The Challenge of the Oracle: Optimizing Transportation Infrastructure in a Changing World

THIS FEATURE EXPLORES TWO OPTIONS THAT RESPOND TO THE RAPIDLY APPROACHING PEAK-OIL CONDITION. THESE OPTIONS FOCUS ON THE REDUCTION OF ACTIVITIES THAT CONSUME OIL, THE USE OF OTHER ENERGY SOURCES AND WAYS TO IMPROVE EFFICIENCY.

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INTRODUCTION

In ancient times, the job of predicting the future fell to the Oracle at Delphi. Today, this type of work is done by economists, modelers and many others. Questions about the future infrastructure needs of our cities are explored by transportation planners through means that seem as mysterious as those of the ancient Oracle.

For all of its mystery, modern-day traffic forecasting is usually based on the assumption that the future will look like the present. For example, it is commonly assumed that:

- the same people will drive the same vehicles;
- faced with a given level of congestion, they will make the same choices;
- the (inflation-adjusted) cost of everything will be the same as it is today;
- cities will continue to grow; and
- people will have the same values that they have today.

There is strong evidence that the future will not be a linear extrapolation from the recent past. Two relevant transportation-related reasons are oil supplies and greenhouse gases. As a result of these looming issues, utilizing a "business as usual" model in a changing world puts the optimization of future transportation infrastructure at risk.

OIL SUPPLIES

According to Paul Roberts in *The End of Oil: On the Edge of a Perilous New World*, "the entire global economy is like a huge machine, steadily turning energy into wealth."[1] The single biggest source of that energy (37 percent) is oil. However, within the next 10 years, global oil production will peak even as demand continues to increase. The popular term for this is "peak oil."

Global discovery of conventional (easily-extractable) oil peaked 40 years ago.[2] Since 1984, more oil has been consumed than discovered; three or four barrels of oil are consumed for each barrel discovered. Peak oil is not defined as running out—supplies of expensive oil will progressively diminish for a long time—but the point when production can no longer grow to meet the ever-increasing demand. This will mark a watershed in a world economy fueled by oil and demanding continuous growth.

Peak oil is being considered at all levels of government. The Swedish government has created a National Commission on Oil Independence with the objective of making Sweden oil-independent by 2020. Municipalities in Canada and the United States have received reports or adopted motions relating to peak oil.

There is general scientific agreement that the peak is coming. The only significant debate is when it will occur. This uncertainty is due to the immense complexities involved in making such a prediction, such as geology, politics, meteorology, markets and new technologies, among others. Oil experts have thus been unable to agree upon a particular date for the peak. The average estimate from 20 recent forecasts in a report commissioned by the U.S. Department of Energy is 2014.[3] Some analysts argue that we are at peak oil today; monthly global oil supply data show a recent peak in September 2006. Other groups suggest that a multi-trillion-dollar investment in oil and gas infrastructure can continue to increase production through 2030.

In view of the scope of effort needed to significantly reduce our dependence on oil, even the latter date is uncomfortably close. David J. O'Reilly, chairman and chief executive officer of Chevron Corporation, writes, "Energy will be one of the

defining issues of this century. One thing is clear: the era of easy oil is over. What we all do next will determine how well we meet the energy needs of the entire world in this century and beyond."[4]

Although hydrocarbon liquids can be made from natural gas or coal, these sources are very capital- and energy-intensive and are highly unlikely to be able to offset the supply declines in oil after peak. The same is true for corn-based ethanol, as well as biodiesel from soybeans or palm oil (to a lesser extent), which some researchers claim is energy-negative. North American natural gas is already past peak production, and coal production could peak globally as early as 2025.[5]

CLIMATE CHANGE

Another reason for reducing oil consumption is climate change. There is an overwhelming scientific consensus that climate change is real and largely the result of human activity.[6] The impacts of climate change can be mitigated by quickly and dramatically reducing greenhouse gas emissions. Scientific literature also indicates that:

