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Traffic Technology for Troubled Times

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Peak Oil (1) - is it still around? The recession following the 2008 global financial crisis has disguised the effects of the approach to Peak Oil, but the problem has not gone away. However, energy availability is only part of the problem of global sustainability.

In 2004 the UN-sponsored Millenium Ecosystem Assessment (2) stated that "Human activity is putting such strain on the natural functions of Earth that the ability of the planet's ecosystems to sustain future generations can no longer be taken for granted." Things have got much worse since 2004 - for example this summer NASA found that for the first time ever recorded melting was taking place simultaneously across the whole of Greenland (3).

The Global Footprint Network (4) takes the complexity of the various global ecological services (biological resources used and waste that has to be absorbed) and translates them into the area of the earth's surface needed to sustain them. In 1986 we went past the earth's capacity, in 2010 we needed 150% of the available land - we are using up our "capital" every day now just to survive. The global economy is basically a giant Ponzi scheme, one day the capital will run out and the scheme will collapse.

The Economics of Ecosystems and Biodiversity (5), a project to establish an up-to-date and quantified understanding of the economic value of the services provided by the Earth's ecosystem, has established that (for example):

- the economic value of the loss of ecosystem services (flood damage, drought, lost nutrients etc.) resulting from deforestation in China between 1950 and 1998 - calculated to be $12.2bn annually - is equal to 1.78 times the market value of the timber extracted;
- climate change arising from the draining of the Aral Sea - which reduced to 10% of its former size by 2007 - has led to creation of a desert with hotter drier summers and colder winters. This has had a devastating effect on the 35 million people who were previously dependent on the lake for water, fish and transport - there have been dramatic increases in disease and birth defects.

The UN medium projection of population growth is about 0.7% a year (6), leading to a world population of 9 billion by 2050, an increase of about a third from the current size. The IMF predicts global output per capita in 2050 will be three times that in 2005, Goldman Sachs (7) and PricewaterhouseCoopers (8) have made similar predictions. If

these predictions are correct, the population that is currently demanding over 150% of the planet's capacity will by 2050 be demanding more than 500%.

Our current economic system is reliant on growth to provide stability, with positive feedback systems pushing the system towards further growth. If growth falters these feedback systems go into reverse towards potentially damaging collapse. We are beginning to come up against the real limits to growth, not just in energy or the effect of carbon emissions, but in food production and basic raw materials. These will have serious consequences for the prosperity of all human beings. As Tim Jackson puts it in *Prosperity Without Growth - Economics for a Finite Planet* we need to consider how we can achieve prosperity which "consists in our ability to flourish as human beings - within the ecological limits of a finite planet" (9 p16).

What about improvements in technology - won't market forces lead to developments which will cater for these changes? Between 1979 and 2009 we used our general resources more efficiently on average at a rate of 1.2% a year, the rate for energy use was 1.1% improvement annually (10, p51). If those rates continue we will be using resources 38% more efficiently by 2050. This is not going to save us from the effects of demanding five times more than the planet can sustain.

Paul Gilding's book *The Great Disruption* (10) presents these arguments very clearly:

- "ecosystem breakdown has far-reaching economic impacts ... (which) will be global and system threatening, and ... these threats are no longer to our children's children, but to us." (10, p40)
- "For fifty years ... (there have been) endless debates (about climate change and the limits to growth) ... They are of relevance only to historians. We didn't change, so now change will be forced on us by actual physical consequences." (10, p49)
- "the global economy is now bigger than the planet, and that means that at some point the economy will stop growing. Whether that was in 2008 or is still to come in 2012 or 2015 is of historical interest only. ... Furthermore, all the evidence to date says we're not going to have a smooth landing" (10, p88)

So what is going to happen? The complexity, and interconnected nature, of the global ecosystem and the global economy mean that detailed predictions are bound to fail. However, some common themes can be identified:

