FEDERAL REGULATION OF TRANSPORTATION AND TECHNOLOGICAL INNOVATION

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I. Introduction

The importance of developing and implementing new technologies is frequently discussed. These discussions generally focus upon encouraging new technology through increased use of federal research and development funds or upon mechanisms to foster transfer of technology used in one area to other areas. However, little discussion has been given to another important area, the environment for innovation that is provided by the regulatory and other governmental policies.

The environment for innovation is determined to a major extent by the government. To some people, the major barriers to innovation lie in this environment in the form of institutional and organizational barriers.[1] These barriers do not involve the government directly in the sense that it is participating in the innovative process, but instead the government is indirectly involved because of its influence on innovation.[2]

The government provides the rules which impinge on the freedom of action of the various forces which might affect innovation.[3] A rule may affect all innovative activity or only one type of activity. Because a discussion of the environment for all areas of innovative activity is not possible within the limits of this paper, it has focused on the effect of the federal government's regulatory scheme on technological innovation in transportation, with a brief introductory comment on general policies that affect innovative incentive.

II. General Federal Policies

At the outset, it is a good idea to get out terms straight. Invention is the development of an idea or concept, while innovation is the application

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1. J. Stedman, *Technology Transfer and Innovation* 37 (1967).

2. D. DeSimone, "The Impact of Law on Technological Innovation," *Technology Transfer and Innovation* 38 (1967) [hereinafter cited as De Simone].

3. R. Charpie, "The Business End of Technology Transfer," *Technology Transfer and Innovation* 46 (1967).

of an invention to a need. For the most part, inventions are applied to needs by entrepreneurs so that the rate of innovation is strongly affected by the enterpreneur's perceptions of the need for the innovation. Governmental regulation can encourage or discourage the entrepreneur's willingness to innovate through manipulation of its various policies, of which federal patent, antitrust, tax, and procurement policies are an example.

A. Government Procurement Policies

Implicit in much of the literature which discusses technological innovation is the assumption that direct subsidization of research and development is the only way for the government to stimulate innovation.[4] However, the Federal Government has enormous purchasing power which it can use to stimulate innovation. It purchases over $30 billion worth of goods and services in the civilian market each year and the manner in which it does so can have an enormous effect on technological innovation.[5] The Federal Government unfortunately has not done this and as a consequence, innovations that might have been encouraged have not been.

B. Antitrust Policies

In contrast to the direct effect on innovation of patent policies, antitrust policies seek to maximize competition and affect innovative activity only indirectly. There is much disagreement as to the effect of antitrust policies on innovation.[6]

Most of the discussion centers on whether larger firms are more likely to innovate them smaller firms. If larger firms are more innovative, then our antitrust policies reduce innovations by limiting firm size to keep an industry competitive. Conversely, if small firms are more innovative, then antitrust policies encourage innovation.

Almost everyone agrees that the larger firms can be more innovative.[7] They have the advantages of economies of scale and the ability to tackle costly research and development that is beyond smaller firms. Yet there is much reason to doubt that the large firm will utilize these advantages.

4. H. Brooks, "National Science Policy and Technology Transfer," *Technology Transfer and Innovation* 53, 56 (1967).

5. M. Michaelis, "The Environment for Innovation", *Technology Transfer and Innovation* 76, 80-81 (1967). [hereinafter cited as Michaelis].

6. For example, see the continuing disagreements in the discussion portions of National Science Foundation, *Technology Transfer and Innovation* (1967).

7. J. Galbraith, *American Capitalism* 87 (1956).

Several studies of innovations in a variety of fields have indicated that most major advances are introduced by small companies or individual entrepreneurs.[8] Generally, small firms and entrepreneurs must be oriented to innovation because this is the area in which they can gain a competitive advantage over the established firms.[9]

From this discussion, one concludes that strict enforcement of the antitrust laws will encourage innovative activity by either making larger firms more competitive or breaking them into smaller units.

Uncertainty and confusion as to permissible activity is an additional problem that results from antitrust and other business regulation. Because businessmen are unsure as to the legality of mergers, joint ventures, or expanding their market share, technological innovations by them are inhibited.[10] The "rule of reason" approach in these areas causes particular difficulty since its flexibility does not permit clear cut decisions on the propriety of innovative activity.

C. Tax Policies

The purpose of our tax system is basically to collect revenue, although special provisions are designed to encourage or discourage certain types of activity. Technological innovation is rarely one of the activities that tax laws attempt to influence, but instead the tax laws affect innovation quite unintentionally and indirectly.

