Nature and Scope of Transport Geography

The unique purpose of transportation is to overcome space, which is shaped by a variety of human and physical **constraints** such as distance, time, administrative divisions and topography. Jointly, they confer a friction to any movement, commonly known as the **friction of distance** (or friction of space). In an ideal world, transportation would come at no effort in terms of cost and time and would have unlimited capacity and spatial reach. Under such circumstances, geography would not matter. In the real world, however, geography can be a significant constraint to transport since it trades space for time and money and can only be partially circumscribed. The extent to which this is done has a **cost** that varies greatly according to factors such as the length of the trip, the capacity of modes and infrastructures and the nature of what is being transported. Transport geography can be understood from a series of core principles:

- Transportation is the spatial linking of a **derived demand**.
- **Distance** is a relative concept involving space, time and effort.
- **Space** is at the same time the generator, support and a constraint for mobility.
- The relation between space and time can **converge** or **diverge**.
- A **location** can be central, where it generates and attract traffic, or an intermediate element where traffic transits through.
- To overcome **geography**, transportation must consume space.
- Transportation seeks **massification** but is constrained by **atomization**.
- **Velocity** is a modal, intermodal and managerial effort.
- The Sisyphus Analogy in Transportation
- The Core Principles of Transport Geography
- Operational Differences between Passengers and Freight Transportation
- Transportation as a Derived Demand
- Representations of Distance
- Mobility of Freight
- Space – Time Convergence
- Atomization versus Massification in Transportation Modes

These principles underline that there would be no transportation without geography and there would be no geography without transportation. The goal of transportation is thus to transform the **geographical attributes** of freight, passengers or information, from an origin to a

destination, conferring them an **added value** in the process. There are substantial operational differences between transportation modes, particularly between passengers and freight, which often operated separately. The convenience at which this can be done varies considerably and is commonly labeled as mobility.

Mobility *The ease of a movement of a passenger or a unit of freight. It is related to transport costs as well as to the attributes of what is being transported (fragility, perishable, price). Political factors can also influence mobility such as laws, regulations, borders and tariffs. When mobility is high, activities are less constrained by distance.*

Transportation is not necessarily a science, but a **field of application** borrowing concepts and methods from a wide variety of disciplines. The specific purpose of transportation is to **fulfill a demand for mobility** since transportation can only exist if it moves passengers, freight and information around. Otherwise, it has no purpose. This is because transportation is dominantly the outcome of a derived demand; it takes place because other activities are taking place. Distance, a core attribute of transportation, can be represented in a variety of ways, ranging from a simple Euclidean distance – a straight line between two locations – to what can be called logistical distance; the complete set of required tasks so that distance can be overcome.

Any movement must thus consider its geographical setting which in turn is linked to spatial flows and their patterns. The concept of flow has four major components:

- **Geographical**. Each flow has an origin and a destination and consequently a degree of separation. Flows with high degrees of separation tend to be more limited than flows with low degrees of separation.
- **Physical**. Each flow involves specific physical characteristics in terms of possible load units and the conditions in which they can be carried. Flows, depending on the transportation mode, can be atomized (smallest load unit) or massified (moving load units in batches).
- **Transactional**. The realization of each flow has to be negotiated with providers of transport services, such as booking a slot on a containership or an air travel seat. Commonly, a flow is related to a monetary exchange between a provider of transportation services and the user.
- **Distribution**. Flows are organized in sequences where the more complex are involving different modes and terminals. Many transport flows are scheduled and routed to minimize costs or maximize efficiency, often through intermediary locations.
- The Spatial Consideration of a Movement

- Types of Spatial Flows
- Transportation and the Mobility of Passengers and Freight
- The Scales of Transport Geography

  Urbanization, multinational corporations, economic globalization are all forces shaping and taking advantage of transportation at different, but often related scales. Consequently, the fundamental purpose of transport is geographic in nature, because it facilitates movements between different locations. Transport plays a role in the structure and organization of space and territories, which may vary according to the level of development. In the 19th century, the purpose of the emerging modern forms of transportation, mainly railways and maritime shipping, was to expand spatial coverage with the creation, expansion and consolidation of national markets.

  In the 20th century, the objective shifted to selecting itineraries, prioritizing transport modes, increasing the capacity of existing networks and responding to the mobility needs and this at a scale that was increasingly global, with its own space of flows. In the 21st century, transportation must cope with a globally oriented economic system in a timely and cost-effective way, but also with several local problems such as congestion and capacity constraints.

