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9 March 2000

Proposal for Transit Solution

Our purpose is to investigate the best transit solution between the two choices that we have: buses or light rail. By saying best, we mean the one that has the least emissions of carbon monoxide. There are many factors involved, and it would be almost impossible to consider all in the process to find an agreeable answer. However, it is our goal to contemplate as many of the essential ones as possible. We will decide which form of transportation is best suited for the Portland Metropolitan area, and then we will make an educated suggestion for the use of an additional $1 billion. Our decision is mainly based on the lowest emission of carbon monoxide.

"Carbon monoxide (CO) is a colorless, odorless, and poisonous gas. A product of incomplete burning of hydrocarbon – based fuels, carbon monoxide consists of a carbon atom and an oxygen atom linked together."[1] "Carbon monoxide results from incomplete combustion of fuel and is emitted directly from vehicle tailpipes. Incomplete combustion is most likely to occur at low air to fuel ratios in the engine. These conditions are common during vehicle starting when air supply is restricted, when cars are not tuned properly, and at altitude, where thin air effectively reduces the amount of oxygen

1 http://www.epa.gov/otaq/03-c.htm

available for combustion."[2]

Even though part of the carbon monoxide that exists in the atmosphere is from naturally occurring sources, a considerable part is from a man-made origin. Since it is out of our range to control the amount of the gas emitted by nature, we should only contemplate the carbon monoxide that is a result of human causes.

Emissions from human causes mostly resulted from the industrialization revolution. Carbon monoxide is a by-product from the incomplete burning of carbon-containing fuels such as coal, gasoline, kerosene, natural gas, oil, and wood. These are the main sources of energy for running factories, modern technologies, and modern transportation like cars, buses, etc.

Relating to vehicles, carbon monoxide results from the incomplete combustion of fuel, and it is emitted directly from vehicle tailpipes. Incomplete combustion is most likely to occur at low air-to-fuel ratios in the engine. These conditions are common during the vehicle startup, when air supply is restricted, and cars are not tuned properly. It also occurs at high altitudes where thin air effectively reduces the amount of oxygen available for combustion.[3] This is what most people call a "cold start." To dramatize this situation, carbon monoxide emissions from automobiles increase dramatically in cold weather. This happens because cars need more fuel to start at cold temperatures, and some emission control devices (such as oxygen sensors and catalytic converters) operate less efficiently when they are cold.

Carbon monoxide levels are most common in urban areas, since it is here that the

2 http://www.epa.gov/otaq/03-co.htm

3 http://www.epa.gov/otaq/03-co.htm

burning of fuels mainly accumulated. In fact, according to data that has been gathered from researchers, two-thirds of the carbon monoxide emissions come from transportation sources (with the largest contribution coming from highway motor vehicles), and in urban areas, the motor vehicle's contribution to carbon monoxide pollution can exceed 90 percent.[4]

If we inhale too much carbon monoxide, it enters the bloodstream through the lungs and forms carboxyhemoglobin, a compound that inhibits the blood's capacity to carry oxygen to organs and tissues. The bond that forms carboxyhemoglobin is 240 times stronger than oxygen's; thus it has a greater advantage over oxygen.[5] This deprives the body of oxygen, and therefore results in many health problems.

Those people with heart disease are especially sensitive to carbon monoxide poisoning, and may experience chest pain if they breathe the gas while exercising. Infants, elderly persons, and individuals with respiratory diseases are also particularly sensitive. Carbon monoxide can affect healthy individuals, impairing exercise capacity, visual perception, manual dexterity, learning functions, and the ability to perform complex tasks.

