Transportation and Economic Development: The Geographical Literature

Final Report: Appendix I
The report written by Prof. Yorgos J. Stephanedes contains nine volumes. Copies of the report may be obtained in its entirety or by separate volume. The title of each volume is as follows:

1. TRANSPORTATION AND ECONOMIC DEVELOPMENT
   Final Report - Executive Summary

2. TRANSPORTATION AND ECONOMIC DEVELOPMENT
   Final Report

3. TRANSPORTATION AND ECONOMIC DEVELOPMENT:
   THE GEOGRAPHICAL LITERATURE
   Final Report - Appendix I

4. TRANSPORTATION AND ECONOMIC DEVELOPMENT:
   TRANSPORTATION AND THE MINNESOTA ECONOMY;
   TRANSPORTATION/ECONOMY LITERATURE
   Final Report - Appendix II

5. TRANSPORTATION AND ECONOMIC DEVELOPMENT:
   EVALUATING CRITERIA FOR HIGHWAY PROJECT SELECTION
   Final Report - Appendix III

6. TRANSPORTATION AND ECONOMIC DEVELOPMENT:
   THE LINK BETWEEN HIGHWAY INVESTMENT AND ECONOMIC
   DEVELOPMENT - A TIME-SERIES INVESTIGATION
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7. TRANSPORTATION AND ECONOMIC DEVELOPMENT:
   THE LINK BETWEEN HIGHWAY INVESTMENT AND ECONOMIC
   DEVELOPMENT - A TIME-SERIES INVESTIGATION:
   SPECIFIC ECONOMIC SECTORS
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8. TRANSPORTATION AND ECONOMIC DEVELOPMENT:
   HEURISTIC DECISION FRAMEWORK FOR
   UPGRADING HIGHWAY WEIGHT LIMITS
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9. TRANSPORTATION AND ECONOMIC DEVELOPMENT:
   SIMULATION OF HIGHWAY INVESTMENT IMPACTS ON
   THE FORESTRY SECTOR IN NORTHEAST MINNESOTA
   Final Report - Appendix VII

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Minnesota Department of Transportation
Research Administration & Development Section
Materials & Research Laboratory
1400 Gervais Ave.
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### Abstract (Limit: 200 words)

A time series methodology is developed that differentiates the effects of highways on development from the effects of development on highways. This methodology uses pooled time-series and cross-sectional data on highway expenditures and county employment for the 87 Minnesota counties and all 9 economic sectors over the 25-year period 1957-1982 and includes classification of counties based on access, demographic and socioeconomic features. Results from vector autoregressions are tested against modern causality tests of Granger-Sims type. In the wholesale and natural-resource-based service sectors (e.g., tourism), increased highway expenditures result in long-term employment increases. While regionally very substantial, the impacts are distributional, i.e., the statewide impact is negligible. Government role is mostly reactive, increasing funding to counties whose economy is increasing, except in rural areas where government also attempts to stimulate declining economies. Funding decisions are highly sensitive to changes in the economy, especially in rural areas, and (as our evaluation of the Minnesota Department of Transportation [Mn/DOT] project selection process indicates) are primarily influenced by the District recommendation. Further, a new B/C project selection process is developed and tested on highway weight restriction policies in Northeast Minnesota. Both simulation with large I/O model and comparison with actual funding decisions made independently by Mn/DOT indicate agreement with our results. An extensive literature review and 175 references are included.

This report consists of nine separate publications: an executive summary, the final report and seven appendices. The publications are listed on the following page.
TRANSPORTATION AND ECONOMIC DEVELOPMENT:
THE GEOGRAPHICAL LITERATURE
Final Report - Appendix I

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Submitted to
Research Administration and Development Section
Office of Materials and Research
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This report represents the results of research conducted by the author and
does not necessarily reflect the official views or policy of Mn/DOT. This
report does not contain a standard or specified technique.
Transportation and Economic Development: The Geographical Literature