- irrational optimists (mostly economists) think that economic growth can be decoupled from the effects on the ecosystem by the application of technology before the rise in global temperatures leads to a catastrophic downward spiral, and we can create a planet capable of sustaining 9 billion people, all aiming towards a lifestyle similar to the one we currently enjoy in the west;
- pessimists feel that resource wars and natural disasters will lead to a collapse of civilisation with profound effects on all species including humans. James Lovelock

(the founder of the Gaia theory) thought in 2009 that there would be a terminal decline and we would end up with a few hundred million people on the planet concentrated in the areas most suitable for growing food (11);

- optimistic realists like Gilding think that the wall of denial will soon break down, and that governments will move onto a war footing aimed at arresting climate change and building a new society which achieves prosperity without relying on continuous growth. It has been reported that Lovelock now feels that this is possible and that "humanity can change the way it acts in order to help regulate the Earth's natural systems." (12)

As a rational engineer I don't think the first scenario will occur, and if the second comes about developments in traffic technology will be the least of our problems. So the sensible thing to do appears to be to work towards the third scenario. It is not a utopian agrarian idyll, it is one in which engineers and technology will have an essential role, and it is one which we can all play a part in developing.

What features will characterise a sustainable society which is aiming to arrest climate change and is not based on continuing economic growth?

(based on Gilding p135-140) :

- A redefinition of prosperity which doesn't rely on acquisition of more stuff - "shop less, live more".
- Changes in taxation to include the environmental costs of activities where these are not reflected by the market.
- An energy economy based on electricity generated from renewable sources, but through the best means identified by the market. Our current global demand for energy each year is equivalent to the amount of solar energy falling on the earth in one hour, or that provided by the wind or geo-thermal sources in one month.
- Closure of the oldest power stations that emit large quantities of CO_2 and retrofitting those that are capable with Carbon Capture and Storage (CCS) technology.
- Rationing of electricity to respond to lower generation capacity and drive efficiency.
- Recycling and reuse of all materials, at least to recover their embodied energy.
- Reducing CO_2 in the atmosphere by the use of biopower and CCS, and the capture and/or burning of methane.
- Moving away from climate unfriendly protein.
- Changing agriculture and forestry to bind CO_2 into the soil.

- Rationing of the use of diesel and petrol cars and encouraging the transition to vehicles using renewable energy - types as determined by the market.
- A drastic reduction in the amount of air and high speed train travel, with a coresponding expansion in the use of electronic communication.

How might these changes impact on the traffic we control?

I don't think that the genie of personal mobility can ever be put back into the bottle, but it will be tempered by what we can afford, when environmental costs are fully taken into account. The likely results will be:

- a reduction in traffic intensity, but a greatly increased demand for efficiency and predictability of movement.
- major reductions in emissions as cars are powered by renewable energy delivered either from batteries or hydrogen and fuel cells.
- dramatically increased vehicle automation leading to autonomous cars being available in showrooms within 10 years.
- high levels of co-operation between vehicles and infrastructure to maximise efficiency for individual journeys and across the network.
- diversification in ways of providing personal mobility, such as renting/leasing or sharing of appropriate vehicles for each journey rather than simple car ownership.
- different forms of public transport - smaller, demand-responsive, buses and shared taxis creating a spectrum between existing taxis and stage carriage buses.
- in all cases, identification of the full costs of making each journey - is it necessary, and what is the most efficient way of making it?

How might these changes impact the traffic technology we develop and use?

Energy cost increases will prompt individuals, on foot and in both public and private vehicles, to provide the network with information about where they are and where they wish to go, so that they can optimise their journeys, which will help us optimise the network. Energy prices will impact even more severely on freight operators, so we can expect them to be leaders in this area of development.

These pressures will also lead to dramatic increases in the demand for information about how the network is performing - historically, in real-time and how it will be performing in the future. We will need to develop real-time simulation of alternative scenarios, and improved ways of optimising network operation.

