Over the rainbow

(a mildly cynical look at future transport technology)

Professor Eric Sampson CBE

Transport Operations Research Group
Newcastle University

Is it all a dream ?

Somewhere over the rainbow
Way up high
And the dreams that you dream of
Once in a lullaby

Predicting is risky

Airplanes are interesting toys but of no military value.

Maréchal Foch, Professor of Strategy, École Supérieure de Guerre, 1912

Very interesting, Whittle, but it will never work.

Cambridge Engineering Professor on Frank Whittle's plan for a jet engine, 1938

I think there is a world market for maybe five computers

Thomas Watson, chairman of IBM, 1943

We don't like their sound, and guitar music is on the way out

Decca Records rejecting the Beatles, 1962

640K of memory ought to be enough for anybody

Bill Gates, 1981

I'm gonna be a great President.

Donald Trump 2016

Some recent predictions / goals

Self-driving cars in use by 2021

50% of cars driverless by 2030

Zero road fatalities by 2050

Road fatalities halved by 2030

Zero vehicle emissions by 2050

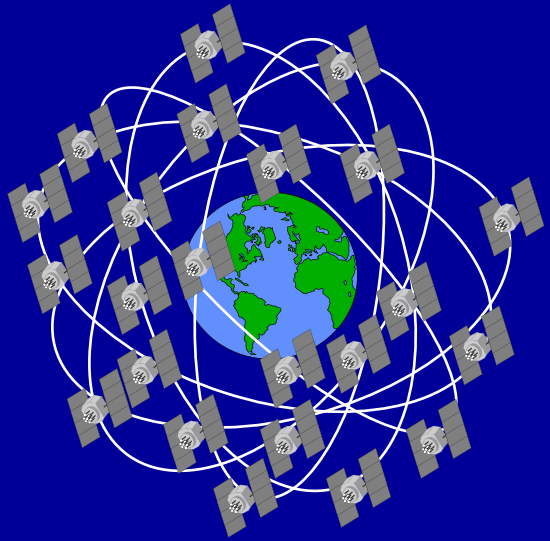
No cars with combustion engines by 2040

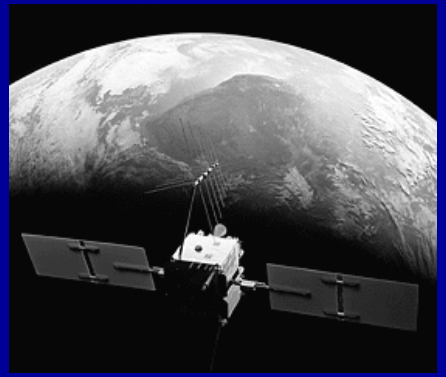
Mobility as a Service ‘profitable’ by 2025