  The Importance of Transportation

  Transport represents one of the most important human activities worldwide as it allows to mitigate the constraint of geography. It is an indispensable component of the economy and plays a major role in supporting spatial relations between locations. Transport creates links between regions and economic activities, between people and the rest of the world and as such generates value. It is composed of core components, which are the **modes**, **infrastructures**, **networks,** and flows. These components are fundamental for transportation to take place, but they also underline that geography, in spite of significant technological, social and economic changes, remains a salient force shaping transportation.

  Transport is a multidimensional activity whose importance is:

- **Historical**. Transport modes have played different historical roles in the rise of civilizations (Egypt, Rome, and China), their trading networks, in the development of societies and in national defense. As such transportation offers a valuable perspective to understand historical processes at any scale; from a local to a nation.

- **Social**. Transport modes facilitate access to healthcare, welfare, and cultural events, thus performing a social service. They shape social interactions by favoring or inhibiting the mobility of people. Higher mobility implies the potential for extended social interactions. Transportation thus supports and may even shape social structures.
- **Political**. Governments play a critical role in transport as sources of transport investments and as regulators of transport operations. The political role of transportation is undeniable as governments often subsidize the mobility of their populations such as providing highways, and public transit. While most transport demand relates to economic imperatives, many transport infrastructures have been constructed for political reasons such as national accessibility or job creation. Transport thus has an impact on nation-building and national unity, but is also a tool shaping policy.
- Economic. The evolution of transport has been linked to economic development. It is an industry in its own rights such as car manufacturing, air transport companies or railways. The transport sector is also an economic factor in the production of goods and services. It contributes to the value-added of economic activities, facilitates economies of scale, influences land (real estate) value and the specialization of regions. Transport is both a factor shaping economic activities and is also shaped by them.
- Environmental. Despite the manifest advantages of transport, its environmental impacts are also significant. They include negative impacts on air and water quality, noise level and public health. All decisions relating to transport need to be evaluated considering the corresponding environmental costs and how they can be mitigated. Transport is, therefore, a dominant factor in contemporary environmental issues, including sustainability and climate change.

  Transportation as a multidisciplinary endeavor can be approached through several fields of inquiry where some are at the core of transport geography, such as transport demand, nodes, and networks, while others are more peripheral, such as natural resources, political geography, and regional geography. Yet, they all contribute to the understanding of transport activities and their impacts of the economy, society and the environment.
- World Main Road Network
- World Rail Network and Rail Systems

  Substantial empirical evidence underlines that the **importance of transportation is growing**, particularly in light of the following contemporary trends:

- Growth of the demand. The second half of the 20th century has seen a considerable growth of the transport demand related to individuals (passengers) as well as freight mobility. This growth is jointly the result of more passengers and freight being moved, but also the longer distances over which they are carried. Recent trends underline an ongoing process of mobility growth, which has led to the multiplication of the number of journeys involving a wide variety of modes that service transport demand.
- Reduction of costs. Even if several transportation modes are very expensive to own and operate, such as ships and planes, costs per unit transported have dropped significantly over the last decades. This is particularly the case for transportation services subject to competitive pressures. Lower transportation costs made it possible to overcome larger distances and further exploit the comparative advantages of space. As a result, despite the lower costs, the share of transport activities in the economy has remained relatively constant in time. More transportation services are used, but their costs are declining.
- Expansion of infrastructures. The above two trends have obviously extended the demand for transport infrastructures both quantitatively and qualitatively. Roads, rails, harbors, airports, telecommunication facilities, and pipelines have expanded considerably to service new areas and adding capacity to existing networks. Transportation infrastructures are thus a major component of the land use.

  Facing these contemporary trends, an important part of the **spatial differentiation** of the economy is related to where resources (raw materials, capital, people, information, etc.) are located and how well they can be distributed. Transport routes are established to distribute resources between places where they are abundant and places where they are scarce, but only if the costs are lower than the benefits. Consequently, transportation has an important role to play in the conditions that affect global, national and regional economies. It is a strategic infrastructure that is so embedded in the socio-economic life of individuals, institutions, and corporations that it is often invisible to the consumer, but always part of all economic and social functions. This is paradoxical since the perceived invisibility of transportation is derived from its **efficiency**. If transport is disrupted or ceases to operate, the consequences can be dramatic such as workers unable to reach their workplace or parts not being delivered to factories.

