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Recurring and Non-Recurring Congestion: Causes, Impacts, and Solutions

Abstract

A discussion of the causes and impacts of recurring and non-recurring congestion accompanied with a review of potential solutions and existing examples. While congestion is a broad and subjective matter, research focused on the separate causes of recurring congestion – mainly capacity and behavioral issues – and non-recurring congestion – mainly incidents which cause unexpected congestion and the impacts of general congestion on the economy, environment, and commuters. Sources reviewed include The Transportation Research Board Special Report: *Implementing the Results of the Second Strategic Highway Research Program: Saving Lives, Reducing Congestion, Improving Quality of Life,* Peter R. Stopher's article "Reducing Road Congestion: a Reality Check," Balaker and Staley's *The Road More Traveled: Why the Congestion Crisis Matters More than You Think and What We Can Do About It,* and Anthony Down's *Still Stuck In Traffic: Coping with Peak-Hour Traffic Congestion.*

Introduction

The United States' society and economy largely relies on the highway system for commuting to and from work, transporting goods and services, and connecting residents with services, businesses, and entertainment. However, congestion often prevents the system from operating in an efficient manner. Whether it be recurring congestion – known to many as "rush-hour" traffic – or non-recurring congestion due to accidents, construction, or emergencies, congestion is a problem which many Americans simply deal with or try to avoid and which many cities try to alleviate. Cincinnati is no exception when it comes to congestion. In fact, congestion may be the axis around which the other problems of I-75 and I-71 corridors revolve. With a growing attention on the economy and the environment, there seems to be a stalemate between simply widening roadways to patch congestion issues temporarily and alternate methods to pull drivers off of overcrowded highway systems. Alternative modes of transportation are on the horizon in Cincinnati, but will they draw enough commuters off of the highway system to make a noticeable difference in terms of congestion? Will a widened I-75 become congested once again if not coupled with another method to relieve congestion? Would a technology based system be effective locally? To understand and recommend possible solution, the problem must be analyzed and understood. In order to understand recurring and non-recurring congestion, I will analyze them as having separate causes, yet having similar impacts.

Recurring congestion is often seen as a capacity problem and is logically combated with raising roadway capacity. However in times which seem to be honing in on sustainable solutions, increasing roadway capacity does not seem to be the best choice socially, environmentally, or economically. The goal of researching recurring congestion is to explore its main causes in order to recommend more sustainable solutions as alternatives to widening roadways.

Non-recurring congestion occurs due to construction, inclement weather, accidents, and special events. Although recurring congestion is often times to focus of roadway improvements, non-recurring congestion is still very common, inefficient, and dangerous. Through researching non-recurring congestion I hope to understand its causes and to find solutions and preparedness plans which would complement solutions to recurring congestion and efficiently alleviate non-recurring congestion.

In researching these two types of congestion, I hope to assess their impacts and find solutions which directly address their causes. Many solutions will be needed to fully address congestion since individual practices may fall short in some areas. It would only make sense that since congestion is a multi-faceted issue, the solution would have to be multi-faceted as well.

Recurring Congestion - Causes

Many metropolitan residents and commuters experience recurring congestion on a daily basis. The morning and evening commutes to appointments and employment turns highways and major roads into grid locks. Put into simple terminology, congestion occurs when the volume of traffic exceeds the roadway capacity. Author Anthony Downs details many of the behavioral and societal patterns which cause recurring congestion in his book *Still Stuck in Traffic: Coping with Peak-Hour Traffic Congestion*, which was published in 2004. The book focuses on the causes of recurring congestion in its fourth chapter: "Causes of Recent Increases in Peak-Hour Congestion."

Peak-hour or "rush-hour" congestion occurs between 6 a.m. and 9 a.m. and again between 4 p.m. and 7 p.m. In the book *Still Stuck in Traffic: Coping with Peak-Hour Traffic Congestion* Anthony Downs estimates that over forty percent of all weekday trips occurred during peak-hour travel times in 1995 (Table 4-1). Downs also estimates that in 2000, 66.4 percent of those who work outside their homes leave for work between 6:00 a.m. and 9:00 a.m. While this study may be slightly outdated, the numbers still generally apply to present day congestion in the sense that the majority of work related trips occur during peak-hour travel times, as well as a reasonably high percentage of all trips in general. The reasons why people travel in these time frames may vary on a case by case basis, but it is seemingly obvious that a major cause of the peak-hour traffic is because many employers require employees to start between 8 a.m. and 9 a.m., with the work day ending between 4 p.m. and 5 p.m. However, peak-hour travel is reinforced by other human tendencies as well, including school schedules and sleep patterns.

