>41</sup> It is important



to understand not only the causes behind the decline in ridership which were dependent on service levels but also the factors which contributed to the transit industry's decline independent of service provisions. These causes or factors may be divided into three categories: individual choice; transit industry responsibility; and government-corporate policies.

The element of individual choice has undoubtedly caused decline in transit patronage. The relative comfort of the automobile, the decline in real prices of the automobile, and the relatively cheap fuel costs (up to the 1970's) have in combination made transit not a very attractive form of transportation.<sup>42</sup> Figures 1.3 and 1.4 show the transit ridership and the increase in private automobile ownership trends throughout this century. One may conclude from the comparison of Figures 1.3 and 1.4 that the automobile has played a key role in decline of the transit.

This is not to say that the transit industry has been responsive to the needs of the public and is only the inevitable victim of competition. Indeed, traditionally the transit companies have been very operations oriented.<sup>43</sup> They have until recently paid little attention to service attributes which might make transit more attractive, such as marketing of service, fare elasticity of various passengers, ride quality, aesthetic appeal, etc. Moreover, they have been apprehensive of new technologies, and except for the PCC car, the U.S. transit industry has lacked timely innovations thus contributing to its uncompetitiveness, compared to the technological breakthroughs in other modes of transportation.

Government-corporate policies have indirectly accelerated the decline of the transit industry in a number of ways. First and most prominent item has been government subsidy to highway construction starting in the 1910's and continuing in a more regular and planned manner to in the 1950's to the

present time.<sup>44</sup> Second, and probably less visible item has been the post World War II policy toward housing. After World War II, the federal government engaged in federally insured home mortgage programs which were aimed partly to induce construction (jobs), and more specifically to allow as many citizens to own their homes.<sup>45</sup> In order to attain their objectives of "the good life," and maximize the security of the loans, lenders favored a safe investments in single family homes, relatively far away from lower-class, racial minority areas.<sup>46</sup> Therefore, the trend toward suburban living, which is difficult, and expensive to serve by conventional transit, was a dramatic factor in transit ridership decline.

Another one of the government's policies having a severe impact on transit service providers, was the forced divestiture of a large number of utility companies from their transit operations. In the early 1930's, due to Congressional concern, the Federal Trade Commission conducted study of structural and financial arrangements of power, gas, and oil operations.<sup>47</sup> This study estimated that power holding companies directly controlled transit operations serving 878.9 million revenue passengers in 1931, i.e., about 10% of the nationwide total.<sup>48</sup> Further, 171 transit companies representing one-fourth of the total were indirectly controlled by interlocking directorates among some dozen power trusts.<sup>49</sup> Subsequent to this investigation, the Public Utility Company Act of 1935 was passed by the U.S. Congress.<sup>50</sup> The key provision of the act from transit point of view stated that, "after January 1, 1938, each registered holding company...[must] limit operations to a single integrated public utility system."<sup>51</sup> As a consequence of this Act, most holding companies divested themselves from their transit operations, which were in most cases cross-subsidized from other operations. Due to already leveraged position of the local transit companies, the dives-

ture weakened their market position even further (i.e., inability to raise capital). It may be noted that, apparently NCL was organized to utilize the opportunity created by this divestiture, although it was unsuccessful.

By the late 1950's, most transit companies had either collapsed or were on the verge of financial collapse.<sup>52</sup> Their financial difficulties were caused by their inability to run the systems out of the revenue obtained from the fare box, the political infeasibility of rising the fares, and providing service with rolling stock having an average age of almost 18 to 20 years.<sup>53</sup> Therefore, the public ownership of the transit industry was almost inevitable. By the early 1960's, most transit operations had become either part of municipalities or taken over by the local (state) governments.<sup>54</sup> Moreover, in the next two decades the federal government became more involved in public transportation policy making, because of this forced ownership, and specifically, due to the extent of the transit problems which these localities had inherited from their private owners. The advent of federal involvement was in 1961, when Section 701 of the 1954 Housing Act was amended to provide assistance to transit agencies for acquisition of rolling stock, and for remedial purposes.

#### 1.4 DIRECT FEDERAL INVOLVEMENT IN URBAN MASS TRANSPORTATION:

##### UMT ACT OF 1964

The Section 701 amendments marked for the first time the recognition on the part of federal government the role of public transportation in development, revitalization, and improvement of cities. These amendments, however, were passed mainly to deal with emergency rolling stock requirements of some troubled transit operators, and thus only provided limited funding.

The Urban Mass Transportation Act of 1964 made a more serious commit-

ment to assisting the urban transportation services of the nation. Two sections, i.e., Sections 3 and 6, are of most interest to this study. Section 3 authorizes the responsible executive agency to make capital grants (from authorized funds) to transit agencies for capital improvement purposes.<sup>55</sup> That is, using funds for acquisition of rolling stock, related transit equipment, and construction of transit facilities. On the other hand, Section 6 provides for funding and direction of the research development, and demonstration programs.<sup>56</sup> The objective of latter activities are, "to assist in the reduction of urban transportation needs, the improvement of mass transportation service, or the contribution of such service toward meeting total urban transportation needs at minimum costs."<sup>57</sup>

One of the programs undertaken by UMTA under the authority of Section 6 was the Transbus program. UMTA officials wanted to develop a new state-of-the-art transit bus which would then be procured by the transit agencies with Section 3 funds. How the Transbus program was formulated and then implemented is the topic of Chapter 2.

## 1.5 SUMMARY AND METHODOLOGY

This chapter presented a brief overview of the evolution of bus technology, and bus market system since the beginning of this century. The evidence suggested that, bus replaced streetcar as the major transit vehicle beginning in the 1920's. This substitution was partly due to inherent advantages of the bus over the streetcar, i.e., low initial costs, high operational flexibility, lower maintenance costs, etc. Another reason for the substitution of the streetcar by the bus was effective, and aggressive marketing strategies of the bus manufacturers, especially GMC. Since her entry into the transit bus market, GMC has gradually increased her share of

the market so that in the 1950's she dominated almost 85% of the market. Further, major design changes in the bus technology have been initiated by GMC. The most recent example of these changes in bus technology are the "New Look" bus, and the "RTS-2" bus. It may, however, be noted that these changes have been in the subsystem components of the bus, and the basic design of buses has remained unchanged since World War II. It is worth noting that there may have been a shift in focus of the latter design changes from earlier functional improvements to current aesthetic/quality improvements. Among other objectives this is supposed to increase transit patronage by making buses more comparable to automobiles.

The trend in market domination, and the sources of design changes suggest that corporate policies and strategies of the major producer of buses, i.e., GMC, have played a major role in shaping the schedule and outcome of technological changes in bus design. Another factor which undoubtedly has affected the direction of technological changes in the buses is related to the characteristics of the transit industry. Transit operators have traditionally been operations oriented, and in most cases apprehensive of technological changes. Some observers have contributed this attitude to the monopoly characteristic of this industry since its inception. Whatever the reasons, it may safely be said that, the transit industry has a low technology base, and is organizationally unreceptive to innovative efforts. The short history of the transit provided us with some insights as to the possible reasons behind the latter attitude, namely, gradual decline which has affected all aspects of this industry in a "circular" manner.

The direct involvement of federal government in transit started in 1961, and has grown subsequently. The corresponding laws provide for federal financial assistance to current transit as well as future transit, via

sponsorship of development/deployment of new transit technologies. The important point from a public policy perspective, however, is that such an established political-institutional subsystems as the the transit industry, and the transit manufacturing industry will probably not respond to innovations that are perceived to be restructuring or revolutionary to themselves. Therefore, successful innovative attempts to bring about technological change may require far more effort and attention than formally provided for in the laws and the statutes.

The methodological basis for this research are a literature survey, interviews, and development of a case study. The research began by exploring the documented material on the Transbus program, including government reports, studies, Congressional hearings, statues, and regulations. Telephone and personal interviews were also conducted to solicit information, and views on Transbus and the role of the federal government on furthering innovation. Interviews included officials at UMTA, the American Public Transit Association, Congressional Staff, consultants, academics, representatives of interest groups, and others professionally related to the Transbus technology innovation.

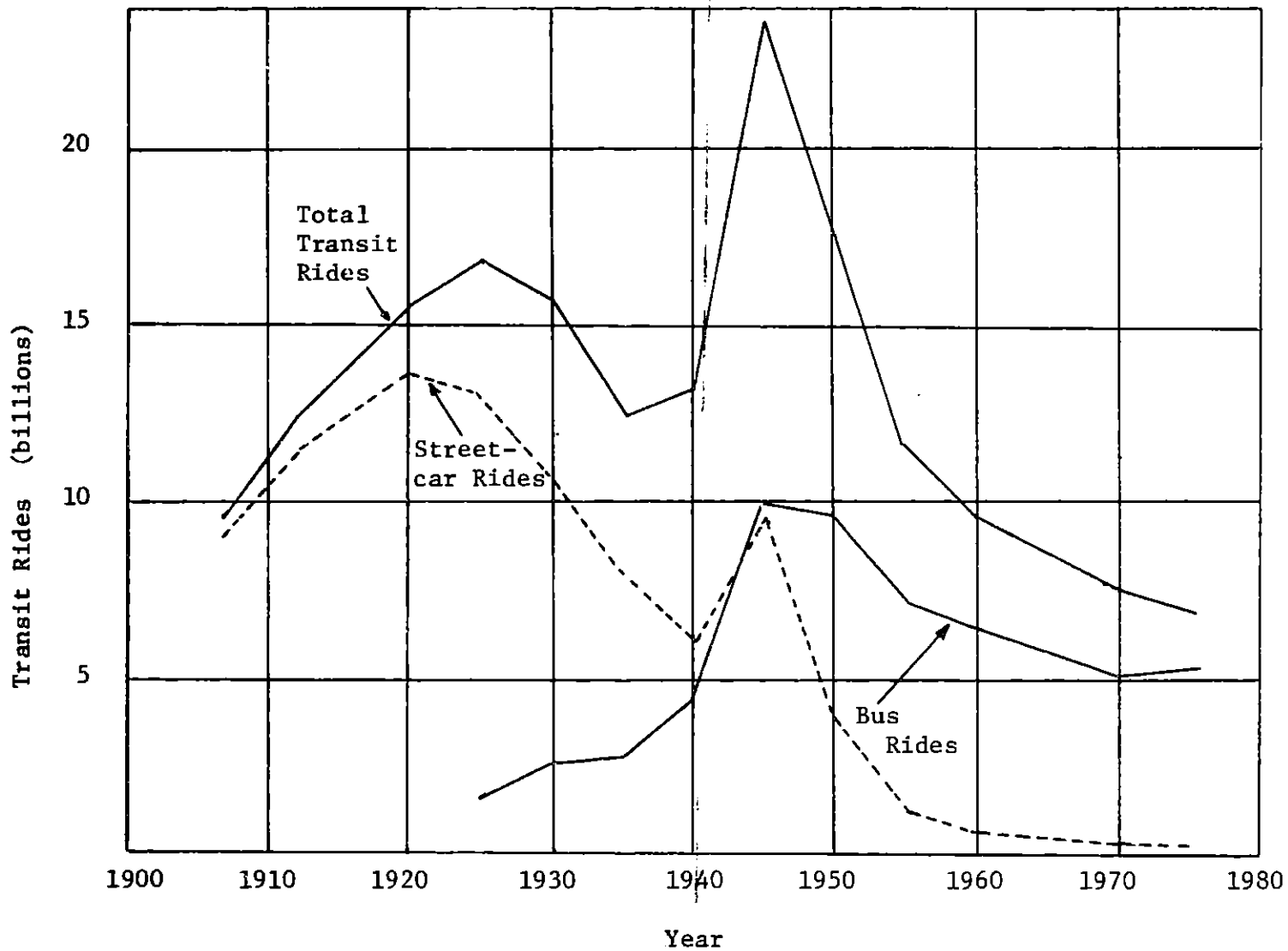


Figure 1.1 Trends in Transit Use by Mode.

Source: Arthur Saltzman, "Decline of Transit," in Public Transportation: Planning, Operation and Management, George E. Gray/Lester A. Hoel.

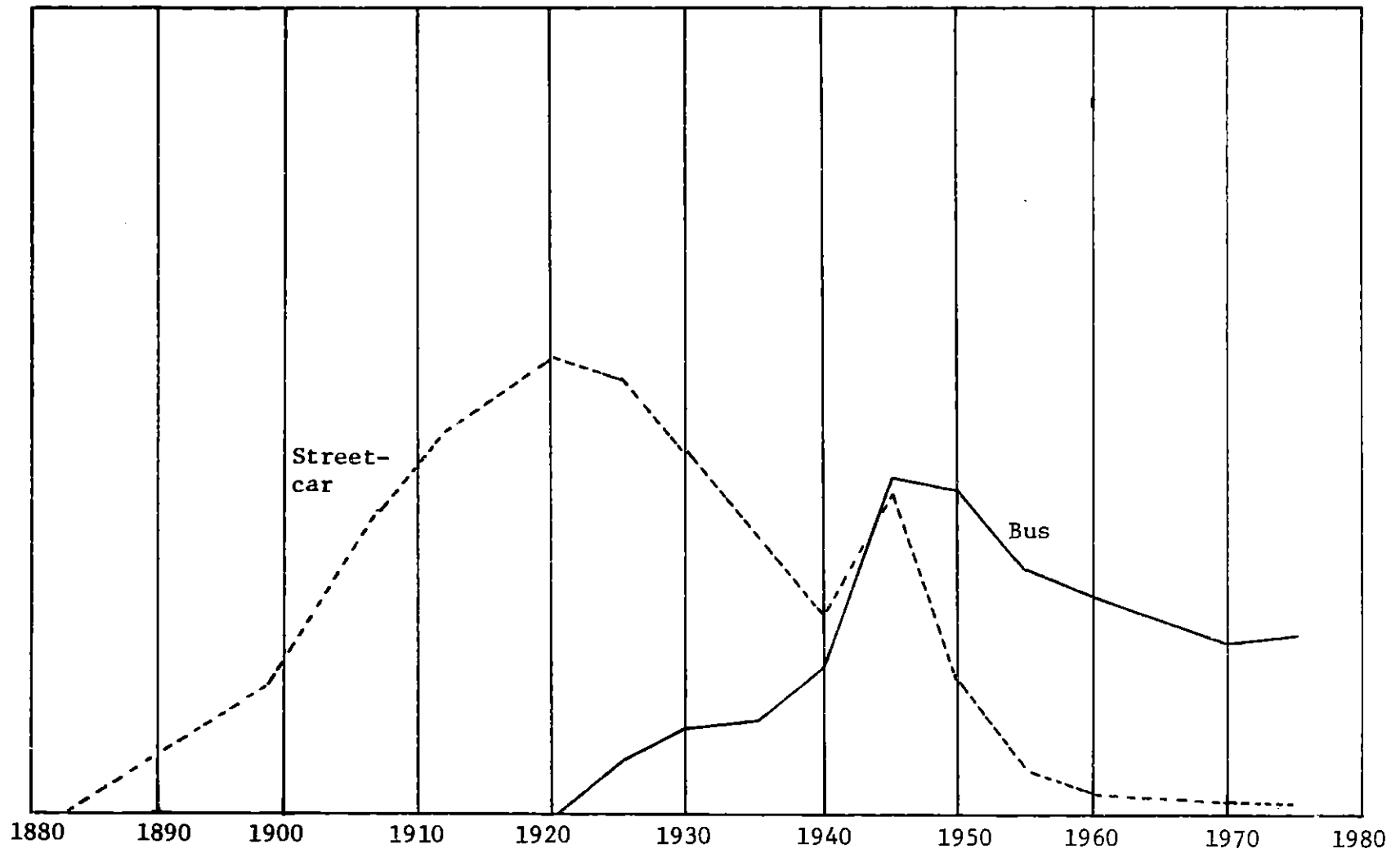


Figure 1.2 Approximate Product Life-Cycle for Streetcar and Bus  
(adapted from Figure 1.1)



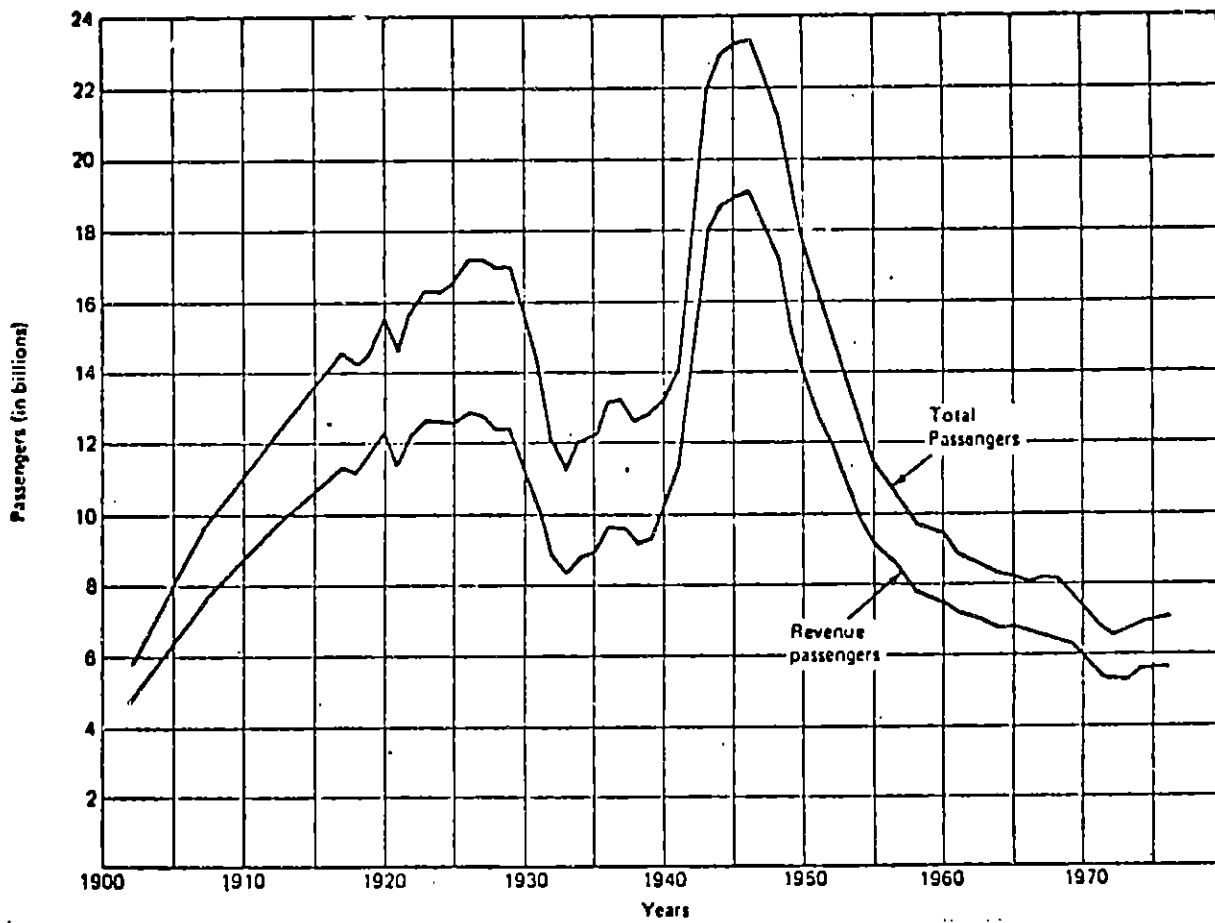


Figure 1.3 Ridership Trends in Transit (1902-1976).

Source: Arthur Saltzman, "The Decline of Transit," in Public Transportation: Planning, Operations and Management, eds., George E. Gray/Lester A. Hoel.

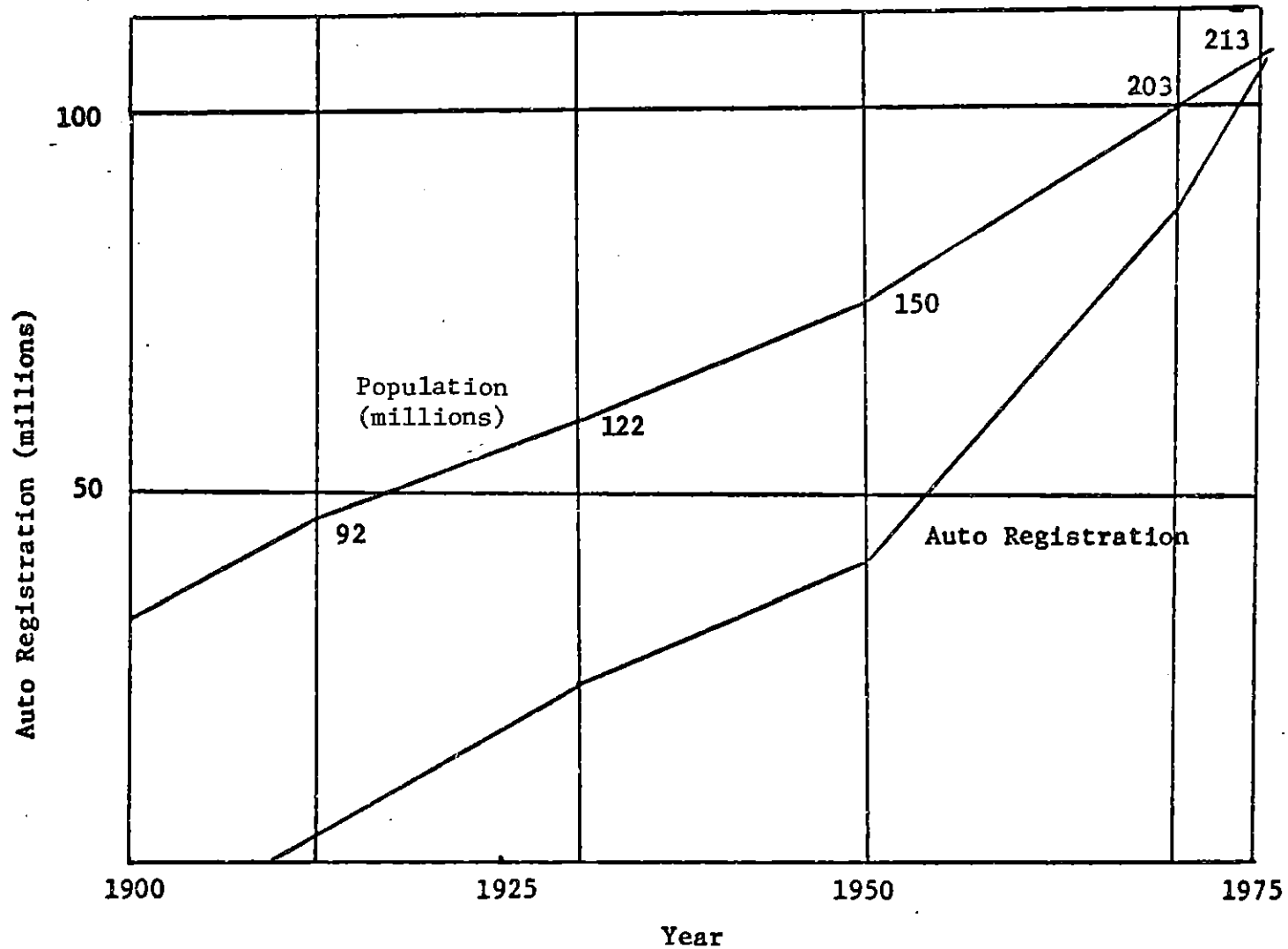


Figure 1.4 Automobile Ownership (1910-1975).

Source: Alan Altshuler, Urban Transportation System: Politics and Policy Innovation (1979).

Table 1.1 Trends in Transit Use by Vehicle Type

U.S., 1925-1979 (billions of total passengers)					
Year	Streetcar		Motorbus		Total
	No.	%	No.	%	No.
1925	12.9	77	1.5	99	16.7
1940	10.5	67	2.5	16	15.6
1935	7.3	60	2.6	21	12.2
1940	5.9	45	4.2	32	13.1
1945	9.4	40	9.9	42	23.3
1950	3.9	23	9.4	55	17.2
1955	1.2	10	7.2	63	11.5
1960	0.5	5	6.4	68	9.4
1965	0.3	4	5.8	70	8.3
1970	0.2	3	5.0	68	7.3
1975	0.1	1	5.1	72	7.0
1979	N/A	N/A	N/A	N/A	N/A

Source: American Public Transit Association, Transit Fact Book, for Period 1940-75 (1976-77 ed.), and Wilfred Owen, Metropolitan Transportation Problem, for period 1925-1940 (1966 ed.).

Table 1.2 New Transit Vehicles Delivered to Properties  
U.S. 1940-1976

Year	Motorbus		Total
	40+ seats	Total	
1940	-	3,984	5,254
1941	-	5,600	6,289
1942	-	7,200	7,840
1943	225	1,251	1,399
1944	1,015	3,807	4,151
1945	1,501	4,441	4,934
1946	2,185	6,463	7,150
1947	6,361	12,029	13,612
1948	4,342	7,009	9,165
1949	1,725	3,358	4,726
1950	1,611	2,668	3,050
1951	2,693	4,552	5,348
1952	1,165	1,749	1,992
1953	1,717	2,246	2,246
1954	1,844	2,225	2,485
1955	1,861	2,098	2,429
1956	2,589	2,759	3,135
1957	1,187	1,946	2,415
1958	1,419	1,698	2,126
1959	1,379	1,537	1,747
1960	2,633	2,806	3,222
1961	2,310	2,415	2,883
1962	1,920	2,000	2,406
1963	3,085	3,200	3,858
1964	2,331	2,500	3,140
1965	2,769	3,000	3,580
1966	2,752	3,100	3,279
1967	2,208	2,500	2,585
1968	1,994	2,228	2,612
1969	2,002	2,230	2,880
1970	1,274	1,442	1,750
1971	2,349	2,514	2,764
1972	2,581	2,904	3,265
1973	2,701	3,200	3,439
1974	4,222	4,818	4,910
1975	4,714	5,261	5,389
1976	4,099	4,745	5,481
1977	1,580	2,437	N/A
1978	2,973*	3,795	N/A
1979	2,974**	N/A	N/A

\* Including 232 articulated buses.

\*\* Quoted from GM and GFC sales.

Source: American Public Transit Association, Transit Fact Book, 77-78.

## CHAPTER TWO

### THE TRANSBUS CASE STUDY

"What has technology to offer in the way of urban-transportation improvement? How can mass transportation be improved, be better adapted to the requirements of modern urban movement, and, in particular, be brought up to the point where it can compete more effectively with the automobile in comfort, convenience, and public esteem? Are there in the offing any radical new developments...? What are the implications for federal policy of the present outlook of transportation technology?"

- From the Fitch Report to the Department of Commerce.<sup>1</sup>

#### 2.1 INTRODUCTION

As indicated from the above statement, the state-of-the-art in mass transportation was often regarded as a technology stalemate in comparison to automobile technology. The federal government, however, was to seek a way out of this stalemate through authorities granted to it by enactment of the Urban Mass Transportation Act of 1964.\* In particular, the Section 6 of the Act authorized the Housing and Home Finance Administration to undertake Research, Development, and Demonstration (RD&D) programs if it determined that such undertaking would serve the public interest and improve mass transportation system of the United States.<sup>2</sup>

In this Chapter the evolution of the Section 6 and the corresponding programs are examined. This provides a useful context for studying the case of a program undertaken under the authority of Section 6, namely, the Transbus program. The case study of Transbus would provide us with useful insights into the process of federal government technology innovation. The

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\* Henceforth the UMT Act of 1964.

study would try to encompass not only the events, decisions, policies, legislation, regulation, etc. which are directly linked to the Transbus program but those which might have been indirectly (or secondarily) related to it. A list of these events, etc. has been provided in chronological order in Appendix A.

## 2.2 UMTA'S RESEARCH, DEVELOPMENT, AND DEMONSTRATION PROGRAM AND ITS ORIGINS

The transportation package included in the 1961 Amendments to the Housing Act of 1954 was a landmark in the federal policy towards mass transportation. This package was intended to be introduced as an independent Mass Transportation Act, although due to prospects of defeat (in Congress) in a strategic move it was added to the omnibus Housing Act amendments.<sup>3</sup> The Section 701 of amendments, which dealt with the urban transportation issues, authorized the Administrator of the Housing and Home Finance Administration (HHFA) to spend up to \$50 million on low interest loans and \$25 million on demonstration grants to the transit properties at his discretion.

The purpose of the loans was to salvage several transit properties, especially in the eastern U.S., which were on the verge of financial collapse and in desperate need for new equipment. On the other hand the demonstration grants served a dual purpose. First, they could be used to improve service and second, if the demonstration showed potential for success then it could be emulated by transit properties throughout the U.S. through dissemination of information about its operation. A hidden by probably equally important purpose of the demonstration grants was that it could be used as a lobbying device.<sup>4</sup>

It is important to further clarify the intent of the demonstration grants and programs, since later research and development would also become

part of this category of programs. This may be done by analyzing a hypothetical program. Suppose transit property "A" would like to implement a new service strategy (or type) "B," however, due to lack of funds it is unable to do so. Now the federal government is prepared to help by sharing the costs. So the property goes ahead experimenting with the new strategy, and further (we assume) the project is successful. What are the (supposed) benefits? First, the transit property A gets a chance to upgrade its service or provide new types of services which were previously impossible due to lack of funds. Second, the federal government would collect the information on the successful operation of B and would publish it so that other transit properties can make use of B. Thus, the federal government not only acts as the initiating agent by providing grants but it also acts as the propagating agent by disseminating information.

Successful implementation of B would also serve another purpose. The transit lobbyists can take their case before the Congress and demonstrate the effectiveness of mass transportation through results of the demonstration projects such as B. This in turn would (hopefully) encourage further support by the Congress for mass transit. Skeptics would say this is an optimistic approach, what if the demonstration B is a failure. The failure of any public undertaking would be hard to justify, however, the expenditure on demonstrations may be regarded in the same category as federal basic research with no definite expectations.

The Section 701 amendments were a landmark as far as the federal mass transportation policy was concerned, but the Urban Mass Transportation Act which finally became law in 1964 marked the recognition of mass transportation as an important area of public policy. The UMT Act of 1964 was far more extensive than the 1961 amendments and included several changes. The

Section of interest to this study, however, is 6. This section was entitled Research, Development, and Demonstration Programs. Under the authority of Section 6 the Administrator of HHFA could:

"Undertake research, development, and demonstration projects in all phases of urban mass transportation (including the development, testing, and demonstration of new facilities, equipment, techniques, and methods) which he determines will assist in the reduction of urban transportation needs, the improvement of mass transportation service, and the contribution of such service toward meeting total urban transportation needs at minimum costs."<sup>5</sup>

The Section 6 was essentially an extension of the Demonstration Programs of 1961 amendments, although addition of research and development was not the only change in the provisions of this section. HHFA could now undertake the programs independently with no limit on the extent of federal funding. Previously the federal government and localities had to share the costs of the projects/programs (2/3 former, and 1/3 latter).<sup>6</sup> There were several reasons behind this elimination. For instance, it would be quite conceivable for the operators to initiate service type demonstrations since most of these demonstrations involved experimentation with various types and methods of services or operational aspects of mass transit. It would not, however, be regarded likely for the operators to undertake research into problem areas of mass transportation or initiate development of new technologies. First, the history of the industry is evident of this attitude and second, the operators were hard pressed for funds and had to rely on little precious local tax revenue to finance their operations.

A prime example of how the elimination of funding requirements opened the way for such undertakings as described above was the Transbus program itself. It would have been very unlikely for any operator (or operators) to initiate a hardware development and testing program of new bus systems given the scarcity of funds and other resources. It is interesting to note that



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the orientation of the majority of programs funded under Section 6 was operational until early 1970.<sup>7</sup> On the other hand, in 1970, there was a sharp increase in the hardware development programs.<sup>8</sup> There were a number of reasons for this the most important of which was probably the Department of Transportation's philosophy on technology in general. This technological outlook affected the direction of policy making on Section 6 programs including the Transbus.<sup>9</sup> Before proceeding to discuss how the Transbus program was conceived of, it may be appropriate to familiarize ourselves with the history of the agency responsible for administration of Section 6, now known as the Urban Mass Transportation Administration.