  Transportation in Geography

Features such as resources, populations, and economic activities are randomly distributed around the world; there is a logic, or and order, to spatial distribution. Geography seeks to understand the spatial order of things as well as their interactions, particularly when this spatial order is less evident. Transportation, being one element of this spatial order, is at the same time influenced by geography as well as having an influence on it. For instance, the path followed by a road is influenced by regional economic and physical attributes, but once constructed the same road will shape future regional developments.

Transportation is of relevance to geography for two main reasons. First, transport infrastructures, terminals, modes, and networks occupy an **important place in space** and constitute the basis of a **complex spatial system**. Second, since geography seeks to explain spatial relationships, transport networks are of specific interest because they are the **main physical support of these interactions**.

Transport geography, as a discipline, emerged as a branch of economic geography in the second half of the twentieth century. In earlier considerations, particularly from a commercial geography perspective (late 19th and early 20th century), transportation was an important factor behind spatial economic representations of space, namely in terms of the location of economic activities and the monetary costs of distance. These cost considerations became the foundation of several geographical theories such as central places and location analysis (see transportation and space). The growing mobility of passengers and freight justified the emergence of transport geography as a specialized and independent field of investigation.

In the 1960s, transport costs were formalized as key factors in location theories and transport geography began to rely increasingly on quantitative methods, particularly over a network and spatial interactions analysis. However, from the 1970s technical, political and economic changes challenged the centrality of transportation in many geographical and regional development investigations. The strong spatial anchoring effect of high transportation costs receded and decentralization was a dominant paradigm that was observed within cities (suburbanization), but also within regions. The spatial theory foundations of transport geography, particularly the friction of distance, became less relevant, or less evident, in explaining socioeconomic processes. As a result, transportation became underrepresented in economic geography in the 1970s and 1980s, even if the mobility of people and freight and low transport costs were considered as important factors behind the globalization of trade and production.

Since the 1990s, transport geography has received renewed attention with new realms of investigation. The issues of mobility, production, and distribution became interrelated in a complex geographical setting where the local, regional and global became increasingly blurred through the development of new passengers and freight transport systems. For instance, suburbanization resulted in an array of challenges related to congestion and automobile dependency. Rapid urbanization in developing economies underlined the challenges of transport infrastructure investment for private as well as collective uses. Globalization supported the development of complex air and maritime transportation networks, many of which supporting global supply chains and trade relations across long distances. The role of information and communication technologies was also being felt, often as a support or as an alternative to mobility. More importantly, the rise of e-commerce is changing the retailing and distribution landscape with the growth of home deliveries. All the above were linked with **new and expanded mobilities** of passengers and freight.

Transportation Systems

A "new transport geography" is based on the premise that transportation is a system supporting complex relationships articulated by three central concepts:

- **Transportation nodes**. Transportation primarily links locations, often characterized as nodes. They serve as access points to a distribution system or as intermediary locations within a transport network. This function is mainly serviced by transport terminals where flows originate, end or are being transshipped from one mode to the other. Transport geography must consider its places of convergence and transshipment.
- Transportation networks. It considers the spatial structure and organization of transport infrastructures and terminals. Transport geography must include in its investigation the structures (routes and infrastructures) supporting and shaping movements.
- **Transportation demand**. It considers the demand for transport services as well as the modes used to support movements. Once this demand is realized, it becomes an interaction that flows through a transport network. Transport geography must evaluate the factors affecting its derived demand function.

The analysis of these concepts within transport geography relies on **methodologies** often developed by other disciplines such as economics, mathematics, planning, and demography. For instance, the spatial structure of transportation networks can be analyzed with graph theory,

which was initially developed for mathematics. Further, many models developed for the analysis of movements, such as the gravity model, were borrowed from physical sciences. **Multidisciplinarity** is consequently an important attribute of transport geography, as in geography in general, as each discipline provides a different dimension to transport geography. Transport geography must be systematic as one element of the transport system is linked with numerous others; transport systems are complex systems.