TABLE 4-1. Weekday Trips

	Percent of all trips during EACH of two major peak periods		*Percent of all trips taken during the entire weekday*				
Type of trip	*6 a.m. to 9 a.m.*	*4 p.m. to 7 p.m.*	*6 a.m. to 9 a.m.*	*4 p.m. to 7 p.m.*	*Both peak periods*	*All other times*	*Total*
To and from work	45.5	49.0	7.75	11.33	19.08	26.88	45.96
To work	37.7	3.1	6.43	0.73	7.16	6.19	13.35
From work	7.8	45.9	1.32	10.60	11.92	20.69	32.61
Other business trips	3.8	1.8	0.65	0.41	1.06	2.44	3.50
All work-related trips	49.3	50.8	8.40	11.74	20.14	29.32	49.46
All non-work-related trips	50.7	49.2	8.67	11.37	20.04	30.48	50.52
All trips in this period	100.0	100.0	17.08	23.12	40.20	59.80	100.00

Source: Federal Highway Administration, *1995 NPTS Data Book*, chap. 6, "Journey to Work," table 6-17, p. 6-30.

Since peak-hour travel congestion is fueled in a major way by human behavior and workplace and school schedules, it is logical to infer that in periods of economic growth or population growth congestion will continue to increase due to the increase in jobs to which employees must travel and the increase of volume due to a growing population. Although the difference may not be noticeable on a national level, congestion will increase in direct relationship with the population or the economy in regions in which rapid growth or large increases occur. In regions experiencing decline in either of these areas may see slight relief in peak-hour congestion, but still traffic will not flow freely unless the volume of traffic on the roadway is below the roadway capacity.

As economies grow, technology will continue to advance which will contribute to automobiles lower in both initial and lifetime cost. Downs argues that as household income rises, the desire to travel in comfortably and efficiently rises (43). This argument is true, but as technology continues to advance and it becomes less costly to own a vehicle, personal desires to own a vehicle and to travel comfortably and efficiently can still rise even while household incomes begin to decrease or hold even. Therefore, even if a region's population is declining or economy is slowing, traffic congestion may still increase due to more vehicles per household. Generally, as long as income allows, Americans tend to feel that "the commuter who drives alone enjoys not only greater privacy and comfort and shorter travel times but also more convenient and flexible timing, the ability to combine several activities on a single trip, and lower day-to-day cash outlays" (Downs 43) which makes carpooling and public transit less attractive. In economic terms, drivers see the net benefits of solo drivers to exceed the net benefits of carpooling, and therefore see the need to own personal vehicles.

Another behavioral cause of congestion is societal settlement patterns. Most of the United States' Metropolitan residential areas are low density and spatially detached, making public transit designed to cater to high densities – such as buses, light rail, and heavy rail -

inefficient and economically unfeasible. Downs cites a study done by Boris S. Pushkarev and Jeffrey M. Zupan for their publication, *Public Transportation and Land Use Policy*, which concluded that "buses need residential densities of 4,200 persons per square mile to be efficient, and fixed rail requires higher densities" (52). Many residents who live in lower density suburbs and commute to work would not have the option of using public transportation. However, this

TABLE 4-4. Vehicle Ownership per Household
Percent of households unless noted otherwise

	Vehicles per household				
Year	*None*	*One*	*Two*	*Three or more*	*Total number of vehicles*
1960	21.53	56.94	19.00	2.53	54,766,718
1970	17.47	47.71	29.32	5.51	79,002,052
1980	12.92	35.53	34.02	17.52	129,747,911
1990	11.53	33.74	37.35	17.33	152,380,479
2000	9.35	33.79	38.55	18.31	179,417,526

Source: U.S. Department of Energy, *Energy Data Book: Edition 22*, Chapter 11, "Household Vehicles and Characteristics," table 11.4, "Household Vehicle Ownership" (www-cta.ornl.gov/cta/data/Chapter11.html).

lower density settlement is also favored by many types of office parks, shopping centers, and industrial buildings. Regulations often require such facilities to be low-rise buildings with low floor area ratios. These regulations cause such businesses and industries to be spread throughout metropolitan areas. Figure 4-4 shows the distribution of job growth by region between the Metropolitan Statistical Areas (MSAs), cities, and suburbs. Although the data behind the graphic is dated, it captures the trend of employers spreading away from the downtown areas and into the suburbs – or lower density, residential development. This spread makes it more difficult to service the population with an efficient public transit system and adds to congestion by changing commuting patterns. To give a local example, residents in Cincinnati can easily use the bus system quickly and efficiently if traveling from a neighborhood like Clifton to the Central Business District, however it would be difficult and time consuming to travel from Clifton to an out-lying and growing area such as West Chester. The transit system in Cincinnati is designed to feed from the neighborhoods into the Central Business District so the system becomes inefficient to many employees who have to travel away from the Central Business District for their daily commute.