Transport Technology Revolution 1

≈ 2600 BC

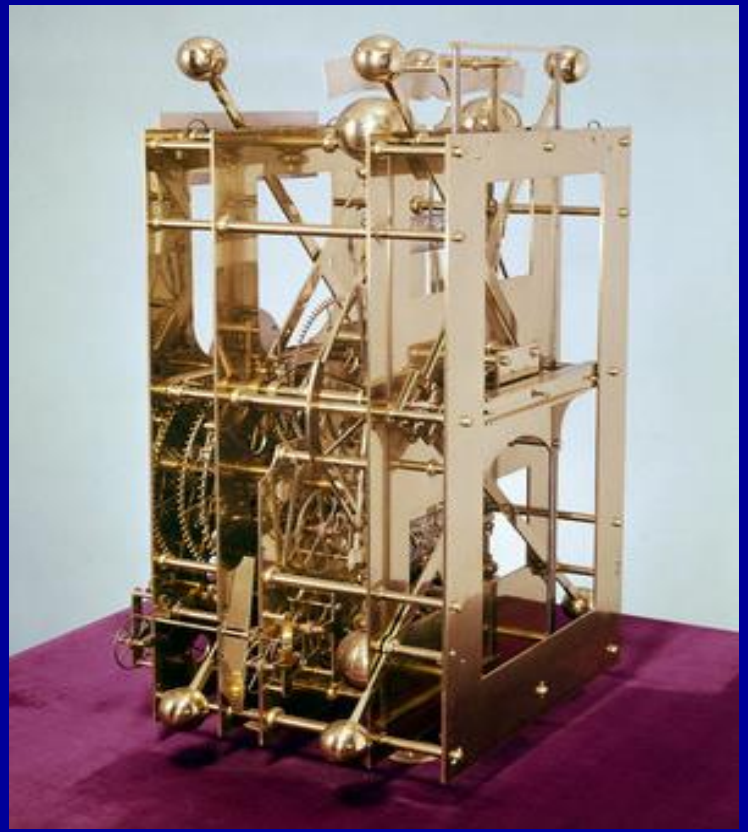
Chinese Chariot





Transport Technology Revolution 2

1760 Longitude through the H4 Clock (John Harrison)



Transport Technology Revolution 3

1844 Samuel Morse (Telecomms)

1857 Elisha Graves Otis ('invents' the traffic jam)

1867 William Phelps Eno (age 9: Traffic management)

1971 First microprocessor chips

1973 Job Klijnhout (Automatic Incident Detection)

1978 First real hand-held mobile phone

Transport Technology Revolution 4

Telecomms Generation	Available
1	1978
2	1988
2.5	1995
3	2003
LTE / 3.5G	2009
IMT-A / 4 G	2012
5G	2019 ?

1960 Disc drive 1.1 tonne; 50 Mb

1976 First digital camera

Transport Technology Revolution 5

1973	First commercial portable computer
1976	ARPANET set up (2 nodes)
1982	IBM PC launched
1983	First commercial digital camera
1983	Korean Airlines 007 (269 killed)
1984	Reagan allows civilian GPS
1985	CD–ROM invented
1989	WWW proposed
1991	First digital mobile phone
1995	DVD invented
2000	Clinton removes GPS ‘wobble’
2007	DARPA Driverless Challenge

So what does it add up to so far ?

- Everything is becoming instrumented / digital

Yes; everything is becoming digital

So what does it add up to so far ?

- Everything is becoming **instrumented / digital**
- Everything/everyone is becoming **interconnected**
- **Open Data** is transforming transport markets
- Consequently everything is becoming **intelligent**
- The physical domain is becoming increasingly **digital**
- This facilitates sharing and cross-over apps
- Digitalised transport becoming a part of **retailing**
- Owning infrastructure is becoming less valuable
- Buying / using data opens many new options

What's driving the changes ?

Supply side

- Cheap powerful devices
- Personal intelligent devices connected 24/7
- Open data enabling new businesses
- New services based on integrating components

Demand side

- Demand for seamless & interoperable services
- Realising the sum is greater than the parts
- Growth of social media

It’s the Fourth Industrial Revolution

First	Mechanisation (*eg* textiles)
Second	Mass production (Ford model T)
Third	Digital and Location technologies (still)
Fourth	Connectivity
	all the time
	anywhere
	between everything

Where is this technology taking us ?

Vehicles

Roads

Drivers

Mobility / Accessibility / Payment

Vehicles 1

- Structure
  - Plastics / carbon fibre = Lighter body (= smaller engines)
  - Steel → Aluminium
  - Nanotechnologies
- Powertrain
  - All-electric or hybrid
  - Advanced petrol / diesel
  - Batteries for all-electrics or hybrids
  - Fuel cell
  - Sustainable power
  - Non-battery energy storage

Vehicles 2

- **Features**
  - Internet link for information and entertainment
  - Vehicle–Infrastructure linking for safety, management, condition report (C-ITS)
  - In-vehicle ‘black boxes’
  - Lateral & longitudinal position monitors
  - Highly automated safety functions

- **Control systems**
  - Driver in control → Driver in command
  - Vehicle–infrastructure & vehicle–vehicle external control for crash-proof vehicles
  - Highly automated and fully autonomous vehicles

Roads

- **Management**
  - Simple urban & inter-urban network management
  - Complex inter-urban network management
  - Complex urban network management
  - Reactive with information sharing
  - Predictive / anticipatory
- **Access**
  - How long for unconstrained and free ‘turn-up-and-go’?
- **City space issues**
  - Passenger *v* Freight
  - Multiple autonomous pods ? ?