Exposures to high-level concentrations of this gas cause physical and pathological changes. These could be changes such as dizziness, nausea, headache, weakness, loss of muscle control, chest tightness, heart fluttering, sleepiness, redness of the skin, confusion,

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4 http://www.epa.gov/otaq/03-co.htm

5 http://www.eurekalert.org/releases/asu-clc021899.html

vomiting and diarrhea.[6] If the gas is allowed to remain in the brain and tissues for a long period of time, it can affect memory, reasoning and other brain functions. Massive exposure to carbon monoxide may even result in death. Since it is a serious problem to our health if we intake this dangerous gas, we should do everything in our power to limit its emission.

"When just one commuter leaves their car at home and uses Tri-Met for a year, our lungs and the planet are spared 78 pounds of pollutants: 63 pounds of carbon monoxide, 9 pounds of hydrocarbons, 5 pounds of nitrous oxides, and 1 pound of particulate."[7] According to the 1994 Oregon Air Quality Annual Report, for the third consecutive year most pollution levels in Oregon were lower than those recorded in previous years. "Continued significant improvement in air quality makes it possible for ninety-nine percent of Oregonians to live where the air meets national health standards. However, as the state's population continues to grow, maintaining clean air will become a greater challenge that will require individuals to look for ways to reduce air pollution, by driving less and choosing environmentally friendly products," said DEQ Director Langdon Marsh.

In Medford, the carbon monoxide problem is attributed to automobile emissions that were traced to a special event. The Classic Car Rally parade passed right by the carbon monoxide monitor in Medford. Since the classic cars were not equipped with pollution control equipment, the monitor registered carbon monoxide levels that were above the national air quality standards.

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6 http://www.aomc.org/NR_carmon.html

7 http://www.Tri-Met.org/envfacts.htm

The picture wouldn't be complete if we didn't take into consideration the cost of operation. According to a chart of Tri-Met financial statements and the Tri-Met Census for 1994, the total cost for running the transportation system is $99,028,973, in which $77,721,437 was used to operate the bus system, which is almost 79 percent of the total cost. By operating the light-rail system, $14,986,693 was spent which is 15 percent. The other 6 percent was spending for other special needs.[8] In order to see whether this money was spent wisely in 1994, we need to take into account the number of riders that each type of transportation carried.

According to the same source buses carried 87.68 percent, which means 175,066 riders out of the total of 199,666. On the other hand, the MAX system carried 12.32 percent, which is 24,600 out of 199,666. Thus, by using 15 percent of the budget to operate light rail while only bringing in 12 percent of the riders was not very wise. However, that's only the case if we consider the percentage proportionately, but other factors may affect our decision-making.

For example, does this 12 percent increase mean that there is a 12 percent decrease in cars driving on the highway, and if so, how much is it worth to us to reduce this amount of emission in carbon monoxide? Besides that, there are other factors that need to be taken into account. For example, does that number of people use the light rail as their only transportation option throughout their whole trip, or do they use others? These factors can significantly change the direction of emission of carbon monoxide from reducing to increasing.

Those are the operation costs of the bus and light rail systems, in which it does

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8 http://www.bts.gov/btsprod/nts/chp4/tbl4x35.html

not cover the cost of buying the buses and the rail cars. According to Tri-Met records, there are 712 buses in nineteen fleets.[9] Each bus costs about $200,000-$300,000. Thus, if we assume that each bus costs about $250,000, then $178,000,000 is needed to pay for the 712 buses. On the other hand, if $1.2 million is the cost of a light rail car, then the 72 cars would be around $86,400,000. With these costs and the operating costs taken into consideration, we had concluded that the total operation cost for running the Tri-Met system is $255,721,437 and the light rail system is $101,386,693. The percentage of cost is 70 percent for the buses and 28 percent for the MAX. Notice that the percentages don't add up to 100 percent. This is due to the 2 percent of special needs cost which is $6,320,843.

Tri-Met says it spends 25 percent less in operating costs on a light rail ride than a bus ride. However, a study by independent researchers found that the planners of the light rail system seriously overestimated future ridership and seriously underestimated their operating and capital costs. Tri-Met's forecast of operating cost per boarding ride for MAX is $1.40, while actual total costs per rail passenger are $9.99. The operating cost amount is $1.76 and the capital cost amounts to $8.23, which totals the $9.99.