Established transit systems like the Cincinnati bus system are not the only modes of transportation which become inefficient once employment centers locate outside of the downtown areas. Many highway systems in metropolitan areas are designed to either bring traffic through the downtown areas or to by-pass the downtown areas. In many systems, the by-pass highways are built to accommodate a lower capacity than the through routes. However, when more employers locate in lower density residential areas which tend to be towards the outer edges of metropolitan areas as opposed to the downtown, more traffic will begin to travel on by-pass routes and main roads to access out-lying employment centers and these routes will quickly become congested.

To complement Downs' explanation of the causes of congestion, Peter R. Stopher defines two prevalent causes of recurring congestion: excessive demand and bottlenecks. The problem of excessive demand has been broken down and analyzed through Downs' research, but bottlenecks are best explained by Stopher in the article "Reducing Road Congestion: a Reality Check." According to Stopher, a bottleneck may be defined as "a location where the capacity of a facility is suddenly reduced" (119). This may occur when a five lane highway is suddenly reduced to three lanes as the left land ends and the right lane is forced to exit, or when a structure, such as a bridge or the built environment, restrict the width of the highway. While a cause of congestion, Stopher also mentions that bottlenecks may often be useful for regulating traffic and removing a bottleneck may only cause other bottlenecks further down the road.

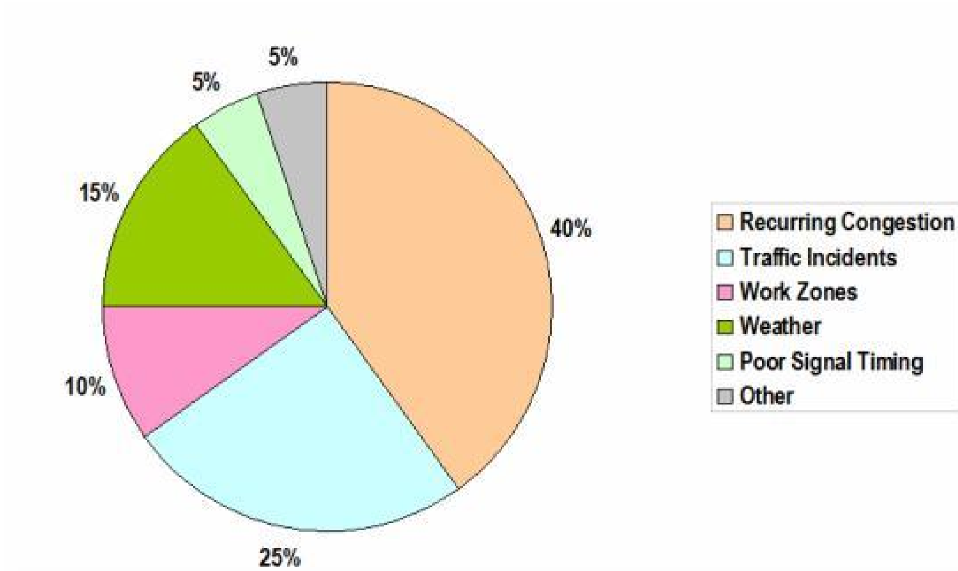
Anthony Downs summarizes the causes of recurring congestion with an emphasis on the impact of societal and personal behavior on congestion. Many factors feed into congestion including economic and population growth, synchronized work and school schedules, the shift of population to lower density areas of the city, inefficient transit systems, and the relocation of businesses from downtown areas to out-lying areas.

Non-Recurring Congestion – Causes

Unlike recurring congestion, non-recurring congestion is usually unexpected. In its 2007 *Congestion Management Process Technical Report* the Miami Valley Regional Planning Commission (MVRPC) of Ohio discusses the causes of non-recurring congestion as part of its congestion mitigation planning process. The Maricopa Association of Governments (MAG) of Arizona also discusses the causes of non-recurring congestion in preparation for a regional Non-Recurring Congestion Study. Both sources will be analyzed to help ensure a comprehensive list of non-recurring congestion causes. However, due to the nature of non-recurring congestion, the explanation of each cause will not be as necessary as for recurring congestion.

