A mathematical rake's progress

by Ivor Catt

Ivor Catt looks back on how he nearly became a maths addict

In my article of last November, I showed that Maxwell's Equations, so long thought to contain the heart and essence of electro magnetism, told us virtually nothing about the subject. Then, in my December article, I discussed the academic mafia's vested interest in knowledge (see panel). Here I try to discover who this group of charlatans*, the maths pushers, are. How does a young student grow up to become part of the social group who live by mathematical nonsense like Maxwell's Equations, and who conspire to prevent the development of a scientific subject in a proper, physical way?

Concern about this question led me to look back on my own education. What pressures were exerted on me to become a mathematical rake?

My experience indicates that the slide is similar to that of the drug addict — a number of small, apparently innocuous, slips downward, culminating in total separation from reality. As we progress through school and college, we are fed a series of potions, each more heady than the last.

The process started with the calculus. My introduction to it, at the age of 15, was worrying and disorienting. It was part of the great disaster which I thought had overtaken me in my first few months in the sixth form. Whereas I had always been good at maths, I found the first few months in the sixth form confusing. Even though Sam Richardson was a very good teacher, and I had help from my mother, a brilliant mathematician, at home, I couldn't understand the basis of what we were learning in mathematics, particularly the calculus.

This was a new experience for me. Previously, I had always found maths easy, and scored high marks. Now, suddenly, it was different. This was serious because if I tried to retreat from maths into some other field, all nearby subjects were based on maths anyway. There seemed to be no escape from my new-found inadequacy in mathematics. As the first half-year exams approached I became more and more worried, because still I couldn't grasp the basis of what I was being taught.

The flaw in the calculus package is what I now recognise as the reductionist fallacy a misconception which underlies and undermines western philosophy.* The error is to think that 'the whole is the sum of the parts', no more; that lots of bits of string are quite as useful as (and the same thing as) a long piece of string. Putting it another way, the problem of discontinuities was ignored. I was right to worry.

A whole array of misleading, damaging concepts slipped in with i, or j as we electrical engineers call it. "Two for the price of one"; if a+jb = c+jd, then a=c and b=d; so we can do two jobs at once. Pretty, but a delusion, similar to the illusion that we can drive better after drinking, and for the same reason — our vision is blurred.

Hot on the tail of j came that awful array of cons under the appropriate descriptor 'sine'. I shall not develop this theme fully, but only repeat that one FRS went so far as to say that "Physical reality is composed of sine waves". In fact, the sinusoidal wave, which is a camouflaged circle, is Ptolemy's pure, circular epicycles fighting back against Kepler's less pure, more real, ellipse. Kepler, who himself loved the idea of the 'harmony of the spheres', saw a more pure 'equal areas in equal time' rather than a distinctly un-heavenly, earthy,

"How does a young student grow up to become part of the social group who live by mathematical nonsense like Maxwell's Equations, and who conspire to prevent development of a scientific subject in a proper way?"

Mathematical mafia

The twisting of historical fact in the hands of the academic mafia is beautifully illustrated by the case of the discovery of the electromagentic theory of light. Obviously, a mathematician would like us to believe that the proposal that light was electromagnetic in nature resulted from subtle manipulations of his electromagentic equations by Professor Maxwell the mathematician. In fact, Whittaker[1] says that the proposal that light is electromagnetic came from Faraday in 1851, when Maxwell was 20. Now it might be asserted that the vague suggestion by Faraday was confirmed and strengthened by Maxwell's mathematics. However, Chalmers[2] says that there is an error in Maxwell's calculations, which "led Pierre Duhem to accuse Maxwell of adjusting his calculation so that he could arrive at a theory of light which he [or should we say Faraday?] already had in mind."

The truth appears to be that the idea preceded the maths; the maths was force-fitted onto the idea, like the ugly sister's shoe; and then the mafia claimed the maths generated the idea. The prince was not hoodwinked; and neither should we be. This racket, of forcing mathematical liturgy onto a reluctant discipline, constantly recurs in science, perhaps reaching its most grotesque in so-called 'computer science' courses.

1. E.T. Whittaker, A History of the Theories of Aether and Electricity, Nelson, 1951, p.194.
2. Chalmers, A.F., Maxwell and the displacement current, *Physics Education*, vol. 10, 1975, p.45.

*The Shorter Oxford English Dictionary entry for this word is particularly apt:

> **Charlatan** 1. A mountebank who descants volubly in the street; esp. an itinerant vendor of drugs, etc. . . .
> 2. An empiric who pretends to wonderful knowledge or secrets . . ., a quack.

However, if we then look up the entry for Empiric, the whole picture backfires on us.

*Titus, H.H., Living Issues in Philosophy. American Book Company, 1964, pp.148, 527, 540 etc.