Initially, the Administrator of HHFA was charged with responsibility of executing the UMT Act of 1964 (including Section 6).<sup>10</sup> In December 1966 the HHFA was merged into the Department of Housing and Urban Development (HUD).<sup>11</sup> Subsequently the executive responsibility came under the Assistant Secretary for Metropolitan Development, and the corresponding organization was known as the Urban Transportation Administration (UTA). Along with these organizational mergers of HUD and HHFA, a federal Department of Transportation was in the process of creation. In 1966, the Congress had passed the federal Department of Transportation Act.<sup>12</sup> This new federal agency would include sub-agencies for practically all modes of transportation (air, highway, sea, rail). One of the provisions of the Act instructed the DOT and HUD to investigate the appropriate organizational location, responsibility, and executive functions of UTA between the two federal agencies. Finally, in July 1968 UTA was transferred to the DOT and the new agency was named the Urban Mass Transportation Administration. According to the executive order it was instructed that "major urban transit, grant, loan and research related" functions under the UMT Act of 1964 must be transferred

to the DOT while cooperation between the two agencies should continue especially in matters concerning urban planning.\* 13

UMTA was initially critically understaffed (and probably still is).<sup>14</sup> Of course the main reason was that the DOT was passing through its adolescence period and also cabinet positions were yet uncertain due to forthcoming national elections. The new Administration of the DOT and thus UMTA, took office in early 1969. The secretary of Transportation was John Volpe and the UMTA Administrator was Carlos Villarreal. The new DOT Secretary being enthusiastic about the future of UMTA, along with mass transportation, tried to boost the number of staff at UMTA.<sup>15</sup> The new staff were especially characterized as innovative and enthusiastic, because they mostly had come with aerospace background in the satellite and space projects of the 1960's.<sup>16</sup> They subsequently played a key part in the direction, selection, and generation of RD&D projects/programs by UMTA, especially since this group of staff also handled the RD&D funds of the Section 6. This is clearly manifest in the evidence, the first formal invitation to bid was published by UMTA in the Commerce Business Daily on September 11, 1970.<sup>17</sup> The invitation to bid was a method used by other federal government agencies to contract development of hardware or basic research. This was especially true in cases of defense and space agencies. Under this strategy usually the contracting agency employed a prime contractor as the project manager instead of dealing with the actual contractors. Then the prime contractor would be responsible for the management of research, development, testing, and evaluation of hardware (standard operating procedure for most defense agencies of the federal government).

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\* In reality the HUD's participation diminished with time in UMT Act matters.

The importance of the above insights into the posture of the DOT and UMTA Administration are that they provide use with a clue as to the predisposition of the policy-makers when the Transbus program was started.

### 2.3 MOTIVES AND BASES FOR TRANSBUS

The federal government was interested in a bus innovation program as far back as 1967. In the previous year, 1966, the amendments to the UMT Act of 1964 included provisions which specifically directed the HHFA Administrator to "undertake a program of research designed to achieve a technological breakthrough in development of new kinds of public intraurban transportation systems."<sup>18</sup>

In a drastic move the HUD (successor to HHFA) contracted several consultants (including research organizations and hardware firms) to propose and study the prospects for these "new urban transportation systems." Among the products of these studies was a report by the Highway Research Board (now Transportation Research Board), National Research Council, and National Academy of Engineering.\* It was entitled Design and Performance Criteria for Improved Non-rail Urban Mass Transit Vehicles and Related Urban Transportation Systems.<sup>19</sup>

The above study essentially laid the ground rules for a possible federal government innovation program in urban transit buses. It advised the federal government to approach such a program in the following way: development of concepts and criteria (the study itself); definitions of prototype vehicle requirements; design and manufacture of prototype vehicles; testing of prototype vehicles against vehicle criteria; and testing of sets

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\* Henceforth referred to as NAE study; TRB, NRC, and NAE are all related to the National Academy of Sciences.

of prototype vehicles in operational environments.<sup>20</sup> In addition, recommendations were made on possible performance and design features of such new vehicles. These criteria were mainly concerned with improvements in passenger/driver amenities such as ease of boarding, better visibility, etc.

In spite of the prospects for improvements the importance of two general problems were acknowledged by the NAE. First, the potential for increased ridership of transit as a result of these improvements would be more dependent on service characteristics (such as frequency of service) and less on mechanical characteristics (such as a lower floor) though, there was certain to be an improvement in productivity.<sup>21</sup> Second, the majority (80%) of improvements suggested were either already incorporated in current buses or could be accomplished using the current state-of-the-art, and the deciding factor, however, was not the feasibility of technology but rather the economic considerations.<sup>22</sup> That is, the costs could become prohibitive, which would be undesirable from suppliers' point of view serving a very small market (approximately 2,500 annual sales).<sup>23</sup>

The NAE study was completed in 1968, although the Transbus program itself did not start until 1971. On the one hand, this may be due to the changes in the organizational location of UMTA during this period and also the subsequent loss of interest in the implementation of 1966 Amendments on "new urban transportation systems." On the other hand, it was General Motors Corporation (GMC) efforts which renewed interest in bus innovation.

GMC had started experimenting on a new design for "advanced" buses in 1964.<sup>24</sup> GMC completed its experiments and demonstrated the new bus to the transit industry in 1968. The bus was called Rapid Transit Experimental (RTX) series. GMC had employed several new advanced features in development

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of RTX prototype including aerodynamic styling, large windows, cantilevered seats, a low 24-inch height floor.

The transit industry, however, was not too optimistic about prospects of the low floor technology.<sup>25</sup> They had expressed concern over operational capabilities of a low floor bus. Consequently GMC had announced that the RTX bus would be modified and would only incorporate those new features which did not pose any operational problems. The new modified model would be called RTS and production would begin as soon as possible.

Following these developments GMC had expressed its interest in producing the RTS bus to the federal government (DOT, UMTA).<sup>26</sup> In GMC's view the support of the federal government in giving a go-ahead to GMC was essential. First, because almost all transit bus purchases had to be approved by the federal government because UMTA provided two-thirds of the funding for their acquisition. Second, the GMC's RTS bus would predictably be higher in price than the current model. This was regarded as a problem since the rolling stock acquisition by the federal funds had to comply with the competitive bidding requirements. According to these requirements only the lowest bid offer could be accepted.\* Thus, if GMC was to market the RTS, a waiver of some kind or a revision of bidding requirements was inevitable (otherwise GMC would be put in an uncompetitive position). The issue was further complicated because of an earlier antitrust suit against GMC's bus manufacturing division. In 1965, the Department of Justice had brought suit against GMC under the antitrust laws which had resulted in a consent decree.<sup>27</sup> The terms of consent decree required that GMC sell bus component parts to its competitors at cost (until 1975). The implication of this antitrust

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\* The competitive bidding requirements could be waived only under special circumstances.

suit for UMTA was that if it gave go-ahead to GMC for production it might further deteriorate the market position of others in the market. At this time there was only one other competitor, namely, the Flexible Company.<sup>28</sup>

These developments renewed the federal government's interest in the bus innovation program. In December 1970, UMTA announced that the DOT would begin a federally supported development program for transit buses.<sup>29</sup> It became known as the Bus Technology Program and later the Transbus program. The Bus Technology was among the several other programs which UMTA had started that same year under three project categories of Bus Transportation, Urban Rail Transportation, and New Systems of Urban Transportation.<sup>30</sup>

Given the stance of the UMTA and DOT on high technology urban transportation at that time, this was not an unprecedented move. Indeed, UMTA chose the standard operating procedure of Research, Development, Testing, and Evaluation (RDT&E). After selecting Booz, Allen, Hamilton Applied Research, Inc. (Booz-Allen, henceforth) as the prime contractor a notice appeared in the Commerce Business Daily, on 27 July, 1971, inviting potential participants to bid on development of a new 40-foot bus.<sup>31</sup>

#### 2.4 TRANSBUS ROLLS

After the initial working plan was drawn up by the Administrator of UMTA, the prime contractor in conjunction with APTA's (American Public Transit Association) Bus Technology Committee and UMTA itself developed a set of specifications for the new bus.<sup>32</sup> Through a process of formal bidding potential bidders were invited to bid for development/building of the new bus. The potential bidder was asked to develop/build prototype vehicles according to the developed specifications. In August 1972, the Secretary of DOT, himself, announced that the three subcontract awards for

development/building of the new bus would go to three bus manufacturers.<sup>33</sup> The contracts allowed for procurement of three prototype vehicles from each manufacturer. After delivery the prime contractor would undertake a testing/evaluation program of these prototype vehicles.

It was tentatively agreed, although no formal commitment was made, that upon conclusion of the testing/evaluation, a best design configuration would be selected among the prototype vehicles.<sup>34</sup> This best design would be a combination of both "viable" and "desirable" features of each test prototype. The federal government would then arrange for procurement of 100 units of vehicles according to the best design configuration from each contractor. The government procurement of these three hundred units would have served at least two purposes. First, it would have provided each contractor with a minimum order thereby reducing his financial risk for the start-up costs. Second, the procured vehicles could be used for in-service operational testing so that the unproven parts of technology could be debugged. With completion of debugging, a single set of specifications would be developed through which the federal government would standardize transit bus procurement (acquired under federal financial assistance).

The delivery of prototype vehicles began in early 1974.<sup>35</sup> These prototype vehicles underwent testing/evaluation which ended in April 1975, although the actual testing lasted 80 days.<sup>36</sup> All vehicles spent a total of 24 days in operational testing in simulated service environment. Earlier, in January 1975, UMTA had publicly announced that it would not implement the original plan of procurement for 300 units of Transbuses and the federal involvement in development of Transbus would end with the conclusion of testing/evaluation.<sup>37</sup> UMTA had also stated that it would soon mandate the Transbus as a standard federal bus.

The Transbus mandate, however, did not materialize until mid-1976. In July 1976, UMTA mandated a procurement package called the Transbus Procurement Requirements (TPR).<sup>38</sup> This procurement mandate required that all federally funded buses must comply with the specifications in the TPR after February 15, 1977. The TPR, however, did not actually specify a low 22-inch as was originally intended, rather it required a 24-inch "effective" floor height. That is, the buses are only required to have a 24-inch height floor at stops which could be achieved by a combination of both kneeling and low floor.

The original TPR, in spite of the long time it had been in the making did not go into effect as intended. In February 1977, DOT (UMTA) suspended the effective date for TPR mandate.<sup>39</sup> Later that year, DOT (UMTA) issued a statement expressing its intent to mandate a low floor Transbus as was intended in the early 1975.<sup>40</sup> After a series of motions UMTA revised the TPR to require a standard 24-inch floor (with the kneeling feature could go as low as 17 inches).<sup>41</sup> Along with the actual hardware aspects of the revisions UMTA applied very stringent warranty and performance requirements. The effective date for the new mandate was set as September 30, 1979.

In order to provide the manufacturers with a minimum order, the pioneering transit operators formed a consortium to procure 530 Transbuses (with low floors).<sup>42</sup> A bid opening date was set, March 30, 1979, for potential bidders to build the Transbus. At the request of one manufacturer this date was postponed, the new date was set as May 2, 1979.<sup>43</sup> Unfortunately, the second bid date passed and no bids were received for the 530 Transbuses.<sup>44</sup>

This created a controversy over the aptness and relevancy of the revised TPR. Thus the DOT missioned "independent" entities to study the



TPR and related issues, especially "Whether the Transbus was buildable?"<sup>45</sup>  
The studies on the whole justified the manufacturers' refusal to bid for  
the Transbus.<sup>46</sup> In the meantime the TPR effective date was suspended and  
the DOT (UMTA) is now in the process of formulating a new procurement pack-  
age for federally funded buses.<sup>47</sup>

To provide a better insight into the Transbus program we now take a  
closer look at the events especially those which affected the above criti-  
cal decisions.

## 2.5 A CLOSER LOOK AT THE EVENTS

To have a better grasp of the events they would be presented in four  
categories: policy shifts due to administrative changes; effects of market  
issues on policy; role of the transit industry; and influence of the elderly  
and handicapped mobility legislation on policy.

The DOT administration which started the Transbus program was headed  
by the Secretary, John Volpe.<sup>48</sup> The DOT (UMTA) had justified undertaking  
the Transbus program before a Congressional Committee as follows:

"The design of currently available buses...has not  
changed fundamentally since 1959. Today's buses are...  
difficult to get on and off, and do not offer desired  
comfort, and amenities...that would make them attractive  
to the riders. Further there are only two manufacturers  
of transit buses and they have no announced plans to  
develop a better transit bus for the near future."<sup>49</sup>

The stance of the Volpe administration and the "prevalent" (as noted above)  
attitude towards bus technology presented a very ripe opportunity to under-  
take a bus innovation program. The following two DOT administrations,  
however, would not share the same enthusiasm about the role of federal  
government in initiating and marketing of new transit technologies.<sup>50</sup>

Claude Brinegar and Frank Herringer who succeeded John Volpe and Carlos

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Villarreal, in 1973, would change the DOT (UMTA) policy on the Transbus program. Early in 1973, after doubts were being raised about the federal procurement of minimum order from each manufacturer after completion of testing/evaluation, UMTA renounced these doubts reiterating its original informal commitment to the procurement.<sup>51</sup> Later, after the procurement issue was taken up with both the transit industry and the bus development/building contractors UMTA gradually moved to eliminate the idea. Finally in January 1975, UMTA issued a statement that expressed its intent to mandate the Transbus by developing a set of compulsory specification standards.<sup>52</sup> In the meantime, until the specifications were promulgated UMTA would provide the transit properties with financial assistance to acquire interim buses (so as not to halt the bus replacements).

The abandoning of the procurement plan was in line with the "new philosophy" of this administration, i.e., less direct federal involvement in the market.<sup>53</sup> The policy shift, although for different reasons, was neither welcomed by the operators nor the prototype manufacturers (except for GMC).<sup>54</sup> The operators were displeased over mandating a federal bus with inadequate in-service testing, and the manufacturers did not particularly like the possible favoritism towards any one of them which had been prepared for production of an interim bus, namely, GMC. The development of the alleged performance specifications was pending the conclusion of test/evaluation results, in the meantime the DOT (UMTA) administration changed again, this time William Coleman as the Secretary of Transportation and Robert Patricelli as UMTA Administrator.<sup>55</sup>

This administration was more or less in line with its predecessor over the role of government, although its job was compounded due to rising regulatory controversy over transit accessibility to the Elderly/Handicapped

(E/H).<sup>56</sup> Further, any policy it developed regarding procurement of Transbus must take into account the issue of the interim bus as well. The first response was a plan which suggested an additional 24-month in-service testing for the 17-inch floor Transbus though later it was dropped since at least two of the contractors did not possess the financial resources to go to low floor.

A hearing was held by UMTA in May 1976 in order to clarify the issues and possibly force the parties involved to take positions publicly.<sup>57</sup> The hearing resulted in the recognition of at least three positions on the Transbus issues: a pro-low floor lobby mainly consisting of E/H and two of the contractors asking for strict adherence to original Transbus configuration; an anti-low floor lobby consisting of the transit industry given the fact that UMTA would not finance further operational testing of the Transbus; a pro-interim bus lobby consisting of one manufacturer who was ready to produce an interim bus.<sup>58</sup>

The outcome of these efforts was a compromise between having a low floor bus and at the same time providing the operators with an improved design bus.<sup>59</sup> UMTA promulgated a standard procurement policy which required all buses purchased with federal financial assistance to comply with the Transbus Procurement Requirements (TPR). The TPR's technical specifications were based mainly on the interim bus technology and the prominent feature was the "effective" 24-inch floor height when at stops. The term "effective" implied a performance specification since it could be met with a combination of both low floor height and kneeling feature.<sup>60</sup>

In 1977, however, as soon as the new Administration took office it suspended the TPR mandate, announcing that UMTA would hold new hearings on the issue of Transbus policy and the E/H transit accessibility.<sup>61</sup> The

new Administration (DOT Secretary, Brock Adams), after the hearings announced that:

"I believe it is my responsibility to insure to the extent feasible that no segment of our population is needlessly denied access to public transportation. It is now within our technological capability to insure that elderly and handicapped persons are accorded access to urban mass transit buses. This access is fundamental to the ability of such persons to lead independent and productive lives..."<sup>62</sup>

Whether due to political commitments to E/H or a genuine belief that low floor technology would be feasible (since later it would be proven otherwise), DOT (UMTA) expressed its intent that it would soon develop a procurement policy for buses which would reflect a low floor specification bus.<sup>63</sup> All buses purchased with federal financial assistance after September 30, 1979 must comply with the latter procurement policy.

An elaborate and thorough revision of the original TPR got underway to reflect the intent of the new mandate. The new TPR was mandated in September 1978.<sup>64</sup> The most prominent changes in the specifications were related to the low floor componentry especially the tandem axle requirement at the rear.<sup>65</sup> Some observers viewed the new TPR as very stringent, given the fact that most of the warranties required involved potentially "unproven" subsystem component.<sup>66</sup> Indeed, most complaints of one manufacturer and her justification for not bidding was that the warranty provisions of TPR were "impossible" which was concurred by the independent entities who studied the Transbus after no bid was received.<sup>67</sup>

The succeeding DOT (UMTA) administration, Secretary Neil Goldschmidt, suspended the low floor TPR in August 1979 opening the way for procurement of interim buses.<sup>68</sup> The new administration is now in the process of developing a new procurement policy on buses and has acknowledged that there would be distinct recognition of E/H mobility and accessibility needs as regards

accessibility.<sup>69</sup>

#### MARKET ISSUES AND THE MANUFACTURERS

An important goal in awarding the contract for development of Transbus was enticement of new entrants into the market.<sup>70</sup> In fact, initially the vehicle prototype development/building contract was drawn up to include only two manufacturers GMC and Rohr Industries, Inc. (Rohr).<sup>71</sup> Rohr had recently acquired the Flexible Company (the only competitor GMC had had since the 1950's).<sup>72</sup> Later, in finalizing the development/building contracts the American General Corporation (AMG), which was a subsidiary of American Motors Corporation, had been "enticed" into entering the market thus increasing the prospective competition.<sup>73</sup>

Bringing in another competitor had arisen out of UMTA concern over effects of government policy on the monopoly aspects of the market. This was particularly true in light of GMC's proposal for the RTS procurement and the 1965 antitrust suit. In the process of the Transbus program UMTA had tried further to mainstream AMG into the market by "encouraging" the operators to purchase their bus rolling stock from AMG (such as Washington Metropolitan Area Transit Authority) which had in the end resulted in the operators' dissatisfaction.<sup>74</sup> Among other things this was due to the inexperience of AMG in this market. Ironically, AMG would quit the transit market in June 1978, six years after its entry into the market.<sup>75</sup> AMG had cited the inconsistent government policies and the small size of the market as reasons for halting bus production.\*

AMG had from the start, continually opposed any federal government

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\* AMG is still involved in production of articulated buses but in very low volumes.

policy which would depart from a standardized design bus. For instance, after in 1973 GMC had issued a statement that it would soon start the production of its Advanced Design Bus (ADB) or interim bus (essentially GMC's RTS), and thus doubts had been raised about the commitments of the federal government to the standardized design bus.<sup>76</sup> UMTA, however, had reassured the manufacturers that were not in a position to produce ADB's.

First signs of departure from the standard design bus appeared in 1975 when UMTA issued its policy statement to mandate the transbus without further operational testing and on the basis of performance specifications. Moreover, the funding for the interim bus or ADB would be forthcoming. The last feature was particularly unpleasant for AMG and Rohr since they had not prepared for production of an interim bus. The situation became more complicated in 1975 after GMC publicized its interim bus called RTS-2 and announced that it would be accepting orders.<sup>77</sup>

ADB had several prominent features. ADB was a Transbus floor up and "New Look" floor down, It incorporated improved seats, streamlined body, more efficient engine, and an optional (29-inch) low floor.<sup>78</sup>

The next move on the part of federal government which finalized the total shift away from the standardized design bus came in 1976. The Administrator of UMTA had promulgated the TPR which was essentially a set for performance specifications for an interim bus.<sup>79</sup> This had come as a result of the inability of at least two manufacturers to independently tool up for Transbus production and the reluctance of the other competitor (AMG, Rohr and GMC respectively).<sup>80</sup> Further, with no federal involvement in development of the needed low floor subsystem components a Transbus would be at least 5 years away.<sup>81</sup> This in turn implied that in the meantime something had to be done about the procurement of interim buses. After

all, transit industry's replacement deferrals may not be desirable from economic and service standpoint. It should be noted that the ability of GMC to produce an interim bus without financial assistance from the federal government was extremely important in formation of the first TPR policy.

The subsequent low floor Transbus mandate in early 1977 probably was a hopeful sign to AMG since it had also lost a suit against the DOT to enjoin UMTA from funding interim buses charging exclusionary specifications were used in the first TPR.<sup>82</sup> This mandate, however, was very shortlived. Shortly afterwards, AMG quit the market and later other manufacturers would successfully, through not bidding for low floor Transbus, force the federal government to change its policy on Transbus in favor of an interim bus.

#### ROLE OF THE TRANSIT INDUSTRY

Beyond the cooperation with Booz-Allen and UMTA in developing the initial Transbus prototype specifications the transit industry's two efforts in procuring the low floor Transbus were ineffective. First, in 1975, immediately after the conclusion of evaluation/tests the transit operators in cities of Los Angeles and Seattle cooperatively developed a set of bus specifications and presented it for bids.<sup>83</sup> These specifications corresponded to the low floor Transbus. At the beginning Rohr had expressed interest in bidding for the Transbuses. As it became clear later, however, that Rohr would not receive any direct federal financial assistance, it decided against bidding for the Los Angeles-Seattle Transbuses.<sup>84</sup> In this way the first chance to build the Transbus in an industry-initiated effort was lost.

Second, cities of Los Angeles, Miami, and Philadelphia formed a similar consortium in 1977 in order to be the pioneering transit properties to have Transbuses in their fleets.<sup>85</sup> This consortium was also formed in order to

give a degree of continuity to the production process, and provide for a minimum order quantity.<sup>86</sup> In reality the specifications of each city included such variation that they were detrimental to the continuity goal.<sup>87</sup> In the end though there would not be any bids to the 530 Transbuses.<sup>88</sup>

Thus, both industry-initiated attempts to go-ahead with the low floor Transbus were not successful. Interestingly, the transit industry overall was not particularly keen on the idea of low floor Transbus.<sup>89</sup> The reasons for this were apparently due to inadequate testing of the components and the traditional attitude towards problems of innovation. The reasons will be further analyzed in more detail in Chapter Three.

#### IMPACTS OF E/H LEGISLATION: SECTION 504

The legitimacy of the E/H right to public transportation was first recognized by the federal government in 1970 when Section 16 amendments to the UMT Act of 1964 required special considerations for the E/H needs.<sup>90</sup> A stronger recognition came with the 1973 amendments to the Federal-Aid Highway Act and the Rehabilitation Act.<sup>91</sup> According to the Highway Act amendments, if federal assistance is requested for mass transit, the transportation secretary must be assured that transit projects receiving federal financial aid can be effectively used by the E/H.<sup>92</sup> The Section 504 amendments to the Rehabilitation Act adopted a more blanket civil rights approach of requiring that:

"No otherwise qualified handicapped individual in the United States...shall solely by reason of his handicap, be excluded from the participation in, be denied benefit of, or subjected to discrimination under any program or activity receiving Federal financial assistance."<sup>93</sup>

The regulatory compliance with the Federal Highway Act requirements as to the needs of E/H first appeared in 1975 as a part of the Transportation



Improvement Plan and Transportation System Management joint regulations by UMTA and Federal Highway Administration.<sup>94</sup> The next step was taken in April 1976, which specifically dealt with the issue of E/H use of public transportation as a mobility requirement.<sup>95</sup> The latter represented a clarification of UMTA's position on hardware aspects of E/H transportation in relation to technological undertakings by UMTA such as the Transbus.<sup>96</sup>

Later in 1976, an Executive Order required timely (within 3-5 years) compliance of all federal agencies with the Section 504 amendments to the Rehabilitation Act.<sup>97</sup> The worrisome aspect of the Section 504 requirements from the transit industry's point of view was its civil rights interpretation of public transportation, that is, equal access as opposed to equal mobility for the E/H.<sup>98</sup> The issuance of the Executive Order was probably to eliminate the doubts as regards the extent of the regulations and due to a string of court cases which involved E/H parties suing the transit authorities and the federal government for non-compliance with Section 504 amendments.

The doubts on the extent of the regulation originated from the likely costs of making the transit industry since an equal access interpretation of the federal law would be considerably more costly than an equal mobility one. This would be especially true if the regulation required blanket and retroactive compliance. The DOT rulemaking process on Section 504 lasted almost until early 1979. In May 1979, the DOT finally promulgated the corresponding regulation effective July 2, 1979.<sup>99</sup> The APTA in objection to transit accessibility requirements regulation, filed a suit enjoining DOT from execution of the regulation. The case is still in the courts after several appeals. The Transbus constituted an important part of these regulatory requirements.

The vagueness of a new federal law, the ensuing litigation, and the final clarification of the law is a rather familiar historical pattern in the United States. In the case of the Section 504 amendments a brief description of a number of litigation cases would enhance our insight into the relation between the technical, and political-legal aspects of the accessibility issue.

One of the early court cases in 1975, involved a wheelchair user (Snowden v. Birmingham-Jefferson County Transit Authority) who brought suit against local and federal transit officials, contending that the development and operation of the federally assisted public mass transportation system that was not accessible to non-ambulatory persons violated her rights under Section 504 amendments of the Rehabilitation Act and the Constitution.<sup>100</sup> She sought an injunction stopping the purchase of the inaccessible buses, "until adequate and effective public mass transportation" had been made available.<sup>101</sup>

The local transit authority, however, argued that the twenty-two new 45-passenger buses it was planning to buy, although not accessible to the wheelchair users, included several improved features for the elderly and physically handicapped. The court accepted the defendants' view and stated that accessible standard buses designed for "safe and convenient use by passengers confined to wheelchairs" were not in production yet.<sup>102</sup> Moreover, the court pointed out the ongoing research, development and demonstration efforts of UMTA in this field, namely, the Transbus program. Finally, the court passed judgement in favor of the defendants (the transit authority) and its decision was affirmed by the appellate court.<sup>103</sup>

Two more subsequent cases involving the accessibility issue closely followed the line of argument in the Snowden case.<sup>104</sup> Later, in the case

of *Bartels v. Biernat*, however, a departure was made from the three earlier cases.<sup>105</sup> This case involved a group of handicapped plaintiffs who brought suit to gain greater access to the public transportation system. The plaintiffs sought to enjoin the defendants from purchasing a hundred new buses, none of which was "accessible." The court issued a preliminary injunction restraining the defendants from accepting any bids then outstanding on the buses pending final action by the court.<sup>106</sup>

In the meantime, another case came about which again involved the accessibility issue of transit. In this case (*Lloyd v. Regional Transportation Authority*) the plaintiff had been unsuccessful in arguing his case before the lower district court, so he appealed his case to the U.S. Court of Appeals.<sup>107</sup> The Appeals Court in its opinion stated that, "handicapped persons who could not gain access to the transit facilities were effectively foreclosed from any meaningful public transportation."<sup>108</sup> It then remanded the case to the lower court for further proceedings.

In the *Bartels'* case the court delivered its second opinion. It stated that the local and federal transit officials had violated the Section 504.<sup>109</sup> The court granted judgement in favor of the plaintiffs and issued a permanent injunction against local and federal mass transit officials. The local transit authority was permanently enjoined from acquiring, leasing, renting, or in any way operating any mass transit vehicles that were not destined for "accessibility and effective utilization by mobility handicapped."<sup>110</sup> The federal defendants were ordered not to release funds to the local defendants for any mass transit vehicles which did not meet the requirements imposed on local defendants (an additional provision allowed funding for emergency cases).<sup>111</sup>

These court cases certainly affected the decision on the accessibility

requirements of the regulations as well as changing the priority patterns of goals of programs such as the Transbus. For instance, in the beginning the overriding objective of the program may have been introduction of new improved buses in transit operations. Later, a multiple of objectives had to be served including accessibility of the buses as reflected in the court cases.

The pressure to provide accessible transportation was not limited to the judiciary. Congress had shown keen interest in the implementation of Section 504. Particularly, a General Accounting Office\* report to the Congress in 1977 had criticized the DOT along with UMTA in not responding to the E/H public transportation needs.<sup>112</sup>

## 2.6 SUMMARY AND CONCLUSIONS

This chapter provided us with insights about the Transbus program from its inception through its abandonment, and finally to its aborted revival. UMTA undertook Transbus under its Research, Development, and Demonstration programs authority. The program got under way in 1971, although the federal government's interest in undertaking such a program went as far back as 1967. In particular, in 1967, the National Academy of Engineering had prepared a study on design/performance criteria for new transit buses, and also had presented a plan for undertaking such a program. The federal government, i.e., UMTA of the DOT, initiated the program after turning down GMC's request for advance procurement of its RTS bus. The RTS bus was a modified version of RTX model bus that GMC had started to experiment on since 1964. The demonstration of RTX to the transit operators in 1968

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\* General Accounting Office acts as a watchdog of the Executive Branch for the Congress.

had brought out several "undesirable" points about the revolutionary low floor height (24-inch) feature.

The Transbus program was initiated by the Secretary Volpe administration, with a tentative plan to procure 100 buses from each prototype manufacturer upon conclusion of tests/evaluations on prototype vehicle models. This plan, however, was not executed by the succeeding administration. Instead, UMTA announced in 1975 that a set of performance standards pertaining to Transbus prototypes would be mandated which would require compliance by all federally funded buses. The following year, the new administrator of UMTA, namely, Robert Patricelli, promulgated a set of performance specifications utilizing the existing bus technology. The corresponding regulations were entitled Transbus Procurement Requirements (TPR), and in effect required a 24-inch "effective" floor height on all buses purchased with federal financial assistance. Moreover, along with the promulgation of TPR Patricelli terminated all direct federal government involvement in further development of Transbus.

In 1977, the new DOT administration suspended the TPR mandate, and revived the Transbus. After revising the TPR to reflect the change, it set the effective date for the new TPR as September 30, 1979. The new TPR was essentially a set of specifications formulated on the basis of Transbus prototype characteristics. In the meantime, a procurement consortium consisting of operators in three cities was formed to purchase the first 530 Transbuses. The formal bid date for these Transbuses, however, elapsed and no bids were received for production of 530 Transbuses. In fact, the only two U.S. bus manufacturers, i.e., GFC and GMC, had presented their arguments justifying their refusal to bid before the bid opening date.

This created considerable controversy, so much so that first, a

congressional hearing was held, and second, the DOT commissioned two studies by independent sources to investigate "whether Transbus was buildable." These studies, by the Mitre Corporation, and the National Research Council, in essence concurred with the manufacturers' reasoning against bidding for the 530 Transbuses. Also, the DOT suspended the Transbus mandate in August 1979, and opened the way for procurement of the Advanced Design Buses (ADB) which utilized the existing technology. It may be noted that the first TPR was formulated so as to allow procurement of ADB's.

From the string of court cases and the announcement by Brock Adams, one might conclude that his decision to revive Transbus was very much influenced by the Elderly/Handicapped (E/H) legislation and the rising concern over a strategy to mainstream the latter group in the main population. Specifically, UMTA intended to carry out the mainstreaming process via public transportation, that is, providing technologically accessible buses. Further, the decision to implement the E/H legislation in this manner was partly due to civil rights interpretation of the E/H right to public transportation. In other words, providing equal access instead of equal mobility. In the end, though, this interpretation proved impracticable from the operational standpoint (at least by the manufacturers).

Several conclusions may be reached from the case study:

1. UMTA emphasis on hardware-oriented RD&D programs during the post-1970 period was partly responsible for undertaking the Transbus program, i.e., viewing transportation problems as technological;
2. GMC's efforts to secure a guarantee by federal government for its RTS bus may have been a key factor in initiating the Transbus program;
3. The enticement of AMG into the transit market proved a false strategy since efforts to further sustain AMG in the market, after the policy shift against standardized bus design, were beyond what the federal government

regarded as reasonable;

4. Participation of the transit operators in the Transbus policy-making, and implementation processes was at best nominal and only in an advisory capacity. This was manifest in transit operators' displeasure over the policy to mandate the Transbus without further operational testing;
5. Posture of each DOT (UMTA) administration directly affected the Transbus policies, to the extent that it shifted the priorities of the program according to the outlook of each administration; and
6. Elements external to the program which were probably not taken into account in the original plan later effectively changed the course and schedule of the Transbus program, i.e., E/H legislation.

## CHAPTER THREE

### ANALYSIS OF THE TRANSBUS PROGRAM

#### 3.1 INTRODUCTION

If one fails to learn from one's errors and not benefit from hindsight, there would be no hope for future correction of these mistakes. Moreover, one course of action would seem as good or as bad as another if a learning process does not take place. If these statements are true for individual actions why not apply them to organizational actions of the past and identify mistaken assumptions or strategies so that mistakes will not be repeated. That is precisely what will be done in this chapter. In analyzing the Transbus case study the merits and disadvantages of particular actions at various stages in the program will be judged and subjected to scrutiny. The implicit assumption in this analysis is that the lessons and insights from this examination will be useful for future decisions. The analysis will provide a basis for the formulation of technology policies, and the implementation of these policies in the public transportation sector.