The Maricopa Association of Governments defines non-recurring congestion as the "unexpected traffic delays caused primarily by crashes and incidents, vehicle breakdowns, road construction activities, special events, extreme weather events, etc" (1). Non-recurring congestion is caused by any number of unexpected events which slow traffic. Non-recurring congestion is not as abstract as recurring congestion and therefore has more straightforward causes. In addition to the Maricopa Association of Governments' list of non-recurring congestion, the Miami Valley Regional Planning Commission lists roadway debris, disabled vehicles, law enforcement activities, heavy merging traffic, and sudden increases in traffic volume as major causes of non-recurring congestion. Any of these events of the combination of these events can cause free-flowing traffic to suddenly slow, causing congestion.

While recurring congestion is normally the focus of capacity improvements, the below graph shows that congestion is almost equally caused by non-recurring events as it is by recurring events. Therefore, if recurring congestion is solved, much of the existing congestion will remain due to non-recurring events. To find solutions to recurring congestion, public entities must focus on adopting emergency preparedness plans and assessing the efficiency of its emergency mitigation systems and traffic detours.



http://people.hofstra.edu/geotrans/eng/ch6en/conc6en/img/congestioncausesusa.png

Congestion – Impacts

Recurring and non-recurring congestion impact the economy, the efficiency of roadways, and drivers and commuters. To assess the impacts of congestion, I reviewed two main sources: Peter R. Stopher's article "Reducing Road Congestion: a Reality Check" and The Transportation Research Board's report *Implementing the Results of the Second Strategic Highway Research Program: Saving Lives, Reducing Congestion, Improving Quality of Life.* Stopher's article focuses on the impacts of congestion on accessibility, the environment, and personal time while the Transportation Research Board presents statistics which show the impacts of congestion on the economy, therefore the two sources together provide a rather well-rounded assortment of impacts. When beginning my research, I set out to assess the impacts of recurring and non-recurring congestion individually. However, as my research progressed I found that the difference in the two types of congestion rests within the causes and that the impacts remain relatively consistent between the two.

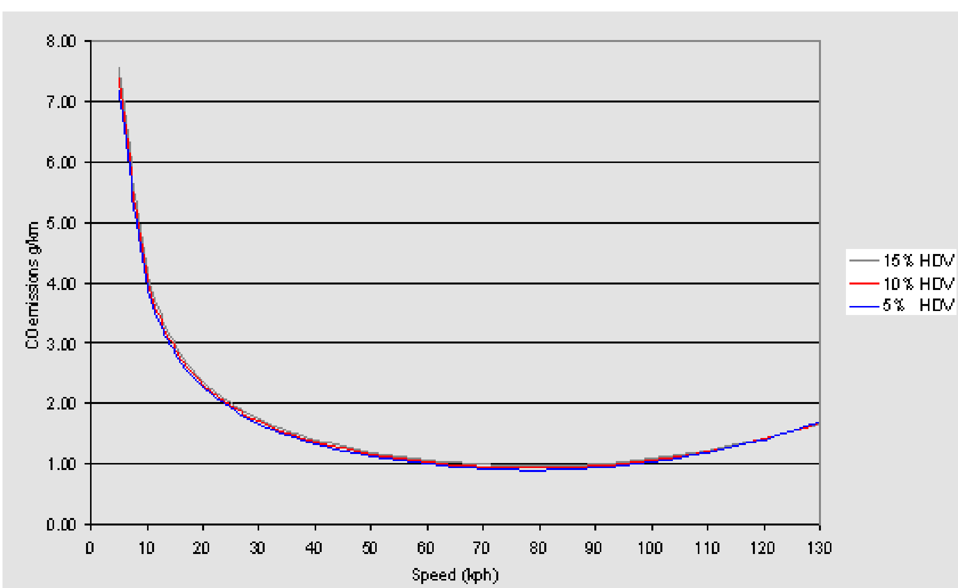
Peter R. Stopher cites three main impacts of congestion: unstable traveling conditions, increase in vehicle emissions, and wasted personal time. It can be said that congestion produces unstable traveling conditions because traffic may still flow well at reduced speeds, but the flow can easily break down and back up, which produces unstable and unreliable travel times.