Tri-Met buses carry the total cost of $2.06 because the operating cost amounts to $1.67 and the capital cost is $0.39. One of the reasons the light rail system is so costly is because of its high capital cost. The Interstate Max system by itself constituted $257 million of federal funds, $30 million from the City of Portland, $38.5 million from Tri-Met, and $24 million from regional transportation funds.

The findings provide strong confirmation for the widely held view that light rail

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[9] http://www.Tri-Met.org/mainfacts.htm

system planners typically use optimistic assumptions when they develop light rail system costs. Overly optimistic forecasts of future transit use favor rail alternatives because of their higher capital costs. Advocates of the light rail system frequently acknowledge that these higher capital costs will be more than offset by lower operating costs, arguing that rail costs less to operate because fewer drivers are required. When the cost of maintenance labor and station personnel are added, this supposed operating cost of rail becomes much smaller and in many situations disappears.

Rail advocates also frequently compare the per trip costs of a particular rail line with average bus system costs. Such comparisons, however, are highly misleading as new rail lines typically replace the most productive bus routes, and the MAX often requires low productivity feeder bus routes. When the costs of providing comparable service are compared, and the impact of rail on bus system costs are properly accounted for, bus operating costs are frequently lower than rail.

There is also a claim that the South-North light rail will cost only $2.50 per ride. Given the estimated construction cost of $1.4 billion for the line, allocating 10 percent annually leaves an annual capital cost of $140 million. Dividing by 250 working days per year, the optimistic forecast of 28,000 daily rides results in a capital cost of $20 per individual ride or $40 per round-trip.

Out of the Tri-Met budget, buses took 70 percent with 88 percent of the riders, and they reduced 92 percent of the carbon monoxide emission, while the light rail system had taken 28 percent out of the budget with 12 percent of the riders, and it reduced only 8 percent of the carbon monoxide emission. When considering this in our spending of money, we could use the money that had been spent for the light rail and use it on the bus system. With the $101,386,693 used for the 72 rail cars, we could buy and operate 282 more buses (it takes $359,159 to buy and run one bus). With this solution, we could reduce the amount of carbon monoxide emitted into the atmosphere by up to 115,101g. Compare this to the 25,784g that the light rail could have reduced with the same amount of cost.

Looking at the problem from afar, a considerable amount of us would have thought that the light rail system is the better option, due to convenience. Thus, more people would ride it and fewer people would drive their cars. However, as we dig deeper into the issue, it is not that plain and simple anymore. For example, even though the light rail can avoid traffic congestion and less stops, which reduces the time of travel for a passenger, there's one inevitable problem with the light rail system.

Most people live far from the transit center. This means that they have to get to the station by another transportation option. One option is to travel by their own cars. According to surveys by Tri-Met, two-third of the riders of light-rail were previously bus riders.[10] Thus, we can deduce that the other one-third may have other wise driven a car or car-pooled. There are other options too, but we think these could be neglected without harming our analysis.

Although a third of its riders may have driven a car, *more* than a third of its riders drive or are driven to the light rail station. This does not take into account the other people who take feeder buses to the light rail station. Recalling that most auto pollution is emitted when engines are cold, starting your car to drive to the station pollutes just about as much as driving all the way to work. So, the distance of driving is not a significant factor in this case. Thus, light rail does almost nothing to reduce pollution.

10 http://www.teleport.com/~rot/transit.htm

As discovered from the above information, the one-third of increase of riders that light rail had brought in would cancel out the one-third that still used their cars to get to the stations. Hence, there's no net decrease in the carbon monoxide emission here. What we need to consider now is the other two-third of riders that were formerly known as bus riders. If the MAX system uses less fuel to run than the bus, this would mean that the MAX is actually reducing the emission of carbon monoxide. However, if it is the other way around, then we have made a huge mistake in building the light rail system because not only does it waste our money, but it has also harmed our environment.