All vehicle manufacturers are working on rapid and progressive development of vehicle automation, building on what is currently available with in-vehicle displays and driver assistance through to fully autonomous vehicles. This will completely change how vehicle controllers/drivers interact with the network, and how we will work as traffic controllers. Google's experimental autonomous vehicles have already completed 300,000 incident-free miles on public roads (13). KPMG and the Centre for Automotive Research predict that autonomous cars will be available in showrooms in 2019, and that the fleet will be large enough for self-driving applications by 2025 (14). Electronic road trains represent an intermediate level of technology. Volvo demonstrated its system on public roads in Spain in May this year (15).

We will have a reduced emphasis on individual control of junctions - autonomous vehicles will be able to communicate with nearby vehicles to negotiate how potential conflicts are managed. We can also look forward to the demise of the traffic signal and the variable message sign - replaced by communication between the infrastructure and onboard systems - just displays initially, direct links to the autonomous vehicle will come later. This will also lead to the end of safety cameras and speeding tickets - autonomous vehicles will not be able to break the speed limit or jump a red signal.

When a large autonomous fleet is available there will be a much reduced need for parking infrastructure. If a vehicle is truly autonomous you don't need to be in it while it drives itself to pick up someone else for another journey instead of sitting in the office car park all day.

How this will all be financed must also change if our growth-fixated economy is replaced by something more sustainable. A post-growth economy probably won't be able to support complex debt-based arrangements such as PFI schemes. If the energy for transportation comes from renewables perhaps road pricing's day may finally come. Ownership of a single vehicle may be replaced by membership of a mobility scheme giving access to an appropriate vehicle for each journey. Peugeot's Mu scheme points the way (16).

The traffic control community must also evolve, working more with vehicle manufacturers and operators rather than building on-street infrastructure. The role is likely to be in monitoring and managing the real-time network, and modelling how it is going to perform in the future. We cannot predict if that will be as an employee of, or subcontractor to, a large corporation or central, regional or local government. What is clear is that the times are likely to be interesting.

References

1) - The Double Whammy - Climate Change and Peak Oil - how will it affect traffic control?, Peter Bull, JCT Symposium 2008

2) - Living Beyond Our Means, Natural Assets and Human Well-Being, Statement by the Board, Millennium Ecosystem Assessment – http://www.maweb.org/documents/document.429.aspx.pdf

3) - http://www.nasa.gov/topics/earth/features/greenland-melt.html

4) - http://www.footprintnetwork.org/en/index.php/GFN/page/world_footprint/

5) - TEEB for Business, Chapter 2 Annex available at http://www.teebweb.org/ForBusiness/TEEBforBusinessDraftChapters/tabid/29434/Default.aspx

6) - See UN Population Division population projections at http://esa.un.org/unpd/wpp

7) - Dominic Wilson and Anna Stupnutska, "The N-11: More Than an Acronym", Goldman Sachs, Global Economics Paper No. 153, 2007. Available at http://www.goldmansachs.com

8) - John Hawksworth, "The World in 2050: How Big Will the Major Emerging Market Economies Get and How Can the OED Compete?", PwC 2006. Available at http://www.pwc.com

9) - Tim Jackson, *Prosperity Without Growth - Economics for a Finite Planet* (London: Earthscan, 2011)

10) - Paul Gilding, *The Great Disruption* (London: Bloomsbury, 2011)

11) - James Lovelock, *The Vanishing Face of Gaia: A Final Warning* (London: Allen Lane, 2009)

12) - http://worldnews.nbcnews.com/_news/2012/04/23/11144098-gaia-scientist-james-lovelock-i-was-alarmist-about-climate-change

13) - http://www.theatlantic.com/technology/archive/2012/08/googles-self-driving-cars-300-000-miles-logged-not-a-single-accident-under-computer-control/260926/

14) - http://www.cargroup.org/assets/files/self_driving_cars.pdf

15) - http://www.motorauthority.com/news/1076588_sartre-self-driving-road-train-takes-to-public-roads-video

16) - http://www.mu.peugeot.co.uk/