Congestion also impacts accessibility and mobility. Stopher draws attention to the differences between the two through the following spatial comparison:

> *If a person lives in an area where there are many possible destinations close by, accessibility may be very high, even though mobility might be constrained, as in a CBD. On the other hand, if a person lives in a relatively remote area, accessibility may be poor because considerable travel time and cost is required to reach any destination, although mobility may be high.*
> *…Mobility is measured as a generalized cost of travel (time plus money) per [mile]; accessibility is measured as the generalized cost of travel per destination (121).*

Stopher uses this example and explanation to convey that accessibility is related to and measured per destination, while mobility is related to and measured by distance traveled. Therefore, increases in highway system capacity will lead to increases in mobility, at least in the short term because it will allow more drivers to travel more miles in less time. However, accessibility relates to destination and therefore would not benefit from capacity increases, but rather from attention to land use patterns and to the qualities and locations of destinations.

An obvious impact of congestion is the negative impact on the environment. The graph below, obtained from the United Kingdom Highway Agency, shows the relation between carbon monoxide emissions and speed. While the graph features an axis labeled kilometers per hour, it still applies to the United States when mentioned that one kilometer is equivalent to approximately .62 miles. It can be seen that at 10 kilometers per hour (6.2 miles per hour), emissions are much higher than at 120 kilometers per hour (74.56 miles per hour). The environmental impacts of congestion would most likely need to be addressed not only by sustainable congestion solutions but also through improved technology in the automobile and fuel industries.



http://www.highways.gov.uk/knowledge/images/rename3.gif

One of the more immediately obvious impacts of congestion is also one of the main reasons why drivers dislike congestion: congestion wastes personal time. The actual economic value of this time could be debated over. Stopher presents the two sides of this hypothetical argument: on one hand, it can be argued that time spent outside of work hours does not contribute to the Gross Domestic Product (GDP) of the nation and therefore has no impact on the national economy. However, it can also be argued that the stress and emotions triggered by traffic congestion can be carried through work hours and reduce employee productivity, therefore negatively impacting the GDP (Stopher 121). If comparing recurring to non-recurring congestion, it could be argued that the time lost in non-recurring congestion has more value than the time lost in recurring congestion since drivers expect delays at specific times in the later. Since non-recurring congestion can occur at any time of the day, the time lost can negatively impact the economy depending on the day of the week, the cause of the congestion, the time of day, and the destination of the travelers.

While discussing the impacts of congestion, Stopher poses the argument that reducing congestion can encourage sprawl (121). While reducing congestion allows easier travel, this argument seems to be more cyclical and it would be difficult to determine if sprawl is a contributor to congestion or if congestion is a contributor to sprawl. The argument could be debated either way. In the midst of this topic, Stopher does make a very sound point:

> *Thus, one could consider that appropriate management of congestion is an important tool in shaping the urban area, and that responses to congestion should take into account the wider system effects, rather than a narrow view of relieving congestion in a specific location (121).*

Often time's congestion is approached by location and not seen as a system-wide phenomenon. In applying solutions to congestion, there is opportunity further control the urban shape and the sprawl of metropolitan areas. Stopher's aforementioned quote raises a question about what the goal of relieving congestion should be: should relieving congestion allow easier access from the metropolitan fringe into the city, or should relieving congestion allow easier connectivity within the metropolitan area? If the goal of relieving congestion is to allow easier access from the fringe to the city, sprawl is inherently encouraged - or at least supported – as it becomes less time consuming to travel from far suburbs to downtowns. However, if the goal of relieving congestion is to encourage greater connectivity within the metropolitan area – whether it be from the suburbs to the downtown or from one neighborhood to the next – commuters may be further encouraged to stay within the close suburbs, move into a different established neighborhood due to increased connectivity, or even redevelop neighborhoods which were previously disconnected.