Proponents of the light rail transit system have used extravagant projections of future ridership to justify the large capital costs these systems entail. In fact, because new rail rapid transit systems are typically built in well-developed transit corridors, where the new rail lines replace the most heavily traveled bus lines, they attract relatively few new riders. There may be benefits from building new rail transit lines in such situations, but a large increase in the number of new transit passengers is not among them.

Portland's trains average a whopping 19 miles an hour from suburb to central city. Most trains run nearly empty much of every day. Buses run empty much of the time also. The light rail and buses combined carried about 10,000 fewer commuters to work in 1990 (four years after light rail opened) than they did in 1980. Light rail actually put more cars on the road because, in order to funnel commuters onto the trains, Portland's public transit agency shut down some of the most productive bus routes into the city. As a result, some of the former bus riders climbed back into their cars, rather than taking buses to park and ride lots, so they could take the train.

Tri-Met's own 1994 study shows that, in the 6 am to 9 am commute time period, only 3,500 people at most use MAX to commute to work. The United States Census found only 2,500 commuters on MAX in 1990. A majority of these people would have ridden the bus if Tri-Met hadn't shut those bus lines down trying to push people onto the train. So MAX probably carries less than 1,700 daily commuters who would otherwise drive. According to the Oregon Department of Transportation, more than 20,000 cars travel from the eastside to downtown on the Banfield freeway from 6 am to 9 am daily. Each auto carries one or more passengers. Thus, the 1,700 MAX commuters must be compared to over 40,000 people who commute by car.

In addition, MAX hasn't been successful in reducing auto traffic. Evidence suggests that ridership is no greater than what the bus network would have generated. And while transit ridership is increasing over time, due to population growth and increases in bus frequency, transit's share of trips is falling. Between 1980-1990, despite the construction of MAX and other efforts, the share of Portland area commuters taking transit to work fell from 8.4 to 5.4 percent. Adding non-work trips reduces transit's share to 2.8 percent, and only 0.3 percent use light rail.

Because of light rail's reliance upon park-and-ride and its inability to divert auto users to transit, the South-North line will have little impact on regional pollution problems. Transportation planners use a rule of thumb of one-quarter mile, as the distance people will walk to or from a transit stop. Using this rule, only 1 percent of Tri-Met's service area is within walking distance of a MAX station. Multiply that by three for the new line, and we still have only 3 percent. Therefore, most people will still have to drive or take a bus at each end if they want to use the train.

Tri-Met claimed that in the period from 1990 to 1997, transit ridership overall grew by 30 percent, and ridership in the western corridor rose 137 percent in 1999 to 33,900 average daily trips. During the Fiscal Year of 1998, bus ridership increased by 2.6

percent, which consisted of 58.6 million bus rides, whereas MAX overwhelmingly increased by 6.9 percent with 10.4 million MAX rides. Moreover, the average daily boardings were 231,000 in which the buses made up 199,600 and MAX was 31,400.

In September of 1999, MAX claimed that the average daily ridership of 64,500 boardings. Buses accounted for 194,100 weekday boardings. If all of these are true, it would certainly make a strong case for light rail and buses. However, all ridership data reported by Tri-Met are subject to overestimation. The vast majority of riders, perhaps 20 percent to 50 percent, must transfer to a second, and sometimes even a third, vehicle to reach their final destination. Some transfer from bus to bus, from bus to MAX, and so on.

There is a large amount of double counting of people. The heavy use of passes, transfers, joint tickets, and cash by people transferring from one vehicle to another makes it impossible to count people. Only boardings (called unlinked passenger trips) can be counted with any accuracy. Therefore, the best estimate is that the number of people using transit on any day is perhaps only one-third the number of trips reported. However, it would be unfair to say that no one rides the MAX because there are those who find it enjoyable to use the light rail system.