The tax system offers several incentives to innovation. Expenses of research and development can be charged to the year in which they are incurred, while the product of this search, innovation, yields benefits into the future. Furthermore, when an innovation is sold, it is treated as a capital transaction even though it probably resulted from years of work that were untaxed.[11] Similarly, the seven percent investment tax credit, proposed as part of the President's economic policy, will have a signifi-

8. See J. Jewkes, D. Sawers, & R. Stillerman, *The Sources of Invention* (1958) and D. Hamberg, "Invention in the Industrial Research Laboratory," *J. of Pol. Economy* 71, 95-115 (1963). These studies indicate that larger corporations are responsible for only about one quarter of major innovations.

9. M. Wachs, "Fostering Technological Innovation in Urban Transportation Systems," *Traffic Quarterly* 39, 45 (Jan. 1971) [hereinafter cited as Wachs]. This is not to say that all small firms are more innovative, but only that the percentage of innovations occurring from small firms greatly exceeds those developed in large firms.

10. De Simone, *supra* note 2 at 42.

11. For example, say a person works on a job for a year and earns $10,000, which is subject to income tax. However, if that same person works on an innovation for a year and develops a $10,000 innovation, he pays no income tax upon his labor.

cant impact on technological innovation.[12] It encourages investment in new plant and equipment which provides a great inducement to introduction of innovative technologies, rather than waiting for present facilities to complete their useful life before introducing new technology.

D. Patent Policies

Unlike most governmental policies which are ostensibly neutral towards innovative activity, the patent system is intentonally designed to encourage innovation. Despite the fact that there has been enormous change in all facets of our lives in the last 150 years, the patent system has remained basically unchanged.[13] This is true even though the federal government's sponsorship of research and development has reached enormous proportions and changed the direction of technology.[14]

Of course, if the patent system continues to provide the kind of innovative encouragement that is optimum, then there is no need to change it. But does it? Compared to the number of innovations classified as trade secrets, the number of patentable innovations is small. Apparently American industry does not feel adequaely protected by the current patent system.[15]

Inadequate protection causes a secrecy which stifles introduction of new technology. Through patents, other companies can purchase rights to use the patented process, but this does not occur if no one is aware of their existence. If innovative technology is kept secret, its distribution is obviously quite limited.

Taxpayers finance three-quarters of the research and development in this country,[16] and this funding usually requires that the products of this research be placed in the public domain. For the remaining one-quarter of the research, use of innovative technology may be better fostered by not permitting monopoly through a patent, but instead placing everything in the public domain by eliminating the patent system altogether. This would eliminate the problem of continuing monopolies such as occurred with Polaroid cameras and Xerox in copying. Of course, the acceptability of this approach will depend on whether the remaining incentives to encourage the innovator such as prestige, trade secrets, or the jump on competition, are sufficient.

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12. De Simone, *supra* note 2 at 40.
13. De Simone, *supra* note 2 at 43.
14. *Id.*, at 44.
15. A major part of this feeling occurs because of the lack of an adequate international patent system. *Id.*, at 45.
16. *Id.*

III. Transportation Regulation Policies

In spite of the overwhelming profusion of technological developments in recent years, our present transportation systems seem unable to provide the kind of service that will keep up with changing transportation demands. For example, one need only contemplate our clogged streets or the plight of the nation's railroads or urban bus systems.

Although public and private organizations invest great amounts of capital in transportation systems each year in the United States, there has been little change in automotive and mass transportation systems in the last 40 years.[17] Expenditures have fostered expansion of existing systems and adoption of new transportation systems has been quite rare. When innovative improvements are attempted, they tend to be incremental improvements, rather than totally new systems, with the possible exception of aviation. While the reasons are not clear for this lack of innovation, it is clear that the answers lie to a great extent in the institutional framework which has been created for the management and control of transportation.[18] The remainder of this paper discusses this institutional framework and its impact on transportation innovation.[19]

A. Policies of the Interstate Commerce Commission

1. Water Transport

Up to the time of the Depression, water transport was not regulated, a source of irritation to the railroads, who were regulated. In order to reduce their competition, the railroads lobbied very heavily for regulation of water transport, which resulted in passage of Part III of the Interstate Commerce Act.[20] The most important provisions of this law restricted entry of new water carriers,[21] gave the I.C.C. control over maximum and minimum carriage rates, and introduced rate publication and notice requirements.[22]

Until the law was passed, entry costs into water transport were quite

17. Wachs, *supra* note 9 at 40.

18. *Id.*, at 41.

19. Obviously not all Federal transportation policies can be discussed in a paper of this length. Consequently, areas such as gas pipeline and merchant marine policies are not included in the following.

