SUSTAINING 'PEAK PRECISION' - CAN A ZERO-CARBON FUTURE BE A HIGH-TECH FUTURE?

I suppose that, like most Clean State readers, my vision of a Zero-Carbon future is mixed up with ideas of a self-sufficient low-tech lifestyle where we all live in sustainable harmony with the Earth. When I attended this year's CAT Members Conference and looked back on previous Members presentations I was struck by the number of talks that echoed this theme. Yet along with composting, community fruit orchards, straw bale eco centres, permaculture and transition towns another thread was evident. Wind and solar power and heating, hydro-electricity, 'intelligent' energy-saving buildings, 'smart' power grids and meters and other Zero-Carbon solutions that were clearly high-tech were also on the agenda. But none of these things sound very Gaian or Whole Earth to me.

I read Zero-Carbon Britain 2030 (ZCB) carefully and this got me thinking. There seemed to be two routes of managed descent to a Zero-Carbon sustainable future. One, the traditional route I suppose we could call it, would renounce technology (other than that of the hand-made variety) and go straight for self-sufficiency via transition towns and permaculture. The other route sees high-technology as part of the solution to sustaining a lifestyle that is similar in some ways to the current one, but that manages a descent which is not only feasible but which also contains a message which is more acceptable to the majority of people.

So, I volunteered to give a talk at the CAT Members Conference 2012 on the need to maintain a minimum levels of what I then called 'Peak Precision'. The basic idea is simple, high-tech can't be handmade – it requires precision engineering of all sorts, it requires computer-controlled manufacturing machines, it requires software, it requires clean rooms, it requires many things that sound like part of an eco-persons nightmare. So in the presentation (which is downloadable, see link [1] below) I took a few everyday icons of low-carbon lifestyles and examined their 'tail' of dependencies on science, technology, engineering, materials fabrication, even chemistry and physics. Here's some examples …

Consider the humble low-power wind-up torch with bright LEDs – could you make this by hand in a low-tech way? No, you can't – that would mean there'd be no LED torches in the future if we go low-tech. What about solar panels? They need ceramics technology, high temperatures and exacting precision to make the silicon layers - they can't be crafted either. How about wind turbines? Their high-efficiency, light, strong blades were computer designed. Hand-made? I think not. What about that essential low-carbon item – the bicycle? Modern bicycles have light titanium frames, are efficient, easy to pedal with sophisticated gears and brakes - to revert to blacksmithed ones would be return to the heavy iron 'boneshakers' of the past.

At this point you may, quite rightly, be saying that people have made exquisite precision objects by hand over the millennia – and of course you would be right - such as beautiful jewellery, watches and artefacts of many types. Even the fabled Antikythera Mechanism (see http://www.antikythera-mechanism.gr/), probably designed by Archimedes, is a work of art whose accuracy has baffled modern scientists and technologists till recently. But these objects are one-offs which took weeks or months of laborious effort to produce. Which was fine when there were only a few hundred million people on the planet, but not adequate for serving the needs of billions now.

So, what was our journey to this inter-dependence with advanced technology? A thousand years ago our machines were simple, one-off and individually crafted. It wasn't really till the 1400s and Caxton's printing press that people could use machines to mass produce items, but it was hard work. By the late 1700s steam power was revolutionising human lives, multiplying our 'strength' so we could lift huge items and transport them great distances across land and sea. With the arrival of the internal combustion engine and flight human activities expanded exponentially into areas of endeavour previously undreamed of, such as electronics and then the digital age.

[1] Presentation available from: **www.cat.org.uk/snip/21535**

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By the 1950s we were making mechanical and electrical devices at scales of illimetres. Although individually, objects could be made to fine sub-millimetre tolerances in their outer dimensions, the objects themselves (overall size) could not. Hence valves, radios and radiosets were physically big and used relatively large quantities of energy.

By the 1970s we were fabricating novel silicon-based materials that enabled smaller devices to be manufactured that used less energy. The transistor radio became ubiquitous and could be run off batteries and was small enough to take to the beach to annoy the grandparents! Scale of manufacture was now down to micro-meters, with tolerances an order of magnitude finer. Note that other scales are relevant here too: radio waves from long-wave, to medium wave to short wave – FM was just on the horizon (shorter wavelength and higher frequencies).

By the 1990s, CMOS (Complementary Metal-Oxide Semiconductors with very low power needs) fabrication had arrived and devices had dimensions of nano-meters. Now, on memory chips, the transistors were so tiny they had to be packaged into 'chips' big enough for the manufacturing machines to pick them up and handle them - ie, the assembly-line technology was still 1970s precision and had not yet caught up.

And today we have smartphones. In the past 60 years humanity has moved from devices the size of a wardrobe using thousands of watts of power, to devices a millionth of the size, using a millionth of the energy and yet - a million times more capable. In one smartphone device we have radio receiver and transmitter, camera, clock and a computer that would outperform previous 'super-computers', a video recorder and player, music player and so on and so on …and all using ultra ultra short-wave signals at GHz transmission rates. Of course there's a limit to miniaturisation, based on the physics of atoms and molecules and sub-atomic forces – but it's not a finite thing we'll run out of like fossil fuels – at 'worst' precision will level out. We can now achieve extraordinary precision at many levels and across timescales.