"The MAX line that connects cities and neighborhoods from Gresham to Hillsboro is a triumph of engineering and politics and has become a symbol of urban vitality."[11] Since the gala opening of Westside MAX last September, Tri-Met has tapped into a stream of customers eager to use light rail transit. A survey of 36 homeowners at Orenco Station found that 22 percent commuted on MAX, and almost all

11 http://www.oregonlive.com/news/99/07/st071304.html

used rail as much or more than they had expected.

Past evidence suggests that East Portland area residents, who have public transit alternatives, choose to use their private vehicles. Since the city completed the first MAX line in 1986, more people are driving more miles. Although MAX ridership increased about 20 percent over the decade, it remains far below predicted levels. In 1986, Tri-Met projected 42,500 daily riders. In 1995, there were only 25,000 riders per day. The percentage of work trips in the Portland area by light rail and buses actually dropped. Even though it is unfortunate that the use of Tri-Mets' services has dropped in the past, the cars of today are much better than the smog machines of the past.

Today's passenger cars are capable of emitting 90 percent less carbon monoxide over their lifetimes than their uncontrolled counterparts of the 1960's. As a result, ambient carbon monoxide levels have dropped, despite large increases in the number of vehicles on the road and the number of miles they travel. With continued increases in vehicle travel projected, however, carbon monoxide levels will begin to climb again unless even more effective emission controls are employed. The 1990 law also introduces several entirely new concepts with regard to reducing motor vehicle related air pollution. For the first time, fuel is considered along with vehicle technology as a potential source of emission reductions, and more attention is focused on reducing the growth in vehicle travel.

The new provisions include emphasis on fuels, nonroad engines, and clean transportation alternatives. Most provisions requiring cleaner cars and fuels will dramatically lower vehicle toxic emissions. Mobile sources are the primary cause of carbon monoxide pollution in the US. Remote sensing has been used primarily to help improve inspection and maintenance programs. Remote sensing obtains instantaneous measurements to tailpipe emissions.

There are three ways that you can do something to help get emissions as low as possible and they are: avoid unnecessary driving, maintain your car properly, and drive your car wisely. The most effective way to reduce emissions from your vehicle is to use it less. Vehicle travel in this country is doubling every 20 years. Several options are available to help you reduce the amount you drive. These include consolidating trips, telecommuting, car-pooling, using public transit, and choosing clean transportation alternatives such as biking or walking.

"Driving situations likely to increase pollution include: idling, stop and go driving, air conditioning, high engine loads, cold temperatures and refueling."[12] You will save gas by turning the engine off and restarting it again if you expect to idle for more than 30 seconds. Driving in traffic is not always avoidable, but whenever possible, plan trips outside rush hour and peak traffic periods. Use of a vehicle air conditioner increases the load on the engine. This can increase emissions and decrease fuel economy. Your car burns more gas and emits more pollution when the engine is operating under high load; that is, when it is working especially hard.

Running the air conditioner, quick accelerations, high speed driving, climbing grades, revving the engine, and carrying extra weight creates extra load. Emission control systems take longer to warm up and become fully operational in cold weather. However, idling will not help. Modern vehicles need little warm-up; they're most efficient when being driven. Idling for long periods in cold weather can actually cause excessive engine wear, and spilling gasoline pollutes the air when it evaporates.

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12 http://www.epa.gov/otaq/18-youdo.htm

In order to determine the amount of carbon monoxide that is either reduced or increased by using a certain transit system, we need to find out how much carbon monoxide is emitted. Since we can't find the information that is needed, we used some data and calculated out the number by ourselves. For example, according to the U.S. Department of Transportation, a public transit bus can travel at an average of 6.6 miles per gallon of fuel.[13] To find how many gallons of fuel were used per mile, we took one mile divided by 6.6, and equaled that buses consumed 0.15 gallon per mile.