20. 54 Stat. 929 (1940).

21. See B. Nupp, "Control of Entry as an Economic and Regulatory Problem," 36 *I.C.C. Pract. J.* 591 (1968).

22. J. Spychalski, "On the Nonutility of Domestic Water Transport Regulation," 37 *I.C.C. Pract. J.* 7, 11 (1969) [hereinafter cited as Spychalski].

low and the large number of new entrants each year kept the market competitive. However, I.C.C. regulation has limited entry, which has reduced competition and permitted firms to increase in size. A result has been increased use of existing towboats and development of larger towboats by the larger firms. This is a significant innovation which greatly increases operational efficiency.[23]

Because water transport competition has decreased and carriage prices have risen since the I.C.C. began regulation, a large number of users of water transport have bought their own vessels for transport. This has been advantageous because the I.C.C. regulates only "for hire" carriers and not those carriers who carry their own goods. The purchase of water transport by users have resulted in purchase of new and innovative equipment at a more rapid rate than might have occurred without regulation.[24]

2. Trucking

The trucking industry has three distinct types of service: common, contract, and private carriers. Common carriers are extensively regulated by the I.C.C. and private carriers, which constitute 85 percent of American trucks,[25] are virtually unregulated, with contract carriers between the two extremes. Trucks used exclusively for agricultural commodities are generally exempt from regulation.[26]

Regulation of common carriers by the states and I.C.C. is virtually identical. Reasonable, nondiscriminatory rates must be published and continuous, adequate service must be provided. Safety regulations must be observed that include minimum driver qualifications, maximum hours of service for employees, operational requirements, and necessary equipment. Contract carriers must also meet these safety regulations, but not the service or rate requirements. Most importantly, new common carriers are permitted to operate by the I.C.C. only if they can show "public necessity and convenience," and contract carriers must obtain a permit.[27] The I.C.C. uses these requirements to limit entry of motor carriers to the number that it considers desirable and to control expansion of existing

23. C. Horton, "Towboat and Towing Technology," *Hearings Before Subcom. on Surface Trans. of Comm. on Commerce, U.S. Senate, on S. 1314, Water Carrier Mixing Rule Exemption* 35 (1960).

24. Spychalski, *supra* note 22 at 15.

25. J. Pinkney, "Motor Carriage—The Long and Short of It," *Transportation Renaissance* 66 (1963).

26. Agricultural commodities carried by water transport are similarly exempt, but not when carried by railroads.

27. 49 Stat. 543 (1935), §§206-210.

carriers.[28] Because of the I.C.C.'s policies, while the great majority of carriers are small enterprises,[29] the tendency has been for the number of large carriers to increase and for the average size of regulated carriers to grow.[30]

Innovative activity in trucking is quite similar to that in water transport. While there have been some incremental innovative improvements, the basic technology in trucking has not changed since regulation began in 1935. Improvements have occurred in areas such as increased use of existing truck capacity and continuing construction of larger and more specialized trailers. However, the effect of these improvements is not particularly great since capital replacement occurs quite rapidly in trucking and innovative improvements have not been particularly significant.[31]

3. Railroads[32]

Because of cartelization and rate fixing arrangements,[33] in 1887 the Interstate Commerce Commission was established to regulate the railroads. The fundamental policy at that time was to prevent monopoly and unfair competition by rate and service regulation.[34] This regulation has resulted in many inequities including the problems caused by nondiscriminatory rate policies. Under I.C.C. policies, small shippers or small communities must be charged the same amount as nearby shippers or communities which are larger, even though the cost to the railroad is considerably higher per unit shipped by the smaller shipper or community.[35] Consequently, small shippers or communities use railroads more because the prices are artifically low and those who are larger use other modes, particularly trucking, which are cheaper because the railroads' prices are set too high.[36]

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28. M. Fair & E. Williams. *Economics of Transportation* 490 (1959), [hereinafter cited as Fair].

29. I.C.C., *Transport Economics* (1957).

30. Fair, *supra* note 28, at 104.

31. J. Sloss, "Regulation of Motor Freight Transportation: A Qualitative Evaluation of Policy," 1 *Bell J. of Econ. and Management Sci.* 327, 353 (1970).

32. Not all railroad problems are discussed here. For example, many states have full crew requirements that discouraged introduction of the diesel engine, but these problems are left to others. See E. Landau, "Arbitration, the Courts, Technological Change, and Craft Definition: Railroad Firemen v. Diesels," 19 *Drake L. Rev.* 93 (1969).