In this chapter, the Transbus program will be divided into two parts so that analysis will be easier and more orderly. These two parts include Part-1, activities leading to the development of the first Transbus procurement policy, and Part-2, the subsequent events up to present time.\* Effort will be made to address technical, economic, and political issues involved, although the focus of the analysis will be on formation and evolution of program objectives, and procedures employed to achieve these objectives.

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\* This approach is not unique. A quite similar approach was adopted by the National Academy of Engineering study.



### 3.2 PART-1: TRANSBUS IN THE MAKING

In this section Part-1 will be studied as regards policy making process, namely, policy inputs, the formulation process, policy design, and implementation strategy. It should be noted that activities in Part-1 are mainly related to development of technology. In Part-2, on the other hand, the main concern is deployment of technology.

#### THINKING ABOUT TRANSBUS: POLICY INPUTS

It was pointed out in Chapter 2 that the General Motors Corporation (GMC) efforts to market the RTS bus, GMC's 1965 antitrust suit, the procurement obligations of Urban Mass Transportation Administration (UMTA), the posture of the Department of Transportation (DOT) officials, and the general mood popularity of seeking technological fixes to public transportation problems heavily influenced the Transbus program. We will now take a closer look at these inputs. These inputs may be referred to as either external elements or internal elements. External elements are related to those events which happened independent of internal elements; internal elements being those related to events which happened because of particular characteristics of the period under consideration. The grouping of these events under either of the two categories is subjective, and of course depends on one's perspective. In the case of Transbus, however, the development of RTS bus by GMC, the antitrust suit, and the procurement issues may be regarded as external elements. Any other matter relating to the administrative posture of DOT could be regarded as internal.

The stabilization of the bus market and the improvement of bus design were among the early goals of the UMTA when it started the Transbus program.<sup>1</sup> In order to understand the market stabilization goal we need to study the

three above external elements.

GMC's efforts to design a new bus went back as far as 1964.<sup>2</sup> In 1968, after several experiments and tests, a prototype model bus was finally built.<sup>3</sup> In demonstrations to the transit industry, however, it was discovered that the so-called revolutionary low floor (24-inches height) and its related components associated with the new design had yet to be fully developed on a commercial basis.<sup>4</sup> Also, the operators were extremely apprehensive of such a sudden departure from the conventional design. The attitude of the operators was understandable in light of the low technology base of the transit industry, and failure of most previous innovative attempts.<sup>5</sup> Therefore, the low floor design bus, known as the Rapid Transit Experimental (RTX), was sent back to the drawing board for modification.

The RTX design after undergoing considerable revision, i.e., abandoning the revolutionary low floor, became known as the RTS model.<sup>6</sup> The RTS bus had several passenger/driver amenities which were absent in the older model. These included 4 to 6 inches reduction in the floor height, better seating arrangements, improved ride quality, more powerful and efficient engine, and improved aesthetics. In GMC's view, the RTS bus represented a reasonable compromise which would be acceptable to the conservative transit operators, and at the same time could be regarded as an innovative attempt. The transit industry, however, was not the only party GMC had to deal with. A commitment from federal government, specifically from the DOT, had to be obtained before committing capital to the production of the new RTS design.

The federal government had become directly involved in transit affairs after 1961 (amendments to the Housing Act).<sup>7</sup> The follow-up, i.e., the Urban Mass Transportation Act of 1964 (UMT Act), and the subsequent amendments have added to the extent of the federal responsibility and involvement.<sup>8</sup>

Particularly, federal financial assistance to transit has grown several fold since 1964. Among other things, UMTA's approval was required before funds could be committed to acquisition of rolling stock. It should further be noted that majority of these rolling stock acquired with federal assistance were buses. Thus, matters related to marketing of a new bus technology such as RTS was of great importance to UMTA. After all, even if the transit agencies proposed procurement of the new technology, UMTA's approval was imperative in order to obtain federal assistance.

GMC's concern though was not just over approval of RTS by UMTA, but she was more concerned with a possible increase in price of the RTS over the current model.<sup>9</sup> The implication of a higher price for GMC was that, if there were any competitors in the market offering cheaper prices, then GMC may not recover its capital expenditures for RTS (and of course not make adequate profit). Ordinarily this should not be a concern in any market, since it represents the free enterprise competitive doctrine. In the transit bus market, however, the situation was quite different. First, the major customers for the product of this market, i.e., transit buses, were transit operators. Also, the transit operators were mostly publicly owned (by state, local, or the municipality governments). Further, these publicly owned transit agencies received two-thirds of their capital for new rolling stock (including buses) from the federal government (UMTA) under the provisions of Section 3 of the UMT Act of 1964.<sup>10</sup> Second, the volume of sales in the market was relatively small, and had stayed quite stable since the 1950's (2000-2500 units per year, at \$50,000 per unit, a \$100,000,000-\$125,000,000 market).<sup>11</sup> So most likely the new product would replace the older one, and unless the end users were prepared to pay a higher price for the new product, it was financially unwise for GMC to commit itself to the new product.

Third, GMC had lost its exclusive patent rights to the current model buses as a result of an antitrust suit by the Department of Justice.<sup>12</sup> The anti-trust suit against GMC led to a consent decree which stated that:

--GMC is enjoined from owning any financial interest in any other manufacturer of buses or any bus operator;

--GMC must make available parts and technical aid, while certain constraints, to its competitors at prices quoted for interdivisional billing within GMC;

--GMC is to grant royalty-free licenses on patents held and developed since 1965 in the area of mass transit up to 1970, and on a "reasonable" royalty basis to 1975; and

--GMC has to either establish a competing firm or sell their bus manufacturing facilities if their principal competitor [Flexible Company at the time] should disappear from the market before 1975, or if GMC should increase their share of market above the 1964-1965 level by 1975.<sup>13</sup>

Therefore, in light of the above factors, and the tentative consent of the transit operators, it was imperative for GMC to secure the commitment of federal government for a minimum order of the RTS buses.

Assurances to GMC for a minimum order of buses, even though UMTA had been funding the purchase of "New Look" buses for which GMC enjoyed 85% of the market share, could be problematic. It was one thing to use federal funds for purchase of a product already on the market, and it was quite another to promise procurement of a forthcoming product. Also, and perhaps most importantly, according to instruction from the Office of Management and Budget, all federal agencies involved in product procurement were required to comply with competitive bidding requirements.<sup>14</sup> The objective of the competitive bidding process was promotion of competition, and prevention of possible waste. The consequence of competitive bidding mandate for UMTA was that, only the lowest bid could be accepted in the process of acquisition of rolling stock.\* This precluded the advance procurement arrangement which GMC had requested for the RTS bus. Further, the prospects for pro-

curement of a product which was priced higher than the competing products went cross-grain to competitive bidding requirements. In addition, UMTA had to observe policies of other federal agencies, namely, the antitrust suit by the DOJ. In effect, a promise of procurement to GMC on her RTS bus could drive the only other bus manufacturer, the Flexible Company, out of the market. This would undo what the antitrust suit by the DOJ had hoped to cure.

In other sectors of the federal government, particularly the defense, because of the extensive federal involvement in development of technology since the World War II, a standard formula had evolved which would satisfy the above requirements. This formula was called Research, Development, Testing, and Evaluation (RDT&E).<sup>15</sup> RDT&E referred to the management of the development of military hardware, and it extended from initial determination of requirement for a system with defined design and performance capabilities to operational deployment of the system. Very often, a number of firms would be contracted to develop prototype models of a certain system. Then upon testing and evaluation of the developed prototype models, the prototype with most superior design and performance characteristics would be selected. Subsequently, the production of the product with the above characteristics would be contracted, according to the competitive bidding requirements, to the lowest bidder. This formula was considered as giving a fair chance to each competitor in delivering the final product, especially since the involvement of the federal government was regarded as intervention in the market place. At first glance, the same strategy seems sensible in developing a new bus, but, as we shall see, experience proved otherwise.

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\* A waiver provision was provided by UMT Act of 1964, only under special circumstances.

UMTA did, indeed, choose the above course of action to relieve the deadlock created by the triangular problem of GMC trying to market the RTS bus, non-monopoly market competitive market preservation efforts by the DOJ, and federal procurement obligations of UMTA under competitive bidding requirements. The plan to launch a federal technology development program for new transit buses was announced in late 1970, and it actually got under way a year later.<sup>16</sup>

We have briefly considered the external inputs to the Transbus policy process, now we look at the internal input. As noted earlier, internal denotes a certain posture or mood which may change with time. In the late 1960's, at the time of the DOT's creation, seeking technological solutions to transportation problems of the U.S. was a rather prevalent attitude. Among the most famous examples of projects undertaken in keeping with this attitude were the Urban Tracked Air Cushioned Vehicle (UTACV), Personal Rapid Transit (RPT), and Light Rail Vehicle Rapid Transti (LRV) standardization.<sup>17</sup> This technological optimism may have been partly due to successes in satellit and communication technologies in space programs of the 1960's which were sponsored by the federal government.

Whatever the reasons, the above view is manifest in sudden increase in Research and Development (R&D) activity by UMTA. The histrogram in Figure 3.1 shows the trend in UMTA's spending on Research, Development, and Demonstration programs for the period 1962-1978.<sup>18</sup> The level of expenditure on hardware development increased substantially during the early 1970's, and surged to its maximum in 1973. In the same period, the number of high technology firms entering the transit equipment market rose significantly, especially from the aerospace industry (e.g. Rohr Industries, Inc., and General Electric Corporation).<sup>19</sup> On the other hand, the expenditure on R&D in the

post-1973 period has declined both in real and actual terms, i.e., constant and current dollars.

The increase in public transportation R&D activity in the early 1970's coincided with the beginning of the second DOT administration. The Secretary of Transportation at this time was John Volpe, and his administration became known later for its high technology advocacy.<sup>20</sup> Among his well known efforts to move in this direction was the strengthening of UMTA's R&D management skills. As noted in chapter two, appointment of Robert Hemmes to the Office of Research, Development, and Demonstration (RD&D), and the subsequent standardization of contracting procedure, towards unsolicited in-house generated RD&D projects, were direct results of the above Volpe policy.

Given the above posture of the DOT (UMTA), and the bus problem which it was facing, choice of the RDT&E strategy should come as no surprise. This strategy proved unsuccessful in the end, although the strategy per se cannot be faulted. It probably failed because the method of application of this formula may have been at fault. The most prominent reasons for successful application of the RDT&E strategy may be found in different characteristics of the defence technology and the transit technology markets. First, the defense-related industries market have a very high technology base compared to the transit manufacturing industry, and consequently in most cases problems with new technologies are more operations than development related. Second, the level of government spending on space and defense-related technology projects are much higher than on the transit-related projects. Comparison of the budgets in the Departments of Defense and Transportation, and funding levels for individual projects would warrant this.<sup>21</sup> Third, the end user of the defense-space technology is the federal government

itself, while the customer for transit technology is at the local level.<sup>22</sup> This affects the characteristics of the technology which in most cases has to satisfy numerous, and sometimes conflicting demands due to geographical-political dispersion among the local transit agencies.

It may be appropriate to note that authority to undertake RD&D independently was given to UMTA only after 1964, and in the early 1970's UMTA utilized opportunity to the full extent. Also, it was this authority which allowed UMTA to undertake such programs as the bus technology program. These projects might otherwise have been impossible, since the local transit operators might not have been willing to share the costs of development. This has both advantages and disadvantages to it. For instance, the federal government can undertake hardware development projects which would have been unfeasible to undertake for local transit operators due to financial, political, institutional, and economic reasons. While ironically, for exactly the same reasons any federal undertaking might fail to achieve its goals and objectives.

#### TRANSBUS POLICY DESIGN

UMTA's goals in undertaking the bus technology program, according to Carlos Villarreal, Administrator (1969-1973), may be summarized as follows:

- "After a lot of discussion internally and with the industry, we concluded that the only way to bring the new bus to the market without destroying the last vestiges of competition was to do three things:
1. UMTA would establish a standard bus specification, with limited options, that would make use of the best features of the prototype vehicles to be designed, built, and tested by the General Motors, Flexible, and AM General. The market for this vehicle would be assured by restricting the use of federal assistance funds to this model;
  2. Product development costs, through the testing and demonstration phases, would be borne by the federal government under the UMTA research, development, and



demonstration program.

3. An initial order of a size sufficient to defray tooling costs would be negotiated with each supplier. Thereafter, competitive bidding would be required."<sup>23</sup>

UMTA proceeded to accomplish the above goals by first hiring a consulting firm, Booz, Allen, Hamilton Applied Research, Inc. (Booz-Allen henceforth), as the prime contractor.<sup>24</sup> The prime contractor would in effect be an intermediary between the federal government, and the product prototype development contractors. As the prime contractor Booz-Allen would develop specifications for the new bus, and it would also monitor progress of the project, as recommended by the 1967 NAE study.<sup>25</sup>

The specifications for the new bus were developed by Booz-Allen. The specifications underwent several reviews before they were finally adopted.<sup>26</sup> Advice of the transit industry in development of the specifications was sought to encourage their participation. Specifically, a Bus Technology Committee was formed whose members were representatives from the American Public Transit Association (APTA).<sup>27</sup> One skeptic from the industry recently noted, however, that "our participation was and still is nominal in programs such as Transbus...and ourselves are to blame for not having a more effective lobbying to get involved."<sup>28</sup> Getting the transit operators to participate in the hardware projects, e.g., Transbus, is a compound problem, since the transit operators as a whole are very operations oriented.

Along with the development of specifications, bids were solicited for developing the new bus.<sup>29</sup> In 1972, the bid selection process was finalized after three of the bidders were announced as the subcontractors for the development phase of the program.<sup>30</sup> These three included American Motors General Corporation (AMG), Rohr Industries, Inc. (Rohr), and GMC. GMC was the last remaining manufacturer in the market with the exception of Rohr, which had taken over the Flexible Company in early 1970, and was

among several aerospace firms to enter the transit market at this time.<sup>31</sup> AMG's entry into the transit market, on the other hand, was the result of direct enticement by UMTA in order to encourage competition in this market.<sup>32</sup> UMTA had encouraged entry of a new competitor in the bus market since it was contemplating about promotion of competition, and increasing the production capacity of this market in light of possible future increase in demand. In fact, in 1972, a UMTA study had predicted that demand for 40-foot buses for the period 1972-1980 could reach 6,000 units annually.<sup>33</sup> This figure was essentially twice the largest annual demand for transit buses since the 1950's, although some observers had predicted volumes close to 20,000-25,000 annually.<sup>34</sup> Evidence in Table 3.1 and Figure 3.2, however, show that the demand for buses has yet to reach the 6,000 level.<sup>35</sup>

As noted earlier, there were other new manufacturers entering this market beside AMG and Rohr. The efforts by these firms may be characterized as technology utilization ventures, which aimed at introducing some high technology products into the transit market. The encouragement, of course, had come from the federal government, i.e., UMTA, that had increased its R&D expenditures in this period significantly. It has been estimated that in addition to federal assistance, private investment on such ventures might have reached \$250,000,000.<sup>36</sup> The results, however, have been disappointing, and accompanied by a private sector loss equal to the latter figure, and along with several market exits (e.g. AMG itself in 1978). A UMTA official has noted on this period as "trying to put too much technology in and rushing it into deployment in a hurry."<sup>37</sup>

As far as the bus technology program was concerned, bringing in an additional competitor proved wasteful, and inefficient, since in the end AMG quit the market.<sup>38</sup> Interestingly, at first only GMC and Rohr were

considered for development of the new bus, and AMG was later added to the list for reasons noted earlier.<sup>39</sup> This was an important step in the design of the Transbus policy, since clearly the perception of the federal government, and the transit operators as regards the importance of competitive environment were quite different. Further, enhancing competition in a certain market may not merely depend on the number of competitors in that market, but on a combination of factors such as the technology base, volume of sales, end user demands, perceived degree of financial risk on new product ventures, deployment environment of the technology, etc. It has, however, been observed that potential demand for a product market is the most effective agent in promotion of competition in that market.<sup>40</sup>

Another important aspect of the new bus policy was the standardized design. In keeping with this, Booz-Allen developed a set of specifications which were a mix of performance-design, although they were referred to as performance specifications.<sup>41</sup> Table 3.2 shows several of these specifications. Among the most technologically important of these specifications were the 17-inch floor height at the front door (for when the vehicle is stationary), and entry provisions for individuals in wheelchairs, since in the end these two features created the most controversy, and also affected other critical components.

To begin the analysis of the above issues, it is important to separate the objectives of the above design features. This is essential in formulation of any policy, since the "value" of, say, having a low floor depends entirely on what objectives are being pursued. This, of course, is the rational approach to analyzing the events by judging the attainments against the objectives. The analysis will first focus on the low floor goal.

The inspiration for the Transbus design goals originated from the NAE

study, particularly the low floor requirement. In that study, NAE had noted that "a lower floor level may be the most desirable means for improving ease of entrance and exit."<sup>42</sup> This comment was mainly based on an informal survey (through newspapers) conducted by NAE whose respondents were identified as either physically handicapped or aged.<sup>43</sup> The most significant complaint from the latter group was that "the steps were too high" on buses, and NAE's recommendations on design of the steps were as follows:

"Height above street; No difference in elevation between floor of vehicle and curb is desirable. In no event should the height be more than 7 inches; and  
Step height: While steps of any sort are undesirable, if they are used they should have riser heights the same as that between the street or curb entrance.  
In no event should the step risers exceed 7 inches."<sup>44</sup>

In other words, ideally no difference in floor height and curb height is desirable or the less the difference the better, and further along the same lines the step height and the riser heights should be equal. The NAE stated, on the consequences of lowering the floor height, that:

"Elimination or substantially lowering the access steps will result in significant changes in the geometry and content of the vehicle components. For example, eliminating conventional transverse axles to lower the floor level, and replacing them with completely independent wheel and suspension units, will totally changed the present mechanical steering and transmission geometry... and a reduction in wheel diameter may follow in order to minimize wheel housing intrusion on the floor area."<sup>45</sup>

The purpose of the low floor in the bus technology program was to achieve very specific objectives which included reduction in dwell time, and safer ingress/egress.<sup>45</sup> According to the specifications boarding time could be halved by lowering the floor 50%, i.e., 34 inches to 17 inches, and also by widening the doors from 27 inches to 40 inches.<sup>46</sup> Table 3.3 contains a number of design goals which were incorporated in development of the specifications. These design changes, however, affected the operational aspects

of the bus considerably, since the changes represented a major departure from the conventional buses. Indeed, the NAE study had recognized this factor, in addition to the economic effect of these changes:

"Vehicles presently available from manufacturers, when equipped with accessories and features that are also now available, can meet over 80% of the criteria developed... Thus substitution of new high performance vehicles for older inadequate vehicles is held back far more by economic than by technological considerations."<sup>47</sup>

Therefore, the NAE had in effect stated that, utilities and costs associated with a low floor design (due to those 20% commercially undeveloped componenetry) have to be taken into consideration before commitment to a design could be made. The difficulty with comparison of design features such as low floor versus high floor is that, unless costs and benefits associated with each are quantifiable, the final choice has to be made on social equity grounds. Such choices are perfectly acceptable, although very often the decision on these grounds are made without clear statement of the corresponding assumptions.

For instance, in the Transbus case, after completion of the tests Booz-Allen attempted to quantify contribution of the low floor and wide doors to the reduction in total trip time. It was concluded that, if the dwell time were reduced to the minimum possible as a result of the above design changes, the maximum potential for reduction in total trip time will not exceed 10%.<sup>48</sup> Further, due to possible increase in bus usage by the physically handicapped and wheelchair users, any such reduction in total trip would be offset by an increase in the dwell time which corresponds to the latter users. The above arguments, however, would only apply to urban areas because of street congestion, and clearly most of transit bus usage does take place in such areas.

At first glance, the above argument could be taken as evidence against

the utility of low floor considering the costs associated with development of related components. It is, however, useful to note that the tests by Booz-Allen were limited to a total of 24 days, and buses were used in selective service usage.<sup>49</sup> Further, the calculations were based on extrapolation of the data collected. Thus, it must be clear that, although the quantified contribution from the low floor could be used as a guideline, its value as the sole basis for a decision in favor or against the low floor would be in doubt. By no means it is implied here that such decisions are not made or should not be made. The objective is to convey that these decisions are mostly social in the public sector, or entrepreneurial in the private sector. Thus, they usually preclude a reliable quantified analysis of expected costs and benefits.

The other important design feature was the entry provision for wheel chair users required on prototype vehicle models, although no specific type of device was required. The practical considerations, however, limited the choice of devices to either a lift or a ramp. At the start of the program superiority of either devices was yet unsure, and to date that still holds true.<sup>50</sup> The two manufacturers currently operating in the market, however, have opted for the lift on their interim model buses.<sup>51</sup> This was despite the fact that the cost of each lift would be between \$7,000 to \$10,000.<sup>52</sup> This choice was made due to the possible dangers of operating a ramp at low height curbs which could increase the chance of accidents involving the wheelchair users. Also, the mechanism of a lift is considered more feasible from maintenance and operational points of view.

It should be noted that although the controversy over the feasibility of ramp and lift continues, the real question involved here has not been technical in nature. A recent survey by UMTA has shown that out of the

total transportation handicapped population, 7,440,000, only 5.5% were identified as wheelchair users.<sup>53</sup> Further, only 5% of the latter group would utilize public mass transportation facilities if given the opportunity.<sup>54</sup> It appears from the above evidence that decision on the use of the life (ramp) very clearly involves social issues of greater importance than the corresponding technical ones. Specifically, the issue of providing separate service to wheelchair users has to be decided on the basis of social-economic considerations.

The development of Transbus first began in August 1972 when the Secretary of Transportation, John Volpe, announced that AMG, GMC, and Rohr had been awarded the new bus development contracts.<sup>55</sup> The program was to proceed according to the following plan. Each contractor would be asked to develop three prototype vehicle models according to the specifications developed by Booz-Allen.<sup>56</sup> These vehicles would then be tested. The testing would include both engineering as well as in-service revenue aspects of the vehicles. It was also tentatively agreed that upon completion of the tests, a "best" design would be selected among the features of the three prototype vehicles.<sup>57</sup> Each of the manufacturers would then be contracted to further produce 100 (200) vehicles according to the best selected design.<sup>58</sup> This plan was designed to serve at least two purposes. First, it provided the producers with a minimum order to recover some of their tooling costs, and reduce their financial risk. Second, the likelihood of eliminating the weaker competitors from the market would be substantially reduced.

#### ROLE OF TRANSIT OPERATORS

The concept of Transbus was received with considerable enthusiasm by the transit industry.<sup>59</sup> The industry's participation, however, was limited

to the cooperative effort with Booz-Allen in development of the specifications. Considering the original design of the plan, the operators had every right to be optimistic, and receptive towards the idea of a new standardized bus, given that the federal government was to finance much of the investment. As the tests were completed though the industry's dissatisfaction with the program grew substantially, especially due to policy changes of UMTA and inadequacy of the tests. The reasons for the latter will be discussed later, but next the focus will be on the role of transit operators and possible alternative strategies as regards this role.

A major reason for dissatisfaction of the operators was lack of representation on their behalf. Except serving in an advisory role, the transit industry's input to the Transbus program was insignificant. For instance, the Bus Technology Committee of APTA had practically little to do with development of the final Transbus Procurement Requirements (TPR). At the present time, even with the benefit of hindsight, it may not be possible to assert that the Transbus program would have been successfully implemented if transit operators had participated more effectively. It is, however, possible to make recommendations for future projects of the same nature. Comparison of the 1970 amendments to the Clean Air Act with UMT Act of 1964 may prove insightful although the contexts of these laws are different.

In the 1970 amendments to the Clean Air Act (CAA) Congress had determined that postponement of the emission standards was only possible after four distinct conditions had been met.<sup>60</sup> One of these conditions concerned the availability, feasibility, and applicability of the pollution abatement technology. Congress had granted an oversight authority to the National Academy of Sciences (NAS) to determine the latter aspects of the pollution abatement technology especially in the case of the automobile emissions.



The NAS in this role would act as an intermediary between the Congress, and the private sector. The NAS's participation would also ensure input from the independent sources into the process of rulemaking on emission standards by the federal Environmental Protection Agency (EPA).

In the case of public transportation, UMTA can also impose standards on the transit industry, although by no means its rulemaking authority resembles that of EPA. Moreover, it can only impose standards on those operators that receive federal financial assistance in contrast to EPA that has industry wide powers. Using the 1970 CAA provisions as a token case for participation of an independent entity overseeing the EPA decisions regarding the feasibility of technology, it may be possible to suggest a similar arrangement in the case of UMTA initiated technology development programs.

One alternative would be to establish an Innovation Board serving similar functions to the NAS in the CAA amendments. In particular, the function of this board would be the oversight of programs which UMTA undertakes in order to introduce new products or utilize the existing technology (diffusion). It would be preferable to establish this entity through an act of Congress. Otherwise, it could easily be disbanded, and/or become an extension of the existing administrative organization. In the case of the DOT this board may encompass the whole department, although at present we are mostly concerned with the UMTA programs. So the UMTA division of the Innovation Board may consist of members from the executive branch, transit operators, and transit equipment manufacturers, and the academic community. For instance, an arrangement, though arbitrary, may include two members from UMTA, four members from the transit industry (two management, and two labor), representatives from major transit manufacturers, and two members of the

academic community (e.g. NAS, NAE, NRC, etc.).

Formation of the Innovation Board, merely on its own does not ensure successful implementation of technology innovation programs. It does, however, establish a legitimate forum for the transit industry along with other interested parties to air their views as far as the innovation projects of the UMTA are concerned. Further, it safeguards against hasty and impractical decisions which in the end can prove wasteful and inefficient. For example, realistically the original plan for pre-production procurement of 100 units of Transbus would probably have been rejected by the Innovation Board at the start of the program due to its costs and the low capacity of operators to handle "high technology products." Finally, the author is aware of possible political unfeasibility of establishing such a board with the above membership arrangement, since it is essentially a direct mix of the public and private sector. The point to be made here, however, is the existence of such an independent board rather than its membership arrangement.

#### DEVELOPMENT, TESTING AND DEMONSTRATIONS

The development of the first Transbus prototype was completed in 1974, and it was delivered for testing in February of that year. The testing included engineering aspects of the vehicles, and they were mostly carried out at the testing grounds in Phoenix (Arizona). Specifically two of the three prototypes from each manufacturer were used for engineering testing which included semi-destructive tests. The third prototype would be used for in-service testing or demonstrations. These demonstrations took place in four cities including Miami (Florida), New York City, Kansas City (Kansas), and Seattle (Washington).<sup>61</sup> The demonstration process included selective

riders, i.e., the elderly and the handicapped, the members of the general public, the bus drivers, and the maintenance crew. It also included comparative (show room type) demonstrations of the prototypes along with current model buses plus the interim model buses.<sup>62</sup> Public opinion surveys were also conducted to investigate the attitude of the riders, and the general public about the Transbus.

One of the purposes of the tests, and demonstrations was the collection of information about actual operational characteristics of the prototype vehicles in revenue service. The standard bases for comparison of the operational characteristics in the transit industry are either the accumulated mileage on the vehicle or the accumulated time spent in operations (or both). In the case of the Transbus tests and demonstrations the average accumulated mileage on each prototype was 15,000 miles, including 6,000 on AMG prototype, 15,000 miles on GMC prototype, and 25,000 miles on the Rohr prototype.<sup>63</sup> Further, the total time spent in testing for all prototypes was 80 days, which included 24 days of actual in-service operational demonstrations. It is appropriate to note that, in the transit industry, the "normal" life cycle for buses is regarded as 12 to 15 years or its accumulated mileage equivalent, i.e., 500,000 miles.<sup>64</sup> Therefore, despite the original intentions, the tests and demonstrations were in actuality far from adequate from an operational point of view.

#### NEW UMTA PHILOSOPHY

As shown in UMTA's timetable on Transbus, Figure 3.3, the original strategy was to select a standard configuration among the prototype models of Transbus which utilized the best features of all vehicles.<sup>65</sup> A standard design package would then be finalized in keeping with the "best" configura-

tion. In 1973, however, a new Secretary of Transportation took office. Claude Brinegar succeeded John Volpe as the new Secretary of Transportation, and Frank Herringer was appointed UMTA administrator.<sup>66</sup> The new administration effectively altered the course of the Transbus program. In order to understand this change, it is first necessary to describe UMTA's strategy of implementing the Transbus policy prior to the 1973 administrative change.

It was anticipated that, after the test and evaluation stages of the program were concluded, procurement of the 300 units of the Transbus would create "a larger scale production capability" for each manufacturer.<sup>67</sup> This policy corresponded to the RDT&E strategy with the objective of sustaining as many competitors in the market as possible. This procurement policy, though, was a departure from the conventional view of demonstration programs which were described in chapter two. That is, the objective of demonstrations was to attract private capital by showing the feasibility of the technology, and leaving the rest to the entrepreneurial process. The above procurement strategy was designated to be the forerunner of the capital grants program of UMTA under Section 3 of UMT Act 1964. In other words, UMTA would sponsor development of new transit technologies under Section 6 RD&D funds, and then it would use Section 3 funds to procure that technology by limiting the choice of the transit operators to these developed technologies.<sup>68</sup>

In spite of the earlier plan, in mid-1973, UMTA began reviewing its position on the Transbus program, and developed a tentative plan for implementation of the so-called phase two, i.e., procurement of 300 Transbus units.<sup>69</sup> This revision involved the elimination of the procurement plan for the 300 Transbus units, although in February of the same year UMTA had publicly reiterated the latter commitment.<sup>70</sup> It may be noted that if UMTA were to procure those 300 units, the costs could exceed \$30,000,000. The

development costs of the nine prototype models were approximately \$15,000,000.<sup>71</sup> Assuming the production models would cost in the range of \$100,000-\$150,000 (possible even more) per unit, then the costs of 300 units would amount to \$30,000,000-\$45,000,000. This figure may look phenomenal in absolute terms, but it was in line with several other UMTA projects at the time. For instance, the costs of the PRT project which began in the early 1970's, has been much higher. In Morgantown, West Virginia alone, the total project costs equal \$64,300,000.<sup>72</sup> Therefore, the prospects of procurement costs in the case of the Transbus program were quite comparable to similar UMTA undertakings.

In January 1975, UMTA, through a policy statement, publicized its official position on the future of Transbus.<sup>73</sup> It contained three important elements. First, the federal government (UMTA) upon conclusion of the Transbus testing and evaluation would develop a set of performance specifications for 40-foot transit buses, and all federally funded transit buses would be required to comply with these specifications. Second, "in the interim... before the arrival of the low floor Transbus...UMTA will fund high-floor, two axle buses incorporating styling and design changes consistent with the Transbus, should manufacturers desire to provide such changes."<sup>74</sup> Third, UMTA abandoned, although not publicly announced, the original idea of funding the purchase and of 100 buses from each manufacturer.

The shift in Transbus procurement policy, which had been contemplated since 1973, may essentially be attributed to the new philosophy which the DOT administration had adopted, namely, less direct federal involvement in the transit market.<sup>75</sup> Obviously, this new outlook could not be carried out to the extent of reversing the past policies, but it could be applied to new policies to which the DOT had made no financial commitment yet. Clearly,

the Transbus procurement policy was in the latter category. Also, the prospects of a standardized design bus unless accompanied by guaranteed government procurement, would have probably led to opposition by the manufacturers. Further, in the transit market the transit manufacturers had the upper hand since the regulatory authority of UMTA was limited to the transit operators (receiving assistance).

The above shift entailed formulation of two procurement policies regarding both the Transbus, and the interim bus, pending the results of the tests and evaluations. In addition to the difficulty of developing these procurement policies which should incorporate a set of performance standards, UMTA faced opposition of the operators, as well as two of the manufacturers. Opposition of each party, however, was based on reasons of self-interest and concern over consequences of moving away from the original procurement policy.

#### TRANSIT OPERATORS' VIEW

From the transit operators' view the operational demonstrations had brought out several problems associated with the operation of the Transbus technology which had yet to be worked out before Transbus could be introduced into transit operation.<sup>76</sup> Therefore, they did not favor procurement of the Transbus at its current (then) status. Further, they argued that before procurement of Transbus and extensive actual revenue service testing has to be undertaken in order to determine the actual operational characteristics of Transbus.