The same thing was done with the data for cars and we found out that an average car only needs 0.061 gallon to go one mile. This means that buses require two and a half times the amount of fuel to run compared to cars. However, this is only the half way point in getting the number for carbon monoxide emitted by each.

According to another chart of the U.S. Department of Transportation, for the average automobile, 3.4 grams of carbon monoxide was emitted per mile.[14] We had already found from earlier calculations that buses require two and a half times more fuel to run per mile. Thus, the carbon monoxide emission of buses per mile is 8.5 grams. However, don't forget that a single bus can carry more people than a single car. In fact, it was estimated that the average number of passengers in one express bus is 11.5 grams.[15]

On the other hand, it was estimated that there was a 1.4 average occupancy assumed for one car. Using the information that we just calculated, 8 cars are needed to

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13 http://www.bts.gov/btsprod/nts/chp4/tbl4x35.html

14 http://www.bts.gov/btsprod/nts/chp4/tbl4x29.html

15 http://www.cascadepolicy.org/transit/cunneen.htm

carry the same number of people that one bus carry. Thus, if 11.5 people were to drive their cars the emission rate would be 27.9 grams per mile, while only 8.5 grams per mile would be emitted from a bus.

Further calculations showed that the carbon monoxide emission of traveling by bus is 0.74g/passenger mile. On the other hand, a car would emit 2.4g/passenger mile. To simplify the problem, we assumed that light rail has a zero emission rate. This is untrue, considering the fuel that is needed to burn, from industrial power plants, in order to run the light rail. However, this will be overlooked for our purposes.

According to the Tri-Met financial statements and Tri-Met Census for 1994, the number of bus riders is 175,066 and the number of MAX riders is 24,600. The bus system had a carbon monoxide emission rate of 125,549g. If all of these riders were former car drivers, the buses had saved a carbon monoxide emission of 290,609g.

The MAX has 24,600 riders, but a third of these are still using their cars to get to the station, thus, we’re only considering the other two-third. This would mean that the MAX system had decreased a carbon monoxide emission rate of 39,360g (this applies if this two-third were former car drivers). However, recall that two-third of the MAX riders were former bus riders. Hence, the MAX had actually saved only about 25,784g of carbon monoxide.

Now remember that the operating cost for the MAX system is 15 percent and the bus system is 78 percent, but the carbon monoxide saving by the MAX is only about 8 percent compared to 92 percent by the bus. Notice that we didn’t use the total percentage of operation that had taken into account the cost of buying the buses and the light rail cars. Since Tri-Met doesn’t buy new buses or light rail cars every single year, we felt that this cost is irrelevant when considering the emission rate of carbon monoxide in the long run. However, in the short run it is necessary that we consider this amount, especially when we make comparisons between buses and MAX and how we should spend our $1 billion in finding the best transit system.

Improvements must be made in public transit systems. Because the contemporary suburban pattern consists of dispersed origins and destinations, the most promising strategies for public transit are those that use small vehicles, such as cars and vans—vehicles sized for the few persons making the same trip at the same time.

An alternative to buses are rail systems. There are three types of urban rail systems, such as light rail, commuter rail, and heavy rail. They are often proposed as a solution to the urban problems of air pollution and traffic congestion. Light rail is self-explanatory from this paper; it travels at 16 miles per hour. Commuter rail operates the average speed of 33.2 per hour. Trains are often up to 10 cars long or more, and may be double deck. Heavy rail operates with grade separation and is often in subways or elevated structures. Heavy rail is normally electricity powered from a third rail and operates at an average speed of 19.5 miles per hour. Heavy rail is expensive to build.

A merger of automobiles, telephones, cellular phones, radios, satellite locators, and computers could support new transit systems that are compatible with modern suburbs. There have been talks about the computer-based dating systems. The computer-based dating systems that, in real time, would match drivers and potential passengers having the same origins, destinations, and schedules. A phone call to “Multi-Mode Transport Center” would permit residential neighbors with common destinations to fill some of those empty seats on any given day and hour, even though they are total strangers. The incentive to the driver is reduced travel cost and perhaps even a supplemental income.