33. G. Kolko, *Railroads and Regulation, 1877-1916* 8 (1965).

34. G. Harrison, Clarification of Transportation Policy Goals," *Transportation Renaissance* 24 (1963) [hereinafter cited as Harrison].

35. *Id.*, at 25.

36. R. Spann and E. Erickson, "The Economics of Railroading: The Beginning of Cartel-

For the railroads, the primary technological changes since World War II have been in the power employed, with some roadbed improvements. The diesel engine has completely revolutionized the railway industry, the "clickless rail" is rapidly replacing its predecessors, and roadway maintenance is almost entirely mechanized.[37]

The economic relationships among the various modes are unclear, but it can be said that each mode has advantages for some types of service. Rail transportation has an advantage for most long distance freight transportation involving full carloads.[38] Trucks have obvious advantages in areas such as short hauls and loads less than a carload.

However, the present rate structure permits motor carriers to compete with the railroads over long hauls when they would not be able to do so without regulation.[39] All rail carriers are subject to regulation but the vast majority of water and truck transport carriers are not. Because of this, unregulated trucks (and water transport to some extent) have been able to carry items that cost little, but yield high revenue, while leaving the unprofitable shipments to the railroads.[40]

The effect of this on the rail carriers ability to innovate has been quite pronounced. Competing carriers have been much more able to innovate for a number of reasons. First, other modes need considerably less capitalization to innovate.[41] Second, governmental financial assistance to competing modes is much greater,[42] such as construction of roads, waterways, or airports. Finally, "inequitable and destructive regulation" causes railroads to have less profits and capital to innovate with.[43]

B. Urban Mass Transportation Policies

Contrary to what one might think, the Federal Government's efforts in urban mass transportation did not result because of a feeling that an alternative to the automobile was needed. Instead, the Federal urban

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ization and Regulation," *1 Bell J. of Economics and Management Sci.* 227, 243 (1970).

37. C. Buford, "Railroads Have Quit Slumbering," *Transportation Renaissance* 60 (1963).

38. Harrison, *supra* note 34, at 25-6.

39. "Piggyback Transportation and the I.C.C.," 41 *So. Cal. L. Rev.* 377 (1968) [hereinafter cited as Piggyback].

40. Harrison, *supra* note 34, at 26.

41. Piggyback, *supra* note 39, at 378.

42. R. Aspaira, "Technological Changes in Transportation and Public Policy," *Technological Changes and the Future of the Railways* 155 (1961).

43. Special Study Group on Trans. Policies in the U.S., *Prelim. Report on Trans. Policy to the Senate Comm. on Interstate & Foreign Commerce*, 87th Cong. 1st Sess. 653 (1961).

mass transit program gathered support by emphasizing its role as a supplement to the automobile and the declining quality of public transportation. This approach brought suburban support to the long standing support of mass transit by the big cities, as well as neutralizing the traditional opposition of the highway lobby to mass transportation.[44]

Unfortunately, the interests of the Congressional coalition supporting the program are reflected in the legislation. These were well expressed by Carlos Villarreal, Urban Mass Transportation Administrator, who stated:

> The highest priority is the saving of the systems which run the risk of going out of business. Second is improving existing systems. Third is extending existing systems. And fourth is new systems.[45]

Consequently, the primary focus of the Urban Mass Transportation Administration is upon saving existing transit systems. Typically, this means using capital grants to place new buses in the same system where old buses were unsuccessful.[46] While this policy has some incremental innovative effect, it has done little to encourage technological innovation. This has a very pronounced effect on mass transport innovation because the ability of individual firms to underwrite development expenditures is very limited.[47] In fact, in Congress there is some distrust of research and development of new mass transit systems. Congress is very cautious about programs which would force a shift from our reliance on the automobile,[48] and the Appropriations Committees have made it clear that they are willing to fund only conventional bus and rail technology and, for the most part, conventional operating methods. These Committees have considered the results of research to be too intangible to justify significant expenditures. Consequently, urban mass transportation research has been approved on practically an item by item basis, and grants have focused upon buying conventional transportation equipment. These policies can be expected to continue until the Federal Government realizes that the solution to the fundamental weakness lies not in providing more conven-

44. 2 *Nat. J.* 2024-6 (1970).

45. 2 *Nat. J.* 2155 (1970).

46. This policy, of only using grant or loan money to support conventional technologies is quite widespread in the Federal Government. Another example is the FHA, which makes little use of ps loan guarantees to induce new housing technology. Michaelis, *supra* note 5, at 81.

47. T. Lisco, "Mass Transportation: Cinderella in the Cities," *Public Interest* 52, 68 (Winter 1970) [hereinafter cited as Lisco].

