Where did technology go?

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Abstract
In the beginning there was techne and episteme. Today we have difficulties with finding technology in the implementations of the curriculum in, at least, Swedish schools. So where did it go? I will give arguments that it is all there but it suffers from specialisation. If we think of techne appearing before the different natural science subjects it is a very natural thought that technology today is what is left "between" the more specialized subjects. However I believe that technology is created also in the meeting between two specialized subjects. When a physicist work with a chemist to solve a problem, than this work will very easy appear as technology from one or both parts view.Also not a revolutionary thought this may explain why the Swedish higher education is organized as it is and why we have diffculties to make a working curriculum for the lower grades.

In Sweden It is possible to study for a master in engineering physics with very little content that is explicit technology. The same can be stated in other subjects but there is a difference then one study a lot of specialization in that subject. Does this make sense? In order to evaluate this we have to look at the definition of technology. If one look for a definition of the word technology on the web one do not and a consensus on the definition. This may not be surprising as even in books dealing with teaching technology the use of the word is consistent within the books. As an example de Vries refrain from defining Technology in his book "Teaching about Technology"[Vries (2005)]

"Throughout the book I will take the term 'technology' in the broad sense of the human activity that transform the natural environment to make it _t better with human needs, . . ."

and Heidegger take the meaning of the word as well known [Heidegger (1993) p.154]

"We have to seek into what Greeks call tèquh. Yet we must divorce this Greek word from our familiar term derived from it, "technology", and from all nexuses of meaning that are thought in the name of technology."

I will as an example give two definitions from the web:

- . . .the practical application of science to commerce or industry [http://wordnetweb.princeton.edu/perl/webwn (n.d.)]
- Technology is a broad concept that deals with an animal species' usage and knowledge of tools and crafts, and how it aspects an animal species' ability to control and adapt to its environment. ...[http://en.wikipedia.org/wiki/Technology (n.d.)]

The discourse of the word Technology has also changed in the 19th and the 20th centuary [Schatzberg (2006)]. There is also a confusion since different words derived from the greek τέχυη has developed differently in different languages [Salomon (1983-84)]. In the text by

Heidegger above he uses the word technicity in a way similar to today's technology in English. One can try different approaches to and a definition. One can look at etymological or historical background. One can also try to see what everyday language average about the meaning. However the rapid development in 'Technology' and the resent changes in discourse make historical approaches a bit limited. Technology today also includes electronics, computers, their programs and virtual artefacts in common language. This wide range of definitions found, and the many possibilities for a definition, reflects that it is difficult to discuss anything involving the word technology without agreeing on the meaning of the word. At this conference 'Technology' always goes together with some other words as in 'Design & Technology' or 'Math, Science & Technology'. It seems as the meaning of the word 'Technology' has to be mediated with our knowledge of something else. I will put forward a philosophical definition of the word technology and follow where it leads. This definition should include the historical path and a etymological background but still allow for the modern development. When I adopt a philosophical approach to the word Technology and I define it here as

What man(kind) do in order to extend her physical or mental reach.

With this definition I include non physical artefacts. This also has historical relevance since technology also used to have the meaning - grammar. I do then realize that this clash with the point of view of that technology is what engineers do, but this only represents one of the stakeholders of the word technology. This type of definition is not new and I will discuss some arguments about it below. I will give two examples where it 'clashes' with 'common' sense or view.

- With this definition writing down a character say A is technology. Probably you can not find a teacher who thinks that teaching a child to write the characters is teaching technology? However this is a sociocultural bias of the west. In China calligraphy is a highly recognized form of art. Art and technology has the same origin and did mean more or less the same thing from the beginning. Art is also a way of extent your reach mentally. Still it would be an impossible and useless task to try to convince all preschool teachers that they only teach technology.
- Pure (natural) science often claims that technology is applied (natural) science. Although this seems to be a common claim arguments against it are presented. Ropohl [Rophol (1997)] following arguments by Ihde[Idhe (1997)] summarize as follows:
    - '. . . (Experimental) science depends on technical instruments to be invented first.'
    - 'Pure (natural) science claims to exist by its own right.'

There are several examples in literature on how so called pure science actually is developed from technological breakthrough.
Two examples in the previous references are Galileo and the development on the telescope and the Carnot cycle developed as a try to increase the efficiency of Watts heat engine. Two less cited examples include the more recent the Nobel Prize in physics 1984 was shared by Carlo Rubbia and Simon van der Meer. Rubbia is an experimental physicist but van der Meer was an accelerator engineer / physicist who were able to brake the interpretation of Liouville's phase

space theorem which at the time limited the believes on how many antiprotons could be stored in an accelerator.

