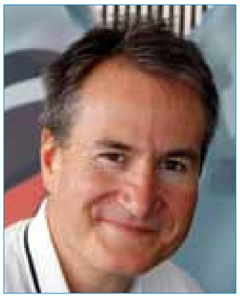
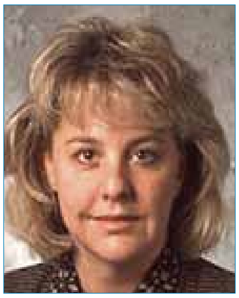
Future propulsion for personal mobility





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More than half the world's population now lives in cities and, according to the United Nations, this fraction is expected to increase to 60 per cent by 2030. Moreover, 80 per cent of the world's wealth is expected to be concentrated in urban areas in 2030 so that issues influenced by wealth (such as materials and energy consumption and greenhouse gas emissions) will be increasingly determined by urban dwellers. In short, it will not be possible to solve these global issues without addressing the challenges posed by urbanisation.

Mobility enhances our lives by allowing contact with others, offering new experiences and supporting the exchange of ideas and goods. Cities facilitate connecting people and goods but their roads are becoming increasingly crowded. This is particularly acute in emerging markets, with increased migration from rural to urban areas and with increasingly wealthy people aspiring to automobile ownership. Despite heavily congested roads, there is still a desire for personal mobility in urban centres because no other means of transport has so far offered the same mix of freedom, comfort, utility and security as the automobile.

However, to achieve sustainable urban mobility we will need to fundamentally reinvent the automobile to preserve the basic appeal of personal mobility ("go where you want, when you want with whom you want") while addressing the societal challenges of congestion, land use for parking, air pollution, greenhouse gas emissions and road accidents.

EN-V concepts outside the SAIC-GM Pavilion at 2010 Shanghai World Expo

A proposed solution from General Motors is the EN-V (Electric Networked Vehicle, pronounced "envy") concept that was introduced at the 2010 Shanghai World Expo as a vision to support the Expo theme of "Better City, Better Life". EN-V is a battery electric vehicle that can reduce energy consumption and environmental emissions. It uses a dedicated short range communications, sensing and Global Positioning System (GPS) platform to enable vehicle networking to reduce congestion and accidents. It is a small footprint, highly manoeuvrable vehicle that can reduce parking space requirements, energy consumption and ownership costs.

EN-V type vehicles could weigh around 500 kg and consume around 100 Wh of electricity per km (approximately 200 miles per gallon on a gasoline energy equivalent basis). This is possible because the vehicles may only need to have a range of 30 miles (not 300 miles), may only need to travel at speeds of up to 30 mph (not 100 mph) and may only need to accommodate 1 or 2 people (not 5 or 6). Compared with today's vehicles, they can provide safe, convenient personal urban mobility at about one quarter the total cost per mile, and will need only one fifth of the land for parking. The same technology that allows them to network and sense each other to reduce collisions will also enable autonomous driving and help provide accessibility to address another megatrend – the increasingly aging population.

This new DNA for the automobile, based on electrification and connectivity, rather than today's petroleum-fueled vehicles that operate as stand-alone transportation products, will also improve the integration of personal and public transport so that a new mobility system, offering the best features of both, can be realized. The convergence of electrification and connectivity, tied to the modest driving needs for urban dwellers, creates the opportunity to reinvent automobiles and fundamentally change how we move around. This quantum leap may be what is needed to meet the urgent sustainability challenges that face densely populated urban centres around the world, where the world's population is increasingly living.

The situation outside the densely populated cities is different. Mobility needs for daily travel can be longer (more vehicle miles travelled), duty cycle requirements can be greater (more movement of goods over longer distances), and roads and terrain can be uneven and unpredictable.

Electrically-driven vehicles could also play a significant role outside cities. However, to overcome range anxiety and the limited recharging infrastructure, the source of electricity may need to come not only from a battery but also from an on-board range extender (as on the Chevrolet Volt or its European equivalent, the Opel/Vauxhall Ampera) or from a hydrogen fuel cell.

For most non-urban applications, other energy and propulsion options may be even more attractive than electric-drive. Where biomass is abundant, for example, liquid and gaseous bio-fuels may be more affordable than electrified options. Recent examples include bio-ethanol in Brazil and bio-diesel in Europe. For liquid fuels, a flex-fuel vehicle is preferred for early commercialisation. Advances in biomass conversion may allow future bio-fuels to have comparable energy density to gasoline and diesel. This would allow relatively affordable, local energy resources to be used without sacrificing vehicle utility in anyway.

Biomass can also be used to produce hydrogen. This conversion holds promise in supporting fuel cell vehicle commercialisation, enabling vehicles of all sizes to have zero tailpipe emissions and to be fuelled from renewable sources. Additional studies on biomass conversion are required, but because the fuel cell vehicle may have twice the efficiency compared to a similar sized gasoline engine equivalent the well–to-wheels greenhouse gas emissions for the fuel cell vehicle could be reduced.

Whether the biomass is used to make biofuels for use in an engine or to make hydrogen for fuel cells, "well-to-tank" energy conversion efficiency has to be combined with the vehicle's "tank-to-wheels" efficiency to understand the most energy efficient solution.

There is also renewed interest towards using compressed natural gas and liquid petroleum gas in several regions of the world. This is likely due to recent discoveries of large reserves and new processes for extracting gaseous fuels from shale. It is generally accepted that there is approximately a 20 per cent reduction in greenhouse gas emissions, compared to gasoline, when internal combustion engines use natural gas. Although compressed natural gas has a lower energy density than gasoline, it is possible to develop vehicles having a range of hundreds of miles. In particular, medium and heavy duty vehicles that can accommodate the packaging of gaseous fuel tanks may be promising applications. In the long-term, as with biomass, these gaseous fuels could be converted into hydrogen and would support the development of zero emission fuel cell vehicles.

Lastly, the venerable internal combustion engine, with or without hybridisation, will continue to serve consumers around the world due to widespread fuel availability and relative affordability, especially for long-distance, high speed operation. Affordability will continue to drive consumers to this option although regulations could drive the market in terms of "carrots" (incentives for other alternatives, price controls, etc.) and "sticks" (feebates, penalties and taxes).

As shown below, it is expected that there will be an increase in the variety of energy and propulsion choices for vehicle usage outside densely populated centres because of consumer needs for range, performance and utility and governmental needs to promote energy diversity, domestic energy sources and cleaner environments. For urban centres, however, urban dwellers and cities may increasingly support a move towards small electric, networked vehicles that can address the energy, environment, safety, congestion, parking, affordability and accessibility challenges. ■

Vehicle application map for various propulsion options