48. 2 *Nat. J.* 2158 (1970).

tional equipment but in developing systems which respond to the urban travel demands of the consumer.[49]

C. *New Modes*

In the overshelming majority of cases, transportation improvement has meant expansion of existing systems, building of new systems utilizing old technology, or occasionally use of new technology on a small scale to improve existing systems.[50] Radically new systems are used infrequently, and instead an incremental approach used. While systems which have enormous potential such as dial-a-bus, tube trains, and automated roadways have been studied and proposed, these significant new systems have not been implemented. The following discussion focuses on the problems associated with the implementation of two new transportation systems, dial-a-bus and vehicle monitoring.

1. Automatic Vehicle Monitoring.

An automatic vehicle monitoring (AVM) system constantly reports in real time the position of a set of moving vehicles to a central point, and displays their positions and identification numbers on a map. The key word is "automatic"; no driver intervention is necessary once a vehicle has entered the system. The word "vehicle" is almost incidental. For, although many AVM systems will workonly for vehicles, others are equally adaptable to the monitoring of other objects such as cargo containers.[51]

Vehicle monitoring as a technology has a substantial history dating from before World War II, involving both passive radio systems such as radar, and active radio systems such as IFF (identification-friend or foe) systems, inertial navigation, and the like. The unique elements broadening the use of AVM are: (1) the civilian context, with its requirement of low cost; (2) the urban environment, with its associated severe radio propagation problems; (3) the possible multiplicity of users, with its implications of joint-usage forms for the system; and (4) the possible public interest inherent in developing AVM.

There are many potential uses of an AVM system. Application to

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49. Lisco, *supra* note 47, at 52.

50. Wachs, *supra* note 9, at 40.

51. Institute of Public Administration, *An Analytic & Experimental Evaluation of Alternative Methods for Auto. Veh. Monitor.* 21 (1968) [hereinafter cited as Alternative Methods].

police work would reduce response time, increase the pool of available vehicles, improve patrol effectiveness, and reduce the present radio spectrum congestion.[52] Urban bus systems could use AVM to keep buses on schedule, equalize loading, and improve driver and passenger security.[53] By enabling taxi companies to dispatch the taxi nearest to the requesting rider, AVM would speed service and reduce vehicle mileage.[54] AVM could also assist demand responsive systems such as dial-a-bus.[55] Use in the future will probably also include air and harbor traffic control, prevention of cargo loss and theft, transportation research and traffic control, personal safety, employee surveillance, and pre-trial surveillance.[56]

AVM systems make extensive use of radio communications, which are primarily regulated by the Federal Communications Commission (FCC). FCC approval is required for any emission of radio waves by any person other than the Federal Government.[57]

The existing FCC regulatory framework does not easily accomodate new uses such as AVM. While allocation of a wave length is normally a one step process (although admittedly difficult), approval of AVM involves revising FCC's entire spectrum allocation, which would involve at least four stages.[58] Because of this, the FCC has been resistant to restruc-

52. The expected benefits per police vehicle are about $3700 per year. Institute of Public Administration, *Urban Vehicle Monitoring: Technology, Economics, and Public Policy* 24 (1971) [hereinafter cited as Urban Vehicle Monitoring].

53. Comm. on Telecommunications, Nat. Acad. of Eng'ring, *Communications Tech. for Urban Improvement* 96 (1971). The expected annual benefits per bus at $1350. Urban Vehicle Monitoring, *supra* note 52, at 24.

54. Other contributions of AVM to taxi operations could include: increasing the pool of available vehicles (i.e., by enabling central dispatching of all taxis operating in a large metropolitan area), alleviating alleged dispatcher favoritism (i.e., by automating the dispatching process), improving driver and passenger security (i.e., by enabling immediate reporting of emergencies) and improving overall taxi supervision (i.e., by permitting owners to monitor driver performance and cross-check driver reports). Taxicab annual benefits are estimated at $1700 per car. Urban Vehicle Monitoring, *supra* note 52, at 24.

55. Comm. on Telecommunications, Nat. Acad. of Eng'ring, *Telecommunications for Enhanced Metropolitan Function and Form* 47 (1969).

56. Alternative Methods, *supra* note 51, at 9-23.

57. 48 Stat. 1081 (1934).

58. The four steps are:

1—classification of users;

2—allocation of the spectrum to the various user classifications;

3—allocation of portions of each user classification spectrum to geographic areas; and

4—assign a frequency to a particular user.