And finally what many say is the ultimate theoretical scientific breakthrough in the 20th century. It is argued in [Galison (2004)] that Einstein's relativity theory was catalysed by his work on clock patents in the patent office in Zurich. At this time there was a high rate of new patents cased by the needs to synchronize clocks on different continents in order to facilitate train traffic on long distance. It was also ‘due’ time since there still today is a debate on who know what about the others work without quoting in between Einstein, Poincare and Lorentz. With the definition above there is no need to discuss as also a purely theoretical interest would fall in the definition because it is extending the mental reach. This feature to include, almost, everything in a definition or a theory's basic words is not unknown. As an example I will give a translated quote from the successful sociocultural theory's [Säljö et al. (1999)]

‘But mankind has not only possibilities to develop and conduct knowledge through language. She also has a unique ability to build in her verbal knowledge I physical devices - artifacts.’

With this perspective language is the base for all including, what can with this technological perspective be seen as one artefact among others language it self. The aim here is not to claim supremacy rather remind that different stakeholders' will have different perspective. Later in this conference John Dakers give arguments, reading Deluze, that technology and technological knowledge has a growth power which see no border where science try to box knowledge in controllable frames.

Useless to add is that so far this extended definition has not added to the understanding but rather to the confusion. There has also to be someway to coexist with other domains. I will do that by discussing a bit what science is. I do not restrict to natural science as often done in English language. What science is, is also debated since a long time. Often definitions try to exclude many things which are not pure natural science. Also when one use definitions like Poppers' one tend to forget about all systematic collection and organization of observations needed for any hypothesis at all if one this a new field. I will use a circular definition of science here but it somehow is enough for this purpose. Science is when you use scientific methods. I will follow Fenshams' [Fensham (2003)] argument about how new scientific fields create an identity of its own. He gives structural, intra research and outcome criteria which are to be met before a new scientific field can be said to be established. This gives us a way to absorb fields of knowledge from technology into science. This show how we can, once science is established, reduce what is included in technology. We have however to observe that what is science is within each scientific field to determine. Thus science can still be considered technology for someone not in that scientific trade. Also this only bring small restrictions to this papers definition of technology it shows a way to put the word technology more towards what is common use.

If the purpose with a definition of technology is to know what to put in a curriculum it can seem meaningless with a definition that do not meet the laymen's view of the word.

However academic subjects are, most often, accepted by layman as scientific knowledge. In the same way it is an accepted believe, among many, that most school subjects are distilled out of academic or scientific subjects. (This is not necessarily true; geography started in school and became a academic subject later). This indicates that academic or scientific knowledge from one end and school subjects from the other end can bracket the definition of technology when we use it for school subject. This bracket will be different for different age groups. There will be some different aspects which will remain technology.

- Interface between school subjects.
- Interface between different scientific domains (for scientists).
- Anything above a person's school level but professional training that is not to be believed being science by this person.

Besides playing a supportive role for school subjects, something all school subjects do, what is the specific for teaching technology? In the Swedish higher education in technology all universities offer one program that is having only about a week worth of technology within a full academic program of 5 years. In those programs one study academic special subjects almost within the entire program. Will this leave the interface between different scientific disciplines to the students to be explored on their own? No there are elements which come with this program that makes it a technology program.

- Just do it. Not a trade mark of a sports manufacturer but often the difference in approach from someone who is trained with a pure scientific background or a scientific background with this programs joined technology background. There are several courses common to this program and higher university math. An anecdote describes the difference in students attitude between the two Universities. In University you prove that there is a solution to a problem, perhaps you can show that it is unique. Then you give an ansatz to a solution looks like. On the same course technology students solve the problem whether it is solvable or not. This anecdote describe that pathological cases are often not so interesting in 'real world' problems but could also refer to the ability of understanding how to interpret a solution or which requirements are real before solving a problem. This can perhaps be compared with how 1984 Nobel prize was made possible by challenging the interpretation of Liouville's phase space theorem.

- Complex systems. In the final years there is flexibility and different students can choose different courses. Common between those courses is that there is an element high complexity. This can be complex mathematical modelling, environmental science, advanced strength of material courses, advanced fluid mechanics, nuclear reactor design and many more. They all serve as a good training in dealing with complex systems whether they are very theoretical or more hands on engineering like courses. There are also elements training open ended optimization.

- There are not so many courses in those programs that focus on design. Design has become increasingly popular recently. However there are a discrepancy in how this word is used in the Swedish context and the international. The design process is included in many other advanced courses such as advanced programming. Most students in those programs will have training in the design process.

Conclusions:

If one try to use a philosophical definition of technology one find that it tends to include ‘everything’. This is not so different from theories that say that ‘everything’ is language. In both cases it is clear that all education can not be based on this wide definition. There have to be special school subjects that are different from there academic counterparts. On the other hand it is possible with a system where all higher technology education is in a form of academic subjects springing from scientific background. There is no best way; technology will always be part of other subjects. We have to help this integration to develop naturally as well as pushing for technology as it own school subject.

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