There were several reasons for their concern over operability of the Transbus. Their most pressing concern was that Transbus had undergone "little" testing compared to the actual desired level.<sup>77</sup> Indeed, compared

to the industry standards of 12-15 years or 500,000 miles equivalent of accelerated testing, accumulated mileage on the whole Transbus test fleet was 30,000 miles. Also, the problems revealed in these tests were worrisome to the transit operators from an operational standpoint. These problems included lower fuel efficiency, higher maintenance time, higher breakdown rate, higher tire wear, lower passenger capacity, and higher initial costs.

The decline in fuel efficiency was mainly due to additional weight of new accessories, and more compact underfloor componentry.<sup>78</sup> Despite the use of more efficient engines in prototype vehicles the fuel efficiency would drop below the performance levels observed in the interim buses. Further, the main contributing factors to the additional weight were the tandem rear axle, and the wheelchair lift. In order to accommodate the underfloor componentry in a smaller space, due to the 22-inch (or 24-inch) floor height, the components had to be made smaller, say, the rear axle. To achieve the same degree of reliability, however, the compact drive unit components inevitably became heavier. In addition, the weight of the wheelchair lift would be quite substantial. The above factors compensated for whatever savings could be achieved through using higher efficiency engines. The efficiency loss was an important factor in transit operations, since fuel costs had continually risen, and contributed to the increased operating costs of the transit operators. These operators are also under constant pressure to reduce their operating costs, and improve the efficiency of their operations.

The maintenance time of the Transbus test fleet had been quite high in the demonstrations period.<sup>79</sup> This was partly attributed to the sophistication of the new componentry which the maintenance crew very often were not familiar with. Also, the compactness of the components made access in cases

of breakdown or general repair, quite difficult and time consuming. It should be noted that the latter problem would gradually have disappeared with time, however, as things stood at the completion of tests these problems would probably have persisted for some time. Therefore, the combination of the aforementioned factors increased the maintenance time of the Transbuses, which in turn would have affected their operations reducing the number of vehicles in service at any given time.

The high breakdown rate was to be expected since the prototype vehicles were being tested under actual revenue service environment for the first time. The importance of this period should not be stressed, suffice it to say that the extensive testing period which the transit operators were asking for was for this purpose. That is, under gradual operational testing, problems would develop which were probably not accounted for or were not discovered in engineering tests, and thus could be corrected.

The tests had shown that, tire wear in Transbuses would be higher than the current buses.<sup>80</sup> This was mainly attributed to characteristics of low profile tires under heavy vehicles such as Transbus. The knowledge about these characteristics, however, was not adequate and thus precluded definitive statements about their relative advantages or disadvantages. The most important immediate concern of the operators, though, was actual life of the tires under heavy wear that could translate into higher tire replacement costs thereby increasing operating costs.

The lower passenger capacity of Transbus was another concern to the industry. The standard passenger capacity of Transbus was between 41-43.<sup>81</sup> This combined with prospects of having wheelchair users on board the Transbus, that could take up to three spaces, was thought to create a total lower passenger capacity for the whole transit fleet of U.S. (assuming all are



Transbuses) so that the whole transit fleet would have to be increased by at least 1% to offset the loss in capacity. At the current level of the bus fleet, i.e., approximately 52,000, this would have meant that an additional 5,000 Transbuses had to be purchased.<sup>82</sup> Bearing in mind the financial situation of the industry, this was a source of concern for the operators in terms of additional initial costs as well as operating costs due to extra man-hours required to operate the expanded fleet (with no additional capacity).

Any disclaimer or concurrence with the above operators' view, however, may be rendered speculative, because the amount of testing conducted was grossly inadequate for either pro or con arguments concerning the newly developed componentry. In addition, although there probably were some basis for above claims, the response of transit operators was not unprecedented. Especially in view of their traditional attitude on regarding introduction of new technologies. Therefore, if one were in place of the federal government (UMTA) one would doubt the extent of real concern as opposed to known behavioral patterns of response on the part of the operators.

THE MANUFACTURERS: AMG, GMC AND ROHR

As noted earlier, AMG's entrance into this market had been aided by the prospects of procurement of a standard design bus by the federal government. Also, there were reasons to believe that a standard federal design bus would, in the long run, create a profitable market. Provided that the volume of sales were sufficiently high so as to warrant expansion of production capacity, and thus realization of economies of scale are existent in most standardized design products, then high profitability potential for a standardized product might hold true. Consequently, when the DOT announced

that, it would not mandate a federal design for buses, and rather the regulation would be in the form of performance standards, AMG's displeasure could be expected. Having entered the market only three years before, and being wholly dependent on government procurement policy for sale of her product, AMG's position was sensitive to the above policy changes. Due to these factors, AMG protested UMTA's policy shift directly, and through Congressional means.<sup>83</sup>

Rohr was probably in the same position, but it might have been more prepared for this policy shift. Rohr's preparedness was due to the production of the export model bus that it manufactured for Israel.<sup>84</sup> As a result, Rohr could have proceeded to produce the interim bus, similar to GMC's RTS-2, while AMG had probably made no such plans. Despite this Rohr had expressed its opposition to the policy shift, especially in light of no forthcoming federal participation in commercial development of the components.

GMC was in a quite different position with regard to the latter two manufacturers. First, she was very well established, and financially capable compared to AMG and Rohr. Second, she had contemplated the introduction of RTS-2 bus since the late 1960's, and she also had announced the production schedule of RTS-2 in 1973 (as two years away). Third, it probably did not favor further federal intervention, since after 1975 it did not have to satisfy the obligations of the 1965 consent decree anymore. The latter point would seem important considering that if the federal government did engage in commercial development of several of the new Transbus components, issues of patent and inter-supplier pricing of these components would entail problems.

Overall, AMG and Rohr were concerned about their future competitive-

ness in the market if UMTA in fact funded the purchase of interim buses, which at the time were only within the production means of GMC. On the other hand, GMC probably welcomed the new UMTA policy due to the likelihood of lesser direct federal involvement in "market" affairs, such as commercial development of the components.

#### PROMULGATION OF THE FIRST PROCUREMENT POLICY

In mid-1975, subsequent to the appointment of William Coleman as the Secretary of Transportation, Robert Patricelli was appointed as the UMTA administrator. Patricelli in addition to the problem of formulating procurement policies regarding the Transbus and interim bus, also faced another important issue, namely, regulation on transportation services and equipment for the elderly and handicapped (E/H). In view of the mounting judicial and Congressional pressure (court cases discussed in Chapter two), UMTA's prompt response was required. The prospects of accessibility versus mobility interpretation of the Section 504 of the 1973 amendments to the Rehabilitation Act, and the Federal Highway-Aid Act of 1973 had raised serious doubts about consequences of such regulations.

The transit operators and UMTA favored mobility interpretation because of economic and operational impacts of making conventional transit facilities fully accessible to E/H. Providing special subsidized services in their view was a far better approach to solving the transportation problems of the E/H. The statutes were vague about this aspect of regulation, though the intent of the law was pronounced as a means of mainstreaming the E/H into the population.<sup>85</sup> Among the issues pinpointed by the advocates of the latter view was the accessibility of Transbus.<sup>86</sup> That is, buses had to be made accessible to the E/H population by mandating a standard low floor feature in

buses purchased with federal funding.

In the first move to clarify the regulatory intent of the E/H laws, UMTA issued notices on proposed rulemaking on the Section 504 mandate on April 30, 1976.<sup>87</sup> In this proposal, UMTA distinguished between mobility and accessibility to the extent that the latter interpretation was regarded impractical, especially from the conventional transit view. Also, the requirements for E/H transportation were included as a part of the annual transportation improvement plan of the transportation system management regulations. The wheelchair accessibility option was also provided for in the rolling stock acquisition.

Having clarified the accessibility issue as regards the floor height of the buses, UMTA proposed a "Draft Policy Statement" on Transbus and solicited the views of the concerned parties consisting of manufacturers, operators, and public interest groups.<sup>88</sup> This draft proposed to mandate the Transbus after a 24-month operational test period. In the meantime the funding for purchase of the so-called interim bus would be forthcoming. From the responses it became apparent that, first at least two (AMG and Rohr) of the manufacturers would require some form of direct financial assistance from the federal government before they could commit themselves to production of the Transbus. Second, the operators favored the 24-month test plan though their new bus replacements were more urgent, and thus they pressed for a procurement plan which would authorize funding of the interim bus. The interim bus, however, was only within the production means of GMC. In fact, GMC had announced the actual production schedule of RTS-2 in May 1975. Third, the public interest groups especially the representatives of E/H groups, were urging to move ahead with the Transbus mandate. Due to these various positions which had developed regarding the Transbus, UMTA

held a public hearing in May 1976. This hearing was to clarify the positions of the concerned parties, and also help to determine a feasible solution to the problem of Transbus/interim bus procurement. Following the hearing and some further deliberations, UMTA announced its policy on Transbus. Transbus policy contained three important elements. It promptly terminated all further federal involvement in commercial development of the components. It mandated a set of specifications which were to be satisfied by buses purchased with federal funding. The development of a bus with 22-inch (or 24-inch) floor height was left to the manufacturers at their own discretion.<sup>89</sup>

The reasons for the new procurement policy included inability of at least two manufacturers (AMG and Rohr) to produce a low floor bus independent of government participation in commercial development, urgent need of operators for new bus rolling stock, GMC's ability capability to produce the interim bus without further delay. This policy raised considerable controversy in the press and among proponents of the low floor bus. In fact, it had been stated by some observers that UMTA was subjected to political pressure by GMC not to mandate the low floor bus.<sup>90</sup> Additionally, AMG filed suit against DOT for funding the procurement of interim bus, contending that the policy was exclusionary.<sup>91</sup> The suit, however, was unsuccessful.

The policy was mandated as the Transbus Procurement Requirements (TPR).<sup>92</sup> After February 15, 1977, buses acquired by federal financial assistance were required to have an "effective 24-inch floor height, a wheelchair entry provision option, and several other features which were essentially the characteristics of the interim bus (e.g. GMC's RTS-2). The effective 24-inch floor height was defined in terms of combination of floor height and a kneeling feature at stops. This kneeling feature was approximately 5-6

inches, thus allowing for an actual floor height of 29-30 inches. This 29-30 inch floor height was within the limits of current interim bus technology.

The above procurement policy was, indeed, a viable solution to the immediate problems of bus replacements. Further, it demonstrated how a performance feature could be incorporated into the standards of procurement without compromising the design flexibility of the vehicles, especially the 24-inch effective floor height. The procurement policy though did not include the major design features of Transbus such as tandem axle, and 22-inch floor height. It in effect was a policy formulated to procure the RTS-2 type buses. Presumably, such policy could have been implemented with pre-Transbus program technology as far as the operators, UMTA and GMC were concerned, since it was GMC's efforts to market the RTS-2 bus which had led to renewed federal interest in a new standardized bus.

It is essential to realize the importance of the above UMTA policy in the context of government-initiated technology innovation. In spite of expenditures of \$28,000,000 on the Transbus program in order to introduce a new transit bus, and also promote competition, the results showed several missing links. First, the major manufacturer, i.e., GMC was reluctant to commit itself to the low floor Transbus. This reluctance might have been due to a number of reasons including operational problems of low floor technology, patent issues of government assisted technology development, advance financial commitment to the RTS-2 bus. It was claimed by some observer that GMC had already committed \$50,000,000 to production of the RTS-2.<sup>93</sup> Second, most of UMTA's efforts were directed at development of the technology, and not its commercialization. In other words, UMTA had only gone as far as establishing that the Transbus-related technology would be technically feasible. The commercial feasibility of the subsystem technology was yet to

be established. At present time, of course, due to the limitations placed on government (UMTA) involvement in such ventures, commercialization efforts are limited to regulatory means, that is, mandating some requirements on the recipients of federal financial assistance.

### 3.3 PART-2: LOW FLOOR TRANSBUS ABORTED

The discussion on suspension of the February 15, 1977 Transbus Mandate by Brock Adams, Secretary of Transportation, was given in chapter two. After suspension, the TPR was revised to reflect the policy shift towards standard low floor transbus. No doubt the recent political pressure by the E/H groups, the Executive Order by the President on prompt compliance of Section 504, and increasing pressure of court cases on accessibility issues influenced the above DOT decision. Whatever the motivations behind the new mandate, it was finally rendered ineffectual by the refusal of the manufacturers to bid.

In mandating the Transbus UMTA had opted the regulatory avenue to commercialization of Transbus-related subsystem technology. Indeed, if any, that was the only avenue left open, since no further government funding for commercial development of the Transbus was forthcoming. In the procurement context, however, such action required careful scrutiny: first, formulation of a set of performance/design standards to introduce desirable subsystem technologies of Transbus; second, the appropriate procurement arrangement for commercialization of these subsystem technologies.

The revised TPR which would have taken effect after September 30, 1979, was a mix of performance/design standards, though the emphasis was pre-eminently on design. For instance, the rear axle arrangement, step height, and step riser were among the required design features. The performance

standards, on the other hand included jerk (rate of change of acceleration), acceleration, emission levels, fuel consumption level. The important factor in formulation of the standards is that they have to be within the technological possibilities leaving only the economic hurdle to be overcome. In case of Transbus, though there still existed several unknown technical features such as fuel efficiency, vehicle curb weight, and vehicle life-cycle. Therefore, requirements about these features could not have been incorporated in the standards with absolute certainty about their feasibility. In fact, the manufacturers did complain about several of these requirements as being technically unfeasible, say, achieving a 26,500 lb. weight limit, and having wheelchair lifts, and a tandem axle or having a 3.5 mile-per-gallon fuel consumption in addition to the latter features.<sup>94</sup>

The procurement arrangement is critical in any technological undertaking by the government. Depending on the existing level of commercially-developed technology related to subsystems of the product the procurement policy may be different. In case of Transbus, UMTA opted for its only available avenue under the statutes, i.e., competitive bidding. Considering that the manufacturers had to undergo some degree of retooling, and that the several of the subsystems were not yet commercially developed by the suppliers, e.g., axle manufacturers, it may have been more appropriate to have procured the first minimum order via the cost-plus-fixed-fee basis system.

Given that there was uncertainty about technical feasibility of several features which were included in the standards and the procurement system of competitive bidding, it was probably no surprise that no manufacturer bid for production of the first (530) Transbuses. It may be asked, however, that financial risk at some price would be worth taking, so why



none of the manufacturers actually bid for Transbus at the actual price which included the corresponding financial risk. It is conceivable that the actual bid price would have been in the \$300,000-\$400,000 range. In that case, one can imagine the amount of negative publicity and criticism that the manufacturers would have received if they actually had bid for the latter amount. Therefore, even though in theory it would have been possible for the manufacturers to bid at high prices, in practice the financial concern was not the only motivation behind their decision to refuse to bid.

Another aspect of the procurement arrangement of Transbus was the nature of TPR. It was formulated in such detail, and with such stringent warranty requirements that even the remotest prospects of failure to fulfill these requirements would have deterred the manufacturers from bidding. An example would help to illustrate this. In 1979, the transit authority of Boston (Massachusetts Bay Transportation Authority), succeeded in claiming \$40,000,000 worth of damages from Boeing Vertol, Inc. (BVI).<sup>95</sup> The damages were awarded due to unfulfilled contractual agreements between MBTA and BVI regarding the warranty, and quality assurance provisions in delivery of (approximately) 130 Light Rail Rapid Transit Vehicles. Therefore, even the possibility of such suit (forthcoming) would have deterred the manufacturers from bidding, or in case they did decide to bid, the above argument, regarding the high price, would probably prevail.

#### LOW FLOOR ALTERNATIVES

Clearly, the low floor became synonymous with Transbus as the program schedule proceeded. Also, the refusal of manufacturers to bid for Transbus

was partly based on commercial "unfeasibility" of low floor components. Further, the controversy over accessibility of Transbus to the E/H was also related to feasibility (or unfeasibility) of low floor technology. Thus, the analysis below concerns the various options and methods of having a low floor.

The revised TPR specified the maximum floor height as 24 inches, and the corresponding step and riser heights as 14 and 8 inches, respectively. Also, the kneeling feature would have allowed this floor height to be reduced by 5 to 6 inches, i.e., to 19 to 18 inches. It is important though to note that TPR specified a single slope floor (or the slope not to exceed 1 degree). This specification is crucial since several buses have been built in Europe with low floor height features. The low floor feature, however, has only been incorporated in the front portion of these buses. At the rear, either the slope changes, i.e., increases or the floor height is increased. The increase in slope of the floor (or floor height) is necessary in order to use the conventional one-axle drive unit. For example, Figure 3.4 illustrates several sloping floor configurations.<sup>96</sup> In fact, the VÖV bus of Germany (manufactured by Mercedes) uses a similar feature and the National Bus of Britain (manufactured by British Leyland) used the double floor height configuration (floor height is higher at the rear).

Seemingly the variable slope floor (or floor height) represents a viable alternative specially since the fate of the single slope floor Transbus is known, so why it was not adopted. The two slope floor, indeed was incorporated in the early revisions of TPR at the suggestion of Rockwell International Corporation (the major axle manufacturer for buses). This alternative, however, was discarded later in favor of the single slope floor.

There were two major reasons for rejection of double slope floor. First, the total weight of Transbus excluding the tandem axle drive unit could exceed the federal weight limit regulations for single axle drive units.<sup>97</sup> At the beginning there were prospects for possible waiver of these regulations though later as it became apparent such waiver would be impracticable. Second, the transit industry did not favor the variable slope.<sup>98</sup> The objection of the operators was to the required internal steps within the bus (see Figure 3.4). They argued that in the U.S. transit riders are not accustomed to having these steps, and thus there might be a large number of accidents due to these internal steps. These accidents in their view could translate into potential law suits resulting in damages to be paid by the operators. They preferred to forego even the possibility of facing such suits rather than using the variable slope floor.

As it appears, the above alternative to single slope floor configuration were discarded without adequate examination. Both objections were based on uncertain prospects of having a variable slope floor. For instance, it would be possible that the single axle Transbus could be built within the federal load/axle regulations, and with an aggressive educational program transit authorities could have avoided potential accidents due to internal steps. The implementation of this alternative, however, would probably have required a pre-production testing period for examination of this design. Also, it is conceivable that the European experience should have been utilized. As a result, it would have been possible to pursue the low floor (24-inch) height objective via means other than the single slope configuration. The ultimate choice of the latter floor configuration depends on the manufacturers. In other words, even if the double slope floor were technically and commercially feasible, adoption of such a design would be at the

discretion of manufacturers. Manufacturers for reasons of their own, i.e., previous investment in the interim bus, could have refused to build the double slope floor Transbus. Therefore, the ultimate deciding factor in successful implementation of the procurement policy (standard specifications) would be dependent on consent of the manufacturers. This is a critical factor and should be taken into account at all stages of policy formulation, that is, design or procurement.

### 3.4 SUMMARY AND CONCLUSIONS

In the analysis of the Transbus in this chapter effort was made to explain reasons and motives behind various outcomes and actions during the schedule of the program. It was argued that the Transbus program was initiated mainly as a result of GMC's efforts to secure a guarantee from the federal government for procurement of its RTS bus, and the technological outlook of the DOT administration at the time. UMTA chose the RDT&E strategy to implement the hardware development part of the program, and moreover, in order to further promote competition, UMTA also enticed AMG into the market. Due to the limitations imposed by the transit market, this strategy did not bring about the desired results. First, the volume of sales to sustain an additional competitor in the market had to be substantially increased. This increase, however, implied higher RD&D and capital grant budgets which were probably not forthcoming. Second, the Transbus technology represented a significant amount of new technology which, due to the low technology base of the transit industry, the operators were probably unable to absorb in the short period planned.

Even after the revival of the Transbus by the Bock Adams administration, transit operators were not enthusiastic about the Transbus. Their lack of

interest may partly be attributed to the lack of adequate representation on their behalf in the formulation of procurement policy. It was proposed that the operators as well as the manufacturers should be involved more actively in the new product innovation programs such as the Transbus. A step toward this goal may be the establishment of an Innovation Board as suggested in this chapter (preferably through an act of Congress). This board would have an oversight function and also would act as a liason with the industry. It was admitted that establishment of such a board may go cross-grain to the traditional view against mixing the industry with government.

As far as the design of the Transbus was concerned, although various alternatives were considered, they were not thoroughly explored, and judgments against or in favor of these alternatives were not based on concrete evidence. In particular, the low floor design that could probably have been achieved via a double slope floor (or double height floor) was only considered in conjunction with single slope floor. The alternative floor arrangements were rejected due to the possibility that the weight of the bus could exceed the load/axle regulations, and the potential for accidents due to the internal steps of the bus.

Another aspect of the Transbus was the downstream benefits of the low floor. Since benefits associated with low floor could not be qualified the decision on the low floor clearly had to be made on social equity grounds. Therefore, the decision could not be supported by any evidence of tangible benefit but only with real costs. This brought about a negative image for the program which implied an expensive technology with no tangible benefits.

An important factor in the reluctance of the manufacturers to commit themselves to the low floor technology was that the related components were yet to be commercially developed. Commercial availability of subsystem

components is in general essential to successful innovations. Otherwise, the financial risk involved may push the procurement price higher than expected. This higher price at first glance may present no problems. However, any of the two companies (GFC and GMC) could have received considerable criticism for bidding at high prices both from the public and from the press. That is, the bid price for the production of the Transbus would have included the financial risk associated with pre-production technology which must have been borne by the manufacturers.

Overall several concluding remarks may be made regarding both the conception and the administration of the Transbus program:

1. Transbus was initiated mainly due to the GMC efforts to introduce its RTS bus. This implies that the Transbus program was conceived of as a response to an outside effort;
2. The hardware development implementation strategy of the defense sector was applied, although this strategy was probably not suitable for the transit market due to characteristic differences between the two sectors, such as the technology base and the budget capabilities of the corresponding executive departments (DOD and DOT);
3. Active participation of transit operators and manufacturers may have proved essential in successful formulation and implementation of Transbus policy. In the future, their participation may be ensured through establishment of an Innovation Board;
4. The design of the Transbus was not based on thorough and exhaustive exploration of all alternatives. In fact, the double slope floor may have been viable though it was rejected on the basis of load/axle regulations and potential accidents due to internal steps;
5. Throughout the program criticism was directed at the costs of having a low floor, since these costs were tangible. The benefits, on the other hand, being intangible could not be accounted for. Thus the decision in favor of the low floor was always regarded as a costly alternative while the corresponding benefits might have outweighed the costs on social equity grounds which are unquantifiable; and

6. The reluctance of the manufacturers to commit themselves to low floor technology was partly because the corresponding subsystem components were not yet commercially developed. Thus, the bid price would have included the risk associated with such a venture at the pre-production stage. Thus, a high bid price and the ensuing criticism probably deterred the manufacturers from bidding.

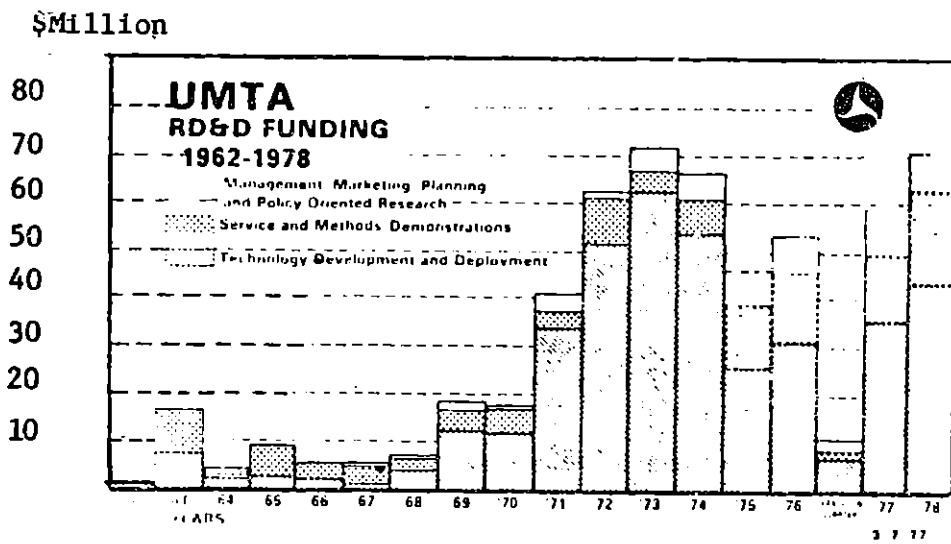


Figure 3.1 Trends in UMTA's RD&D Expenditure (1962-1978)

Source: Department of Transportation R&D Programs, Committee on Science and Technology, 1977.



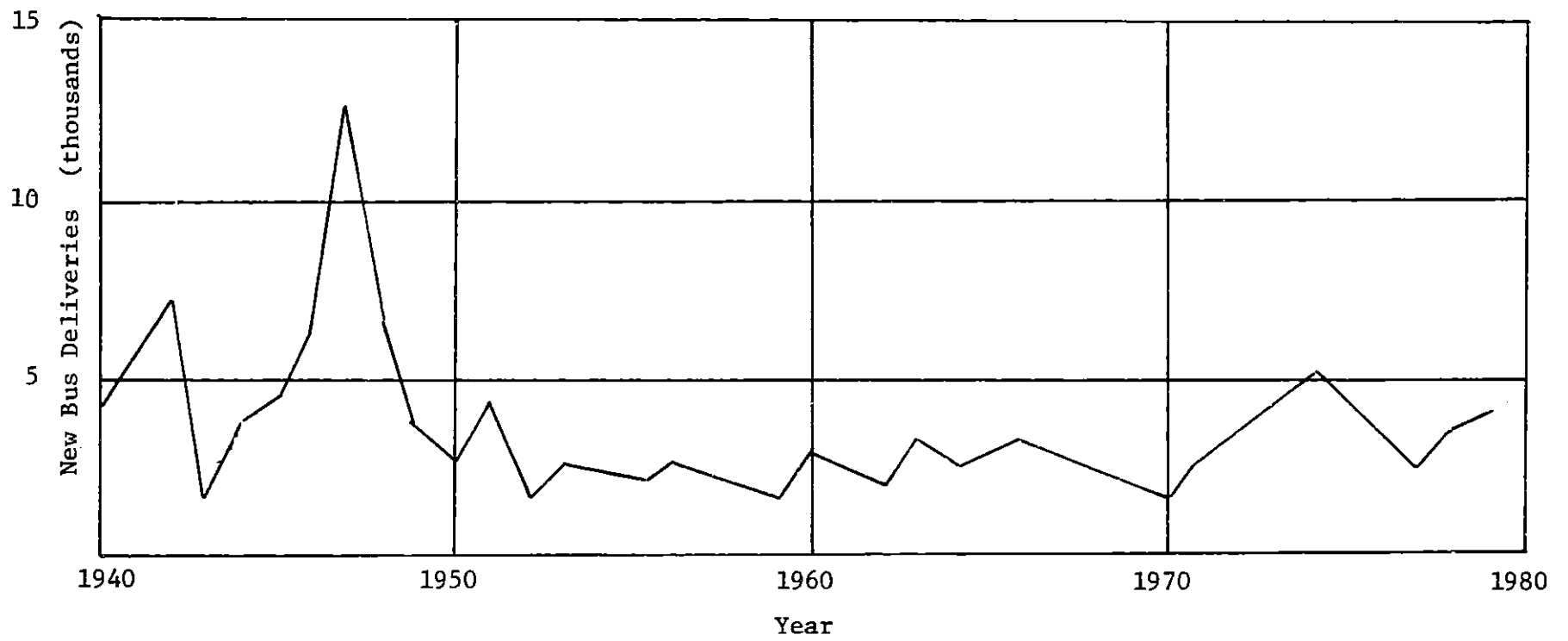


Figure 3.2 New Bus Deliveries

Source: American Public Transit Association. Transit Fact Book, 77-78.

**TRANSBUS**  
**NEW 40-FOOT TRANSIT BUS**  
**MILESTONES BY CALENDAR YEAR**

EVENT	1971	1972	1973	1974	1975
1. Issue RFP for Development	▲				
2. Award Contract		▲			
3. Deliver Prototype			▲		
4. Select Standard Configurations				▲	
5. Final Design Package Presented					▲

Figure 3.3 UMTA Timetable for Transbus.

Source: U.S. Congress, House, Committee on Appropriations, DOT's Appropriation for 1974.

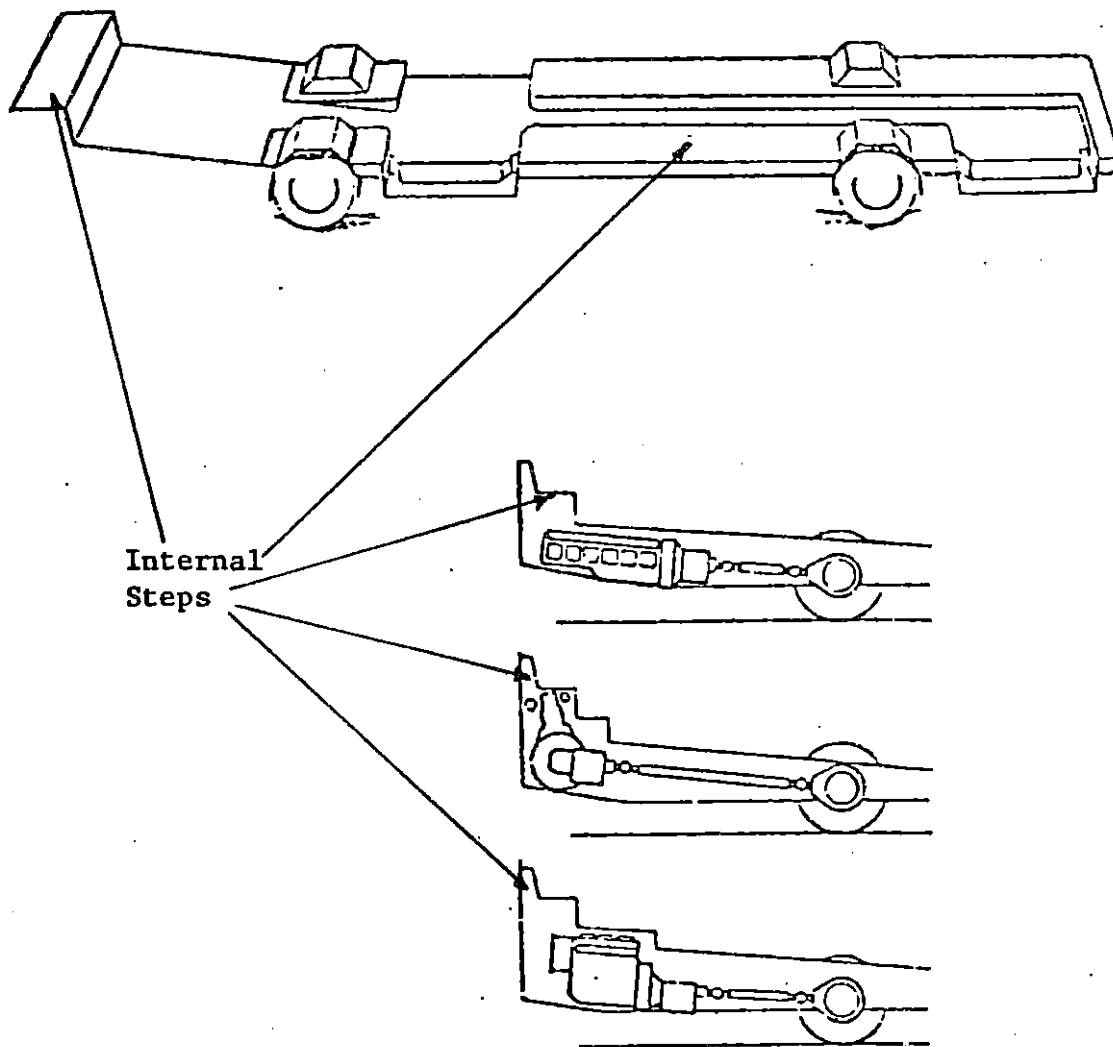


Figure 3.4 Alternative Arrangements for Variable Slope Floor

Source: O.W.O. Schulz, Motorbus and Man, International Union of Pacific Transport, 41st Congress, International Commission for the Study of Motorbuses (Brussels: UTIP, 1975).

