Wrong...but right enough

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In recent weeks I have been forced to think a bit about right and wrong…not in the sense of good and bad but rather in the sense of accurate and inaccurate. When I was at school, my metal-work teacher very proudly boasted that – in his workshop – we worked to an accuracy of 1/1000 of an inch (it was a long time ago). By contrast, my woodwork teacher – never one to be out-done – insisted that in his workshop we had much higher standards than that since we worked till it was right. I was never quite sure which of them was the more demanding.

I was reminded of that experience in my recent trip to Sweden. Every year I spend some weeks working in the university of Stockholm – and I have been partly responsible for supervising a research student – Per – preparing a very interesting PhD about the role of the many different kinds of knowledge that have relevance to us in technology. His latest tutorial paper included a fascinating account of some examples of 'knowing' that are technically 'wrong' (in the sense of *mistaken* or *confused*) but that still remain useful.

> In the 1990's, I worked in the computerised automation and industrial robotics business. We often used vacuum grippers on the robots and pick-and-place units. When I and my colleagues discussed the vacuum, we talked about it almost as if it was a substance. The so-called vacuum (which of course was not a proper vacuum, but the pressure was low) was created in an ejector where compressed air blew out of a nozzle, the vacuum was then transported through pipes and hoses to the suction cup in the robot's hand where its sucking abilities fixated the object it was to grip.
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> The view of vacuum as a sucking substance has no support in science, though. A true vacuum is literally nothing, and can therefore not produce forces. It is the pressure of the air outside that pushes the object toward the suction cup. Nevertheless, talking of vacuum as a sucking substance makes sense in many situations. It is perfectly possible to design grippers for robots and handling automata using this model, as long as the machine is used in contexts with approximately normal air pressure.
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> (Norström P. Tutorial paper. Oct 2010)

In the paper, Per provided all sorts of other interesting examples where incorrect science is used perfectly successfully in technology.

…centrifugal force, the force that pushes a body moving following a circular path away from the centre, has been experienced by everyone who ever visited an amusement park or travelled in a car through a narrow curve at high speed. It has been experienced even though it is not a real force, but a fictitious force caused by a moving frame of reference. That it is only fictitious does not stop engineers from using it; reasoning as if centrifugal forces exist leads to useful predictions in many contexts.

At the heart of his paper is the idea that to interpret 'reality' we create all kinds of models that are more-or-less approximations of that reality, and being only approximations, they are liable to error or mis-representation. He cites the well known case of electrical circuits being represented as water flowing in a pipe. And he instantly falsifies the analogy by pointing out that a cut hose-pipe leaks water, whereas a cut wire in a circuit does not 'leak' electricity…or at least not in the same way. I suppose one might see a spark to earth – from a cut wire – as some kind of 'leak'.

Anyhow his point that technological knowledge is different from scientific knowledge seems to me to be sound. The truth test for scientific knowledge is literally to do with truth. Is it really true that…? But the truth test for technological knowledge is NOT about its truth but about its usefulness. If it's *useful* to hold a half-truth (or even a falsehood) so as to arrive at an effective working solution then that is justification enough. The 'truth' test is simply efficaciousness. Any old half-truth will do as long as it's useful. It's a bit like being a technological witch-doctor.

But the tutorial with Per then took another turn. For surely in the *education* world of schools and curriculum, neither scientific nor technological knowledge (allowing for now that they might be different things) are the key issue. Schools are premised on the idea that students start from a state of NOT knowing and gradually grow through various degrees of half-knowing into a state of 'rather-more' knowing. In short – in a learning context – we are wrong (I think) to use the term 'knowledge' as though it represents a *state* of being, and we should rather think of 'knowing' as a process – as representing a state of growth – a state of emergent transition.

The importance of this for design and technology is that our students are constantly getting into design tasks that require them to *find out about* things that are (at the

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outset of the task) unknown – or maybe half-known. Rather than saying that they can't do that sort of designing until they have learned the text-book – what we do is formulate a view of knowing that empowers learners to take action with *provisional* knowledge – and that encourages them to refine and deepen that knowledge in response to the demands of the task. So we have deliberately transposed the issue of 'knowing' stuff into the business of 'finding-out-about' stuff. As the DES pointed out thirty years ago….

> The designer does not need to know all about everything so much as to know what to find out, what form the knowledge should take, and what depth of knowledge is required for a particular purpose.
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> (DES 1981 p. 5)

Some years after this really quite radical statement emerged from the DES, we (in TERU at Goldsmiths) produced (as part of the 20,000 pieces of work collected in the APU research project) all kinds of evidence to substantiate the idea. Amongst this rich collection is the following illustration from a 15 year old who was tackling the task of generating a cooking timer. It was to be a hand-grip size piece with a twisting top that enabled the user to 'dial' time (e.g. four minutes for a boiled egg). Once set, the device was illuminated from the inside and a yellow filter of light moved round to indicate the lapse of time. At the appropriate moment an alarm was automatically triggered.

What I would draw readers' attention to in particular is the little scribble of text in to top right corner. The student is concerned that when cooking, one ends up with slippery hands so its necessary for the twisting top piece to be made of (or maybe coated with) "grippy-stuff…".
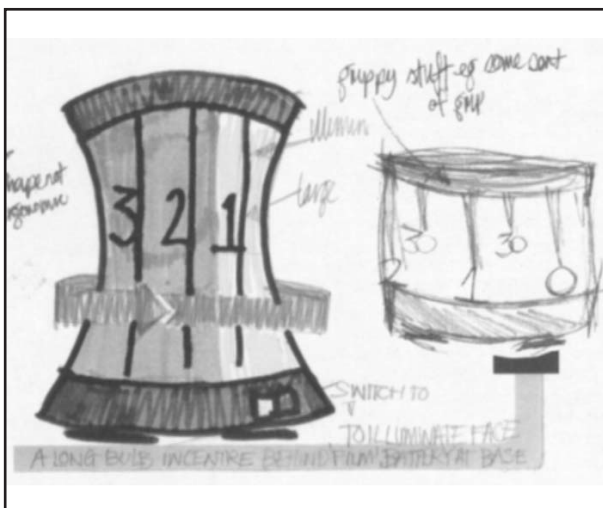
This is a classic example of a student operating in a state of half-knowing. S/he knows that there are materials out there that have a grippy quality – but the point that s/he is at just now does *not* require that s/he knows all the details of it. It is enough to acknowledge that this needs to be found out – and for now s/he presses ahead with the design on the assumption that the details can follow.

Out of interest, I put 'grippy-stuff' into Google and got 14.5 million hits in 0.3 seconds – the top one being grippy stuff for sailors to put on the boat trapeze to have better foot-grip. And thereafter followed pages and pages of really useful stuff that our design student could readily have capitalised upon – including technical specifications and sources for purchase. It is inconceivable that this should all have been known by the student *before* starting out on this project. The information they need will be driven by the directions in which their project takes them.

It follows of course that both students and teachers must be able and willing to operate in this indeterminate zone of activity where hunch, half-knowledge and intuition are essential ingredients. As early as 1983, Hicks described this pedagogic challenge for teachers.

> Teaching facts is one thing; teaching pupils in such a way that they can apply facts is another, but providing learning opportunities which encourage pupils to use information naturally when handling uncertainty, in a manner which results in capability, is a challenge of a different kind.
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> (Hicks, 1983, p. 1)

Google did not exist when our APU student undertook that activity. In fact it's a bit of a shocker to realise that 15 year old student is now 37 years old. I wonder what s/he is doing.

References

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REFLECTION