The Federal Transit Administration is now exploring the idea, as are increasing numbers of state and local transportation agencies. Under the banner of APTS (Advanced Public Transportation Systems), they're conducting experimental field tests of potentially integrated communication-transportation transit systems. With this system, a person wishing to go from here to there, at a specified time, phones the transport help line and places a request by punching the phone buttons. The computer then searches for a neighbor traveling at that time to that place and willing to share an empty seat for a fee. If no one is found, it searches for the nearest publicly or privately owned bus, van, or taxi, which is then sent to the caller's front door.

Being virtually guaranteed a ride at an acceptable price and at the right time, many that are now solo drivers might be enticed into becoming car-poolers. Whether the vehicle that arrives is a neighbor's car, van, small bus, or taxi is probably inconsequential: whatever the small-vehicle type, the operational service characteristics are approximately the same. Any of these interchangeable paratransit vehicles can provide door-to-door, short wait, no transfer service, comparable to the level of service that a private car provides—and, for some, without the hassle and costs of parking.

Another alternative would be a jitney. Other countries long ago demonstrated the viability of automobile-based transit services. Jitneys are the main components of transit systems in many Third World countries. Some jitneys ply fixed routes while others operate likes collective taxis and takes passengers directly to their destinations. They furnish low-cost transportation service that, in some places, approximates that of private autos. However, a high barrier stands in the way of expanding paratransit service in the United States.

Strict regulations in many cities severely constrain entry into the taxi-jitney business, largely through limits on the number of licenses they allow. However, if that oligopolistic constraint can somehow be overcome—if the jitney-taxi business can be opened to new entrants and if the attributes of high-tech communications can be merged with the attributes of low-tech Third World jitneys—we might generate a new high-quality transit service.

If we use electric vans for a jitney service, assume that each electric van costs about $40,000-$50,000 and each van can carry ten people. We could use the jitney service as a feeder service that will take people to MAX stations. In this way, we could cut back the number of people driving to MAX stations. If we could get at least 500 people to use the jitney service to MAX stations, we could save 31,500g of carbon monoxide emissions (500 people x 63 lbs. CO) from single occupancy vehicles for one year.

If we actually use the jitney service, the cost of an electric van could be $35,000 (the same price as a regular van). The reason electric vans cost too much is because there is no production line for them, due to low or no sale volume. Therefore, if we order these electric vans, there will be production and it would result in a lower cost. Assume that each electric van costs $35,000 and each van will carry ten people each day. With $1 billion to spend, we could buy 28,000 electric vans, we could reduce 17,640,000 (10 people x 28,000 vans x 63 lbs. CO) pounds of carbon monoxide emitted into the air by a single occupancy vehicle for one year.

Any such paratransit system will have to deal with passengers' potential fear of strangers. Recent experiences with Shirley Highway and Bay Bridge carpools, and with rideshare benches in retirement villages, suggest that persons living in the same neighborhood are likely to be fairly trusting and safe. Nevertheless, a formalized transit system must provide reasonable assurance of safety, at least comparable to that of municipal bus operators.

Of course, no transit system can be the best. Real-time carpools might never attract more than 10 percent of potential commuters. But for right now, it seems to be the best solution. If it's true that the automobile owes its tremendous success to its door-to-door, no wait, no transfer service, and if it's true that the structure of the modern metropolis is incompatible with large vehicle transit systems like trains, trolleys, or buses, then it must also be true that workable transit systems in low-density sections of the metropolis must be those using automobile-like vehicles. The ideal suburban transit system will take its passengers from door-to-door with no transfers, with little waiting, and it will fit the small numbers of persons having the same origin, the same destination, and the same schedule. Only such a system can compete with the private car.