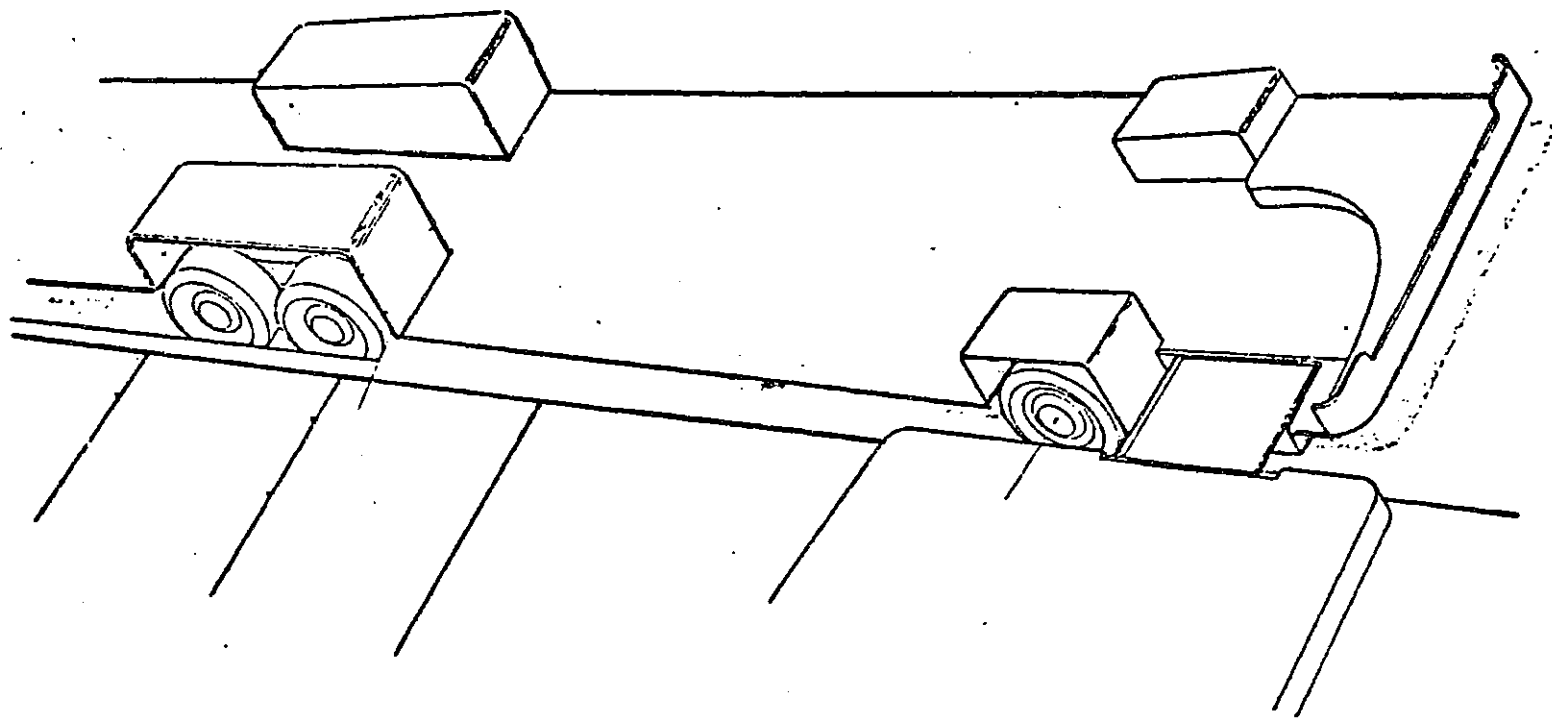


Figure 3.5 Tandem Axle Floor Configuration in Transbus.

Table 3.1 New Transit Vehicles Delivered to Properties  
U.S. 1940-1976

Year	Motorbus		Total
	40+ seats	Total	
1940	-	3,984	5,254
1941	-	5,600	6,289
1942	-	7,200	7,840
1943	225	1,251	1,399
1944	1,015	3,807	4,151
1945	1,501	4,441	4,934
1946	2,185	6,463	7,150
1947	6,361	12,029	13,612
1948	4,342	7,009	9,165
1949	1,725	3,358	4,726
1950	1,611	2,668	3,050
1951	2,693	4,552	5,348
1952	1,165	1,749	1,992
1953	1,717	2,246	2,246
1954	1,844	2,225	2,485
1955	1,861	2,098	2,429
1956	2,589	2,759	3,135
1957	1,187	1,946	2,415
1958	1,419	1,698	2,126
1959	1,379	1,537	1,747
1960	2,633	2,806	3,222
1961	2,310	2,415	2,883
1962	1,920	2,000	2,406
1963	3,085	3,200	3,858
1964	2,331	2,500	3,140
1965	2,769	3,000	3,580
1966	2,752	3,100	3,279
1967	2,208	2,500	2,585
1968	1,994	2,228	2,612
1969	2,002	2,230	2,880
1970	1,274	1,442	1,750
1971	2,349	2,514	2,764
1972	2,581	2,904	3,265
1973	2,701	3,200	3,439
1974	4,222	4,818	4,910
1975	4,714	5,261	5,389
1976	4,099	4,745	5,481
1977	1,580	2,437	N/A
1978	2,973*	3,795	N/A
1979	2,974**	N/A	N/A

\* Including 232 articulated buses.

\*\* Quoted from GM and GFC sales.

Source: American Public Transit Association, Transit Fact Book, 77-78.

THE ORIGINAL PRINT ON THE FOLLOWING PAGES IS ILLEGIBLE

Item	TRANSBUS Performance Specification	AM General Prototype Design	CMC Truck & Coach Prototype Design	Robt Industries Prototype Design
Capacity	43 seated passengers.	42 seated passengers.*	41 seated passengers.*	43 seated passengers.*
Floor Height	17 inches at front door.	20 inches/kneels to 17 inches at front door for boarding.	23.5 inches/kneels and tilts to 18 inches at front door for boarding.	17 inches at front door.
Propulsion	70 mph top speed, 0.1 g acceleration, 55 mph on a 2.5% grade	Uses Caterpillar 3406 TAPC, 6-cyl diesel; turbocharged-aftercooled, 375 bhp at 2100 rpm, to meet specification.	Uses Detroit Diesel/Allison gas turbine, regenerative, split shaft, 280 bhp at 2900 rpm, to meet specification.	Uses Cummins VT-903, V-8 turbocharged diesel; 350 bhp at 2600 rpm, to meet specification.
Transmission	3 mph/sec <sup>2</sup> max jerk.	Dana Turbo-matic 186, two speeds plus torque converter-90 deg drive.	Allison MT-740T, 4 speeds with fluid coupling in-line drive.	Allison 730, 3 speed plus torque converter-63 deg angle drive.
Accessory Drives		Air conditioning compressor, 2 alternators, and hydraulic pump are driven off a chain accessory drive case mounted to the transmission. The hydraulic pump serves the cooling fan motor, the leveling and leveling system, and power steering. Only the air compressor is engine driven.	A chain drive carries the main driving torque from the engine to the transmission. Accessories also driven off this system by chain include 2 air conditioning compressors, 2 alternators, one 24 volts and the other 208 volts, for coach heating, and the cooling fan drive. The transmission oil pump, power steering pump, and the air compressor are engine driven.	An accessory gear case is driven off the engine by a small prop shaft. The accessory case drives 2 hydraulic pumps, an alternator, and the power steering pump. The hydraulic pumps serve the refrigerant compressor, cooling fan, condenser fan, and evaporator fans. Only the air compressor is engine driven.
Rear Axle		Tandem driving, drop center, offset drive.	Tandem driving independent with two separate differential units, chassis mounted. Driver controlled laterals lock-out.	Tandem driving independent with all gearing in a single case mounted to chassis. Internals differential is no-split.
Rear Suspension	4 inch min bounce and rebound travel. Ride quality equivalent to full size automobile.	Torilastic springs with hydraulic height control.	DeDion with air suspension and height control.	DeDion with air suspension and height control.
Front Suspension		Single independent wishbone shaped, short upper, long lower arms, torilastic suspension with hydraulic height control.	Single independent wishbone shaped short upper, long lower arms, air suspension and height control.	Tandem independent short upper, long lower arms with leading strut rod, air suspension and height control.
Brakes	100,000 mile friction material life-meets new air brake safety standard 121.	Bendix Air over hydraulic actuation-4 piston single disc; Krisley Hayes antilock system.	Air over hydraulic actuation-single dry disc front, oil cooled multiple disc rear brakes mounted on differential housing. Eaton antilock system.	Rockwell Stopmaster-air actuated drum type: 12x5-1/2" front, 12x7-1/2" rear Rockwell antilock system.
Tires		6 Firestone 350C-19.3 with 33-in OD and 14-in width.	6 Firestone, 350C-16.3 with 32-in OD and 14-in width.	12 Goodyear MR60-16.5 with 28-in OD and 10-in width.

Table 3.2 Transbus Prototype Specifications.

Source: Booz-Allen, Transbus Public Testing and Evaluation Program.

<u>Design Factor</u>	<u>Improvement Goal Over Current Buses</u>
<b>SPEED OF TRANSIT</b>	
Top Speed	Increased from 70 mph to be comparable with freeway traffic.
Acceleration	Increased from 1.4 to 2.2 mph/second for greater maneuverability. This is the greatest desirable acceleration without sacrificing passenger comfort.
Gradeability	Increased from 40 to 55 mph on a 2½ percent grade for increased travel rates in hilly terrain.
Boarding Time	Halved from 3 to 1.5 seconds per passenger for expeditious ingress and egress. Accomplished by increasing door width from 27 to 40 inches and reducing height of bus floor above curb.
<b>PASSENGER COMFORT AND SAFETY</b>	
Interior Noise Level	Reduced from 85dBA to a maximum of 80dBA under all operating conditions and at all passenger locations. This represents a 70% reduction in noise.
Air Conditioning	To be standard equipment on all vehicles; redesigned for greater reliability.
Interior Lighting	An increase in intensity at the reading position over present bus lighting systems.
Seat Width	Increased from 16 to 18 inches per passenger.
Knee Room	Increased from eight to 10 inches.
Passenger Information	Destination sign letter height increased from four to five inches with a minimum of two signs per vehicle, each with a 200-destination automated storage capacity.

Table 3.3 Transbus Design Goals

Source: Booz-Allen, Transbus Public Testing and Evaluation Program.



<u>Design Factor</u>	<u>Improvement Goal Over Current Buses</u>
<b>PASSENGER COMFORT AND SAFETY—CONT'D.</b>	
<b>Window Area</b>	A 100 percent increase in side window area for increased visibility for both seated and standing passengers.
<b>Jerk</b>	Kept to a maximum of three mph per second/per record to provide smoothness of acceleration comparable to modern rail transit.
<b>Floor Height</b>	Reduced 50 percent from 34 to 17 inches above the road surface to reduce boarding accidents, especially those involving the aged.
<b>Boarding Steps</b>	Step from street reduced from 14 to 10 inches, with interior step height reduced from 10 to seven inches, and the number of interior steps reduced from two to one.
<b>Passenger Windows</b>	Converted from operable type to permanently fixed and sealed to insure that passenger limbs do not protrude from bus envelope and to protect passengers from flying objects.
<b>Crashworthiness</b>	Interior dimensions to be altered by no more than three inches in typical roll over and side impact crashes for improved passenger protection.
<b>Emergency Egress</b>	Hatches in roof and side windows which can be opened in an emergency for rapid egress in event of roll over and fire.
<b>Pedestrian Protection</b>	Right rear wheel area redesign and elimination of potential hand holds to reduce pedestrian fatalities.
<b>Bus Body and Bumper</b>	Energy absorbing concepts to reduce the severity of bus/automobile and bus/pedestrian accidents. Design target is 35 percent reduction in accident costs.
<b>Interior Design and Padding</b>	Improved assist devices, interior padding, elimination of interior hazards and the development of new safety bus seats.

**Table 3.3** Transbus Design Goals (continued).

<u>Design Factor</u>	<u>Improvement Goal Over Current Buses</u>
<b>AESTHETIC APPEAL</b>	
Exterior Appearance	Low profile, smooth lines, simple shape.
Interior Appearance	Simple design, comfortable, attractive appointments.
<b>ENVIRONMENTAL ADAPTABILITY</b>	
Gases and Smoke	Meets 1974 Federal heavy duty standards with the 1975 California heavy duty standards as a design goal.
Odor	Reduced by 50 percent.
Exterior Noise	Reduced by 70 percent from noise levels of present vehicles (from 85 to 80 dBA).
Traffic Congestion	30 or more automobiles removed from rush hour traffic for each full bus.
<b>MAINTENANCE AND SERVICING</b>	
Interior Cleaning	Interior cleaning costs reduced with conversion from supported to cantilever seating.
Glazing Material	Conversion to glazing that increases impact strength and eliminates breakage caused by vandalism.
Bumper Impact	Withstand a five mph impact by a 4,000 pound automobile without incurring damage to the bus, and reducing damage to the car.

Table 3.3 Transbus Design Goals (continued).

<u>Design Factor</u>	<u>Improvement Goal Over Current Buses</u>
Exterior Panel Replacement	Non-stressed exterior panels to be replaceable within 30 minutes.
Brake Friction Material	A 100 percent increase in friction material life from 50,000 to 100,000 miles for a reduction in brake maintenance costs.
Brake Adjustment	Self-adjusting brakes to eliminate 20 percent of current vehicle maintenance time requirements.
Electrical System	Built-in diagnostics for fault isolation to reduce current maintenance load by as much as 18 percent.
Tires	Low pressure sensors built-in. Unique cantilevered tire does not come off rim when flat. A safety and maintenance breakthrough.

Table 3.3 Transbus Design Goals (continued).

## CHAPTER FOUR

### GOVERNMENT INNOVATION PROCESS: THEORY AND PRACTICE

#### 4.1 INTRODUCTION

The purpose of this chapter is to propose a general framework for federal government-initiated technology innovation. Two most important issues are identified to put the Transbus program in the context of this framework, namely, the policy on development of technology, and technology procurement. The focus of the discussion will be on commercialization of technology, and its relation to development, procurement issues. The insights gained from the Transbus case study will help us compare the practice, and the current framework. Finally, conclusions, and recommendations are made as regards improvements in the process of federal government-initiated technology innovation, specifically in the public mass transportation sector.

#### 4.2 GOVERNMENT-INITIATED TECHNOLOGY INNOVATION

A general framework has been recently developed regarding analysis of government intervention in the market either to create technology or induce its creation/diffusion or both. This general framework divides government actions into two types: technology push actions; and technology pull actions.<sup>1</sup> Technology push includes government actions which are directed towards creation or development of a particular technology. This may take the form of joint cost sharing or full funding by the federal government, either contracted to private sector firms or developed in federal government laboratories (or other facilities). Technology pull, on the other hand, consists of those series of actions which indirectly affect either a specific product or a particular market, such as performance standards (specifi-

ccations) or regulatory measures, respectively.

This framework is useful for several reasons. First, most of the supporting data on technology innovation is either qualitative or sector specific.<sup>2</sup> There is no general theory which could provide a useful basis for government policy regarding market intervention. As the level of inquiry matures in this area such a theory will hopefully result. Second, the relationship between technological change and economic activity is little understood at the present time.<sup>3</sup> This has to be further clarified in order not to be construed as nullifying or disputing the works of economists in this area. Our understanding of the relationship between economic activity and technological change is not yet fully developed in the causal sense, i.e., knowing exactly what economic actions would produce precisely which technological outcomes. At present the "best" explanations are based on the empirical econometric studies which relate research and development (R&D) expenditures to technological change. The R&D expenditure is only one of the inputs to the process of technological change.<sup>4</sup> It says nothing about the actual dynamics of the process itself.<sup>5</sup> The consequences of economic actions as far as technology is concerned are particularly important to the federal government, because most levers at its disposal for influencing technology change are economic, that is, sponsoring development, giving tax incentives, etc.

The factors which affect the diffusion of new technologies, however, are not only economic but also institutional.<sup>6</sup> The importance of the institutional factors have long been recognized by researches. Most economists, for example, recognize that the process of technological change in the majority of cases is entrepreneurial.<sup>7</sup> In other words, more than anything else it requires zeal, enthusiasm, and the capability to accept risk, and

and uncertainty.

A large number of technological innovations since the beginning of the Industrial Revolution have also been "spin-offs" from government-supported military hardware development projects. For instance, in the nineteenth century major innovations in typewriters, and bicycles were the direct result of the componentry developed in the armament manufacturing industry, which were supported by the U.S. government.<sup>8</sup> In the twentieth century such technologies as transistors, digital computers, atomic energy, and aircraft were also a result of basic research funded by the federal government.<sup>9</sup>

In most cases innovations occur in an evolutionary manner (rather than revolutionary).<sup>10</sup> This is especially true in manufacturing industries. Very often a certain part or component of a machine is under research either for improving productivity or general dissatisfaction with operation of that component.<sup>11</sup> This trial and error research process usually leads to more efficient and productive operation of that component. In order to fully utilize the efficiency, and productive capacity of that component (after improvement), however, other components in the system usually have to be improved to realize the full benefits of the initial innovation. Thus, the innovation process evolves slowly. This evolutionary nature of most innovations is extremely important in devising government innovation programs, especially from diffusion standpoint. Given that the "natural" diffusion of innovations for various componentry takes anywhere from 5 to 25 years, the hurdles for overcoming a total product innovation would probably take longer and much more effort.<sup>12</sup>

Up to now a brief overview of technology innovation has been provided. In general, there are three components in considering any technology innovation: economic, institutional, and technical (or hardware).<sup>13</sup> In most

cases, the technical feasibility of an innovation is first established; second, the perceived economic benefits should outweigh the corresponding risks; and third, institutional hurdles have to be overcome in order for the innovation to be adopted. The first and second component are more producer related, while the third component is user oriented. To put these in the government innovation context, each will be discussed in the context of technology push, and technology pull framework developed earlier.

#### 4.3 TECHNOLOGY PUSH AND TECHNOLOGY PULL ACTIONS

Technology push as noted earlier, includes those actions related to the funding of technology development. On the other hand, technology pull are those actions or policies of government which affect development, diffusion, and adoption of technology indirectly. This may take the form of regulation and it may be imposed on either the supply side or the demand side depending on the mandate of the federal agency.

The relationship between the technology push, and technology pull is very important from the government perspective, since most government supported technology innovation projects/programs are often a mix of both actions with varying intensity, and extent of government intervention. If we were to classify or define such projects using these two kinds of actions, a project/program may be depicted as shown in Figure 4.1<sup>14</sup> The vertical axis represents a subjective measure of intensity of government action as regards technology push. The horizontal axis by the same token represents the intensity of technology pull.<sup>15</sup>

Consider a hypothetical project sponsored by the Department of Defense to develop a hardware system for the rocket. It is very likely that such a product will only be used by the federal government itself, and most likely

no civilian market would welcome such a product. Such a project may be depicted by point A in Figure 4.1. Clearly, hardware development efforts are dominant here. Another example would be to sponsor development of a microprocessor computer device which could be used by the local level law enforcement agencies to diagnose the alcohol level of blood in drunk drivers. In this case, although the user is still government but at lower levels, the needed level of technology pull is greater than before because the local level law enforcement agencies must have an incentive to adopt such technology. Point B illustrates this. Still another example where market pull should dominate for full utilization of technology is in the development, and commercialization of solar energy. The Barriers to adoption and diffusion of solar technology are far more numerous than development hurdles.<sup>16</sup> Point C depicts this.

The technology pull actions may be further refined into two broad categories of product intervention, and market modification. For clarification, Figure 4.2 includes a number of specific actions which may be included in each category, i.e., creation of technology in technology push, and product intervention/market modification in technology pull. The important point to be made here is that if government initiated technology innovation is to be successful, an optimal mix has to be worked out including actions from both categories. The optimal mix should include specific actions of varying intensity in both directions, and choice of the intensity may be based on the following variables: type and extent of mandated authority (to the federal agency); structure of the industry; and technology base of the industry.

The type, and extent of the authority delegated the federal agencies by the Congress influences the course of action taken by the individual federal agency. For instance, the Congress has granted direct authority to some



agencies such as the Environmental Protection Agency, Federal Communications Commission, and Federal Trade Commission to regulate the market activities of suppliers (or producers/manufacturers). While in some other cases the delegated authority is indirect, such as the Maritime Administration of the Department of Commerce, and Urban Mass Transportation Administration (UMTA) of the Department of Transportation (DOT). The latter agencies may dictate various requirements upon the recipients of federal financial assistance, however, they do not hold any direct regulatory authority of the market. This distinction is important from a technology pull perspective, since the action of the federal agency with the above characteristics, is only legally binding on those who receive assistance. This will become clearer when the Transbus program is analyzed in this context.

The structure of the industry, and its technology base are often referred to as "a two way street." This signifies the fact that usually technology base shapes the structure of the industry, and vice versa.<sup>17</sup> For example, industries in the service sector such as public transportation would be structurally different from those in the manufacturing sector, say, automobile. As a result of this, it is advisable that, the historical evolution of both technology, and structure should be taken into account when a government innovation program is being formulated.

Consider the airline industry which has a very high technology base, and a correspondingly different structure from mass transit industry, which has a very low technology base. Thus it would seem safe to assume that the airline industry would adopt technological innovations at a much higher rate than the transit industry. As a result, the former industry operates in an environment which is much more conducive to innovation than the latter.<sup>18</sup> Identifying the structure of the industry may also tell us how many firms

operate in the market, their organizational structure, the geographical and demographic characteristics of the area they operate in. It would be equally important to identify and take into account the above variables in the supply side of the industry.

#### 4.4 ISSUES IN A MISSION ORIENTED GOVERNMENT INNOVATION PROGRAM

Before proceeding to discuss the Transbus program, it may be useful to give a brief description of a typical mission oriented R&D program which includes marketing of the product as well as its development. Ideally, a technology innovation program would proceed as shown in Figure 4.3.<sup>19</sup> The first step is the conceptualization of the product. Second, the definitions of requirements, and criteria which these requirements should satisfy, are formulated. Third, prototype models are manufactured according to the requirements. Then the prototype models are tested against the criteria, and the corresponding modifications are made following a feedback process as shown. Up to now the main theme of the actions have been oriented towards establishing the technical feasibility of the technology.

The next phase consists of testing the technology in the actual service/operational environment. These tests would ideally determine the acceptability of technology among the end users, and could also serve as a marketing tool to demonstrate the technology to potential investors/buyers. Alternatively, the project after completion of these tests, may be abandoned depending on the acceptability, and a host of other factors including the costs of modifications. If it were decided to market the product, the next step would be the production of the technology.

It is worth noting that the second phase may take longer than phase one, and also cost more (see Figure 4.4). This may be due to a number of reasons.

On the one hand, debugging is inherently a slow process since problems usually show themselves only in service, and the in-service tests take between two to five years.<sup>20</sup> Further, costs may be large depending on the level of complexity of technology in the product. Finally, the nature of the procurement policy would depend on whether the federal government is the end user, the level of competition to be achieved among the producers, or competitive bidding and whether the procurement policy specifies the design or performance of the final product.

Thus if a government-initiated technology innovation takes the form shown in Figure 4.3, i.e., in two distinct phases (as suggested by the National Academy of Engineering study), it would then be appropriate to identify the most important elements in each phase. The crucial elements of phase one are the development of the prototype specifications which is very important from the design perspective. The specifications should be flexible enough to allow for necessary changes while at the same time the approach should not be ad hoc. The design process itself is inherently evolutionary, i.e., it is trial and error. This flexibility should be incorporated into the specification development process, and the specifications themselves. The flexibility would ideally allow modification of specifications as the design/manufacture of prototype proceeds. The effect of the opposite would be to trap the designer/manufacturer into one rigid framework, which in the end may prove very costly.

The process of establishing the technical feasibility should be kept in low profile. For a number of reasons the contrary may prove harmful not only to the government but also to the private firms that take part in the project. Inappropriate publicity may give rise to public stances, and

promises by the government which could be undeliverable. In addition, it might solidify certain attitudes in the concerned parties which later cannot be changed. It may also cause undue bad publicity for the private firms. Another important attribute of a low profile feasibility testing is that, it leaves the designers with a free hand to adjust designs without being subjected to publicity, and thus be forced to take public positions.

The objective of operational feasibility tests may vary for different purposes. One objective would be to debug the operational problems. Another objective which is related to the previous one is to test the acceptability of the product among the end users. Still another goal may be to attract private investment in the commercialization process of the technology (or idea). Of course, the latter two have been the prime objectives of UMTA's RD&D programs.<sup>21</sup> It should be noted that there are striking differences between demonstrations and debugging, not only in terms of costs but as regards the extent of government involvement in the process. It is important to realize the significance of this difference for ideological as well as economic reasons.

We now turn to the final element, the procurement policy. A procurement policy is usually developed in cases where the (federal, state, or local) government is the "customer" for the technology being developed under the government innovation program. By definition, the government intervened in the development of technology, in question, because of lack of market incentives for private firms to provide that technology. Additionally, in the majority of cases, it is some level of government which often purchases the technology.

The procurement process, however, can also easily evolve into a relationship between the government, and the private firm in which the

private sector is not independent of the government anymore. For political, and ideological reasons, this is usually regarded as unacceptable in most cases (with the exception of the defense sector). So a solution (or partial solution) may be suggested so as to devise a policy which would preserve the "free enterprise spirit" of the market as far as possible. This should limit the extent of the government procurement to elimination of the initial financial risk for the private firm. Theoretically this is done by ordering a minimum number of units of the product or allowing for cost overruns which would have otherwise been impossible. The government procurement can further be used as a policy tool, e.g., to achieve a degree of product standardization. There is also an economic principle behind the minimum order procurement arrangement. In theory, the unit costs of production would decrease as the output units increase (up to an optimum point). Also the demand for the product should obey the traditional curve. Thus, ideally the intersection of the latter two would be the point beyond which it would be profitable for the private firm to go independent of the government. Figure 4.5 illustrates this principle. There is an implicit assumption, however, that beyond the breakeven point there would be a commercial market for the product. In practice though the breakeven point is regarded "breakaway" point for government assistance. That is, due to independent adequate incentive for the private firms to produce and market the product, further government assistance to sustain the market would be redundant.

It may also be noted that there is a learning curve associated with most new products. It states that costs of production for a new product will decrease with time, as a result of learning to improve the production process (e.g., the digital computers).<sup>22</sup> Figure 4.6 depicts the principle of the learning curve.

The standardization of the product as well as the acquisition process may also be among the goals of a procurement policy. In addition, by requiring competitive bidding in the acquisition process the competitiveness of the market could increase. It must be noted that product standardization from a design standpoint could become very costly if the end user requirements differ from one another widely. In other words, requiring certain features (or additional devices) to be included in the end product as standard equipment, which are only needed by a few end users, may prove wasteful. This approach though costly is used in some sectors such as the defense for the obvious reason that the Department of Defense is the only end user of the product and has a relatively high budget. In the civilian sector, however, the more prevalent approach is to develop a set of performance specifications which would be flexible enough to allow for differences between the needs of various end users.

Theoretically, this latter is the best approach, though in practice developing a set of performance standards which allows for end user differences as well as producer differences is extremely difficult. Very often these specifications are so detailed that they hinder the achievement of the original goal in the long, i.e., innovation.<sup>23</sup> In the case of bus vehicle performance specifications, there are a few which could be regarded as "pure" performance standards, and the rest are in effect design specifications. For example, fuel economy, jerk (rate of change of acceleration), noise level, emission level, etc. all can be regarded as performance standards. The seating arrangement, the height of front step, floor slope, and axle geometry would fall under the design category. When the federal government undertakes some innovation program there would definitely be certain desirable features of the new technology which fall under the

design category, and thus the important point in developing a procurement policy is that a "reasonable" balance has to be struck between the design and performance standards.

Formulation of a procurement policy with a reasonable balance between performance, and design standards is inevitably open to "abuse," i.e., depending on the view of those who develop the standards, they may be "too flexible" or "too rigid." Therefore, to develop a fair, and reasonable procurement policy which incorporates performance as well as design standards requires extensive knowledge, and insight into technological possibilities, plus the economic impacts.

Another important issue in procurement of technology which has received a great deal of attention recently is the life-cycle costing method. Life-cycle costing refers to a method of procurement in which the price for the product reflects its total economic life. The objective of having a life-cycle costing method is to reduce the total costs of acquiring and operating a product. For instance, the initial capital costs of a certain product may be lower than its competitor but its operational costs may be higher. So depending on the lowest combination of both capital costs operating costs, the use of life-cycle costing (in theory) can result in savings for the end users.<sup>24</sup> In practice, however, there are a number of impediments to implementation of this method of procurement. First, before a technology is fully developed (initial stages of the learning curve) it would be very difficult to obtain an accurate estimate of total life-cycle costs of any product. This so-called technological uncertainty rules out effective use of life-cycle costing method. Second, the government funds which are used for procurement of such technologies are often appropriated according to a combination of political/economic considerations. In most cases, the short-

term immediate consequences of government expenditure is of most importance to decision-makers which in effect does not allow the use of life-cycle costing. Thus, to employ the life-cycle costing in procurement of new technologies not only requires full operational knowledge of characteristics of new technologies, but it also requires a drastic departure from the traditional political-economic considerations of emphasizing the short-term consequences.

#### 4.5 TRANSBUS PROGRAM IN CONTEXT

In order to place the Transbus program in the technology push/technology pull diagram, it is important to assign intensity levels to both types of actions in the program. The technology push actions in the Transbus include the specifications development, prototype manufacture, and demonstrations. Given that the development of low floor componentry was a sharp departure from the available technology, the program may be categorized as moderate-to-high technology push intensity. As explained in chapters two and three, however, these actions did not include commercialization of the developed subsystem components. That is, the government did not go beyond establishing the technical feasibility of the Transbus subsystem components, such as tandem axle, low profile tires, and small diameter brakes.

The technology pull action was in the form of procurement policy. This procurement policy would in effect have mandated certain standards which all federally funded buses had to comply with. This type of mandate was in line with UMTA's authority. The first version of the Transbus Procurement Requirements (TPR) was a compromise since most subsystem components associated with the Transbus were not yet fully developed. It, however, satis-



fied at least two of the program objectives, namely, standardization of the procurement process, and establishment of a uniform set of standards for the buses.

Before taking effect, the first version of TPR was suspended, and later substituted by the second version. The second TPR took the opposite approach to the initial TPR, it mandated the subsystem components which were not yet commercialized in order to induce the commercialization process. In other words, the philosophy was that if the standards were made adequately stringent, making a more design-oriented emphasis, that would then force the manufacturers to initiate the commercial development of those components in question. The refusal of the manufacturers to bid though proved this strategy false.

At the present time UMTA is trying to modify the Transbus mandate to make it more in line with the first TPR. In the meantime the funding for purchase of the interim buses, and the older ("New Look") buses have been approved. The current outlook of the DOT is more liberal towards technological issues in mass transit with greater emphasis on software, and management problems.

There were several reasons for lack of effectiveness in the second TPR. Assuming that the second TPR was a high technology pull effort the Transbus may be located as shown in Figure 4.7 on the upper right hand quarter of the diagram. Presumably, a high technology push/technology pull action should be successful, the Transbus program was not. One of the important factors in failure of the TPR was that there was too much emphasis on technology pull, and the procurement itself. That is, UMTA relied too heavily on its authority to grant financial assistance as a means of introduction of the Transbus. Of course, given the circumstances in which the procurement

policy was formulated this probably was inevitable due to political commitments of the DOT (explained in previous chapters).

Another factor was the relatively high technology nature of the Transbus compared to the traditional technology which is used by the transit industry (the importance of technology base and industry structure). The transit industry has traditionally been apprehensive of new (sophisticated) technology, and the transit equipment manufacturers are probably best aware of this attitude. A better mechanism for conveying the need for innovation may be the transit industry itself, since the industry has long established ties with the manufacturers. It would indeed, be difficult for the federal government to achieve the same degree of intimacy with the concerns of both producers, and the operators as they themselves can. The point should be made that change usually comes about as a result of outside intervention in any process, and most often these changes are favorable. A step toward closing the above gap, however, would be the establishment of the Innovation Board suggested in chapter three.

A combination of above factors led to an ineffectual technology push/technology pull , and thus resulted in failure of the program. The necessity of private sector cooperation, and present inability of the transit industry (in the current environment) to absorb moderate levels of technology may be a possible basis for future innovation programs to concentrate on the lower quarters of the technology push/technology pull diagram. This implies that the federal government (UMTA) should engage in development (creation) of low-to-moderate technology products or subsystem components which are consistent with the environment of the transit industry. This should be accompanied with technology pull actions which are based on mutual understanding with the private sector. This is especially important since

first, the federal government is not the ultimate user of the transit technology, and second, private sector's refusal to cooperate renders the government efforts ineffectual.

As far as the micro-issues of innovation process are concerned, e.g. hardware design, the program again emphasized certain design features such as tandem axle, and single slope floor that in the end led to the lack of adequate consideration of other options such as double slope floor. Indeed, double slope geometry deserves further analysis, and investigation of the European experience may prove useful in the long-run.