1. INTRODUCTION

The purpose of this brief report is to review the work carried out by economic and transportation geographers into the question of the relationship between investments in transportation and geographical patterns of economic development. This report was constructed on the basis of the author's familiarity with ongoing research in economic geography, and his knowledge of transportation geography. Since I have not performed any research specifically in transportation geography for several years, the latter was supplemented by a bibliographic search which identified all publications in English on transportation geography since 1978. The report is structured as follows. First the nature of the debate among transportation geographers on transportation and regional development will be reviewed. Secondly, in the light of the apparently inconclusive nature of this debate, and the seeming dearth of empirical studies into this question by geographers in the United States, the literature on economic geography will be examined in detail in order to understand possible reasons for this situation and to provide a backdrop for interpreting the relationship between transportation and development in Minnesota.
2. THE DEBATE IN TRANSPORTATION GEOGRAPHY

The traditional view among transportation geographers has been that the improvement of transportation infrastructure is a necessary precursor to economic development in a region (Eliot Hurst, 1974; Robinson and Bamford, 1978). However, in the last ten to fifteen years this view came under heavy criticism from a number of directions. Empirical research in a number of countries provided a series of counter examples which called this view into question. Hunter (1965) studied the development of transportation and economic development plans in the Soviet Union and China, and found that transportation was a concomitant of rather than a precursor for regional economic development, and suggested that the same was true of the role played by the development of railroads in America (a point also made by Cootner, 1963 and Fogel, 1964). In a similar manner, research into the role of transportation in Third World countries also discovered many instances where the development of transportation into the interior exacerbated rather than decreased economic development differentials between the major cities and rural peripheries of these countries. Finally, work in the developed market societies has often come to the conclusion that because transportation is so well developed in general in such places, improvements in transportation are more likely to reallocate growth from one place to another than to generate new economic growth. Furthermore, the complexities of the interdependencies between places in a well integrated spatial economic system may mean that the effects of transportation improvements are hard to predict and not necessarily beneficial. The most influential such study was that reported on by Garrison et al. (1959). This study examined the impact of the development of the inter-state highway system on the competitiveness of small towns, and of economic establishments along the older state and federal highways.
In the case of locations whose relative accessibility was reduced because they were not accessible to the new highways, the redirection of traffic to the highways had an immediate deleterious effect. For places that happened to be located close to interstate highway intersections, there was always a short run benefit, but whether this translated into a permanent stimulus to growth depended on the distance of these places from other larger towns. In some cases increased competition from those older towns led to a long run negative impact despite the fact that the highway had increased the accessibility of these economic establishments.

These inconclusive findings had an impact on the study of transportation and development by transportation geographers. From a major focus in the subject, typified by Hoyle's (1973) edited book on Transportation and Development, interest has steadily declined. Instead, transportation geography has turned its attention to other matters: Models of individual travel behavior (Senior, 1979; Baxter, 1983; Timmermans, 1984); studies of geographical measures and patterns of accessibility to transportation (see the reviews by Hay, 1980, 1981); studies of trip making within cities (typified by the special issue of the journal Economic Geography, October, 1981, edited by A.P. Burnett); and models of the development of transportation networks (Barber, 1978; Ralston and Barber, 1982).

The current state of thinking on this subject is therefore still the position summarized by Eliot Hurst (1974, pp. 382-385, drawing on the work of Wilson, 1966, and Storey, 1969). He suggests a two dimensional classification of opinions. The first dimension subdivides studies according to whether they conclude that transportation has a positive, neutral (i.e. "no more an initiator of growth than any other form of investment (Wilson, 1966, p. 218)") or negative effect on development. The second
dimension is whether investment in transportation precedes, is concomitant with or follows economic growth. These together provide nine possibilities:

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Clearly the two dimensions are related, in that if policy makers believe that transportation has a positive impact, then they would choose the option of transportation investment preceding development, whereas if they believe that the impact was neutral or negative then investment in transportation would only occur as needed (simultaneously with, or after, other investment in economic growth). In any event, it is clear from this matrix that the best way to empirically evaluate whether transportation investment can improve the accessibility of a place would be to examine situations where transportation investment does seem to temporally precede changes in the local economy, and to determine whether, and in which situations, that impact is likely to be positive, neutral or negative. As the second major section of this report will make clear, in different geographical situations we would expect different results.

