



Exam

Mastering Theories of Technology and Innovation II

course code: GEO4-2258

MSc Programme Science and Innovation Management

Faculty Geosciences

University Utrecht

27 January 2010

10.00 – 13.00 Educ Megaron

Professor:

Harro van Lente

The exam consists of 4 open questions with the same weight.
Please be precise in your answers and write as readable as possible.

Question 1 – What is science

- a) What demarcates science from other forms of knowledge according to Karl Popper and according to Thomas Kuhn?
- b) According to Popper, science should be based on the principle of falsification. Why would a science based on the principle of induction lead to an infinite regress?
- c) What is the role of communities in the progress of science according to Logical Positivism, Karl Popper, Thomas Kuhn and Bruno Latour?

Question 2 - Making facts

- a) What is a ‘black box’ and why does it play such a central role in science and technology? Use the example of GRF in your answer.
- b) At the end of Chapter 1 of *Science in Action* Bruno Latour concludes about scientific texts: “This literature is so hard to read and analyse not because it escapes from all normal social links, but because it is *more* social than so-called normal social ties” Explain this conclusion.
- c) Harry Collins argues that “as soon as an experiment is successful – which in turn reaffirms the independent regularity of nature - any irregularity must be explained as arising out of human error”. What are his arguments? Does this also apply in the case of using or testing innovation theories?

Question 3 - Explaining

- a) What are auxiliary hypothesis, naturalistic fallacies and epiphenomena?
- b) Why would it be both attractive and simplistic to adopt Poppers model (of conjecture and refutation) in both projects such as the Superconducting Supercollider?
- c) What are the three principles of causal explanations.

Question 4 - Using theories

Last month, the *Economist* reported about difficulties in the development of electric vehicles. Suppose you were interested in investigating this problem. Indicate how you could use the following three theories to study the development of electric vehicles and the problems of ‘range’ and ‘range anxiety’. Explain what the use of these theories in your research would highlight in the case of electric vehicles and what it would ignore.

- a) SCOT
- b) Path Dependency
- c) Technological Cycles

Powering the drive

Economist, Dec 10th 2009

Motoring: Manufacturers of electric cars, and prospective buyers, will have to find ways to deal with “range anxiety” for the next few years

Illustration by Allan Sanders



OVER the next three years most of the big carmakers, along with several newcomers, are planning to launch dozens of all-electric vehicles—in other words, cars that are entirely battery powered. Unlike hybrid cars, which are powered by a combination of an electric motor and a petrol engine, they will not be able to fall back on fossil fuels when the battery runs low. Accordingly, potential customers are expected to suffer from what the industry has come to call “range anxiety”.

This is no idle malady, as test-driving some of the first electric cars and prototypes reveals. Motorists have become used to getting into an ordinary car in confident expectation of being able to drive hundreds of miles on a full tank—and, with an occasional glance at the fuel gauge, finding a filling station when the fuel runs low. By contrast, the gauge showing the remaining power left in the battery of an electric car demands almost constant attention.

Small electric cars, designed for use in cities, can typically travel some 100km (62 miles) on a full charge. But the range of an electric car depends on how it is driven, as well as its battery capacity. If you zoom along fast roads or go up a lot of hills, the battery depletes more rapidly. Switching on the lights, the heating and the wipers also takes its toll, as does carrying passengers. Drivers are not used to taking account of such things before setting out on a journey. But with an electric car you need to. If there is only, say, a 25% charge left in the battery, nipping out with the family to a cinema about 15km away on a rainy night might leave you stranded. A trudge to a filling station will not help, nor might roadside assistance. When an electric car runs out of juice you need a power socket—and the car needs to be plugged in for several hours to get a good top-up.

Despite range anxiety, electric cars do have a lot to offer. Most are quick off the mark, thanks to the ability of an electric motor to deliver torque almost instantly. This means they do not need a gearbox, making both driving and maintenance simpler. But in most respects, electric cars drive and handle much like ordinary cars. With less machinery to go wrong, they should be cheaper to service. They should be cheaper to run, too: the cost per mile for electricity is much lower than for fossil fuels. But real cost-of-ownership calculations will not be possible until more electric cars arrive in showrooms displaying their sticker prices. The cost of batteries will make electric cars more expensive than petrol ones, although the batteries may be sold or leased separately.

It's not your volt

To cope with range anxiety, prospective buyers need to be sure about two things when selecting a particular model: how it will be used and how it will be recharged. There will be a wide spectrum of alternatives. A small car, like the forthcoming Smart Fortwo Ed, is tiny enough to slip into the smallest parking places, nippy in town (it takes 6.5 seconds to reach a speed of 60kph, or 37mph) and capable of coping with a daily commuter round-trip of 70-80km. Alternatively, the Tesla roadster, with a top speed of 200kph, would leave it in the dust and keep going for another 300km or so after the Smart's battery was flat. But the Tesla costs about \$100,000, compared with around \$20,000 for the Smart. The Mitsubishi i MiEV is a capable small car, and it has four seats. The MINI E has a range of around 160km, but its rear seats are taken up with batteries so it is only a two-seater. And Renault, which is making the biggest push into electric vehicles, is planning to launch a scooter-type car called the Twizy (in which a single passenger sits behind the driver like on a motorcycle), a midsized family car called the Fluence and the sportier Zoe.

Having found an electric car with the appropriate range, performance and number of seats, buyers must then consider how it will be charged—something that may only be practical on a private driveway or in a garage. BMW is restricting the field trial of its MINI E to drivers with off-street parking, and is fitting special high-power 240-volt fast-charging stations as part of the deal. Using a dedicated high-current electric circuit, like those installed for electric ovens, these can recharge the MINI E in 4.5 hours. (With an ordinary mains socket, by contrast, recharging could take all day.) For cars with smaller battery packs, like the Smart, overnight recharging from a conventional socket is possible.

Being able to plug in once you get to work makes things easier, too. Some streets and buildings are being fitted with recharging stations, but such infrastructure will take time to appear. Renault is particularly keen to promote fast-charging stations, along with exchange centres on motorways where depleted batteries can be quickly swapped for another one during long journeys. (This approach is being championed by Better Place, a start-up which has developed robots to handle the battery-swapping process.) Meanwhile the tinkerers are already at work: some are planning to build small, petrol-powered generators which can be towed behind battery-only cars on long trips.

More standards would help. At this stage there is little standardisation between manufacturers when it comes to battery packs. Sockets also vary, although standards are emerging in America and Europe. In both cases the sockets will allow fast-charging and will include a communications interface so an electric car can, for instance, identify itself for billing purposes when plugged into a public recharging spot. Only when such spots are commonplace will range anxiety finally subside.