Normally, a user becomes involved only in this fourth stage, but AVM, being a completely different form of use, would require revision of all of FCC's spectrum policies. See Institute of Public Administration, *Public Urban Locator Service: Technical and Institutional Foundations* 9-2 (1969) [hereinafter cited as PULSE].

turing their spectrum policies.

Attempts have also been made to fit AVM use into one of the present user classifications. This suffers from two disadvantages: present user classifications (except UHF television) are overloaded now and AVM does not really come close to fitting any of the present classifications (the closest being navigational).[59] Certainly a new classificaton is most logical, since acquisition of a portion of the spectrum is relatively easy if it is granted. However, until AVM gains popular acceptance, a new classification is unlikely.

The FCC is not unaware of the development of AVM systems and has indicated a willingness to issue experimental licenses to test AVM under a variety of operating conditions. Nevertheless, applicants for wave lengths have been cautioned against attempts to integrate vehicle locating systems into their operations. The FCC has indicated that this should not be done until it has evaluated the experimental usage.[60] Unfortunately, this attitude has largely precluded issuance of experimental licenses because of the enormous costs of establishing an AVM system (approximately $1.5 million at a minimum)[61] and the short length of experimental licenses (six months). No user can recover his initial capital outlay during the six month period and he has no assurances that the system can operate any longer than that period.

2. Dial-A-Bus

Dial-a-bus provides door-to-door transportation in response to telephone requests. It utilizes a small bus, but has taxi characteristics in that it provides door-to-door service. Costs per trip are estimated at slightly above that of a bus and considerably below that of taxis.[62]

A computer is responsible for determining the assignment of vehicles to service customer requests in an optimal manner. The customer will have no direct contact with the computer, but will talk to an operator when he phones in his request. After learning his origin and destination, the operator will type this information into the computer. It will immediately print out the estimated time of customer pickup and arrival at

59. *Id.*

60. *Id.* at 9-14.

61. Urban Vehicle Monitoring, *supra* note 52, at 22. Furthermore, annual operation costs are estimated at $200,000, so that probably $100,000 in operating costs would have to be recovered in six months.

62. A. Altshuler and D. Roos, "Dial-A-Bus," *Innovation in Urban Transportation* 83, 93 (1970) [hereinafter cited as Altshuler].

destination. The operator will give this information to the patron and it will also be displayed to the bus driver. The patron will be expected to watch for the bus and enter it within thirty seconds or so of its arrival. The vehicle will take him to his destination, making minor detours to pickup and drop off other passengers on the way. The route will be determined for the driver by the computer.[63]

Dial-a-bus is thus a personalized, flexible public transportation system in which the routes of the vehicles are determined by and adapted to the particular travel demands as they arise.[64] The real cause for excitement about dial-a-bus is that it can serve the highly random travel patterns and low-density land use patterns typical of this automobile era. It can take people where they want to go when they want to go. And it can do so quickly, directly, and at reasonable cost. It can do this either as an independent system or more likely, as a supplement to existing transit systems. At present, the technology is ready to support an automated dial-a-bus demonstration. Regular service could begin on the streets of an American city within six months of a decision to go ahead.[65]

The regulatory constraints on dial-a-bus have occurred at both the local and federal level. Local regulatory officials try to categorize the system as both a bus or taxi without realizing it has characteristics of both and is best considered as a new category.[66] As a result, dial-a-bus may be required to follow fixed routes, adhere to bus-like fare schedules, or carry only one passenger group at a time. Since dial-a-bus is most effective in larger metropolitan areas, severe inter-area conflicts over fares and operation would be expected.[67] All of these and many other local regulations would completely cripple a dial-a-bus system.

The Federal Government has not been particularly helpful. The Urban Mass Transit Administration, which provides the Federal Government's mass transit funding, has steadfastly refused to fund to new transportation improvements such as dial-a-bus. Because of the poor financial position of existing transportation systems, they are unlikely to implement dial-a-bus until they can obtain assistance.

D. Federal Airline Regulation.

Federal regulation of aviation falls into three main categories: safety

63. *Id.*, at 83.
64. City of Phoenix, *Personalized Transit Study* 2 (1970).
65. Altshuler, *supra* note 62, at 84.
66. Institute of Public Administration, *Demand Actuated Road Transit* IV-4 (1969).
67. H. Bauer, *A Case Study of a Demand Responsive Transportation System* 51 (1970).

regulation, promotion (including facility development and operation), and economic regulation.[68] Economic regulation includes route certification, merger regulation, and fare regulation. Promotion is basically the responsibility of the Federal Aviation Agency, while the Civil Aeronautics Board (CAB) is responsible for economic and safety regulation.

