Physics for taxi-drivers

With the International Year of Physics due to start next month, physicists need to be able to explain how their subject relates to other people. **Michael Berry** gives two examples and calls for more from the physics community

Most people enjoy conversations with taxi-drivers. I occasionally fantasize the driver beside me morphing into my father, who was a London cabbie and never shy about sharing his opinions with his fares. A recent journey began with a question: "I often drive between the airport and the university physics department, but I don't understand what you do there. It seems very clever, but does it have anything to do with the real world?" My response was to tell the driver two stories.

The first began with a factory producing consumer goods – surely as connected with "the real world" as anyone who uses that dismal expression would wish. This particular factory makes CD players, which enable anyone to hear music, reproduced almost perfectly, anywhere in the world: in the desert, up mountains, in forests, on the seas and so on. This is a new development in human history. Previously, people who wanted to hear music had to be physically present when and where it was performed (or, more recently, within range of radio reception and tuning in at the right time). In a sense, the CD player represents the ultimate cultural democracy: making available to many what could previously be enjoyed only by a few.

But the CD player is also a "quantum physics machine", in several senses. First, it contains a laser, the beam of which reflects from the pits on the disk that encode the music. This was an application by engineers of a device invented 30 years earlier, and, moreover, an unanticipated application – recall the cliché that the laser was an invention looking for an application. The laser itself was an application by physicists of ideas about the quantum physics of light, initiated by Einstein four decades earlier still – an application that was surely not anticipated by Einstein himself. And, of course, each of the millions of transistors that guide the flow of electrical information is itself a direct application of the quantum mechanics of electrons in the periodic environment of a crystal.

From this chain of associations comes an unexpected conclusion: quantum mechanics has democratized music.

Note the connection between three abstractions: quantum mechanics, which raises doubts about previous conceptions of physical reality; democracy, a relatively recent ideal in the organization of human affairs;

Tell me more – what do physicists do?

and music, where sounds unrelated to any in the natural world, and continually changing in ways incomprehensible to each previous generation, exert strange powers over our deepest emotions.

Where and when

For my second story, I pointed to the taxi's GPS navigation device. To decode the signals from the GPS satellites to discover our location, it is necessary to incorporate various relativistic effects that influence the time it takes for the signals to travel to and from the satellites. If these effects were ignored, disastrous navigation errors would soon result. So the GPS is a "relativity physics machine" – to my knowledge, the first such consumer device. It enables the solution, for all everyday purposes, of the ancient problem of knowing where we are, much as the vibrations of little quartz crystals in wristwatches recently solved the analogous problem of knowing when we are.

I have deceived you. The driver's question caught me off balance, and what he got from me was not what you have just read but ill-articulated and probably not very convincing versions of these two stories. But they did seem to give him an unfamiliar perspective on what we do, because he went on to ask me about my own research in theoretical physics, which has no applications as far as I know. (Actually it does have applications in philosophy, where it contributes to the long-standing problem of how our different levels of descriptions of the physical world – e.g. classical and quantum mechanics – are related.)

However, physicists should avoid the serious misjudgement of claiming these revolutionary devices for ourselves, as though we alone created them. No physicist, or group of physicists, would ever have produced a CD player. As I have already mentioned, the invention of the CD player also involved engineers, while mathematicians developed and optimized the codes that transform the music into light and electricity. Moreover, to get any invention into people's hands requires factories to produce it, businesses to finance and sell it, advertisers to tell people about it and so forth. The world is strangely and wonderfully connected.

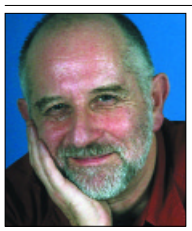
Nevertheless, it is good for people to see that our subject affects them in ways they usually have no conception of. Not just taxi-drivers, of course: I made the CD player story the centrepiece of a recent prize-giving speech at a secondary school, and it seemed to go down well with the 11–18-year-old students in the audience.

Be prepared

Now I come to the point. 2005 is the International Year of Physics, when we can hope for a higher profile for our subject. We should anticipate more questions like that of my taxi-driver, and be ready with a good supply of convincing stories. As it happens, both of mine involve Einstein, which is appropriate for the year that also celebrates the centenary of his monumental early contributions. Every physicist knows dozens more.

My reason for writing this article is to encourage readers to share their favourite stories by sending them to this magazine, which will publish a selection of the best. The type of stories I have in mind are characterized by connections between the intellectual and the everyday, where an abstract concept in physics leads, perhaps after many decades, to a direct effect on people's lives. Stories should be not more than 500 words and should be sent to *Physics World* before 31 January 2005.

- Stories should be marked "Physics for taxi-drivers" and can be sent by post to *Physics World*, Dirac House, Temple Back, Bristol BS1 6BE, UK, or by e-mail to pwld@iop.org



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