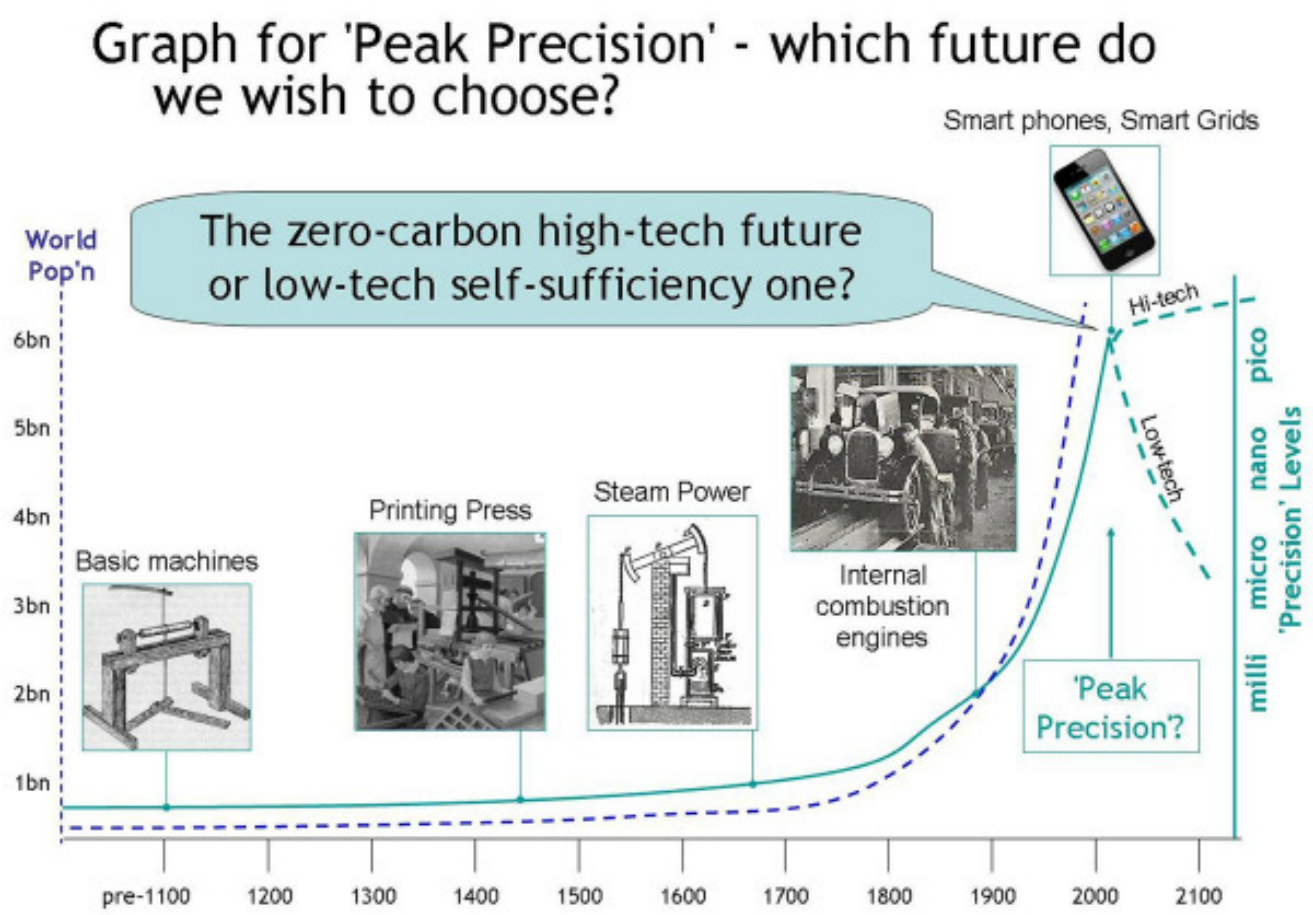

Figure 1 – The 'Peak Precision' Graph - Which future to take?

Figure 1 illustrates this journey with a graph showing the increasing ability of humanity to make devices to ever finer precision (right-hand axis) over time. It shows on the timeline when the iconic examples previously discussed came about. There is, you see, a link between our ability to produce things which are standardised and precisely interchangeable and the development of humankind. When everything had to be handmade, when even every individual nut, bolt and screw was unique, that took time. When something broke, you could not reach into a box for a replacement, you had to make another to match the broken part. Then, as innovation moved on, we were able to harness engines and machines to magnify our capabilities and our influence grew – for good or for ill. With the Enlightenment came the growth in science and technology and the incentives to invent new and ever more intricate devices. Along with this came population growth (left-hand axis of Figure 1 and the dashed line) - though the nature of the connection between increases in precision engineering and the expansion of cities, towns and communities is a complex one which has led us eventually to the current climate change challenges.

So now we face a choice. To relinquish the ability to make finely engineered devices and take the low-tech self-sufficiency route forward, or to sustain our manufacturing capabilities as a route to a low-carbon but high-tech future? Figure 1 indicates that we may be at a peak of precision - but of course precision doesn't have to drop back from its peak . . . it's up to humanity to see its value and to sustain it if it wishes.

Why might we unwittingly let these precise capabilities go? Well, precision is almost invisible, plus it's not 'cool'. We make fun of those 'boring' people, usually men, who subscribe to the 'Nuts and Bolts' weekly magazine – with their 'obsessive' attention to detail .. when did you last take their skills for granted? Also, precision engineering is not directly on anybody's 'bottom line' - if 'the market' doesn't want it then it will let the precision go. BUT, we need may to sustain that precision for the Zero-carbon General Good – and who is responsible for making that happen? I would maintain that, if we are to take the high-tech route to the future, then initiatives like CAT's ZCB 2030 need to express much more clearly what that future depends upon in terms of science, technology and so on engineering terms – talking just about 'green skills' is necessary but not sufficient. Which route do you think we should follow?

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