- The Transport System
- Dimensions of Transport Geography
- Complex Systems and Transportation
- Common Fallacies in Transport Geography
- Common Challenges for Transport Systems

The role of transport geography is to understand the spatial relations that are produced by transport systems. This can give rise to several fallacies about transportation in terms of the respective relations between access, accessibility, distance and time. A better understanding of spatial relations is essential to assist private and public actors involved in transportation mitigating key transport problems, such as capacity limits, transfer between different systems, the reliability of mobility and the integration of transport systems. There are three basic geographical considerations relevant to transport systems:

- **Location**. As all activities are located somewhere, each location has its own characteristics conferring a potential supply and demand for resources, products, services or labor. A location will determine the nature, the origin, the destination, the distance and even the possibility of a movement to be realized. For instance, a city provides employment in various sectors of activity in addition to consume resources.
- **Complementarity**. Some locations have a surplus of labor, resources, parts or final goods while others have a deficit. The only way an equilibrium can be reached is by movements between locations having supply (or a surplus) and locations having demands. For instance, a complementarity is created between a store (supply of goods) and its customers (demand for goods).
- **Scale**. Movements generated by complementarity are occurring at different scales, pending the nature of the activity. Scale illustrates how transportation systems are established over local, regional and global geographies. For instance, home-to-work journeys generally have a local or

regional scale, while the distribution network of a multinational corporation is most likely to cover several regions of the world.

Consequently, transport systems consume land, support the relationships between locations at a scale that is increasingly global. Over this, transport geography provides a multidisciplinary perspective to understand the complexity of transportation and how space supports and hinders mobility.

5. Prospects for Transport Geography

Transport geography played a relatively small role in the field of transport studies, a field that has been dominated by engineers and economists. This was due in part to the needs of the industry is focused on providing infrastructures and technologies, at what cost and benefits and at what level of pricing. The contemporary industry is much more complex, with issues as varied as safety, aesthetics, working conditions, the environment, and governance being necessary considerations. A much broader set of skills is required therefore, and **transport studies have become a multi-disciplinary field of application**. Transport geography thus has opportunities to contribute to transport studies, transport planning, and transport operations, in part because of the breadth of the approach and training. Still, transport geography, like the field of transportation in general, does not receive a level of attention in academia proportional to its economic and social importance.

It is also fundamental to underline that **transport is a spatial activity**. It has always been a space adjusting service, but over the last few decades, it has become increasingly global. Contemporary transport operates at a wider range of scales than ever before, from local home deliveries to global air transport networks. Further, there are complex interactions between the local and the global. For example, the issues surrounding the expansion of an airport are usually decided at the local level, and the impacts are likely to be felt locally, namely its externalities such as noise and congestion. However, the effects on passenger and freight flows may have a global impact. The spatiality of transport and the many scales at which it operates are elements that are of concern to transport geography. No other discipline has as its core interest the role of space in shaping human activities. The globalization of transport activities thus has represented unique opportunities in the development of transport geography.

One reason for the success of engineers and economists in transport studies and applications is that their training has been rigorous in the application of mathematics and multivariate statistics.

They have demonstrated the ability to provide precise answers to the questions that decision-makers have required – what to build, at what cost, with what cost effects. This underlines a dominant perspective in the transport industry that unless a process can be quantified it is of little value. Transport geography provides **quantitative skills** in modeling, graph theory, and multivariate statistics. However, there are newer techniques that provide geographers with opportunities to contribute to transport studies. Geographic Information Systems for Transportation (**GIS-T**), is becoming an essential element in transport geography education and research. The multi-scalar, multivariate nature of the transport industry makes GIS-T an invaluable tool and one that is raising the profile of transport geography in the transportation industry.

One of the key challenges in transport studies is **data availability**. Many times, census and survey data are inadequate or unavailable in the form required. However, the online availability of large datasets is increasing offering a richer array of information to analyze transport issues. New opportunities also arise from what came to be known as "big data", where a large amount of digital information is made available at a low cost through mobile devices, sensors, remote sensing, and RFID. Mobility can now be observed at an unprecedented scale and level of detail, where passengers, vehicles, and cargo can be tracked.

Knowledge of survey techniques and their limitations are also an important part of the transport geography toolkit. In spite of the appeal of information technologies, many of the traditional tools and approaches are still relevant. They allow addressing problems that are frequently overlooked by other disciplines because of the lack of data or the inability to spatially represent this data. Questionnaires and interviews represent a vital source of information in many situations. Content analysis is extremely useful in providing quantified data from non-quantified sources. At the same time, fieldwork provides the opportunity to obtain a detailed understanding of the particularities of the local conditions that cannot be obtained otherwise. Data, methods, and models are no palliative to common sense, which remains a constant challenge when the approach is more focused on the tools than the reality in which transportation is evolving. The following chapters are going to focus on the numerous dimensions of this reality, beginning with the relationship between transportation and space.