#### 4.6 SUMMARY AND CONCLUSIONS

In this chapter an overview of the state-of-the-art in the study of innovation in relation to economic activity was given. The important factors affecting technology innovation were then presented, namely, technical feasibility of innovation, economic viability of innovation, and institutional attitude towards innovation. A framework for government-initiated technology innovation was briefly discussed: technology push/technology pull actions by the federal government. The important variables which shape and affect the schedule, and outcome of technology push/technology pull actions were identified including the type of regulatory authority which is delegated to the federal agency, and the structure and technology base of the industry in which the innovation is to be introduced. The stages in a typical government-initiated technology innovation--mission-oriented R&D programs--were analyzed. Finally, the Transbus program was analyzed in the above context. The underlying reasons for the failure of the Transbus program included:

1. Too heavy emphasis by UMTA on technology pull actions, i.e., very stringent procurement standards (second TPR).

Also the high technology push effort was only limited to the establishment of technical feasibility which had left the commercialization of the technology to the manufacturers themselves.

2. The design/manufacture was not flexible enough to allow for consideration of other alternatives especially the viable floor configurations which European countries have opted for. The design reflected the original National Academy of Engineering (1967) recommendations.
3. The level of technological sophistication of the Transbus was much higher than the traditional technology base of the transit industry. This plus the negative impact of demonstrations dampened the potential support which the Transbus could have enjoyed among the transit industry.

The combination of the above factors (and others) led to an ineffective mix of technology push/technology pull actions, although the overall program may be placed in the upper right-hand quarter of the diagram in Figure 4.7. With respect to the above points, it is recommended that for future innovation programs in the transit sector:

1. Design process should be flexible enough to allow room for maneuver, otherwise the innovation would be confined to the initial design even if inadequacies of the design are discovered later since alterations would be costly. Also views of the end users, especially since transit hardware is a public technology, are extremely important from an operational point of view of the design.
2. In a low technology base industry, high technology programs have a very high chance of failure unless they are accompanied by aggressive educational and incentive schemes. Demonstrations fall in the latter category. The outcome of the demonstrations are extremely important from a marketing/adoption/diffusion point of view, since a negative impact of demonstration of a technology would be difficult to overcome. The incentive/educational programs should, therefore, be carefully planned in advance to avoid the problems such as those of Transbus.
3. The technology push actions are, in most cases of government innovation, only the initial effort, and thus without the commercialization chances of a successful innovation program are slim.
4. The technology pull actions are extremely important in bringing about technological change, although the indirect and

subtle nature of technology pull requires policies which are less straightforward, and more complicated in relation to technology (creation) push. These actions should be incentive-oriented, and should utilize marketing practices already developed in the private sector.

In summary, in the current environment, federal government (UMTA) action in the civilian sector of the market is limited to two specific ways of influencing technological change: funding the development of technology, and promulgating performance/design related standards. In the case of development, very often government effort does not go beyond establishing technical feasibility of technology. This, however, is only one of the several stages in the process of technological change which includes commercialization. The latter is probably the most important stage in the whole process. The regulations, on the other hand, are only one of the means of inducing commercialization of the technology. Up to the present indirect regulations have not produced the ideal results intended though there clearly is potential for improvement and better understanding of inducing technological change via standards. Therefore, overall government efforts at initiating technological innovation involve very complex problems which she is only equipped to tackle in a limited manner. A better approach towards technological innovation initiatives may be the wider framework of the industrial strategy. However, that involves a centralized approach to planning and cooperation with the private sector that would probably be some time before it is adopted in the United States.

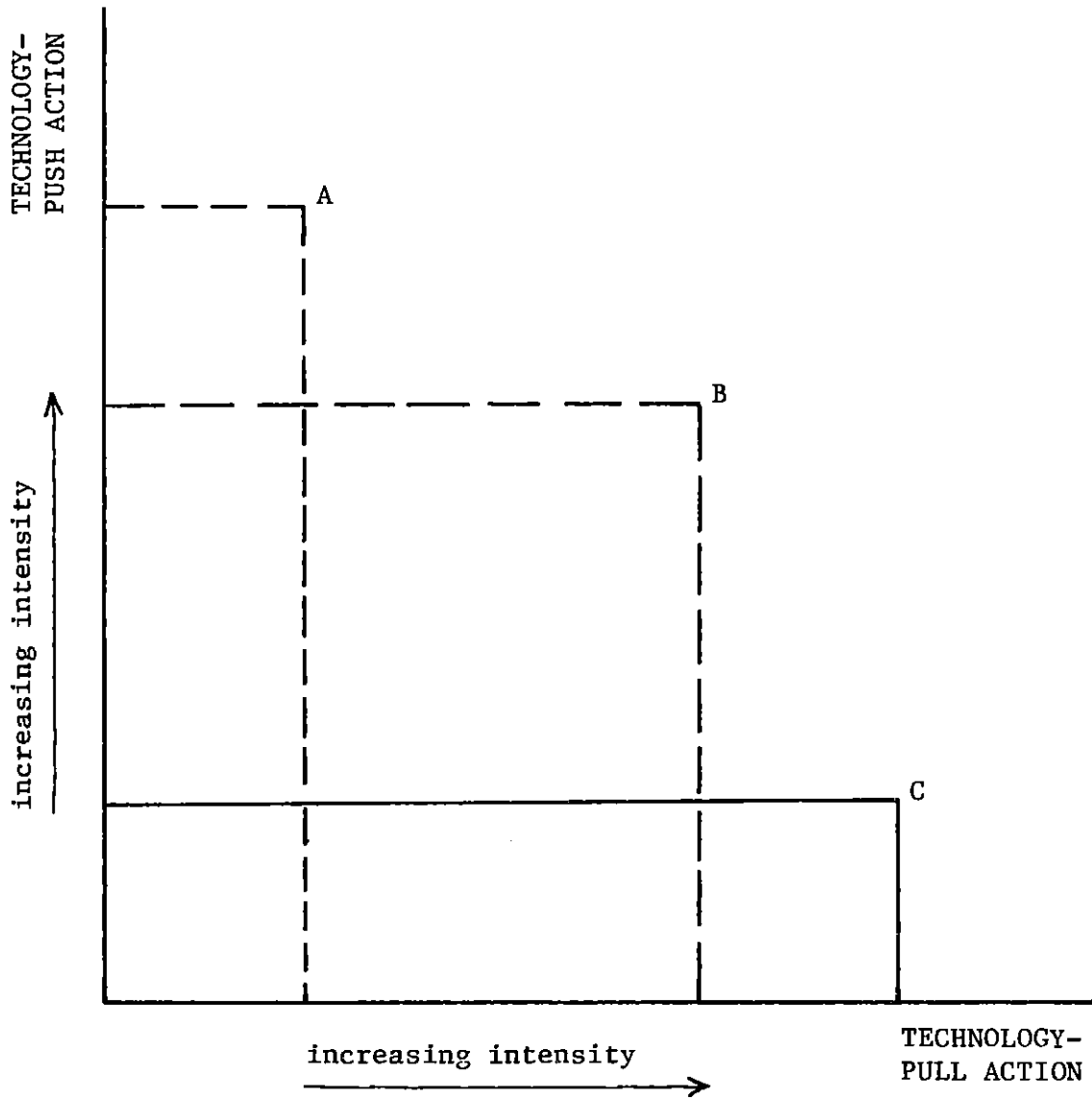
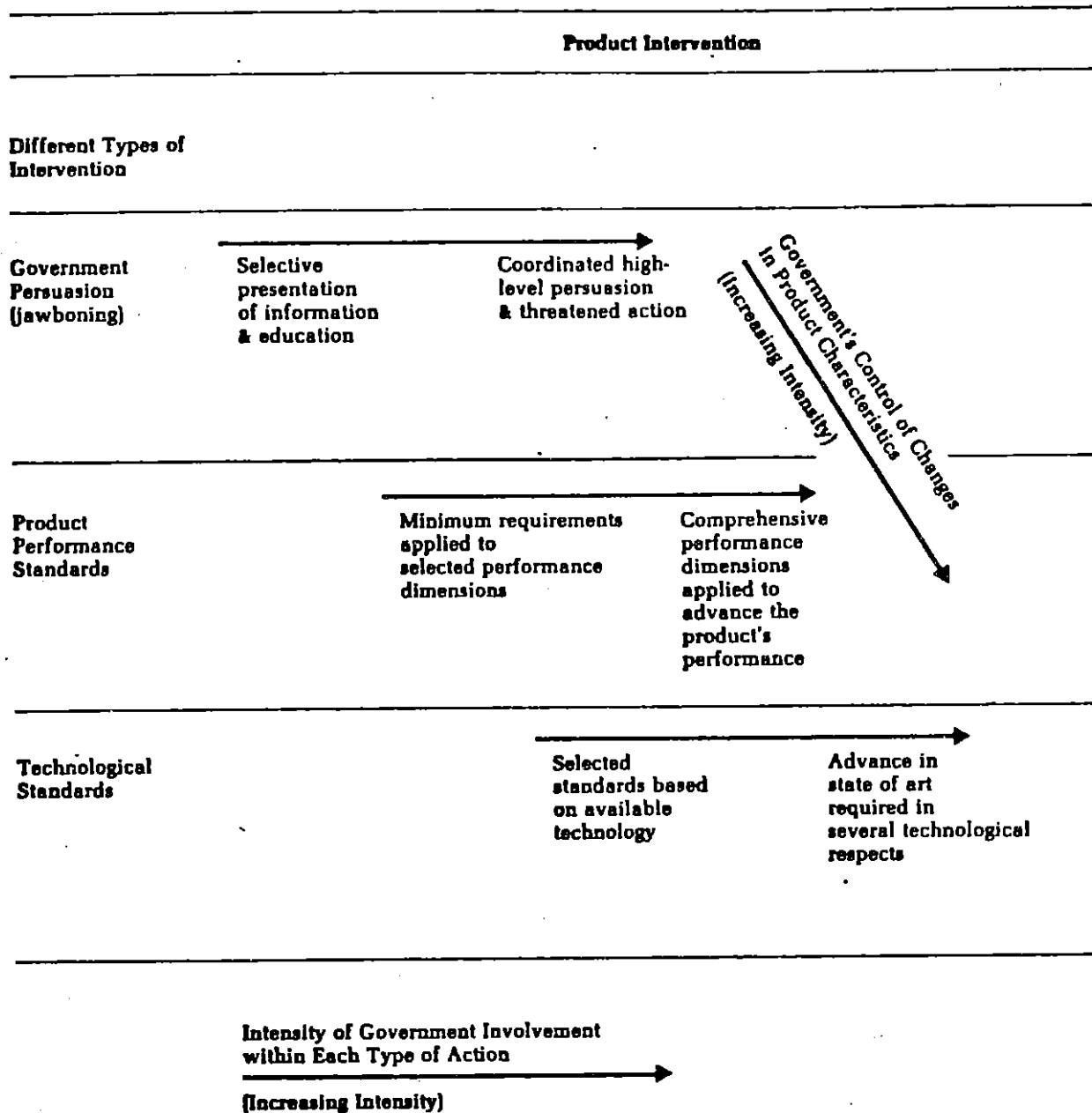


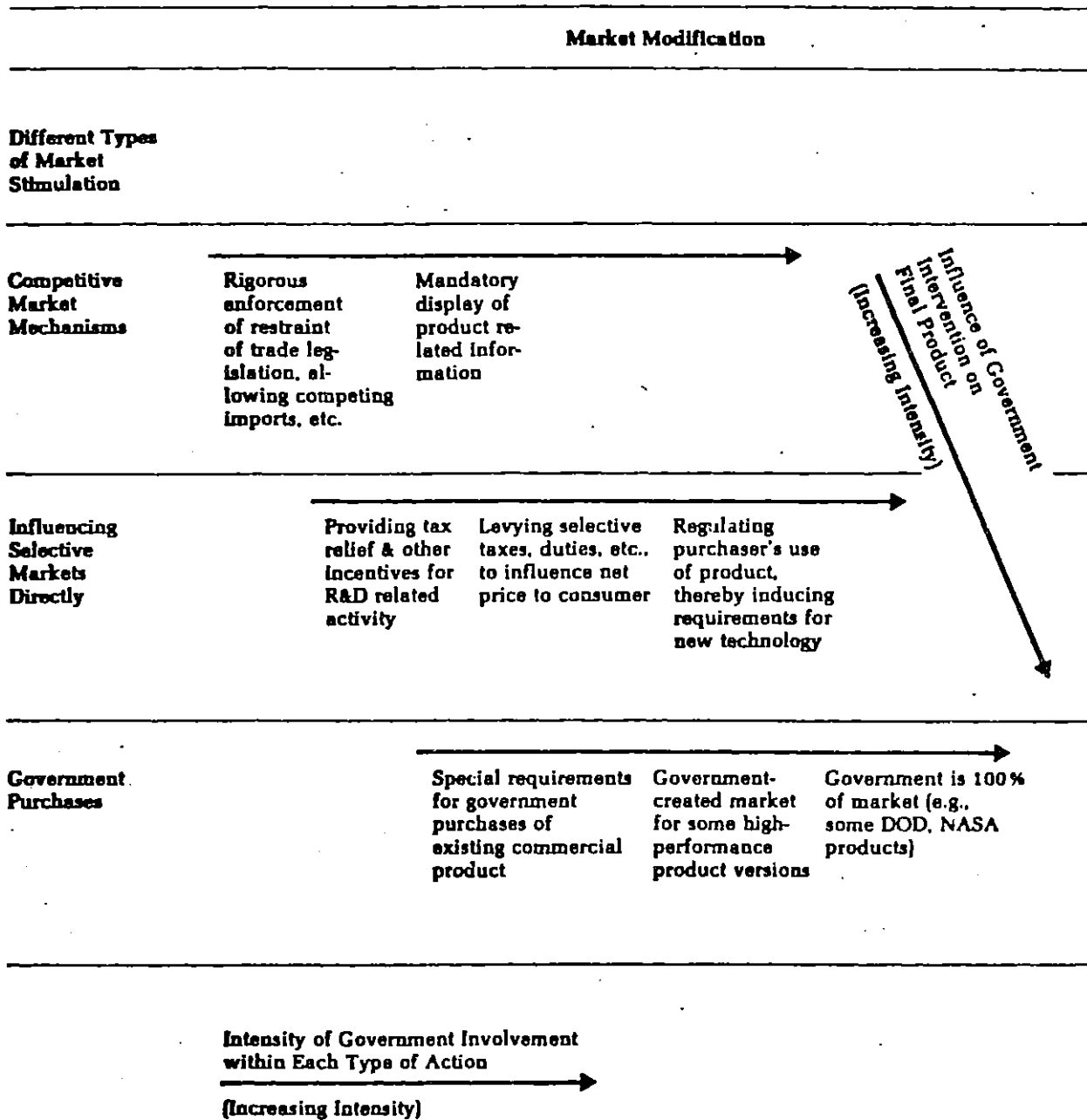
Figure 4.1 Graphical Representation of Technology Push and Technology Pull Actions.

Source: W.S. Baer, et al., Analysis of Federally Funded Demonstrations, R-1926-DOC, Rand Corporation.



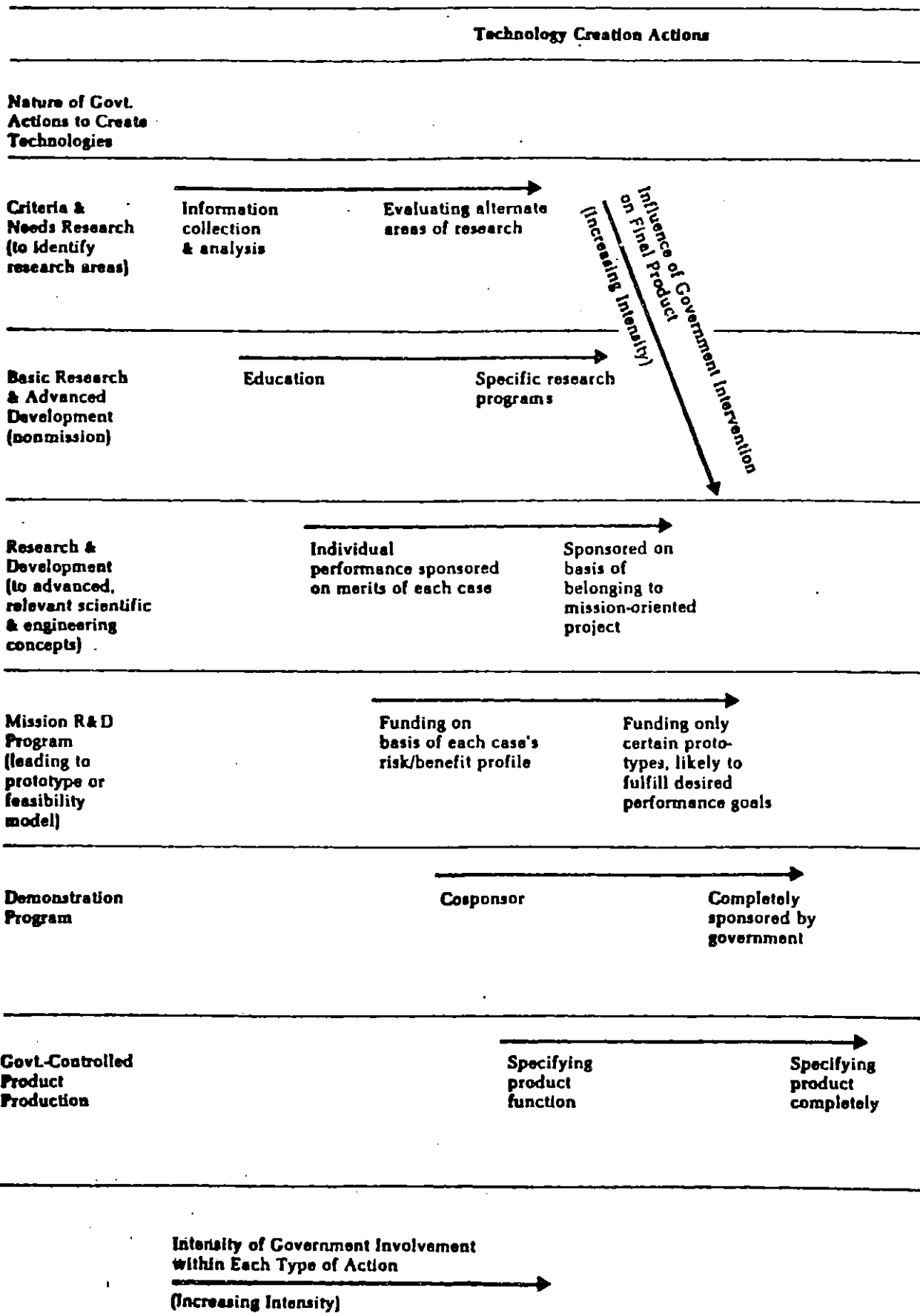
**Figures 4.2** Types of Technology Pull and Technology Push Actions.

**Source:** William J. Abernathy and Balaji S. Chakravarty, "Government Intervention and Innovation in Industry: A Policy Framework," Sloan Management Review, Volume 20, No. 3 (Spring 1979).



**Figure 4.2** Types of Technology Pull and Technology Push Actions (continued)





**Figure 4.2** Types of Technology Pull and Technology Push Action (continued)

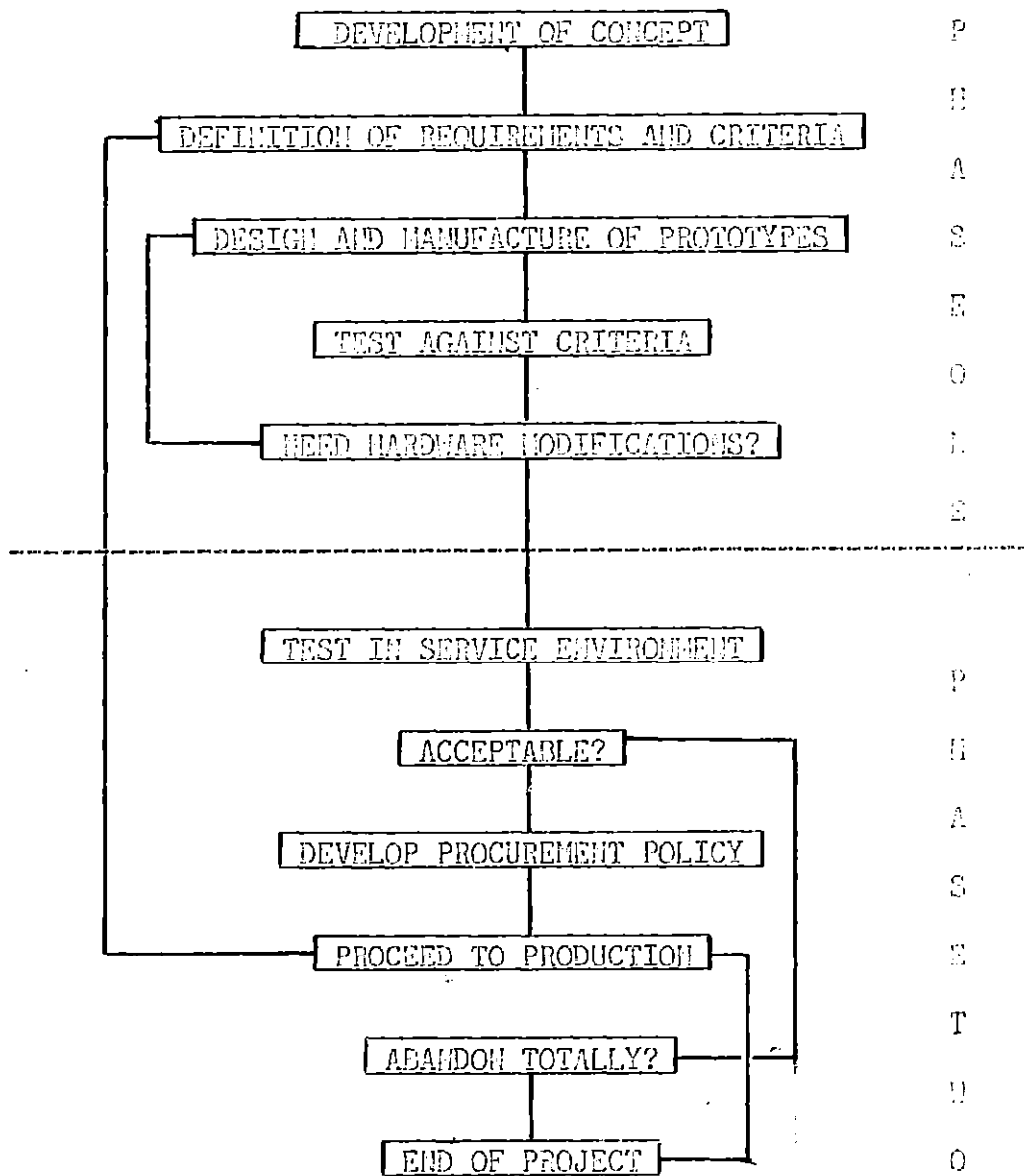


Figure 4.3 Introduction of a Product by Federal Government: An Ideal Systematic Approach.

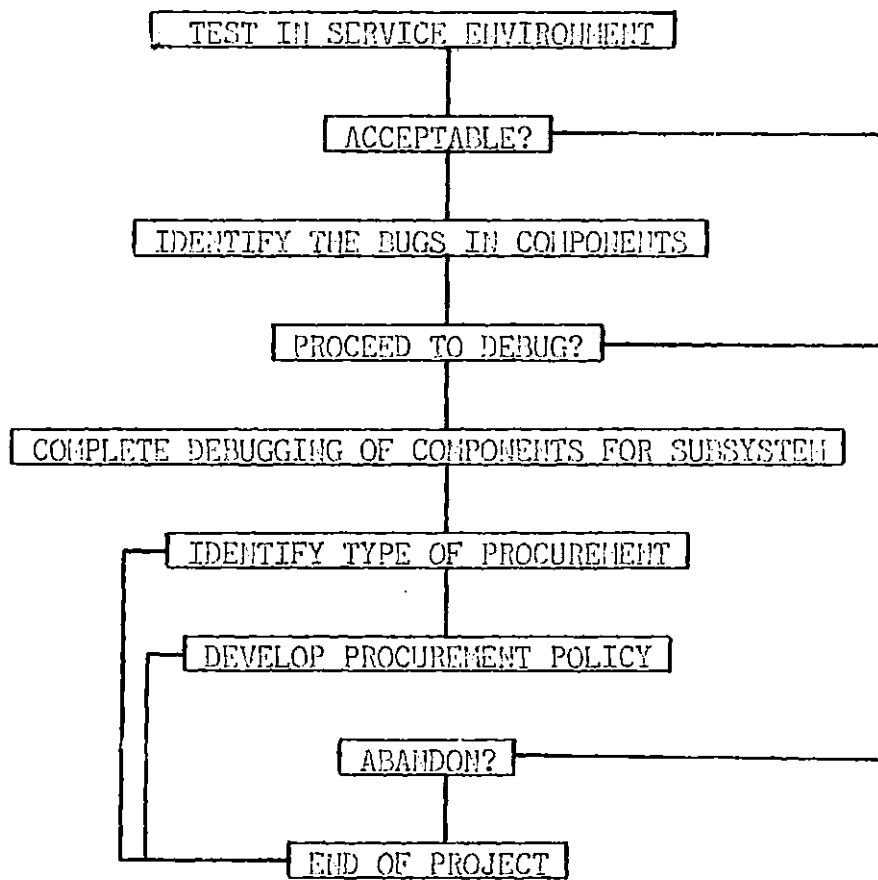


Figure 4.4- Phase Two Elaborated.

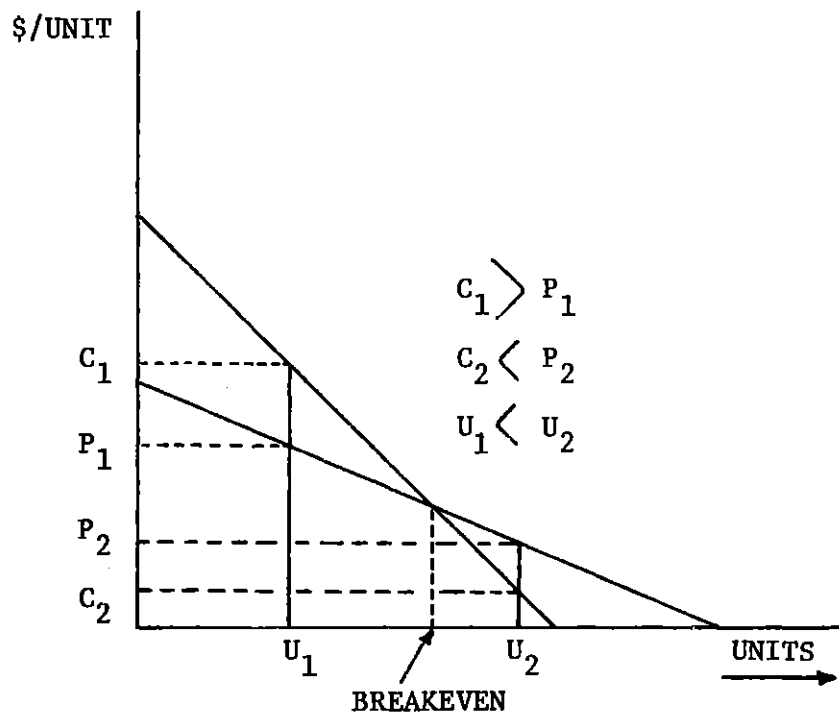
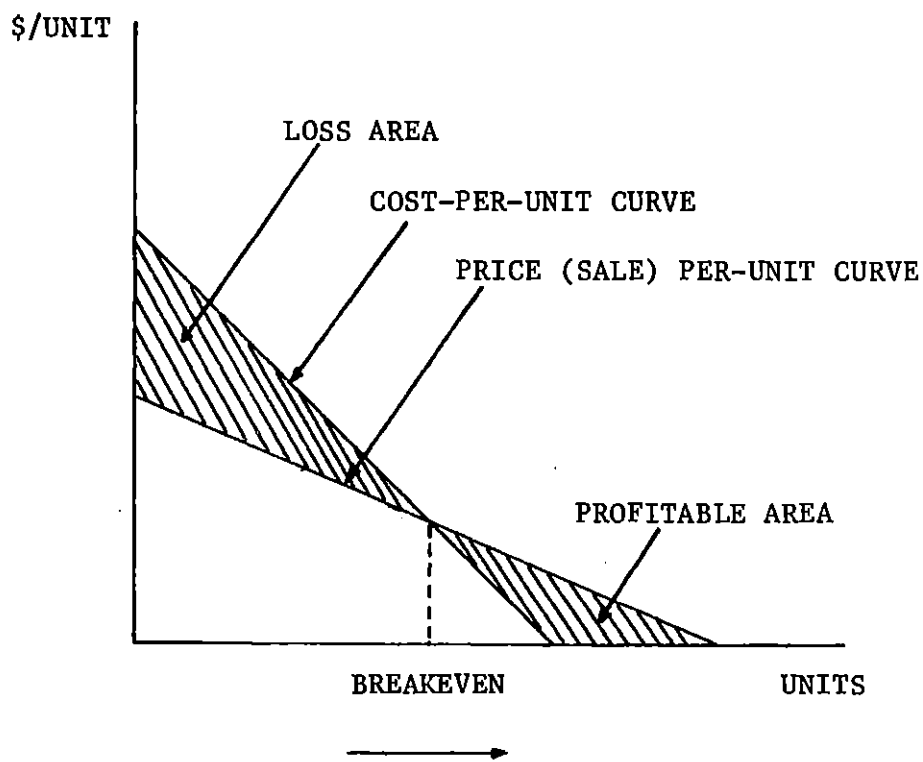


Figure 4.5 Economics of Minimum Order Procurement.

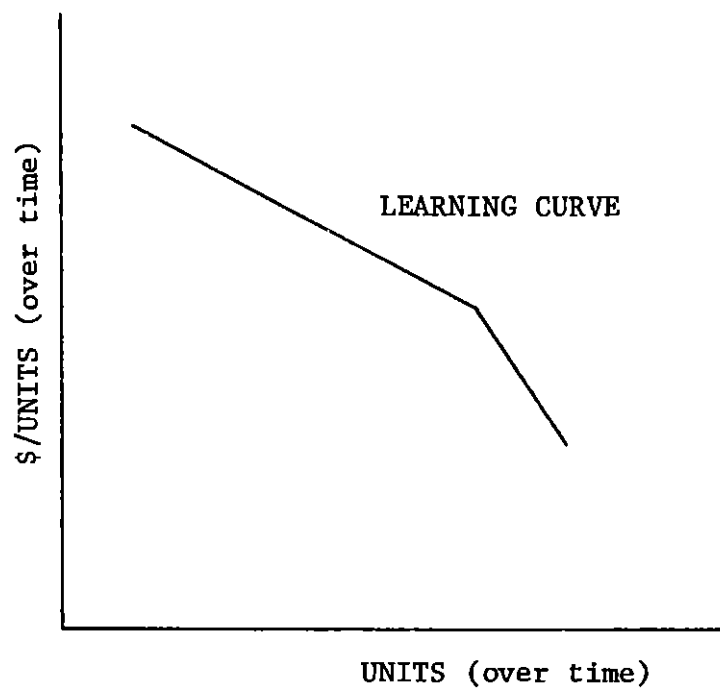


Figure 4.6-A Learning Curve for a Hypothetical Case.

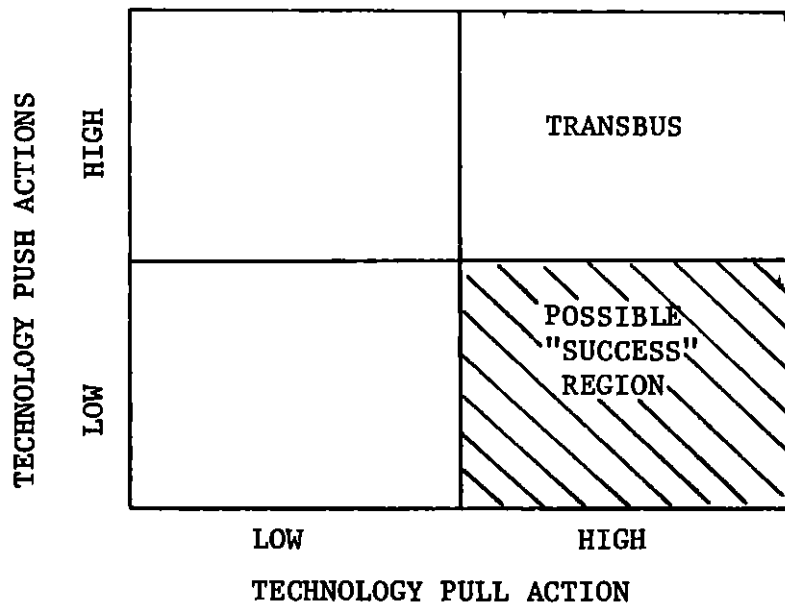


Figure 4.7 Transbus in Technology Push and Technology-Pull Context.