- A limited window of opportunity is available to control global warming, beyond which the probability of dangerous climate change rises unacceptably.
- Several feedback loops have already been activated but can be minimized through emission reductions:
  - Increased glacial melting will decrease the surface area of glaciers and thus reduce the amount of solar energy that is reflected back into space. This will further accelerate global warming and additional glacial melting. The resulting sea-level rise may put tens of millions of homes at risk. According to the Intergovernmental Panel on Climate Change, "the last time the polar regions were significantly warmer than present for an extended period (about 125,000 years ago), reductions in polar ice volume led to 4 to 6 meters of sea level rise."[7]
  - Thawing of permafrost will release large volumes of methane, a powerful greenhouse gas that will accelerate global warming.
- While the exact threshold to dangerous climate change is unknown, much of the literature suggests that we should not allow the global average temperature to rise more than 2 degrees (º) Celsius (C) above pre-industrial levels.[8,9] Hare writes, "above 2º C, the risks increase very substantially, involving potentially large numbers of extinctions or even ecosystem collapses, major increases in hunger and water shortage risks as well as socio-economic damages, particularly in developing countries."[10]
- About one-third of that 2º C limit is already gone. Average temperatures have already risen 0.76 º C.[11]
- An additional one-third of the limit is largely unavoidable. The gases emitted today will contribute to warming for many years. For example, quickly stabilizing gas concentrations at year-2000 levels would still produce an additional temperature rise of 0.6º C in 100 years.[12]
- This leaves a safety margin of only about 0.6º C.
- Carbon dioxide is the most important greenhouse gas due to the high volumes that are emitted.
- In order to achieve the 2º C target, emissions in industrialized countries will need to decline by 85 to 90 percent.[13] The precise number is not the issue for this feature. The key point is that the reduction falls in the range of most to almost all greenhouse gases. This dramatic change will need to be achieved by the year 2050 or sooner, depending on the estimate used.

Public concern about global warming continues to increase. A survey in British Columbia, Canada, found 72-percent support for the statement, "I am desperately concerned that if we do not take drastic action on climate change/global warming right now, the world may not last much longer than another couple of generations because of the damage that is being done."[14] Under conditions like these, it is reasonable to suggest that even countries such as the United States and Canada, which have failed to implement significant greenhouse gas reduction measures in the past, will take such actions in the near future.

Solutions to both the energy supply and the climate change problems have many parallels, the first of which is to reduce consumption. This requires that consumers be given alternatives and has profound implications for the build-out of new transportation infrastructure. It involves a relocalization to form more resilient, self-contained communities that are less dependent on oil. In seeking solutions, it is important to focus on strategies that address both climate change and peak oil.

RESPONDING TO HIGHER PRICES

Whether due to peak oil or the implementation of effective policies to address global warming (such as a carbon tax or emission cap-and-trade system), the result for the transportation profession is the same: a dramatic change in transportation as it is currently practiced. Potential responses include:

- **Reduce activities that consume oil.** The quickest and least expensive way to reduce oil usage is by modifying transportation consumption patterns. Given the high percentage of oil that goes to transportation (67 percent in the United States), any change to oil consumption patterns must clearly include dramatic changes to how people and goods are transported.[15] Increased transit, cycling, walking and relocalization are obvious possibilities. Rail is more than three times as energy efficient as trucks, and ships are twice as efficient as rail.[16]
- **Switch to other energy sources.** Several options exist, including electric vehicles such as plug-in and other hybrid vehicles that are viable today. The so-called "hydrogen economy" is much further away (except for niche applications) due to issues with the storage, distribution and manufacture of hydrogen, as well as technological and cost issues associated with fuel cells.
- **Improve efficiency.** All vehicles can be made more efficient by creating more efficient engines and smaller vehicles, as well as using lighter materials. It has been noted that 25 percent of total global oil consumption today serves only "… to satisfy a certain vanity attached to the car as a status symbol."[17]

TRANSPORTATION, PLAN A

Transportation professionals plan, design and construct infrastructure that will last 30 to 100 years. Most of that work is based on the unrealistic assumption that the world of tomorrow will be like the world of today. However, this feature illustrates that transportation costs within the lifetime of our current projects will be dramatically different: They will need to rise to a point that generates an absolute reduction in oil consumption. Many feasible actions to prepare for this future are ones that are already being followed, to varying degrees, in many jurisdictions.

For the automobile mode of transportation, actions can include measures such as road pricing, parking pricing, or distance-based insurance that better internalize the full cost of this mode. Other actions include carpooling to increase vehicle occupancy or car-sharing so that the fixed costs of automobile ownership are converted to marginal costs, payable (like transit) at the time that trip decisions are made. Through proper internalization of automobile costs, the demand for road capacity in the future will likely be lower than it is today, and capital-spending priorities must be adjusted accordingly.

For transit, actions can include physical priority for transit vehicles, a higher-quality travel experience (such as bus stops with benches, shelters, schedules, etc.) and fare structures that support regular transit usage. An example of the latter is the U-Pass program in Vancouver, British Columbia. All students at participating universities are issued an unlimited transit pass, for which they are charged a much-reduced rate. Transit mode share at one university quickly rose from an already respectable 26 percent to 42 percent. The U-Pass concept is now being extended to new residential developments. In the future it is possible that municipal zoning bylaws will specify the number of transit passes that must be provided with new developments rather than the number of parking stalls.

For non-motorized modes, actions can include completing pedestrian and cycling networks, creating a finer-grained transportation network with multiple route choices, developing a high-quality urban realm that begs to be experienced on foot and providing end-of-trip facilities for human-powered modes.

Most important, governments must have a stronger commitment to mixed-use, higher-density, transit-oriented development that minimizes travel distances and maximizes modal choice.