The most important aspect of CAB regulation is control of entry,[69] through which no new carrier has been permitted since CAB was established in 1938.[70] Not only have new carriers been precluded, but the number of carriers along routes is strictly limited. CAB feels its job is to avoid facility duplication, prevent excessive competition, and insure service quality.[71] These policies have resulted in a service quality competition, but little price competition, and generally higher prices.[72]

The effect of service quality oriented competition among the airlines has been to encourage technological innovation before it might have occurred under price competition.[73] In this regard, California's unregulated[74] intrastate carriers provide a marked contrast to their CAB regulated competitors. The California carriers provide significantly cheaper prices and utilize older airplanes and equipment. Conversely, the CAB regulated carriers have consistently introduced service quality improvements[75] to compensate for their inability to compete with prices.[76]

> . . . the development of the California intrastate carriers' fleets provides an indication of the types of aircraft the interstate carriers would have operated had there been no CAB regulation. It seems reasonable to conclude that without regulation the nonpressurized DC-3's and DC-4's would have had longer lives, especially in short-haul markets. Pressurized, piston-powered aircraft would have been adopted, particularly for medium- and long-range operatons, but the final series of these aircraft (the DC-7's, later model L-1049's, and the L-1649's—those aircraft powered with turbo-compound pis-

68. Fair, *supra* note 28, at 509.

69. *Id.*, at 516.

70. 52 Stat. 973 (1938).

71. Fair, *supra* note 28, at 517.

72. R. Caves, "Performance, Structure, and the Goals of Civil Aeronautics Board Regulation," *The Crisis of the Regulatory Commissions* 131, 133 (1970).

73. W. Jordan, *Airline Regulation in America* 13 (1970) [hereinafter cited as Jordan].

74. Unregulated by CAB, but still regulated by California's Public Utility Commission which does regulate either price or service quality.

75. Jordan, *supra* note 63, at 39.

76. Competition has not merely involved newer aircrafts such as jets, but also improvements such as the pressurized cabin.

> ton engines) would not have been adopted because their small improvements in speed over the DC-6's, DC-6B's, L-749's, etc., were obtained through very much higher operating costs. Turbine-powered aircraft, however, would have been adopted in much the same manner that actually occurred since this innovation offered both superior service quality and lower seat-mile costs—a potent combination.[77]

However, when the first unregulated carrier introduced an innovation, all others were forced by competition to provide the same service.[78] Nevertheless, the CAB regulated carriers were consistently the first to introduce an innovation unless it also involved a cost per passenger reduction.[79]

E. Federal Air Pollution Control Policies[80]

In recent years Americans have become increasingly aware of air pollution, roughly two-thirds of which result from motor vehicular emissions.[81] Each vehicle in the United States averages a ton per year of contaminants.[82]

Control of motor vehicle emissions was first initiated by the State of California, perhaps because Los Angeles was the first major American city to observe the problem. In 1965, the first Federal motor vehicle pollution control law was passed.[83] It required the Federal Government to prescribe emission standards for all new cars sold in the United States and in 1967 the law was clarified to indicate that federal pre-emption of new car emission testing was to apply, except in California.[84] The most significant motor vehicular air pollution controls are in the Clean Air Amendments of 1970.[85] The effect on technological innovation of the most important provisions, emission standards and transportation controls, will be discussed in the following paragraphs.

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77. Jordan, *supra* note 63, at 49. It is interesting to note that CAB regulated carriers who had a monopoly over a route had even poorer innovative records than the unregulated carriers. Apparently, on monopolized routes passengers must pay higher prices and receive a lower quality service than they might if there was no CAB regulation. *Id.*, at 54.

78. *Id.* at 55-56.

79. *Id.* at 53.

80. The effect of safety regulations on motor vehicles, not discussed in this paper, is quite similar to air pollution control in its encouragement of technological innovation.

81. "Air Pollution: The Problem of Motor Vehicle Emissions," 3 *Conn. L. Rev.* 178, 181 (1970).

82. U.S. Public Health Service, *The Sources of Air Pollution and Their Control* 5 (1966).

83. Motor Vehicle Air Pollution Control Act, 79 Stat. 992 (1965).

84. Air Quality Act of 1967, 81 Stat. 485.

85. 84 Stat. 1676.