While Stopher provides more subjective ideas on the impacts of congestion, the Transportation Research Board of the National Academies provides statistics to show and support the economic impacts of congestion in the special report *Implementing the Results of the Second Strategic Highway Research Program: Saving Lives, Reducing Congestion, Improving Quality of Life.* In the Transportation Research Board's report, it is argued that the national highway system carries roughly sixty-five percent of the nation's freight traffic and eighty-eight percent of all noncommercial personal travel, making it the backbone of the United States' economy (1). Since such large percentages depend on the highway system for transportation and business, it is logical to assume that congestion negatively impacts the businesses and travel depending on efficient flow. The Transportation Research Board argues:

> *In 2005, congestion cost travelers more than 4.2 billion hours and nearly $80 billion and resulted in the waste of approximately 3 billion gallons of fuel (2).*

The Transportation Research Board presents data to support the negative impact of congestion on the economy. While Stopher presents the debate of whether or not personal time lost as a result of congestion effects the GDP, the Transportation Research Board emphasizes the amount freight relies on efficient highways. The time lost in congestion while transporting freight does negatively impact the GDP since more loads of freight could be delivered with free flow traffic. Along the same lines, congestion negatively impacts businesses and employees delivering goods and services because it increases travel time and fuel costs.

The Transportation Research Board cites predicted future growth as an impact on congestion, rather than an impact of congestion. According to the report:

> *By 2030, the U.S. population is expected to grow by 24 percent, VMT by 60 percent, and truck VMT by 75 percent; truckloads are predicted to increase by 80 percent, to nearly 23 billion tons, by 2035.*

With growth in both population and vehicle miles traveled (VMT); congestion would dramatically worsen if the highway systems remained as they exist today. With such high increases in VMT and truck freight predicted, it reinforces my earlier assertion that highway capacity increases via widened roadways are not sustainable. If the highways need to be widened in the present, subsequent widening will need to occur as population and VMT increase. In a metropolitan area like Cincinnati, the built environment would only allow widening to a certain extent before the built environment is infringed on or overpowered by the highway. Therefore, solutions which either reduce VMT or hold VMT steady while population increases need to be explored.

Solutions

Since the causes of recurring and non-recurring congestion encompass a variety of facets from accidents to economics, various solutions will need to be explored to noticeably and sustainably reduce congestion. In the book *The Road More Traveled: Why the Congestion Crisis*

Matters More Than You Think by Ted Balaker and Sam Staley, various solutions are outlined and discussed. Balaker and Staley support their suggestions with examples from various countries.

As mentioned earlier, most travelers assume that widening roadways will cure their congestion woes. In general, improving infrastructure is usually looked at to ease congestion and allow free flowing traffic during peak hours. However, Balaker and Staley use Chicago as an example of exactly how costly this process would be. The authors cite University of North Carolina-Charlotte professor David Hartgen for estimating that the necessary infrastructure improvements needed to bring Chicago's infrastructure up to capacity – that is, the volume of traffic that currently encounters gridlock on the roadways would be able to flow freely – would entail $54 billion (Balaker et al. 105). Hartgen also estimates that to bring all of metropolitan America's congestion to acceptable capacity levels would cost approximately $750 billion, while "these investments are inescapable, how we achieve them is not" (Balaker et al 106).

The first alternate solution offered is privatizing toll roads and major infrastructure investments. The first example alluded to by Balaker and Staley is London Heathrow Terminal 5. In many of the framework plans discussed this quarter; multi-modal transportation hubs were included or alluded to in some way. London Heathrow Terminal 5 is a prime example of a multi-modal transportation hub. From the airport, London can be accessed by car, rapid transit, bus, and rail with interchanges from the same terminal. The interesting thing about Terminal 5 is that it is a private project (Balaker et al 103). The theme of privatization does not stop with Terminal 5 as Balaker and Staley move on to use Paris, France as their next example. Paris features a loop bypass highway much like I-275 in Cincinnati and more than seventy percent of Paris's population lives outside of the loop in what would be equivalent to American suburbs. In dense suburbs, sixty-three percent of Parisians commute to work using the bus or train, while in less-dense suburbs almost half commute by car (Balaker et al 109). Much like America, the demand for roads and private vehicles rises with income levels. In order to keep up with the demand and ensure the quality of infrastructure, France pioneered long-term concessions to finance new road infrastructure through tolls. The company responsible for the upkeep of the roadways, VINCI, makes most of its profit from its construction and engineering services, but the trend of running public infrastructure using toll revenue has been rapidly growing (Balaker et al 110). In 2006, France had almost five thousand miles of roads under concession – or private operation and financing through tolls – and various companies hold the rights to sections of the roadway. Most of the European toll systems utilize technology so cars do not stop and back up in order to pay tolls. Tolls can now be paid through billing – by taking an image of a license plate and sending a bill to the registered address – or through a transponder tracking miles (Balaker et al 111). Like toll roads in the United States, these roads are less congested due to the out of pocket cost to the drivers. Like France's example, many other European countries are privatizing infrastructure, and in the process alleviating congestion.