## CHAPTER FIVE

### CONCLUSIONS AND RECOMMENDATIONS

The purpose of this research was to study a case of federal government-initiated technology innovation, namely, the Transbus, and then to try to answer several questions concerning the role of federal government in fostering technological change. Obviously there would be a potential for misleading generalizations in all case studies, but it appears that several conclusions about the characteristics of technology innovation programs may be made that apply regardless of the specifics of the particular program studied. A conscious effort was made to avoid unilateral emphasis on technical issues, with the pre-disposition that political-administrative issues are as important in determining the success/failure of government efforts to foster technological change.

#### 5.1 CONCLUSIONS

Several conclusions emerged regarding both the specific issues in formulation/implementation of the Transbus program, and the general approach to government-initiated technological innovation. The specific issues included those which were internal as well as those which were external to the sponsoring agency. The external issues were related to GMC's (General Motors Corporation Truck and Coach Division) efforts to market the RTS bus, the DOJ (Department of Justice) policies on antitrust/monopoly in the bus market, competitive bidding requirements in government procurement of rolling stock, and the legislation on public transportation services for the elderly/handicapped (E/H) persons. The internal issues were mostly related to the political-administrative posture of the sponsoring federal agency, i.e., changes

in the policy outlook of the Transportation secretaries Volpe, Brinegar, Coleman, Adams, and Goldschmidt.

The first three external issues, and the technological outlook of the Volpe administration influenced the initial formulation of the Transbus program. In other words UMTA (Urban Mass Transportation Administration) initiated the Transbus program partly (or mainly) in response to the external issues enumerated above. As the program proceeded, however, the political-administrative posture of the DOT (Department of Transportation) changed, and an additional external issue appeared, namely, the mainstreaming of the E/H into the main population via accessible public transportation. The post-Volpe DOT administrations, on the other hand, wanted to curb the extent of direct federal involvement in development of transit technology. This affected the Transbus program so much so that first, in 1975, UMTA abandoned the 300 unit procurement plan, and then in 1976, it opted for total abandonment of Transbus in favor of the Advanced Design Buses (ADB's). Even in 1977, when the new Administration revived the Transbus, the new plan did not entail further government involvement in development/commercialization of technology, but the DOT intended to introduce the Transbus via the promulgation of standards pertaining to the Transbus prototype models. The E/H legislation, especially after a series of litigation cases, in 1977 became interpreted as the civil right of equal access to public transportation contrary to the existing approach of equal mobility. Further, the equal access to public transportation for the E/H was thought to be only possible with hardware improvements on transit vehicles and constructed facilities. This was despite the possibility that there might have been no considerable increase in public transportation usage by the E/H because of other factors: long walking distances, and general discomfort over inner vehicular

movement. The latter factors altered the priority pattern of the program in such a way that full accessibility became the overriding goal of the program from the political-administrative perspective.

The general issues that can be considered in the broader context of the federal government's role in fostering technological change are related to the following: prototype specifications and design; establishment of technical feasibility; in-service testing; demonstrations; and development of procurement policy.

The prototype specifications and design are extremely important, since a rigid initial design may later confine the prototype manufacturers and not allow them to make necessary changes in accordance with operational/economic requirements. Thus, the design process should be flexible enough to allow room for maneuver and exploration of various alternatives, and at the same time it should not be ad hoc. In case of Transbus, it may be argued that the single slope floor which was adopted from the design criteria suggested by the National Academy of Engineering study (1967) should not have been unilaterally incorporated in the specifications at the expense of inadequate consideration to other alternatives such as double slope floor or double height floor. The establishment of technical feasibility is probably the easiest stage of the process, given that adequate funding and other resources are provided.

In-service testing, on the other hand, could be very prolonged and costly. This stage is also often referred to as a part of the commercialization process. Essentially, during the in-service testing operational problems which develop are investigated and eliminated. This is also a "testing ground" for examination of environmental adaptability of design, and the economic consequences of the corresponding modifications. The demon-



stration stage would be the next stage, which may be used as a marketing tool to advertize the positive aspects of the technology and thus aid its adoption/diffusion. In the Transbus program the latter two stages could not be distinguished, and were carried out collectively. This was probably not desirable and mainly produced negative impacts. The actual in-service testing period was very short with respect to standard practice (average of 15,000 miles compared to 500,000 miles). Also, due to several operational problems which developed during the demonstrations, the demonstrations served to amplify the undesirable points about the Transbus technology. Further, the negative impact of the demonstrations helped transform the little support which Transbus enjoyed among the operators to open hostility. It would be advisable to keep the in-service testing stage in low profile, and be completely separated from the demonstrations. The demonstrations, on the other hand, should be given maximum publicity and even the marketing strategies already developed in the private sector should be utilized.

Development of procurement policy is the final stage of the technology innovation program, and it is crucial in adoption/diffusion of the new technology systems. It is worth emphasizing that in general an incentive-oriented procurement policy would be much more effective than compulsory standards. Also, the mix between the performance specifications and design specifications has to be carefully balanced. Inappropriate emphasis on either aspect could result in failure at the implementation stage. In the Transbus case, the manufacturers' complaint about the stringency of the procurement standards amplifies this aspect. Also the Mitre Corporation and National Research Council concurred with the complaints of the manufacturers.

Overall, two broad conclusions may be reached regarding the role of federal government in fostering technological change within the current

environment and limitations. Federal government can fund (or engage in) the development of technology, and it can try to aid the adoption/diffusion process by imposing compulsory standards on recipients of federal financial assistance. First, due to the historical experience of federal government in the development stage of technology since World War II, most government expertise lies in the management of the process of establishing the technical feasibility of technology. This, however, is only one stage (in Phase-1, Figure 4.3) in the whole process of the technological change. The other stages, namely, in-service testing, demonstrations, and procurement policy formulation, are equally (or even more) important in cases where the federal government is not the sole end user of the product being developed (and is to be deployed). Second, the effectiveness of government efforts and the amount of resources available to it to achieve the latter are limited, and in most cases promulgation of regulatory standards is the main choice of a federal agency to effect the diffusion of the technology. Limitations of the regulatory strategy, however, are clearly manifest in the manufacturers' refusal to bid in the case of Transbus. Therefore, in spite of all tools available to the Federal agencies to influence the process of technological change, in practice, evidence shows the effectiveness of these tools are limited by practical considerations including the technology base of the industry in question, its structure, and the willingness of the industry (or end users) to receive the new technology.

## 5.2 RECOMMENDATIONS

The following recommendations may apply to both the Transbus and also to other technology innovation programs in the public mass transit sector. The Transbus program may have been successfully implemented provided that:

1. The design/manufacture process allowed for examination of other alternatives to the single slope floor configuration, e.g., double slope floor (or double height, Figure 3.4);
2. The effective participation of both manufacturers and operators were ensured, through a "permanent" Innovation Board, so that a continual communication channel would be available;
3. The prototype vehicles underwent more thorough and lengthy testing in the service environment so that debugging of the subsystems technology could be completed;
4. Demonstrations were separately conducted, and with the specific objective of showing the positive aspects of the technology, only after the debugging process was completed;
5. E/H accessibility were considered as a distinct objective, with clearly defined assumption about the basis of policies regarding fully accessible buses;
6. UMTA relied less on regulatory standards and more on incentive oriented grants in order to facilitate the adoption of technology. It also provided similar incentives for the manufacturers during the procurement stage of the program;
7. UMTA formulated the program giving necessary consideration to factors such as technology base and structure of the industry, in order to design an adequate strategy for overcoming the institutional hurdles that may hinder the introduction of innovative systems and technologies;
8. UMTA's policies were more coherent, and more stable over time, since the changing policies may deter the manufacturers from making long-term investments for the production of new innovative technologies.

It is recognized that the above recommendations fall under ideal conditions, and political/administrative realities rarely allow for ideal situations. The motivation, however, is that improvement would result only if the current attainments are measured against ideal/perfect attainments.

NOTES

Chapter One Notes

1. National Research Council, NRC Transbus Study, Part-1: Transbus Procurement; Part-2: Mobility Options for the Transportation Handicapped, report to OST, DOT, DOT-OS-90094(Washington: U.S. DOT, 1979), pp. 76-80.
2. *ibid.*, p. 37.
3. George M. Smerk, "The Development of Public Transportation and the City", in Public Transportation: Planning, Operations and Management, by George E. Gray/Lester A. Hoel, eds. (Englewood Cliffs: Prentice-Hall, 1979), p. 8.
4. *ibid.*, p. 9.
5. *ibid.*, p. 11.
6. *ibid.*, p. 12.
7. *ibid.*
8. *ibid.*, p. 13.
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APPENDIX A  
CHRONOLOGY OF TRANSBUS CASE STUDY EVENTS

1961

Passage of Amendments to the 1954 Housing Act; Section 701, the urban mass transportation package including \$25 million for demonstrations, and \$50 million for loan guarantees.

Fitch Report Delivered to the Department of Commerce, most recommendations adopted for the text of Urban Mass Transportation Act.

1962-1963

Urban Mass Transportation Act introduced in Congress, but not passed.

1964

Urban Mass Transportation Act signed into law.

General Motors Corporation(GMC) starts experiments with a new bus design: Rapid Transit Experimental(RTX) series.

1965

Department of Justice brought antitrust suit against GMC's bus division for monopolization of market, and GMC signed a consent decree to sell bus parts at cost.

1966

Amendments to Urban Mass Transportation Act, including "New Systems" provisions.

Housing and Home Finance Administration merged with HUD.

Department of Transportation Act passed, DOT and HUD required to investigate appropriate location for Urban Transportation Administration.

New Systems studies initiated.

1967

The Federal Department of Transportation becomes established: Alan Boyd first Secretary of Transportation.

National Academy of Engineering, National Research Council, and Highway Research Board undertake a study of new bus design at the request of HUD.

1968

The NAE study proposes design changes in transit buses, along with a plan for a federal bus innovation program.

The joint DOT-HUD study recommends that UTA be transferred to DOT: the new agency is named Urban Mass Transportation Administration(UMTA).

Conclusion of GMC's RTX and demonstration to transit operators: response unenthusiastic about the low floor of bus; plan for production of a modified version.

GMC writes to UMTA(DOT) on possibility of federal advance procurement for the new modified bus, called RTS.

1969

John Volpe becomes the new Secretary of Transportation, and Carlos Villarreal appointed as UMTA Administrator.

GMC writes again to DOT expressing her interest in RTS provided federal government arranges for advance procurement of RTS.

1970

Robert Henmes, with strong management background in aerospace industry, appointed as UMTA Associate Administrator for Research, and Development.

Rohr Industries, Inc. acquires the Flexible Bus Company, enters the transit equipment market.

UMTA announces Bus Technology Program among other programs in the Commerce Business Daily.

1971

Requirements for the Bus Technology Program initiated by the UMTA Administrator.

APTA forms a Bus Technology Committee to help UMTA in the Bus Technology Program.

Booz-Allen is awarded the contract as bus system manager (prime contractor).

Invitation to bid appears in Commerce Business Daily for prototype manufacture of buses in Bus Technology Program.

Booz-Allen recommends six of the twelve bidders for consideration.

Booz-Allen in conjunction with UMTA and APTA's Bus Technology Committee develops prototype specifications for new buses.

1972

After evaluation of bid proposals, Undersecretary of Transportation approves three of the bidders for prototype manufacture: AMG, Rohr, and GHC.

DOT Secretary announces the subcontracts to three manufacturers.

1973

New Secretary of Transportation, Claude Brinegar, and UMTA Administrator, Frank Herringer appointed.

UMTA reiterates its commitment of Transbus in a public statement.

GHC reveals production plans for the RTS-2 bus in two years. GHC writes to UMTA expressing its intent.

Discussion on procurement phase begins, meetings with APTA Bus Technology Committee, AMG, Rohr, and GHC are held.

AMG protests the contemplated plan of performance specification and also expresses concern over any policy away from standardized design bus.

1974

Delivery of Transbus vehicle models begin.

George E. Pastor becomes Associate UMTA administrator for Technology Development and Deployment.

UMTA establishes an ad hoc Transbus Committee; it meets with APTA, and Manufacturers.

Testing and Demonstrations of Transbus prototype begins.

1975

New Secretary of Transportation, William Coleman appointed.

UMTA announces new policy, abandoning the 300 Transbus procurement plan, to mandate performance specifications.

Tests and Demonstrations completed. APTA writes to UMTA expressing concern over future of Transbus because of inadequate testing.

Los Angeles, transit authority prepares a bid proposal for procurement of Transbus.

New UMTA Administrator appointed: Robert Patricelli.

GMC officially announces production of RTS-2.

1976

"Draft Transbus Policy Statement" prepared by UMTA, and circulated among transit operators, and manufacturers.

UMTA promulgates the E/H regulations.

UMTA holds hearing on Transbus; E/H, AMG, and Rohr opposed to change of Transbus policy. They do not favor the interim bus.



Rohr abandons plan to bid for Los Angeles Transbuses.

UMTA announces that Transbus program will be terminated and further development of Transbus at the discretion of Transbus.

First version of Transbus Procurement Requirements promulgated effective February 15, 1977.

1977

New DOT Secretary, Brock Adams appointed. The February 15 deadline postponed to hold further hearing. New Hearing is held March 15, 1977.

Transbus will be mandated according to prototype specifications, Secretary announces.

Revised version of Transbus Procurement Requirements is published and circulated. APTA announces its policy on Transbus. Rohr expresses the need for a contract with the federal government.

Rockwell International proposes a single axle arrangement for the rear of Transbus.

Transbus Consortium of Los Angeles, Miami, and Philadelphia is formed.

Meetings and communication with operators, manufacturers, and suppliers: Rockwell states that tandem axle is four years away from production.

1978

Several Meetings with Transbus Consortium, Bus Technology Committee of APTA, manufacturers, and UMTA; new TPR issues to reflect the single axle arrangement.

AMG announces its exit from the market.

Tandem axle re-incorporated into the specifications (TPR), due uncertainty about weight of Transbus, and operators' dissatisfaction. The new TPR is mandated, effective September 30, 1979.

George Pastor briefs Committee on Science and Technology on Transbus.

1979

The proposal for bid issued by the Transbus Consortium; bid date March 30, 1979.

Manufacturers protest the stringency of the standards and request a postponement to April 27, 1979.

The postponement is granted, the new bid date May 2, 1979.

GFC announces that it would not bid the Transbus. GMC also announces its intention not bid.

The bid date passed no bid appeared.

A Congressional hearing held by the Committee on Public Works and Transportation, Subcommittee on Oversight and Review. It is announced by the DOT, a panel of expert will be appointed to investigate "Was Transbus buildable?".

Mitre Corporation and National Research Council are asked to study Transbus and report by the end of August 1979.

Niel Goldschmidt appointed as the Secretary of Transportation; the September 30, 1979 deadline is suspended. The ADB will be funded.

Mitre Corporation reports to DOT that the standards may have forced the manufacturers to undertake "unreasonable" risk. National Research Council concurs with the Mitre report.

UMTA(DOT) in the process of formulating a new procurement policy, in the meantime funding for acquisition of buses approved.

APPENDIX B

A-109 Federal Procurement Circular

**EXECUTIVE OFFICE OF THE PRESIDENT**  
**OFFICE OF MANAGEMENT AND BUDGET**  
WASHINGTON, D.C. 20503

April 5, 1976

CIRCULAR NO. A-109

**TO THE HEAD OF EXECUTIVE DEPARTMENTS AND ESTABLISHMENTS**

**SUBJECT: Major System Acquisitions**

1. **Purpose.**—This circular establishes policies, to be followed by executive branch agencies in the acquisition of major systems.

2. **Background.**—The acquisition of major systems by the Federal Government constitutes one of the most crucial and expensive activities performed to meet national needs. Its impact is critical on technology, on the nation's economic and fiscal policies, and on the accomplishment of government agency missions in such fields as defense, space, energy, and transportation. For a number of years, there has been deep concern over the effectiveness of the management of major system acquisitions. The report of the Commission on Government Procurement recommended basic changes to improve the process of acquiring major systems. This circular is based on executive branch consideration of the Commission's recommendation.

3. **Responsibility.**—Each agency head has the responsibility to ensure that the provisions of this circular are followed. This circular provides administra-

tive direction to heads of agencies and does not establish and shall not be construed to create any substantive or procedural basis for any person to challenge any agency action or inaction on the basis that such action was not in accordance with this circular.

4. **Coverage.**—This circular covers and applies to:

a. Management of the acquisition of major systems, including:

- Analysis of agency missions
- Determination of mission needs
- Setting of program objectives
- Determination of system requirements
- System program planning
- Budgeting
- Funding
- Research
- Engineering
- Development
- Testing and evaluation
- Contracting
- Production
- Program and management control
- Introduction of the system into use or otherwise successful achievement of program objectives.

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b. All programs for the acquisition of major systems even though:

(1) The system is one-of-a-kind.

(2) The agency's involvement in the system is limited to the development of demonstration hardware for optional use by the private sector rather than for the agency's own use.

5. Definitions.—As used in this circular:

a. *Executive agency* (hereinafter referred to as agency) means an executive department, and an independent establishment within the meaning of sections 101 and 104(1), respectively, of Title 5, U.S. Code.

b. *Agency component* means a major organizational subdivision of an agency. For example: The Army, Navy, Air Force, and Defense Supply Agency are agency components of the Department of Defense. The Federal Aviation Administration, Urban Mass Transportation Administration, and the Federal Highway Administration are agency components of the Department of Transportation.

c. *Agency missions* means those responsibilities for meeting national needs assigned to a specific agency.

d. *Mission need* means a required capability within an agency's overall purpose, including cost and schedule considerations.

e. *Program objectives* means the capability, cost, and schedule goals being sought by the system acquisition program in response to a mission need.

f. *Program* means an organized set of activities directed toward a common purpose, objective, or goal undertaken or proposed by an agency in order to carry out responsibilities assigned to it.

g. *System design concept* means an idea expressed in terms of general performance, capabilities, and characteristics of hardware and software oriented either to operate or to be operated as an integrated whole in meeting a mission need.

h. *Major system* means that combination of elements that will function together to produce the capabilities required to fulfill a mission need. The elements may include, for example, hardware, equipment, software, construction, or other improvements or real property. Major system acquisition programs are those programs that (1) are directed at and critical to fulfilling an agency mission, (2) entail the allocation of relatively large resources, and (3) warrant special management attention. Additional criteria and relative dollar thresholds for the determination of agency programs to be considered major systems under the purview of this circular, may be established at the discretion of the agency head.

i. *System acquisition process* means the sequence of acquisition activities starting from the agency's reconciliation of its mission needs, with its capabilities, priorities and resources, and extending through the introduction of a system into operational use or the otherwise successful achievement of program objectives.

j. *Life cycle cost* means the sum total of the direct, indirect, recurring, nonrecurring, and other related costs incurred, or estimated to be incurred, in the design, development, production, operation, maintenance and

support of a major system over its anticipated useful life span.

6. General Policy.—The policies of this circular are designed to assure the effectiveness and efficiency of the process of acquiring major systems. They are based on the general policy that Federal agencies, when acquiring major systems, will:

a. Express needs and program objectives in mission terms and not equipment terms to encourage innovation and competition in creating, exploring, and developing alternative system design concepts.

b. Place emphasis on the initial activities of the system acquisition process to allow competitive exploration of alternative system design concepts in response to mission needs.

c. Communicate with Congress early in the system acquisition process by relating major system acquisition programs to agency mission needs. This communication should follow the requirements of Office of Management and Budget (OMB) Circular No. A-10 concerning information related to budget estimates and related materials.

d. Establish clear lines of authority, responsibility, and accountability for management of major system acquisition programs. Utilize appropriate managerial levels in decision points in the evolution of each acquisition program.

e. Designate a focal point responsible for integrating and unifying the system acquisition management process and monitoring policy implementation.

f. Rely on private industry in accordance with the policy established by OMB Circular No. A-76.

7. Major System Acquisition Management Objectives.—Each agency acquiring major systems should:

a. Ensure that each major system: Fulfills a mission need. Operates effectively in its intended environment. Demonstrates a level of performance and reliability that justifies the allocation of the nation's limited resources for its acquisition and ownership.

b. Depend on, whenever economically beneficial, competition between similar or differing systems design concepts throughout the entire acquisition process.

c. Ensure appropriate trade-off among investment costs, ownership costs, schedules, and performance characteristics.

d. Provide strong checks and balances by ensuring adequate system test and evaluation. Conduct such tests and evaluation independent, where practicable, of developer and user.

e. Accomplish system acquisition planning, built on analysis of agency missions, which implies appropriate resource allocation resulting from clear articulation of agency mission needs.

f. Tailor an acquisition strategy for each program, as soon as the agency decides to solicit alternative system design concepts, that could lead to the acquisition of a new major system and refine the strategy as the program proceeds through the acquisition process. Encompass test and evaluation criteria and business management considerations in the strategy. The strategy

could typically include: • Use of the contracting process as an important tool in the Acquisition program • Scheduling of essential elements of the acquisition process • Demonstration, test, and evaluation criteria • Content of solicitation for proposals • Decisions on whom to solicit • Methods for obtaining and sustaining competition • Guidelines for the evaluation and acceptance or rejection of proposals • Goals for design-to-cost • Methods for projecting life cycle cost • Use of data rights • Use of warranties • Methods for analyzing and evaluating contractor and government risks • Need for developing contractor and government risks • Need for developing contractor incentives • Selection of the type of contract best suited for each stage in the acquisition process • Administration of contracts.

g. Maintain a capability to: • Predict, review, assess, negotiate, and monitor costs for system development, engineering, design, demonstration, test, production, operation, and support (i.e., life cycle costs) • Assess acquisition cost, schedule and performance experience against predictions, and provide such assessments for consideration by the agency head at key decision points • Make new assessments where significant costs, schedule or performance variances occur • Estimate life cycle costs during system design concept evaluation and selection, full-scale development, facility conversion, and production, to ensure appropriate trade-offs among investment costs, ownership costs, schedules, and performance • Use independent cost estimates, where feasible, for comparison purposes.

8. Management Structure.—a. The head of each agency that acquires major systems will designate an acquisition executive to integrate and unify the management process for the agency's major system acquisitions and to monitor implementation of the policies and practices set forth in this circular.

b. Each agency that acquires—or is responsible for activities leading to the acquisition of—major systems will establish clear lines of authority, responsibility, and accountability for management of its major system acquisition programs.

c. Each agency should preclude management layering and placing nonessential reporting procedures and paperwork requirements on program managers and contractors.

d. A program manager will be designated for each of the agency's major system acquisition programs. This designation should be made when a decision is made to fulfill a mission need by pursuing alternative system design concepts. It is essential that the program manager have an understanding of user needs and constraints, familiarity with development principles, and requisite management skills and experience. Ideally, management skills and experience would include: • Operations • Engineering • Construction • Testing • Contracting • Prototyping and fabrication of complex systems • Production • Business • Budgeting • Finance. With satisfactory performance, the tenure of the program manager should be long enough to provide continuity and personal accountability.

e. Upon designation, the program manager should be given budget guidance and a written charter of his authority, responsibility, and accountability for accomplishing approved program objectives.

f. Agency technical management and government laboratories should be considered for participation in agency mission analysis, evaluation of alternative system design concepts, and support of all development, test, and evaluation efforts.

g. Agencies are encouraged to work with each other to foster technology transfer, prevent unwarranted duplication of technological efforts, reduce system costs, promote standardization, and help create and maintain a competitive environment for an acquisition.

9. Key Decisions.—Technical and program decisions normally will be made at the level of the agency component or operating activity. However, the following four key decision points should be retained and made by the agency head:

a. Identification and definition of a specific mission need to be fulfilled, the relative priority assigned within the agency, and the general magnitude of resources that may be invested.

b. Selection of competitive system design concepts to be advanced to a test/demonstration phase or authorization to proceed with the development of a non-competitive (single concept) system.

c. Commitment of a system to full-scale development and limited production.

d. Commitment of a system to full production.

10. Determination of Mission Needs.—a. Determination of mission need should be based on an analysis of an agency's mission reconciled with overall capabilities, priorities and resources. When analysis of an agency's mission shows that a need for a new major system exists, such a need should not be defined in equipment terms, but should be defined in terms of the mission, purpose, capability, agency components involved, schedule and cost objectives, and operating constraints. A mission need may result from a deficiency in existing agency capabilities or the decision to establish new capabilities in response to a technologically feasible opportunity. Mission needs are independent of any particular system or technological solution.

b. Where an agency has more than one component involved, the agency will assign the roles and responsibilities of each component at the time of the first key decision. The agency may permit two or more agency components to sponsor competitive system design concepts in order to foster innovation and competition.

c. Agencies should, as required to satisfy mission responsibilities, contribute to the technology base, effectively utilizing both the private sector and government laboratories and in-house technical centers, by conducting, supporting, or sponsoring: • Research • System design concept studies • Proof of concept work • Exploratory subsystem development • Tests and evaluations. Applied technology efforts oriented to system developments should be performed in response to approved mission needs.

**11. Alternative Systems.**—a. Alternative system design concepts will be explored within the context of the agency's mission need and program objectives—with emphasis on generating innovation and conceptual competition from industry. Benefits to be derived should be optimized by competitive exploration of alternative system design concepts, and trade-offs of capability, schedule, and cost. Care should be exercised during the initial steps of the acquisition process not to conform mission needs or program objectives to any known systems or products that might foreclose consideration of alternatives.

b. Alternative system design concepts will be solicited from a broad base of qualified firms. In order to achieve the most preferred system solution, emphasis will be placed on innovation and competition. To this end, participation of smaller and newer businesses should be encouraged. Concepts will be primarily solicited from private industry; and when beneficial to the Government, foreign technology, and equipment may be considered.

c. Federal laboratories, federally funded research and development centers, educational institutions, and other not-for-profit organizations may also be considered as sources for competitive system design concepts. Ideas, concepts, or technology, developed by government laboratories or at government expense, may be made available to private industry through the procurement process or through other established procedures. Industry proposals may be made on the basis of these ideas, concepts, and technology or on the basis of feasible alternatives which the proposer considers superior.

e. Requests for alternative system design concept proposals will explain the mission need, schedule, cost, capability objectives, and operating constraints. Each offeror will be free to propose his own technical approach, main design features, subsystems, and alternatives to schedule, cost, and capability goals. In the conceptual and less than full-scale development stages, contractors should not be restricted by detailed government specifications and standards.

f. Selections from competing system design concept proposals will be based on a review by a team of experts, preferably from inside and outside the responsible component development organization. Such a review will consider: (1) Proposed system functional and performance capabilities to meet mission needs and program objectives, including resources required and benefits to be derived by trade-offs, where feasible, among technical performance, acquisition costs, ownership costs, time to develop and procure; and (2) The relevant accomplishment record of competitors.

g. During the uncertain period of identifying and exploring alternative system design concepts, contracts covering relatively short time periods at planned dollar levels will be used. Timely technical reviews of alternative system design concepts will be made to effect the orderly elimination of those least attractive.

h. Contractors should be provided with operational test conditions, mission performance criteria, and life cycle cost factors that will be used by the agency in the

evaluation and selection of the system(s) for full-scale development and production.

i. The participating contractors should be provided with relevant operational and support experience through the program manager, as necessary, in developing performance and other requirements for each alternative system design concept as tests and trade-offs are made.

j. Development of subsystems that are intended to be included in a major system acquisition program will be restricted to less than fully designed hardware (full-scale development) until the subsystem is identified as a part of a system candidate for full-scale development. Exceptions may be authorized by the agency head if the subsystems are long leadtime items that fulfill a recognized generic need or if they have a high potential for common use among several existing or future systems.

**12. Demonstrations.**—a. Advancement to a competitive test/demonstration phase may be approved when the agency's mission need and program objectives are reaffirmed and when alternative system design concepts are selected.

b. Major system acquisition programs will be structured and resources planned to demonstrate and evaluate competing alternative system design concepts that have been selected. Exceptions may be authorized by the agency head if demonstration is not feasible.

c. Development of a single system design concept that has not been competitively selected should be considered only if justified by factors such as urgency of need, or by the physical and financial impracticality of demonstrating alternatives. Proceeding with the development of a noncompetitive (single concept) system may be authorized by the agency head. Strong agency program management and technical direction should be used for systems that have been neither competitively selected nor demonstrated.

**13. Full-scale Development and Production.**—a. Full-scale development, including limited production, may be approved when the agency's mission need and program objectives are reaffirmed and competitive demonstration results verify that the chosen system design concept(s) is sound.

b. Full production may be approved when the agency's mission need and program objectives are reaffirmed and when system performance has been satisfactorily tested, independent of the agency development and user organizations, and evaluated in an environment that assures demonstration in expected operational conditions. Exceptions to independent testing may be authorized by the agency head under such circumstances as physical or financial impracticability or extreme urgency.

c. Selection of a system(s) and contractor(s) for full-scale development and production is to be made on the basis of (1) system performance measured against current mission need and program objectives, (2) an evaluation of estimated acquisition and ownership costs, and (3) such factors as contractor(s) demonstrated management, financial, and technical capabilities to meet program objectives.



d. The program manager will monitor system tests and contractor progress in fulfilling system performance, cost, and schedule commitments. Significant actual or forecast variances will be brought to the attention of the appropriate management authority for corrective action.

14. Budgeting and Financing.—Beginning with FY 1979 all agencies will, as part of the budget process, present budgets in terms of agency missions in consonance with section 201(i) of the Budget and Accounting Act, 1921, as added by section 601 of the Congressional Budget Act of 1974, and in accordance with OMB Circular A-11. In so doing, the agencies are desired to separately identify research and development funding for: (1) The general technology base in support of the agency's overall missions, (2) The specific development efforts in support of alternative system design concepts to accomplish each mission need, and (3) Full-scale developments. Each agency should ensure that research and development is not undesirably duplicated across its missions.

15. Information to Congress.—a. Procedures for this purpose will be developed in conjunction with the Office of Management and Budget and the various committees of Congress having oversight responsibility for agency activities. Beginning with FY 1979 budget each agency will inform Congress in the normal budget process about agency missions, capabilities, deficiencies, and needs and objectives related to acquisition programs, in consonance with section 601(i) of the Congressional Budget Act of 1974.

b. Disclosure of the basis for an agency decision to proceed with a single system design concept without competitive selection and demonstration will be made to the congressional authorization and appropriation committees.

16. Implementation.—All agencies will work closely with the Office of Management and Budget in resolving all implementation problems.

17. Submissions to Office of Management and Budget.—Agencies will submit the following to OMB:

a. Policy directives, regulations, and guidelines as they are issued.

b. Within 6 months after the date of this circular, a time-phased action plan for meeting the requirements of this circular.

c. Periodically, the agency approved exceptions permitted under the provisions of this circular.

This information will be used by the OMB, in identifying major system acquisition trends and in monitoring implementations of this policy.

18. Inquiries.—All questions or inquiries should be submitted to the OMB, Administrator for Federal Procurement Policy. Telephone number, area code, 202-395-4677.

HUGH E. WITT  
ADMINISTRATOR FOR  
FEDERAL PROCUREMENT POLICY

Approved:

JAMES T. LYNN  
DIRECTOR

APPENDIX C

MECHANICAL AND OTHER CHARACTERISTICS OF TRANSBU

Table C-1  
COMPARISON OF FEATURES IN TRANSBUS, ADE, AND "NEW LOOK"

<u>FEATURE</u>	<u>New Look</u>	<u>ADE</u>	<u>Transbus</u>
Height with- A/C	124.25"	118.9"	114"
Width	102"	102"	102"
Length with- Energy- Absorbing- Bumper	41'	40'-8 1/4"	41'
Front Door- Width	32.25"	36"	44"
Rear Door- Width	26.50"	30"	30"
Floor Height- at Front- Door	34"[Nominal] 30"[Kneeled]	30"[Nominal] 24"[Kneeled]	22"[Nominal] 18"[Kneeled]
Number of- Front Steps	2	2	1
Front- Step- Height	14"[Nominal] 10"[Kneeled]	14"[Nominal] 8"[Kneeled]	14"[Nominal] 8"[Kneeled]

Source: Testimony by Grumman -Flexible before Subcommittee  
on Oversight and Review, May 1979.