THE CATCH

While these proposals will assist with both peak oil and climate change, they require decades to implement on a significant scale. This timeframe may not be available.

A study for the U.S. Department of Energy estimated that society could accommodate peak oil by engaging in a crash program of preparedness starting 20 years before the peak.[18] That timeframe is potentially already here, but even if it is not, most governments will not implement a crash program 20 years before a crisis. It is far more likely that the government will wait until the peak is obvious and imminent or has already passed.

Similarly for climate change, inaction over the last two decades has used time that could have been put to good use. This delay decreases the likelihood that necessary emission reductions can be achieved with slow but politically easy technological solutions.

TRANSPORTATION, PLAN B

This conundrum leads to a final question: What can be done in a hurry? If the need for urgency is clearly perceived by the public at large, what bold and innovative plans could regain the ground that has been lost to delay?

By waiting until the last minute, certain options become more challenging. For example, it will be difficult to double a city's bus fleet if every other city is simultaneously placing orders for more buses. Therefore, plan B should focus on the resources that are already available.

Because this scenario assumes a widespread sense of urgency, it would be accompanied by willingness, or even an eagerness, to accept alternative solutions that might otherwise be shunned. There is thus more latitude available in the crafting of solutions.

If each of us as individuals needed to quickly reduce transportation-related oil consumption by 50 percent, how would it be done? Low-priority trips may be cancelled. Other trips would be combined to accomplish several tasks in one trip. Destinations closer to home would be chosen, where possible. There would be more walking.

There would also be a dramatic increase in cycling. While 57 percent of Canadian adults own bicycles, only a tiny fraction of these are used on any given day.[19] The use of cycling can be increased quickly and dramatically, at minimal cost.

Transit use would obviously rise but would be constrained in the short-term by the capacity of the existing fleet. Methods that would still allow for a rapid increase in transit ridership include marketing targeted at off-peak travelers; bus-priority measures to bypass congestion; all-door boarding; shifted employment times; compressed work weeks; and the use of other agencies' under-utilized buses (such as schools or retirement homes).

All these steps may still not be enough to bring the consumption of oil in line with the necessities of peak oil and global warming. The rest of mobility will need to come from cars, but they can be used far more efficiently than at present. For example, when buying groceries today, a vehicle weighing 2,000 kilograms is used to transport 25 kilograms of food. Only 1 percent of the energy is being used to achieve the objective. The remaining 99 percent is being used to drag around a vehicle. This would be like running a freight train with one car full and 99 empty. Clearly, there is much room for improvement.

The average vehicle occupancy in the United States is 1.6 people; the average vehicle capacity is more than five.[20] A large decrease in oil consumption could be obtained through a dramatic increase in average vehicle occupancy. Most carpool programs are based on repeatable trips booked far in advance. For more widespread use, carpooling needs to work on a spontaneous basis.

Such a system has operated for more than three decades in Washington, DC, USA. Known as "slugging," drivers and prospective passengers across the region congregate at two dozen pick-up points, each of which serves specific destinations.[21] Passengers wait in slug lines for a car that is going to their destination. Many pick-up points are co-located with transit exchanges for increased mobility. The region's high-

occupancy vehicle lanes provide sluggers with a shorter travel time.

The system operates in the morning and afternoon peak hours, but could be expanded to other times. At a suitable scale, such a system could accommodate most medium- and longer-distance urban trips.

Spontaneous carpooling can also rely on a central database to provide the matching service. As piloted in several cities, such a database can be accessed via the Internet or cell phones.[22,23] To be successful, these systems need to have enough participants to produce a high probability of finding a match for any given trip. Responses to peak oil or global warming could make such a threshold achievable.

In short, plan B is a strategy to make use of the large surplus capacity that exists today for all modes of urban transportation. That surplus capacity is enough to reduce vehicle-kilometers by 50 percent or more.

Another benefit of plan B is saving money. In Vancouver, for example, governments are presently advancing $7 billion in transportation investments that would not be needed if plan B was implemented. In short, the Vancouver region is paying $7 billion to avoid carpooling. Residents of the region are also paying $8 billion in unnecessary vehicle operating costs.[24] The total savings are thus on the order of $15 billion, for just one urban area. Plan B also has numerous other benefits, such as reduced toxic emissions, better water quality, improved health, enhanced livability and a greater sense of community.

CONCLUSION

Peak oil is inevitable. The timing is uncertain, but it is relatively soon in terms of planning horizons. The impact will be dramatic. Agencies responsible for transportation should develop both a plan A of ongoing preparations and a plan B for rapid response. For optimal allocation of capital funds, they should avoid the use of "business as usual" trend planning scenarios.

These same actions would also address transportation's role in global warming. Through plan B activities in particular, the ability to dramatically reduce greenhouse gas emissions very quickly is possible without significant impact to the economy. ■

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