The authors then jump "state-side" and discuss Houston, Texas' plan to battle congestion. In the past, Houston combated congestion by adding lanes, upgrading coordination quality of traffic signals, metering highway access, and reconfiguring access from feeder roads (Balaker et al 127). However, when the construction of new lanes slowed and the population continued to increase, congestion continued to worsen. Houston's current plan includes a mixture of congestion remedies including: increasing highway lane miles by up to seventy-eight percent, increasing arterial lane miles by 68 percent, improving traffic flow at over three thousand intersections, using Geographic Information Systems to monitor crash patterns and expedite accident removal, mitigating over three hundred crash hot spots, and converting toll roads to variable rate pricing (Balaker et al 131). The Houston example addresses congestion on and off highway systems as well as both recurring and non-recurring congestion. Yes, capacity is increased by widening or adding miles to roadways, but this is coupled with tactics to provide more efficient accident removal and congestion pricing through variable rate roads. Variable rate roads would charge higher tolls when traffic flow is heavy so that fewer drivers would want to take the route and traffic flow will decrease. When the flow is light, the toll is less or nonexistent since congestion is not an issue. Therefore, when roads are congested, drivers who value their time or who can afford to pay to move faster can choose to take the toll road and travel at a closer to free flow pace. The drivers on the non-toll roads are still benefiting since every time a car moves to the toll road, the overall volume of the highway decreases and traffic moves more freely. The variable rate lanes in Houston are well planned. There are plans in place for multiple lanes to follow I-10, a major interstate in Houston, to allow for variable rate options is drivers would want to pay the toll, and also to allow for transit options that would flow generally in the same route as commuters are already heading (Balaker et al 135). One aspect that makes Houston's plan unique is the statewide support for congestion relief. The Texas Metropolitan Mobility Plan is a result of Houston's plans for a success with reducing congestion. Having statewide support not only makes the process flow smoothly, but it also helps to ensure that congestion issues are not just pushed away to another metropolitan area.

Balaker and Staley point out the lack of innovation and improvement on roadways by asking one to "consider the improvements made to the cars we drive in versus the roads we drive on" (140). While the authors use the comparison at a fifty year range, the difference is obvious even on a yearly basis. Car models are updated yearly to please the consumer looking for the next new gadget – whether it be reverse cameras, built in GPS systems, heated seats. Compare one section of the highway with a year lapsed in between and there may be little difference. The roadway conditions may even get worse. Innovation has shown in the 91 Express Lanes of Orange County, California. Where a ten mile long section of the median once was, express lanes now exist – similar to many express lanes found in Ohio. However, these express lanes are tolled and run by a private company. Privatization is not the only aspect that makes the express lanes flow at or above speed limits while I-91 sits still. The company, CPTC, manages the express lanes with customer service at heart. Crews sit along the lanes in case of accident or vehicle breakdown so the incident can be quickly taken care of and customers can get the extra speed they pay for (Balaker et al 141). Those against congestion pricing say it favors the upper class and makes the disadvantaged worse off. However, with a model seen on the 91 Express

Lanes, avoiding congestion is a luxury. No one would argue that it is unfair when a wealthy person buys the newest model of a car while the more disadvantaged person shops at the used car lot since the newer car is a luxury. These lanes can be viewed the same way.

As mentioned earlier, congestion relief should be viewed more as a way to shape the urban form. Congestion in each metropolitan area is caused by different factors and different travel patterns. Instead of just widening roadways where congestion occurs, transportation planners should step back and look at the bigger picture. Maybe the problem is not the capacity of the roadway, but rather lack of efficient public transportation. In this case, routes may have to be redistributed to make cross city commutes as easy as commutes into the city. Congestion is not one hundred percent contributed to capacity issues. If located in a city where many employers are moving closer to the suburbs, it may be an issue of changing shape and commuter patterns. Balaker and Staley close their book by presenting ten steps to congestion relief. As summarized and paraphrased, they are as follows (168):