1 Bus ≈ 20-40 cars 1

1 Bus ≈ 20-40 cars 2

1 Bus ≈ 20-40 cars 3

Drivers

- Independence – removing the weakest link
  - Unpredictable
  - Easily distracted; often unsafe / dangerous
  - Inconsistent in responding to information
  - A poor source of information
  - Source of complexity / difficulty (see ‘Intentions’)
- Insurance
  - IVUs enabling pay-as-you-drive, accident analysis
  - Mandatory in-vehicle device (ISA ?)
  - 1968 Vienna Convention
- Intentions
  - “Turn up and go” ≠ rail, marine, air

Mobility / Accessibility / Payment

- Smart mobility and payment
  - Personalised journey planners
  - Biometrics for access / payment
  - Smart Cards for ticketing / payment and P.A.Y.G
  - Road pricing linked to distance or congestion
  - Road pricing linked to carbon trading
- Replacement of mobility ?
  - Remote working / Park-and-work
  - Immersive / 3D videoconferencing
- Buying the ends not the means: buying mobility
  - Bus / Rail / Tram annual bulk purchase + discount
  - Mobility as a Service

Some recent predictions / goals

Self-driving cars in use by 2021
50% of cars driverless by 2030

Zero road fatalities by 2050
Road fatalities halved by 2030

Zero vehicle emissions by 2050
No cars with combustion engines by 2040

Mobility as a Service ‘profitable’ by 2025

Towards self-driving cars – driving today

Collect information

See

Touch

Hear

(Smell)

In-vehicle information

Process information

Brain

Muscle memory

Experience

In-vehicle automatic systems

Use information

Power steering

Brake

Accelerate

Brake boost

ABS

Air Bag

Stability progs.

Collision avoid

Driving 2050 – the “Machine” Model

Sensors collect information

- Radar
- Lasers
- GPS fix
- Cameras
- Accelerometers
- Information to & from vehicles and roadside

Intelligence processes information

- Computers
- Patterns
- Memory
- Learning
- Strategies
- Maps

Actuators use information

- Steer
- Brake / Accelerate
- Air Bag
- Stability programmes
- Collision avoid

Towards zero fatalities

Component actions

- Reduce traffic
- Strong traffic management
- Eliminate inappropriate speeding
- Eliminate the possibility of driver error

A provocative thought

- How safe is “safe enough” [pharmaceuticals ?]

Towards zero emissions 1

Component actions

- Widespread car sharing
- Remove all combustion engines
- Develop electric trucks
- Develop electric airplanes
- Extend charging / H_2 networks
- Boost national power generation

Another provocative thought

- Allow ICEs with exhaust gas treatment ?

Towards zero emissions 2

It’s not very easy

- Transport 26%
- Energy 26%
- Business 18%
- Residential 16%
- Other 14%

Towards Mobility as a Service

Component actions

- Data on services available
- Data on timetables available
- One-stop information & payment
- Integration of supply side
- An offering that works outside cities
- Interoperability at least nationally

The top 10 technology-linked challenges

- Devising generic test regimes for automated cars
- Managing ‘control hand back’ in semi-autonomous cars
- Managing a mix of highly- and non-automated vehicles
- Specifying traffic management for autonomous cars
- Getting standards for digital mapping
- Establishing if a Hydrogen regime is efficient / effective
- Finding new techniques for storing energy
- Sorting out liability issues for automated cars
- Balancing data sharing, security and privacy
- Matching road safety technology to personal freedom

My predictions

Self-driving cars 2021	Yes at specific places
50% driverless by 2030	No; perhaps 15%
Zero fatalities by 2050	No
Fatalities halved by 2030	No; perhaps down 20%
Zero emissions by 2050	No
MaaS ‘profitable’ by 2025	If Governments act
No ICE cars by 2040	Depends on Govt nerve

How might we do better ?

- Get industry & public sector cooperating nationally
- Get industry & public sector cooperating internationally
- Recognise that some companies want autonomous vehicles for their data not mobility use
- Get regulators to accept more risk
- Hold trials not talks
- Consult and involve travellers of all types
- But do remember – there are no Silver Bullets

Was it all a dream ?

Somewhere over the rainbow
Way up high
And the dreams that you dream of
Once in a lullaby
Somewhere over the rainbow
Bluebirds fly
And the dreams that you dream of
Dreams really do come true

Thank you for listening

eric.sampson1@btinternet.com