Finally, two other factors are agreed on as important in affecting the size and direction of the relationship between transportation and development. The first is
whether the impacts being studied are short or long run impacts. The Garrison study showed that the direction of long run impacts may be different to that of short run impacts, and also suggests that the direction of long run impacts is hard to predict (see also the empirical work by Stephanedes and Eagle, 1982, which supports this position). Yet it is longer run impacts that are of most relevance to questions of economic development, since this is by definition a long run issue. Secondly, the degree of transportation development that already exists in an area has an important impact. No researcher questions the fact that if there is no transportation infrastructure at all then transportation is necessary for development, simply because development without communication and trade is meaningless. The traditional view of transportation geographers referred to at the start of this section is just an extension of this obvious fact to situations where it is not relevant. It is in situations where a transportation system already exists that researchers disagree about the efficacy of transportation investment; and if there is any agreement at all in this area it seems to be that the more complex and well-connected the initial transportation system is, the harder it is to predict, on the basis of past research, whether transportation improvements will help the local economy. Since the state of Minnesota certainly has a transportation system that is by and large both well developed and well connected, this result is of some interest.

My search of the literature has been able to reveal very few empirical studies by geographers of the impact of transportation on the economic development of places at the local (sub-state) geographical scale of this research project. The Garrison study seems to be the paradigmatic example, and the other studies do not seem to have added to the general body of knowledge developed within that research. There are, of course, other studies by transportation researchers, economists and regional scientists, but
these are adequately covered in the research report already provided by Stephanedes to the Department of Transportation.

3. ECONOMIC GEOGRAPHY

3.1 Static Approaches

Much of what we know about the role of transportation in affecting the development of a local area (a town or county) stems from our knowledge of how transportation costs affect the profitability of locations for different kinds of activities. Typically, for geographical purposes we divide activities into three distinctive types: Activities that consume large quantities of land, agriculture and forestry being prime examples; activities which do not consume large quantities of land but for which geographical variations in the costs of production are the prime element in choosing locations, such as manufacturing industry; and activities for which access to the consumer is vital, such as tertiary services. For each of these groups of activities there is an extensive theoretical and empirical literature, too extensive to survey here, from which our current knowledge stems. I shall examine each in turn.

3.1a agriculture and forestry

The profitability of a location for agricultural and forestry activities depends primarily on two factors: Production costs, which are a result of environmental site specific factors such as climate, water availability and soil type, as well as transportation
costs from the site of extraction to the place of storage or initial processing (McCarty and Lindberg, 1966; DeSouza and Foust, 1980); and marketing costs which vary from place to place as a result of accessibility to markets (Von Thunen, 1875). In von Thunen's day, transportation costs played a vital and determining role in influencing the profitability of a location for agricultural activity. The consensus of most researchers today, however, is that in advanced societies we can see the effects of transportation costs only at a large scale, such as for Western Europe as a whole (Chisholm, 1967), or for the entire United States (Kellerman, 1977; Muller and Wheeler, 1981). Given contemporary methods of transportation, and the dense network of highways that currently exists, the costs of shipping a product to the market vary much less from place to place within a state than do production costs. This can be seen most dramatically with the forestry industry. Von Thunen calculated that forestry had to be located close to cities in nineteenth century Germany because of the high demand for construction and heating and the high costs of shipping such a bulky product by horse drawn cart. Today it is inexpensive to ship wood, and forestry production is relegated to places such a northern Minnesota where the soils are too thin and acid for arable or livestock farming. A policy of increasing the weight limits for trucks that would favor lumber trucks, and reduce the cost of lumbering more than the cost of other crops, could expand the area of land where lumbering occurs, and the intensity of production per acre. Yet given the relatively low costs of transport per mile for lumber, theory would suggest that it is the acreage rather than the intensity of production that would increase, and that some of this acreage would be gained by reducing the acreage of other crops in the state. It is place to place variations in environmental conditions that are likely to affect farming more than changes in transportation costs. A general increase in the accessibility of Minnesota to the rest of the national economy or to the international economy might generally improve the profitability of farming in Minnesota, but
policies of the Minnesota Department of Transportation do not cover inter-state or international transportation improvements.