Table C-1(cont'd)  
COMPARISON OF FEATURES IN TRANSBUS, ADB, AND "NEW LOOK"

<u>FEATURE</u>	<u>New Look</u>	<u>ADB</u>	<u>Transbus</u>
Front Step- Riser Height	10"	8"	8"
Floor Height- at Rear Door	36"	35"	24"
Number of Rear- Steps	2	2	1
Rear Step- Riser Height	10"	10.2"	9.5"
Aisle Width	22"	25.75"	20"
Seat Width	36"	36"	36"
Road Ground- Clearance[Min.]	6.25"	6"	6.25"
Turning Radius	42'	44'	44'
Seating- Capacity	48[Nominal] 44[W W/C]	46[Nominal] 42[W W/C]	42[Nominal] 38[W W/C]

Table C-1(cont'd)  
COMPARISON OF FEATURES IN TRANSBUS, ADE, AND "NEW LOOK"

<u>FEATURE</u>	<u>New Look</u>	<u>ADE</u>	<u>Transbus</u>
Nominal Hip- to Knee Room	26"	28"	27"
Energy- Absorbing- Bumpers	Optional	Standard	Standard
Wheelchair- Lift	Optional	Optional	Standard
Seat- Construction	Floor Mounted	Cantilevered	Cantilevered
Flammability- Requirements	FVSS 302	FVSS 302	FVSS 302
Crashworthiness	None Specified	Per ADE	Per Transbus
Wheelhousing- Material	Stainless- Steel	Stainless- Steel	Stainless- Steel
Brake System	FVSS 121	FVSS 121	FVSS 121
Electrical- System	12V	12V or 24V	24V

Table C-1(cont'd)  
COMPARISON OF FEATURES IN TRANSBUS, ADB, AND "NEW LOOK"

<u>FEATURE</u>	<u>New Look</u>	<u>ADB</u>	<u>Transbus</u>
Fuel Tank- Capacity	95 Gal.	135 Gal.	125 Gal.
Power Steering	Optional	Standard	Standard
A/C System	Manufacturer- Specification	Per ADB	Per Transbus
Noise Level	-----EPA From 11/80-----		
Transmission	V-730	V-730	V-730
Fire Detectors	Optional	Standard	Standard
Location of- Exhaust System	Optional	Upper Left- Rear Corner	Upper Left- Rear Corner
Tire Size	Conventional	Conventional	Low Profile
Curb Weight-- with Lift	24,500 lbs 24,500 lbs	25,000 lbs[GFC] 26,000 lbs[GMC]	27,500 lbs* 28,000 lbs**
Number of Axles	2	2	3

\* Grumman-Flexible estimate.

\*\* GMC estimate.

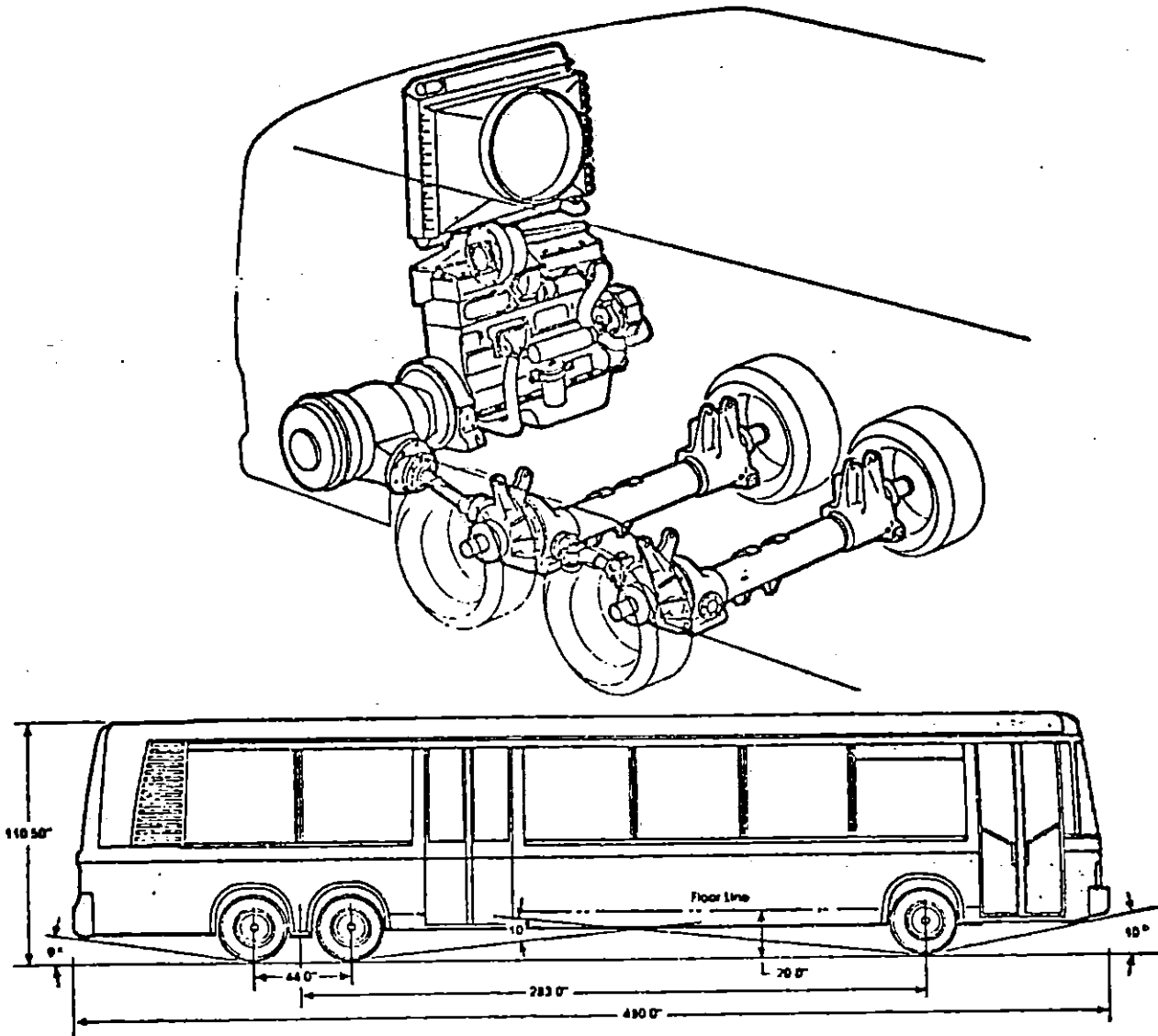
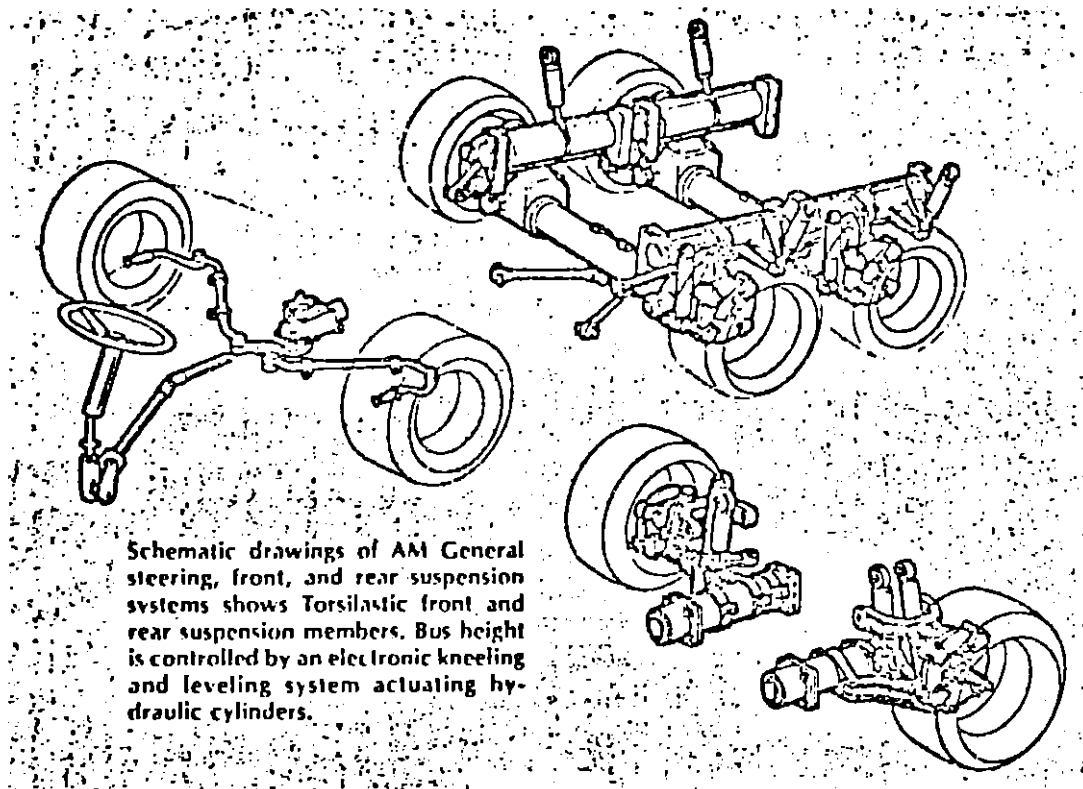


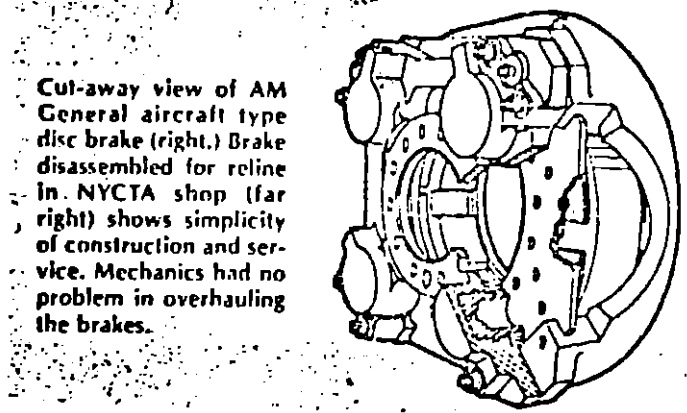
Figure C-1 American Motors General Corporation Transbus  
 Source: Booz-Allen, Transbus Engineering Testing.

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Schematic drawings of AM General steering, front, and rear suspension systems shows Torsilastic front and rear suspension members. Bus height is controlled by an electronic kneeling and leveling system actuating hydraulic cylinders.



Cut-away view of AM General aircraft type disc brake (right.) Brake disassembled for reline in NYCTA shop (far right) shows simplicity of construction and service. Mechanics had no problem in overhauling the brakes.

Figure C-1 American Motors General Corporation Transbus (continued)

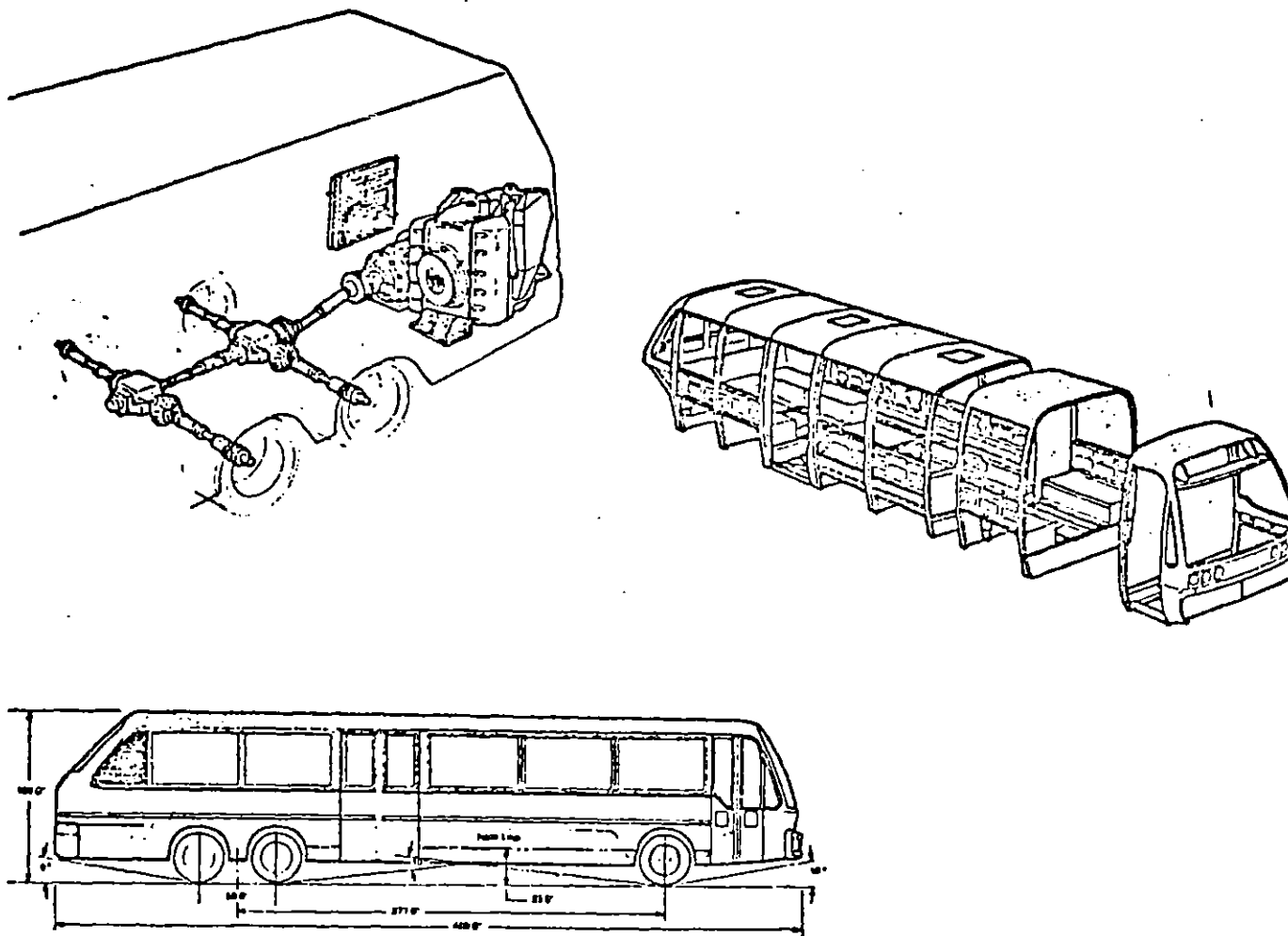
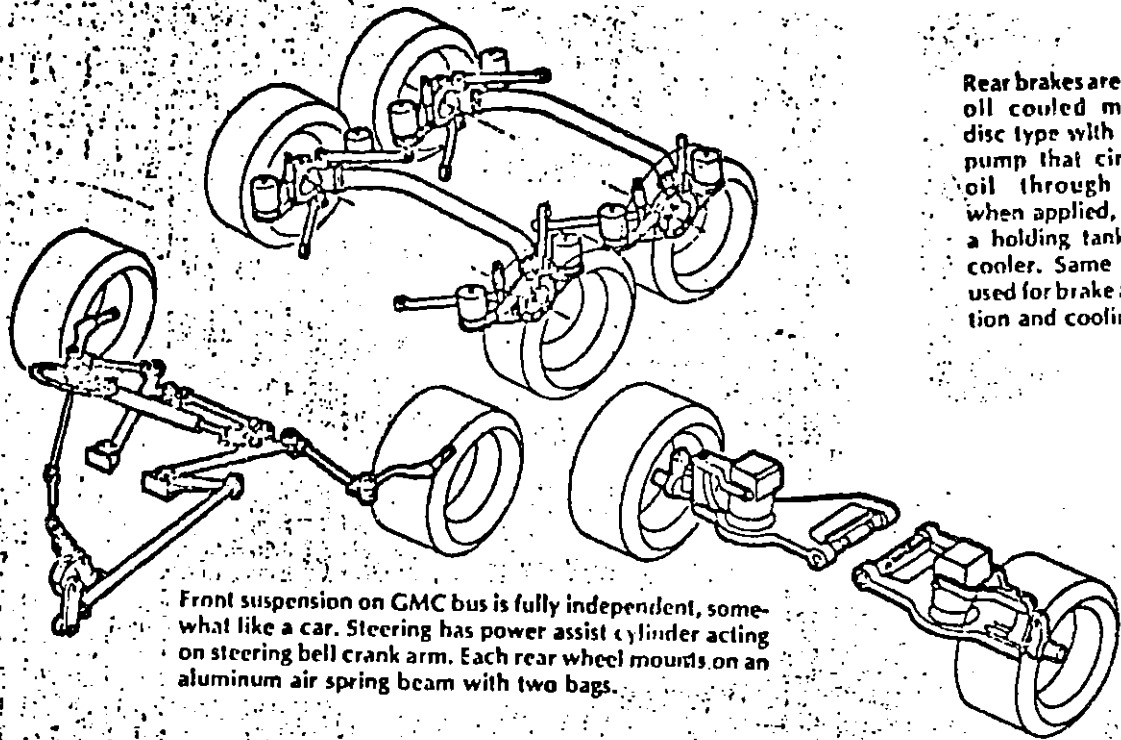


Figure C-2 General Motors Corporation Transbus

Source: Booz-Allen, Transbus Engineering Testing.



Front suspension on GMC bus is fully independent, somewhat like a car. Steering has power assist cylinder acting on steering bell crank arm. Each rear wheel mounts on an aluminum air spring beam with two bags.

Rear brakes are unique oil cooled multiple disc type with built-in pump that circulates oil through brake when applied, then to a holding tank and a cooler. Same fluid is used for brake application and cooling.

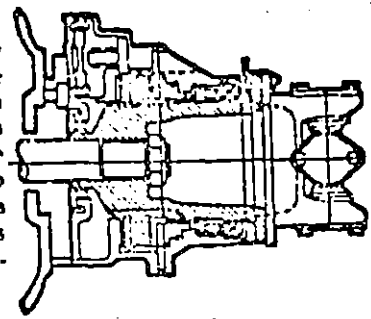


Figure C-2 General Motors Corporation (continued)

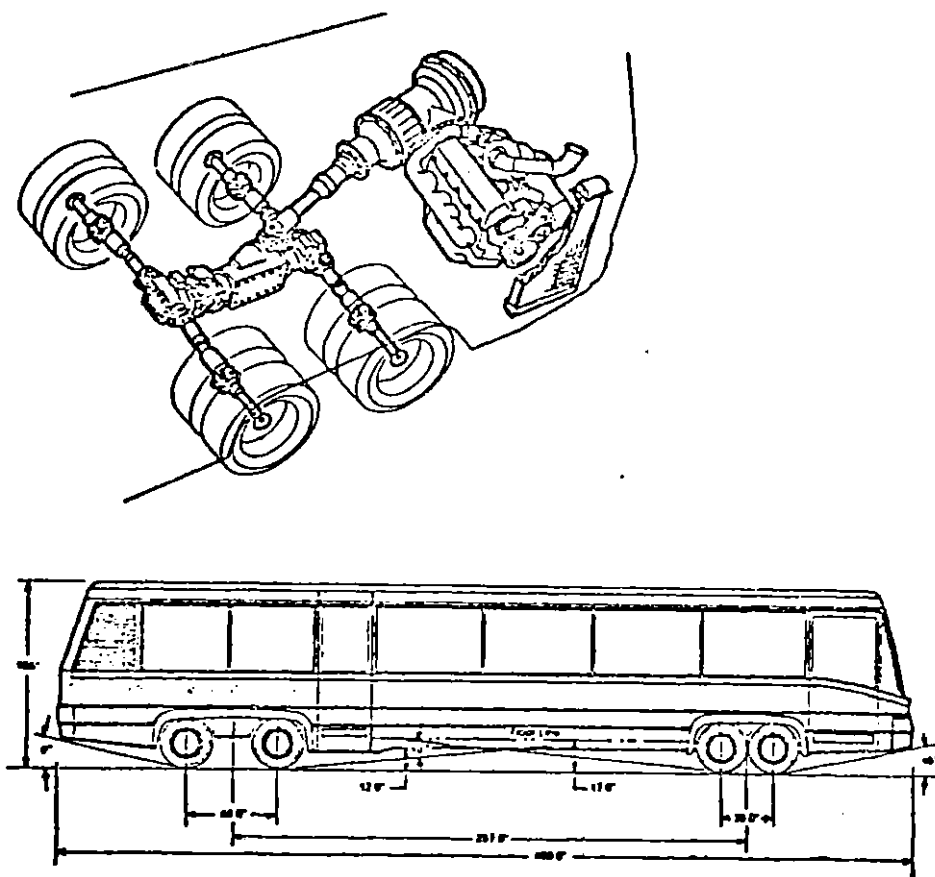
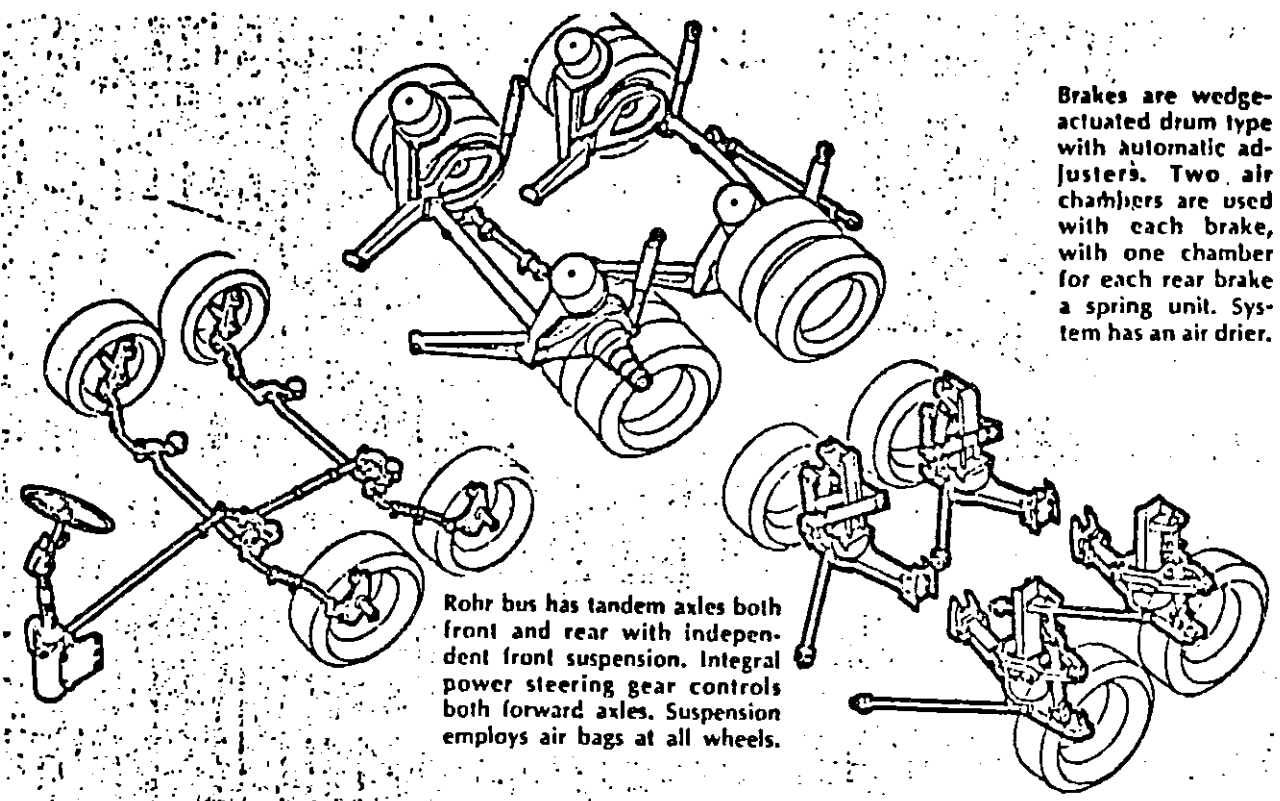


Figure C-3 Rohr Industries Transbus

Source: Booz-Allen, Transbus Engineering Testing



Rohr bus has tandem axles both front and rear with independent front suspension. Integral power steering gear controls both forward axles. Suspension employs air bags at all wheels.

Brakes are wedge-actuated drum type with automatic adjusters. Two air chambers are used with each brake, with one chamber for each rear brake a spring unit. System has an air drier.

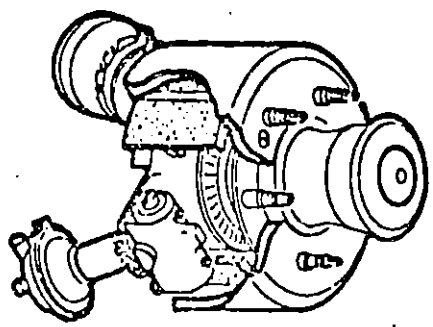


Figure C-3 Rohr Industries Transbus (continued)

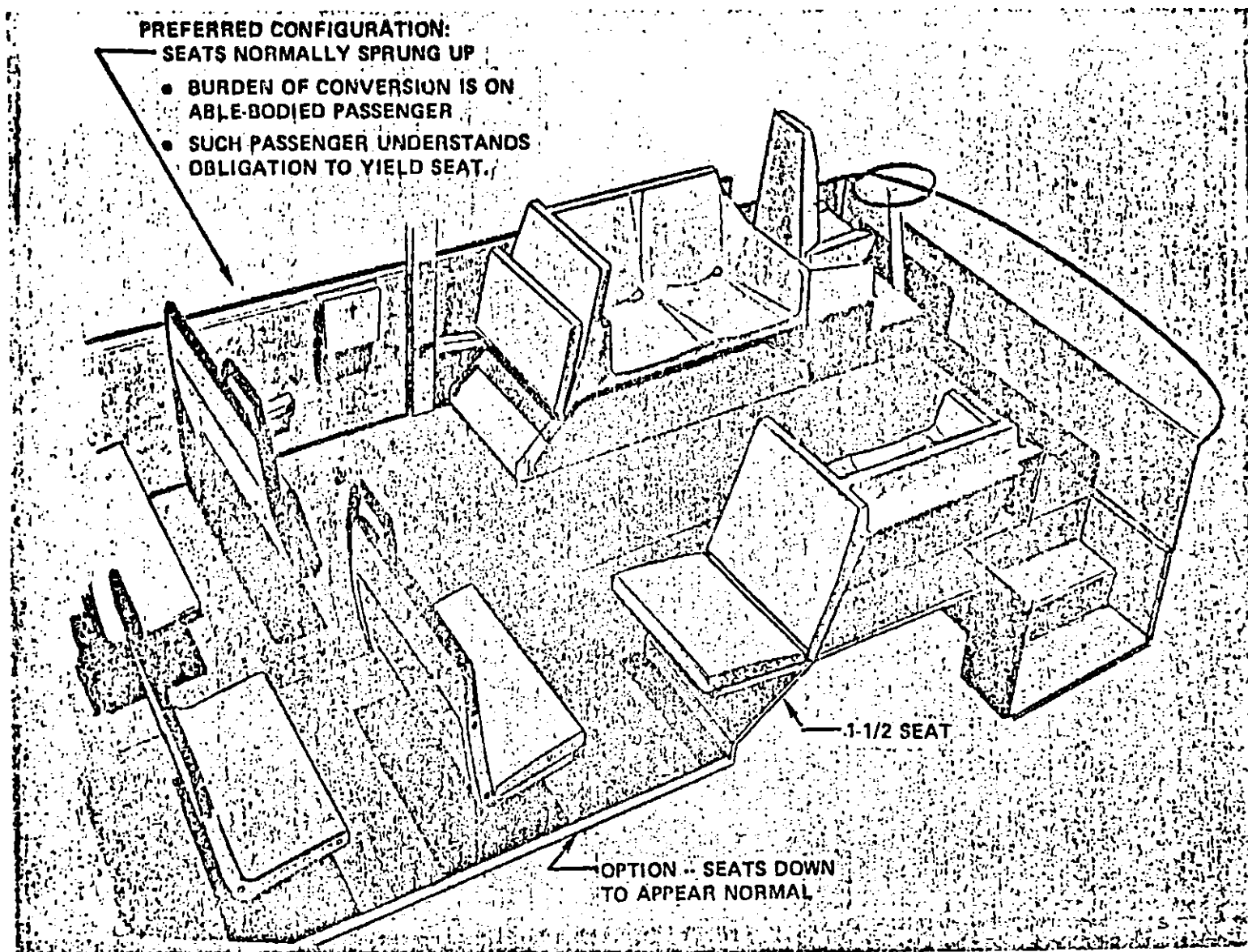


Figure C-4 Wheelchair Arrangement Inside Transbus

Source: Thomas Black, et al., "Bus Design for the Elderly and Handicapped," SAE Paper-760082.

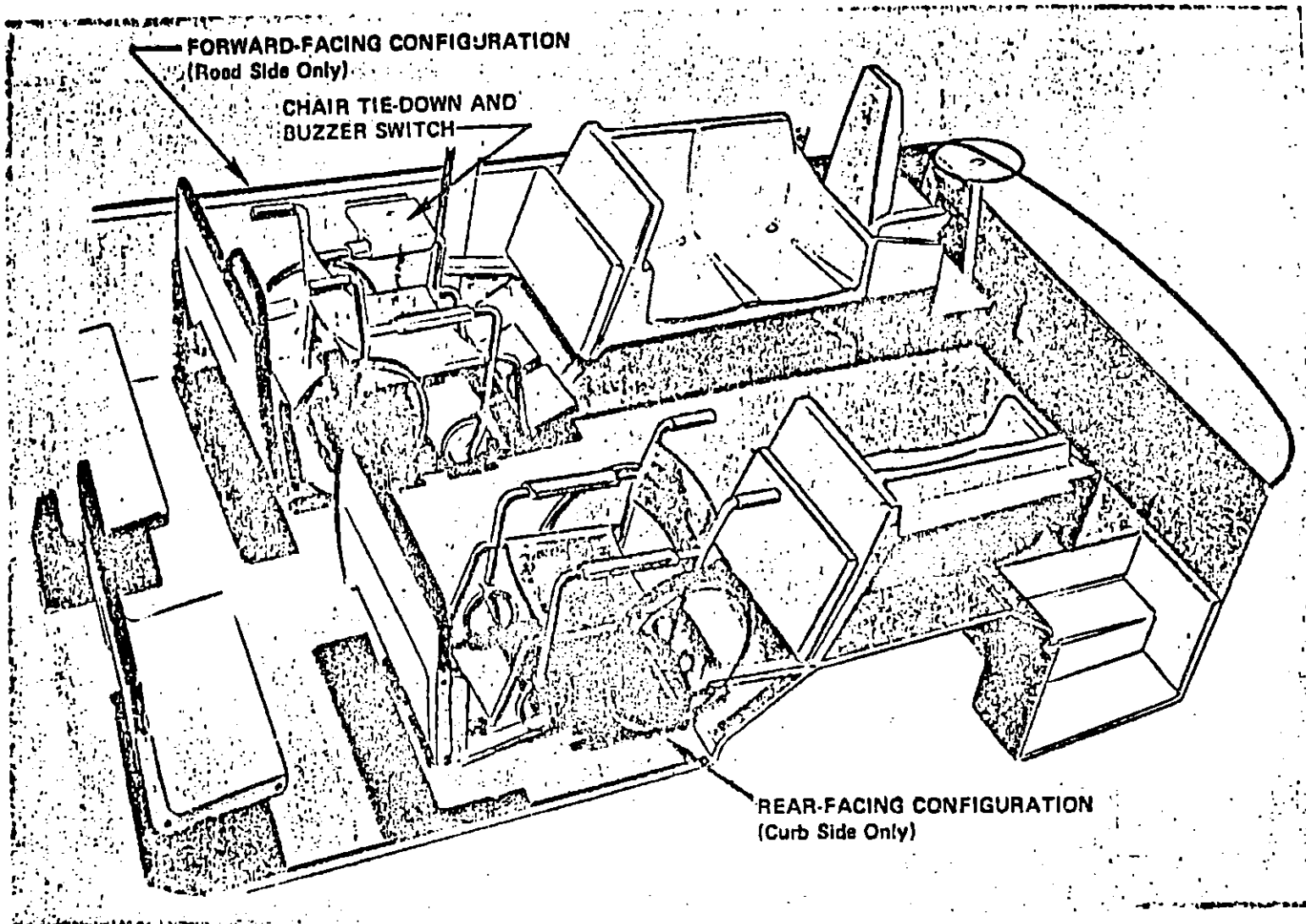


Figure C-4 Wheelchair Arrangement Inside Transbus (continued)