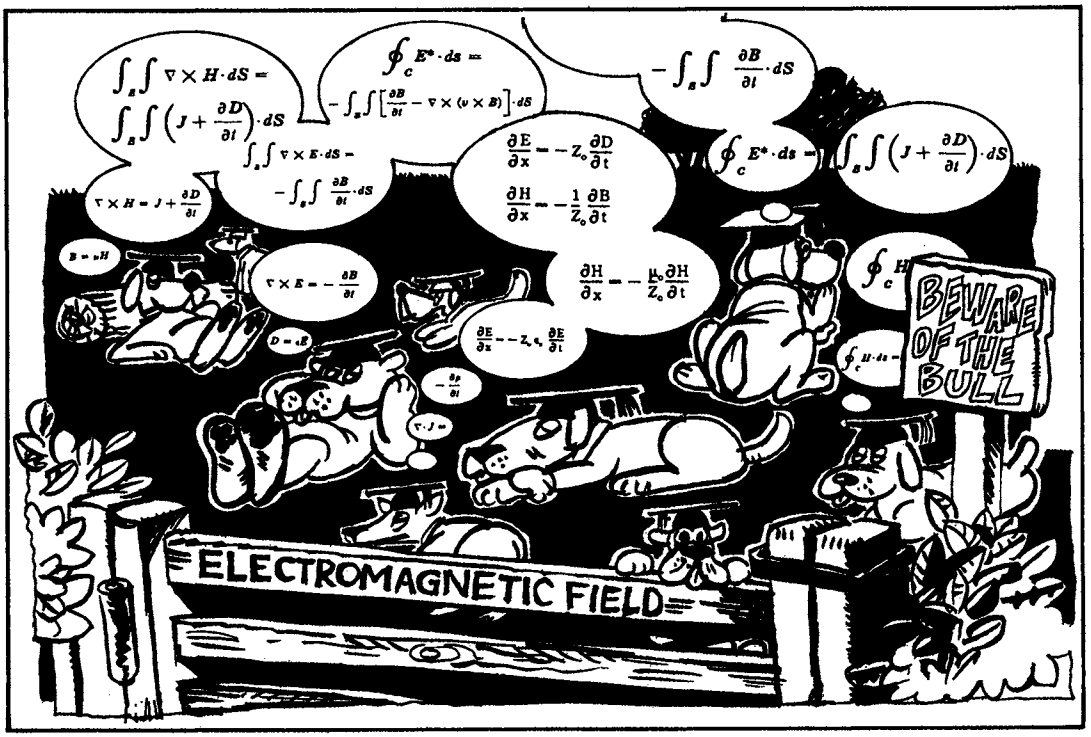
(we would say 'real',) ellipse.

The *Wireless World* July 1981 editorial, 'The decline of the philosophical spirit', contrasts the nineteenth century, when scientists were interested in and capable of distinguishing between the physically real and the mere mathematical construct, and today, when scientists no longer know or care about the difference, and have even developed a philosophy of science which confuses them.*

An example of the destructive effect of sine is the way in which it suddenly appears, unannounced and without justification, on the second page of a text book discussion of the t.em. wave.

In the event, my first half-year exams in the sixth form didn't seem too hard, and I felt that I must have scored over 50%, which would give me a breathing space in which to re-plan my future. To my astonishment, I learned that I had scored 99% and 92%.

However much I might *think* I didn't understand what was go-



"There is a similarity between the maths pushers and the drug pushers. Both entice the victim with promises of elysium. Both gradually increase the does. In both cases, there is nothing at the end of the rainbow."

ing on in maths, the marks I scored 'proved' otherwise. My high scores told me that I *was* still good at maths, as I had always been. However, a nagging suspicion remained with me that something was amiss. I doubted whether I could really have misjudged the situation so badly. Today, I believe that I was correctly judging the situation, and it was my exam marks that were wrong. I was being brainwashed into the belief that understanding was unnecessary, even impossible; that success meant the ability to manipulate the symbolism of the subject, not to understand it. I was being encouraged, the initial carrot being high exam marks, to turn the handle of the mathematical barrel organ, and not to ask too many awkward questions.

I seemed to learn my lesson, and later on, when taking A-levels, I gained a State Scholarship in maths although only 17 years old. This was a remarkable achievement, and should have secured my loyalty to the administrators of the mathematical myth. However, I was already questioning the usefulness of some of this maths, particularly the interminable geometry (since dropped) in the Cambridge Open exam, and so at Cambridge I decided to leave my strong subject, maths, and read engineering.* My background must have made me particularly sceptical. My mother had scooped the lot, gaining the top 'first' in maths in London University, but the payoff to her in benefits in later years proved minimal.

The next piece of blatant brainwashing occurred during my engineering course in Cambridge. We had a lot of thermodynamics, which was very mathematical. One day I asked my tutor, Professor Binnie, what practical interpretation I could place upon an equation containing a college of terms involving the three e's — energy, enthalpy and entropy. His answer was that I should not bother to look for a physical interpretation, but should merely regard it as a piece of algebra to be manipulated according to the rules of algebra. I was shocked by this, and I remain shocked today. Had I left maths and taken up engineering for nothing?

Whereas drawing, or draughting, was strong in the Cambridge Engineering Faculty and seemed to occupy a large part of our time, being the only subject you were not allowed to fail, electricity was weak, rating only one lecture a week, or at most two. One suspects that conservative Cambridge of the 1950s hoped that this newfangled electricity thing would prove to be a flash in the pan, and go away soon. (Gaslight, I have been told, was very pleasant; much softer on the eye than electric light.) I suspect that my later success in elecromagnetic theory resulted from the lack of teaching in it that I had sustained while at college.

We did not cover the Laplace Transform, and this set me apart from upstart graduates from redbrick universities, who enjoyed discovering how backward Cambridge was. I was lucky in this omission, because I now feel that transforming is one of the destructive mathematical techniques in engineering that increases the divorce from reality, and which is the legacy to engineers from mathematicians. Whereas to me it is obvious from first principles that to get constant current through a capacitor* you need a continually increasing voltage, I recently found that for a student of Laplace this is the conclusion of a lengthy piece of complex calculation.

Thus was the stage set for Maxwell's Equations, that phoney apology for electromagnetic theory, which held sway for a century and so befogged the subject.

There is a similarity between the maths pushers and drug pushers. Both entice the victim with promises of Elysium. Both gradually increase the dose. In both cases, there is nothing at the end of the rainbow.

*Popper, K. Conjectures and Refutations, R.K.P., 1963, p.100

*I love the Heaviside remark; "Whether good mathematicians, when they die, go to Cambridge, I do not know." — Heaviside, O., Electromagnetic Theory, Vol. 3, Dover, 1950. (First published 1903.)

* using theory N