There is one exception to this situation; perishable horticultural crops grown for local markets in the summer do depend on access to those markets, as can be seen by observing the origins of the farmers who sell in the Minneapolis and St Paul farmers' markets. For such a crop, I would anticipate that the improvement of transportation to a particular place would increase the profitability of growing it by comparison to other crops for which such improvement make little difference. However, the more dense the overall network of roads, the less dramatic this effect would be. If any conclusion at all emerges from this, it is that the effects of transportation improvements on agricultural production, while generally positive, are not likely to be particularly significant in a space economy such as that of Minnesota.

There is another aspect of land use change that should be considered, and that is the effect of transportation improvements on the fringe of urban areas. Sinclair (1969) has argued to good effect that locations which are close to the fringe of a city may be subject to reduced agricultural activity since farmers expect to be able to sell the land for urban development in the near future, and thus are less likely to invest in its upkeep for agricultural purposes. Such land might be left fallow, or be rented to weekend farmers. It would be concluded from this that in situations where transportation close to the metropolitan area is improved, and where there are no regulations such as those of the Metro Council which prohibit further urban development, this could lead to a fall in the intensity of agricultural production in locations within commuting distance of jobs in the metropolitan area.
3.1b manufacturing activities

Industry can be crudely divided into two groups: That for which the transportation cost of inputs and products varies significantly from place to place, and that for which it is geographical variations in other production costs that are more important. Those manufacturing industries for which transportation costs are still important today tend to be industries which use or produce products that are perishable or expensive to transport in comparison to their delivered price. Thus most heavy manufacturing does not fall into this category. For these industries, when transportation costs were generally high then location choice typically reduced to an intermediate location representing a compromise between access to suppliers and access to markets (Weber, 1922). The historical decline of transportation costs has also led to a situation where long distance shipping has become less expensive relative to short distance shipping, while terminal costs have become higher relative to per-mile costs. As a result of this, in those industries for which transportation costs are still important, terminal locations have become more favorable than intermediate locations (Smith, 1971). Terminal locations are locations either at the market or next to a supplier, or locations at a major node in a network (particularly if it is also a transshipment point). This tends to favor metropolitan areas and nodes in the transport network. In this case, an improvement in the transportation network would tend to reinforce the attractiveness of terminal locations if that improvement tended to reduce the importance of per-mile relative to terminal costs, but would favor intermediate locations if the converse were true. However, given that heavy manufacturing is declining in importance as a provider of jobs in the national economy even more rapidly than is manufacturing as a whole, perhaps of more importance is the influence of transportation improvement on other industries.
Reductions in transportation costs have increased the number of types of manufacturing industry for which transportation costs are less important in choosing a location for industry than are differences between places in other costs; labor, utilities, land rents, government regulations, incentives and taxes. These industries are known as footloose industries. The term does not imply that such industries could locate anywhere but rather that transportation costs are not important in the location decision. Even in these other production costs transportation may be important. For instance it is easier to obtain a labor force in a low wage area if transportation to the plant is adequate, and for this reason a significant component of the industry that had left major metropolitan areas in recent years relocated to places that were somewhat accessible to major population centers (Erickson and Leinbach, 1979). Yet in attempting to encourage the local development of footloose industries it should be clear that investment in transportation alone is likely to be less effective than trying to determine what other cost factors are important and investing in their improvement.

3.1c Tertiary services

For economic activities for which accessibility to consumers is of overriding importance, the major question to be asked is how changes in transport costs will affect the geographical pattern of sales. As an example, consider a neighborhood shopping center. The market area which is served by such a center has an upper and a lower limit. The lower limit is the geographical area around the center which generates enough sales on a weekly basis to pay the fixed costs of operating it. This is known as the threshold market area. The upper limit is a distance beyond which no customers of this center live because it is too remote or too expensive to make purchase worthwhile.
This is known as the ideal range of the services being provided (Christaller, 1933). This represents the ideal maximum sales area, but in practice the real range is typically less than this because nearby competing shopping centers may be closer to some consumers living within the ideal range, and they will take their business to these closer competitors (Getis and Getis, 1966). Finally, the threshold and range vary greatly from one service to another, being small for a corner grocery (a low order good) but large for a Dayton's department store (a high order good: Christaller, 1933; Losch, 1934).