Another option that we had considered was the buses that run on liquid natural gas. Natural gas is the cleanest burning alternative fuel. Exhaust emissions from natural gas vehicles are much lower than those from the equivalent gasoline-powered vehicles. In fact, emissions of carbon monoxide are approximately 70 percent lower in natural gas vehicles than in regular vehicles.[16] This happens because every per unit of energy of natural gas contains less carbon than any other fossil fuel, and thus produces lower carbon monoxide emissions per vehicle mile traveled.

Another benefit concerning liquid natural gas running vehicles, besides that it produces less carbon monoxide, is that it has a higher energy density. This is due to its chemical state. Since it is a liquid, a greater volume of liquid natural gas (LNG) can be stored in a smaller space. Onboard a vehicle, getting the greatest possible range and

16 http://www.iangv.org/sources/qa.html

lowest weight are especially important considerations.

Another advantage that LNG has is that large vehicles can often be filled in four to six minutes, and fuel composition can be determined with a high degree of accuracy since most LNG produced for vehicles is now in the 99 percent range of methane. This control over composition results in a more finely tuned fuel system and engine, which leads to optimization of engine performance and thus greater fuel economy and lower emission rates.

However, it is quite costly to establish a system for natural gas running buses, since it costs around $1 million or more per fueling station. This is not even counting the cost of buying new buses. There's also an implicit cost for switching between transit options, between regular buses and the new natural gas buses. The LNG buses would cost about 25 percent more than the regular diesel buses, which cost $200,000-$300,000 for each one.

But more importantly, reductions in emissions and in congestion from transit system improvements depend primarily on reductions in the number of cold starts and vehicle miles of travel by passenger cars. Moreover, spending subsidy dollars on bus system improvements, particularly by reducing fares and increasing vehicle miles of service, provides substantially larger reductions in cold starts and vehicle miles of passenger car use. As a result, serious analyses of reductions in congestion and air pollution that result from alternative transport system improvements strongly favor bus system improvements over spending for costly and ineffective rail systems.

Light rail is a great thing for this community, and its absolutely essential to the future of this region. Citizens of the Portland Metropolitan area chose light rail as the foundation of new transportation investment instead of freeways. Light rail is better, because its costs are of the same magnitude as those for new freeways and exclusive busways, and because it fosters other important community goals. It doesn't add to pollution from auto emissions or roadway water run off. Light rail will have negligible impact on traffic congestion because it attracts few automobile drivers from their cars.

But light rail is expensive. The most cost effective, federally funded systems have required subsidies of $5,000 and more per new ride. New rides are those riders brought out of their cars and into the transit system. Light rail is inflexible once in place and light rail will not improve commuter travel times, energy conservation, and safety.

"Light rail's ability to move large numbers of people has virtually no value to the modern urban area because it doesn't match the needs of the modern urban traveler."[17] Light rail has been proposed as a solution to our urban transportation problems. The OCTA planners imply that light rail can reduce traffic congestion and do so for lower costs than other alternatives. This principal benefit has been implied in Outreach literature and public meetings to obtain voter or public agency approval for the proposed light rail system currently under study.

After all of these alternatives for transit were researched, we felt that they would be a waste for the $1 billion that we are in charge of disbursing. We really liked most of the alternatives, but they were either not cost-effective or not allowed in Portland. So, when considering the two options that already exist, the bus system and the MAX, we have decided to invest in more buses. They are less expensive than light rail cars, and when taking into consideration how many riders actually use Tri-Met, they emit a lower pollution of carbon monoxide.

17 http://www.octa.net/gjreport.asp

Also, out of the 712 buses in Tri-Met's many fleets, ten buses have the liquid natural gas system. We might invest in more of these particular buses, but not so many as to need to build a natural gas refueling station. We found that the closest refueling station that had natural gas was on the Southeast side of Portland. It's not too far away, but it's not very convenient, either. So, we decided to not pursue too many of the LNG buses.