The Clean Air Amendments require a 90 percent reduction[86] in carbon monixide and hydrocarbon emissions for all new cars sold in the 1975 model year and thereafter. There is a similar 90 percent reduction requirement for nitrogen oxides which becomes effective in 1976. To prevention deterioration of a vehicle's air pollution control capacity, the manufacturer must warranty that the vehicle will comply with the 1975 standards for five yers ro 50,000 miles, whichever occurs first.[87] to insure that this warranty is complied with, the law requires the states to inspect vehicles if non-compliance could have an adverse effect on air quality in the state.[88]

While there seems to be little question that the technology to meet these standards does not currently exist, the demands of the standards will result in technological breakthroughs and innovations. A multitude of different technologies are being tested which utilize different engines, components, and fuels. Or if the law is enforced, but automoble manufacturers cannot comply, sufficient demand for other vehicles may be generated that they can adequately fill transportation needs.[89] In any event, it is apparent that the effect of the law will be to accelerate technological innovation.

While there is little awareness of the general public about the transportation controls requirement in the Clean Air Amendments,[90] they will probably have a more pronounced effect on the lives of Americans than the motor vehicle emission standards discussed above.[91] The law requires states to utilize land use and transportation controls when necessary to attain ambient air quality standards.[92] This is expected to occur in about 60 major cities in the country.[93] In these cities, controls such as banning or restricting traffic, motor vehicle inspection and retrofit, mass transit

86. The 1970 model year standards are used as a base. *Id.*, §202(b)(1).

87. *Id.*, §202(d).

88. *Id.*, §110(a)(2)(G).

89. For example, an electric vehicle that can supply the power and endurance demands of the urban motorist is available for about $7000. With mass production, the costs might be considerably lower. See S. Kalish, *The Potential Market for On-the-Road Electric Vehicles* (1971).

90. 84 Stat. 1676 (1970), §110(a)(1)(B).

91. For example, controls will affect over 300,000 residents of Manhattan and the millions who travel into the area each day. "What Hath Henry Ford Wrought," *Car & Driver* 26 (Oct. 1971).

92. This could occur because areas in some cities have such a high volume of traffic that a 90 percent reduction in emissions per vehicle is not sufficient to reach the standards.

93. J. Middleton, Deputy Ass't Administrator for Air Programs, Environmental Protection Agency, 2 *Nat. J.* 2187 (1971).

improvements, land use controls, parking fees, and a multitude of other controls are being contemplated.[94]

Changes in transportation patterns as broad as these should have significant effect on transportation innovation. These changes provide enormous encouragement of new mass transit systems, such as the new subway systems or dial-a-bus, and new technological innovations related to transportation, such as automatic fare collection. New vehicle technologies will be required or at least encouraged, such as propane, natural gas, or electric powered vehicles. Traffic flow improvements[95] will introduce computerized and other new flow control technologies. Other effects might be increased communication development because of restricted mobility, development of high-speed, mechanized parking systems, and rapid development of emission measuring technology. Many of the effects of the implementation of transportation controls are not now known,[96] but it is expected that technological innovation in areas such as mass transit improvements will be strongly encouraged.

IV. Conclusions

The Federal Government's efforts to encourage technological innovation have almost exclusively focused upon policies that directly subsidize research and development. Unfortunately, the Federal Government has neglected the subtler effects that its other policies have upon technological innovation. Its antitrust, tax, procurement, and even to a certain extent its patent policies do not reflect anything other than a neutral attitude towards innovation.

For the most part, federal regulation of transportation has focused upon transportation innovation. The impact of this neglect has been largely neutral since innovation in trucking and water transport has been

94. For example, the District of Columbia is proposing mandatory emission inspection of all vehicles registered in the District, banning parking on downtown streets and main thoroughfares, requiring conversion of fleet vehicles to natural gas, banning on-street truck deliveries during the day, banning parking anywhere in the District during the day by Maryland and Virginia residents, and making standing illegal anywhere in the city. In addition, the District has proposed inspecting all vehicles entering the city unless Maryland and Virginia agree to inspect their vehicles. See District of Columbia, *Proposed Implementation Plan* (1971).

95. Traffic flow improvements decrease pollution by increasing average speed which causes engines to operate more efficiently. J. Middleton and W. Ott, "Air Poll. and Trans.," *Traffic Quarterly*, 175-189 (April 1968).

96. See Institute of Public Administration, *The Effect of Different Transportation Controls on Urban Air Pollution* (1971).

basically unaffected, with railroad innovation discouraged and airline innovation encouraged. The only areas where the Federal Government has actively encouraged transportation innovation are in areas such as air pollution control and safety restraints, where current technology has adverse effects on consumers.

If the Federal Government is interested in fostering technological innovation in transportation or other aspects of our lives, then it should actively involve itself in utilizing all of its policies towards that goal. Rather than relying solely on pouring money into research and development, the government should also use its other powers to hasten technological innovation.