The effect of improvements in transportation on the development of tertiary services in a place will depend on its effect on the range and threshold, and on the location of competitors. Transportation improvements will generally reduce the size of the threshold market required, since the service is now more accessible to potential customers, making it effectively cheaper, and they will be inclined to buy more (Sheppard, 1980). However, given the generally good transportation system in Minnesota this effect is unlikely to be dramatic. Transportation improvements will also increase the ideal range, but this is not always beneficial for tertiary services, because it can increase the range for competitors also. In situations where the tertiary service is located a long way from potential competitors, an increase in the ideal range will also lead to an increase in the real range, because more people will take advantage of increased access to use the service in that place. But where there are competitors nearby whose ideal range also increases, then the two firms are in heavier competition for customers in the market area between them. This heavier competition can have three effects. If the original firm provides the better service, it can expect a net gain, but at the expense of the local economy at those locations where its competitors are to be found. If the firms are roughly comparable, no-one's real range will increase, but profits are likely to fall since the greater competition will force the services to charge a
lower price. If the original firm provides a poorer service it will experience a drop in its real range and consequently in its profitability.

The situation is further complicated by the fact that tertiary services are provided from places that range in size from major metropolises providing virtually everything to small villages with just a limited range of local services (Borchert and Adams, 1963). The towns at the top of this urban hierarchy have extensive ranges for their high order goods, but when people come into town to buy a Cadillac they may also stop off at Rainbow Foods and do their grocery shopping, even though groceries are available in their home town. If the accessibility of a small town some 50 miles from the Twin Cities is improved, in the short run that can lead to increased sales because the real range of its grocery store is increased. But that accessibility improvement may also make it easier for people to travel to the Twin Cities whenever they consider purchasing an auto. If during such trips they also stop and buy in the Twin Cities goods that otherwise they would have bought locally, then the long run effect might be a decrease in grocery sales in the small town because demand within its market area has fallen. It is this kind of fluctuation that underlies the results of the highway improvement study by Garrison et al., discussed in section two.

While our knowledge of the geography of retailing allows us to understand rather precisely the range of scenarios possible, it implies that any general prediction of the effect of a transportation improvement on tertiary activities is impossible: It will depend crucially on the particular geographical situation. But once again it is clear that there is no automatic link between transportation investment and local economic development. If there are any general conclusions to be drawn, they are:

(1) transportation improvements are likely to have a more dramatic effect on
competition between service locations than on the overall propensity of consumers to purchase goods, because Minnesota has a good highway net and most services are available in most parts of the state;

(2) following from this, highway investments are more likely to relocate service employment between different parts of the state than to generate a lot of new employment, and;

(3) Low order services are most likely to benefit from highway improvements as long as they are not too close to larger urban centers.

3.2 Functional Regions and the Urban Hierarchy

The various components of the economic geographical landscape discussed in section 3.1 are each just partial pictures, and an important question is how they are combined together into an overall regional and urban pattern of economic activities linked by systems of communication. Often, it is assumed that different areas specialize in different activities, and that it is then possible to divide the landscape up into a series of homogeneous regions — areas that are uniformly dominated by one kind of activity, such as the corn belt, and the American manufacturing belt. Yet this view of the world, a view that is implicit in attempts to use trade theory to examine the interdependencies of transportation and economic growth among regions that have supposedly each specialized in a particular activity, is rather unrealistic. A more natural way of dividing up the national economy geographically is into functional regions — sub-areas of the nation that are distinguished by the strength of the economic linkages within each region counterposed by weaker links with other such regions. This is seen as a natural division, since economic activities are typically centered on an urban area which is
surrounded by a zone of influence containing smaller settlements, locally oriented farming, and residential areas from which people commute into the urban area. Within the United States it is generally agreed that the most appropriate definition of functional regions is given by "Daily Urban Systems", representing by and large the major metropolises and the area around them from which each metropolis draws its daily commuters (Berry et al., 1968). While each of these regions is itself heterogeneous, including within it the gamut of activities from farming to services, they represent good definitions of functioning economic regional subsystems – each with its own intra- and inter-regional transportation requirements. Indeed Fox (1973) has gone so far as to suggest that they would be useful spatial units for the purpose of examining the relation between transportation and regional development.