1. Admit that mobility is good. Recognize congestion is bad. Road building and upkeep in the United States has not kept up with economic and population growth. While expanding roadways will not by itself solve congestion, physical capacity has to keep pace with this growth.
2. Recognize that sound transportation policy should increase mobility. Focus on building road systems and transportation networks that provide maximum mobility and mesh with preferred and existing lifestyles.
3. Recognize that there is no free lunch. Congestion pricing flows from this principle. When we don't pay for the full cost of what we consume, we use more of it. Commuters too often view roads as free. Fees and congestion pricing force commuters to think about their travel choices and adjust accordingly.
4. Choose tools that make sense. Each area is different and has different problems. In Cincinnati, it may be the close proximity of the universities and hospitals. While being in close proximity may help with efficiency of research, appointments, and scheduling, it congests many arterials in the Uptown area and makes parking difficult. Maybe variable rate parking meters would reduce the demand for parking and ease congestion. Different tools are right for different cities.
5. Identify leaders and champions. Front the battle against congestion with a leader who will get community support. No plan will move forward quickly if the opposition is too strong.
6. Enable real solutions. Make sure the right legislation is in place at the state and local level to ensure or encourage creativity and innovation. "A good rule of thumb should be that new services should be allowed if they make money when users pay for them" (Balaker et al 173). If a new transit service could profit from a niche of employees wanting to travel from Mason into the Uptown area, it should be allowed to do so.
7. Cut off ineffective programs. Transit investments need to focus on maximizing mobility for those dependent on transit.

8. Adopt performance measures. Performance measures make it easier to maintain transparency. In the Texas example, the state adopted standards to measure hours of delay and travel time. These became important benchmarks for evaluating projects across the state.
9. Require accountability. Building institutional accountability will help ensure that congestion relief is an ongoing focus of public policy efforts. Accountability requires targets, goals, and implementation projects and strategies to help achieve the targets and goals.
10. Take the long view. Develop long term mobility plans and implementation strategies which involve public education, reachable benchmarks, and marketing to move the projects forward.

Balaker and Staley present these ten steps to help ensure that congestion plans address the needs of the area in which they are proposed for. Many other sources reviewed for this research – such as Beck and Posner's *Uncommon Sense,* Partnership for New York City's *Growth or Gridlock,* and Peter R. Stopher's article "Reducing Road Congestion: a Reality Check" – agreed with Balaker and Staley and reiterated the importance of many key aspects of their solution suggestions, especially privatization of highways where possible and variable toll roads. While these solutions would most likely be met with initial rejection since not many people appreciate more out of pocket costs for daily activities, public education and worsening congestion in the mean time may make the solutions more acceptable in the present.

Conclusion

Congestion is an issue in many American cities. Whether it be recurring congestion dealt with during peak commuting hours, or non-recurring congestion from an accident or special event, congestion causes traffic to flow at a reduced pace. Many aspects of congestion are broad and subjective. This research mainly focused on the general causes, impacts, and solutions of congestion. Recurring Congestion is mainly caused by the high demand to travel at specific hours of the day, which can further be attributed to the demand for common work schedules, school schedules, and business hours. Non-recurring congestion has less complex causes but can be just as prevalent as recurring congestion. Non-recurring congestion is mainly caused by construction, accidents, broken down vehicles, debris on the roadway, and other incidents which temporarily and abruptly disrupt the normal flow of traffic. While recurring congestion is generally the focus of many roadway improvements, congestion is almost equally caused by non-recurring incidents as it is by peak-hour travel volume.

While the causes of recurring and non-recurring congestion are different, the impacts are generally similar. Congestion reduces economic efficiency in America since freight economies greatly rely on efficient travel between destinations. Congestion also negatively impacts the environment due to increase emissions when traveling at greatly reduced speeds. There is little argument against saying that congestion increases travel time. However, it is debatable whether or not the time wasted has actual economic value. Of course, a business which delivers a good or service would be greatly set back by congestion, but many commuters calculate peak-hour congestion into their normal travel time.

There is an array of solutions available to relieve congestion. Raising roadway capacity will only work as long as the growth in capacity can match the growth of volume caused by growing populations or economies. Many roadways cannot see the capacity increases needed to fully alleviate congestion due to financial constraints and the built environment. The United States can learn from European countries which are privatizing major infrastructure investments. A major private development is Terminal 5 in London, a major airport and multi-modal transportation hub. Another example of privatization comes from France, a country which has pioneered long-term infrastructure concessions. In the United States, solution examples include privatized express lanes and multi-faceted, statewide congestion relief plans.

At this point, there is no easy cure-all solution for congestion. Each highway will need its own mixture of components discussed within this research and also components which have yet to be thought of to fully alleviate congestion. Since congestion is so closely tied into the growth of the economy and population, the solution would have to logically include both economic and capacity facets to help relieve congestion caused by volume and demand.

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