The existence of an urban hierarchy suggests that within each of these metropolitan-centered regions there are smaller functional sub-regions centered around smaller cities, towns and villages. There is certainly a regional specialization of activities between higher and lower levels of the hierarchy, for reasons described in section 3.1. These specializations and changes in them are described in Noyelle and Stanback (1983). Yet Noyelle and Stanback also point out that there are significant differences between regions at the same level of the hierarchy. In addition we have little up-to-date information on how (and whether) different levels of the hierarchy below that of the daily urban system can be defined. The study by Borchert and Adams (1963), which examined the economic activities of settlements in order to classify them into various levels of the urban heirarchy, has not been updated, either for the nation as a whole or for the upper Midwest. Indeed it is still used as if it were valid today despite major changes in the American economy and in the growth dynamics of cities in the last twenty years (Dunn, 1980; Borchert, 1986). Thus although there is clearly a hierarchy of cities within Minnesota, a part of the Twin Cities centered branch of the
U.S. urban hierarchy (Borchert, 1986), it would at this stage be premature to state precisely at which level of the hierarchy each settlement in Minnesota would be defined, or whether the structure and changes in that settlement were more similar to others at the same level of the hierarchy than to settlements at other levels of the hierarchy. The changes in the urban system in recent years have been sufficiently dramatic to dictate that we should be wary of such generalizations without further empirical analysis (Noyelle and Stanback, 1983).

Perhaps these difficulties explain why Fox's suggested approach, while appealing theoretically for a region that is in reality structured like a central place system, has not been taken up by transportation and economic geographers. The research necessary to determine the nature of the contemporary urban hierarchy within Minnesota, and to determine whether the important relations between transportation and development can be usefully examined separately for different levels of the hierarchy or whether alternatively the entire set of settlements should be treated as an interdependent spatial economic system, would be a very major undertaking. In addition, in the view of this author, the distinction that Fox makes between different levels of the hierarchy as representing spatial scales where different modes of transportation prevail and can be planned for is exaggerated. Within Minnesota, distances are short enough that trucking can compete well with railroads over any distance (except, perhaps, for very large shipments such as grain) and cars are the dominant mode for personal transportation over all distances.

3.3 Dynamic Approaches

The above results stem from research in economic geography that does not try to
determine in detail changes over time, but rather compares notionally two different situations (in our case before, and after, highway improvement) and ask what has changed. This kind of comparative static analysis is a considerable simplification of the real world. In particular it does not try to account for the ways in which changes in the transportation system and thus in travel behavior are a result of as well as a cause of changes in the location of economic activity. This two-way interdependence between the geography of economic development and the geography of transportation is very difficult to represent. Morrill (1963) in a pioneering study attempted to show how manufacturing, services and transportation affected one another by simulating on a computer the development of the economic landscape of southern Sweden. His results showed us something of the complexity of the process, but did not provide any easy and non-trivial conclusions that could be generalized to other places because they depended crucially on the particular situation he was examining. More recently there have been a series of studies attempting to determine at least qualitatively, the dynamic behavior of such a complex spatial economic system. White (1977, 1978) and a group of researchers led by Allen and Sanglier (1979) have looked at these kinds of dynamics in a hierarchical system of urban centers. Wilson, Harris and Clark have done similar work for shopping center development within urban areas (Harris and Wilson, 1978; Wilson and Clark, 1979). Finally Dendrinos, Haag, Weidlich and Sheppard, among others, have been examining the relationship between migration, and demographic and economic growth in a system of cities (Dendrinos and Mullally, 1983; Haag and Dendrinos, 1983; Haag and Weidlich, 1984; Sheppard, 1985). The one general result that seems to have emerged from this research is that the very fact that transportation and economic development are interdependent makes the behavior of a spatial economic system very unpredictable. This unpredictability takes two forms. First what seems to be happening in the short run may turn out to be very different from what happens in the long run.
Second, external factors, such as state intervention to build a new mall or changes in the international economy, can alter the entire direction of change that is occurring in the system. Once again this reinforces the suggestion that there is no easily predictable effect of transportation investment on local economic development.
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