HOBBY HORSES

De inertia urbanorum

Ronald Williams

When I first started using a bicycle for my home visits in central London 22 years ago I had in mind only fine sunny days. But I saved even more time when it was wet, for the cars then clogged the streets in even greater numbers. Now, 87 000 cycling km (54 000 miles) later, the disparity between the slowness of the motor car and the swiftness of the bicycle is so apparent that some comparison of these vehicles—and their effects—is called for.

In the first century BC Cicero knew the difference between inertia and velocitas. But he can hardly have imagined, or been equipped to analyse, the complexities of the machines and mechanisms now in question, even though the remarkably quiet and highly developed power unit of the modern bicycle is identical in all important respects to that used by the ancient Romans in getting themselves on foot to the forum.

Furthermore, the efficiency of the car engine in converting chemical energy into mechanical work is only 20%¹ whereas that of the cyclist is about 25%.² This is hardly surprising, for our fuelling, motor, and control systems have been refined and tested, often to destruction, under appallingly rigorous conditions over 500 million years. Fortunately, we can still use this clean and extremely complex equipment to advantage even in 20th century London, although not while we remain strapped in our cars. It is a source of continuing wonder to me that healthy general practitioners will sit inert behind their steering wheels, queuing for half an hour to cross a bridge, when they could reach their destination in a fraction of the time on a bicycle. It is not as if all that much effort were required, for the cyclist uses five times less oxygen—and energy—than the walker in covering a given distance,³ and 60 times less than the car, assuming average, moderate speed.⁴

Our technology now allows us to tap the energy reserves of the earth to a degree which would have been unthinkable 200 years ago. The known reserves of oil have risen by 10 times between 1950 and 1990,⁵ and reserves of coal and natural gas have risen equally remarkably. Our use of these resources is rising at a global rate of 2% a year,⁵ and estimates of how long the supply will last vary from 100 to 600 years. World total energy consumption is increasing even faster than the continuing exponential growth in population—from 1 terawatt (1×10^{12} watts) in 1890 to 3.3 in 1950 and 13.7 terawatts in 1990.⁶ By 1991 the world's commercial energy consumption had risen to around 8000 million tonnes of oil equivalent energy (10.7 terawatts) a year.⁵ Ninety five per cent of this energy is derived from fossil fuels and fuel for transport now accounts for 60% of total oil consumption.⁵

These advances have made possible, at least in developed countries and particularly in cities, a level of physical inertia for which we may not yet be physiologically adapted. Some town dwellers, no doubt sensing this danger, try to raise their activity level by frequenting golf courses, where they can be seen ambling gently about or simply just standing. But for

the real inertia enthusiast—if this is not too much a contradiction in terms—no one spoke out more honestly than that splendid, if slightly overweight American, Robert Benchley: "Whenever I feel the need for exercise, I go and lie down for half an hour until the feeling passes."

A recent advertisement seen above a traffic jam in London announced a new British car which can accelerate from 0-60 mph (0-96.5 km an hour) in 6.2 seconds. Now I have the highest regard for this particular make because I have a much cheaper and less sporty model myself and am devoted to it, but the energy implications of such acceleration are worth noting. In my own car it takes me not 6.2 but 22 seconds to reach that speed, and applying Newton's second law of motion, $f=ma$ (force=mass $\times$ acceleration), the energy—and therefore the fuel—required for these two acceleration rates differs by a factor of 3½, although the time saved by such acceleration in relation to a completed journey—assuming that speed limits are respected—is small. It would be so nice if exhaust gases did not matter. Unfortunately, it seems that they do.

In 1990 carbon dioxide emissions into the atmosphere in Britain totalled 160 million tonnes of carbon.⁷ Of this, over 70% came from power stations, industry and agriculture, and households, in that order. Road transport accounted for 19%—30 million tonnes of carbon—and just over half of this derived from the private use of cars. As this country's contribution to the total world output of carbon dioxide is barely 3%,⁷ the global tonnage is quite considerable and carbon dioxide accounts for roughly half the climate changing impact of the greenhouse gases.⁸

The cyclist's output of carbon dioxide is from 1/60 to 1/100 that of his or her car,⁴ and the cyclist breathes out no oxides of sulphur or nitrogen and no burned or unburned hydrocarbons. Cyclists have the added advantage that they can calculate the moments of inertia of their speeding front and rear wheels with a clear head. Ask London motorists about their cars' moments of inertia and all they can think of is their local main road or the M25.

Unprecedented levels

According to a recent discussion document from the Department of the Environment, "the concentrations of greenhouse gases in the atmosphere are now approaching levels unprecedented for at least the last 100 000 years."⁹ The particular greenhouse gases implicated are not specified and no reference is given for this statement, but as it comes in a government publication it must be true; and indeed it is, although not scientifically precise, for the methane and carbon dioxide concentrations 100 000 years ago were only average.⁹ It was 30 000 years before that, at a time of high temperatures, that these two gases reached the peak which brought them nearer to present day levels.

Such seemingly esoteric information derives from

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the analysis of air bubbles entrapped at various depths in the ice below Vostock, the Russian research station in central east Antarctica and one of the coldest places on earth. This decidedly frigid billet is at an altitude of 3490 metres (11 450 ft), has an annual mean temperature of -55°C , is at latitude $78^{\circ} 28' \text{S}$ and rests on an ice sheet 3700 metres (12 100 ft) thick.⁹ It is not at all a comfortable surface for the cyclist, and were it not for the motor car and the Department of the Environment's anxiety about pollution we would not be considering such an inhospitable place here.

But for the record, at a depth of 2000 metres (6560 ft) the Vostok ice cores and their contained air bubbles are believed to date back 150 000 years, and this assumption tallies well with climatic information deduced from deep sea sediment studies.⁹ By early 1993 the drill had reached 2546 metres (8350 ft), which takes the measurements well back into the penultimate ice age.

Yet the Department of the Environment's statement needs putting in context, and the first thing to be said about the greenhouse or glasshouse effect is that it is not entirely a bad thing. Without it our atmosphere would be 30°C colder than it now is and life as we know it would not exist.¹⁰ But what about 130 000 years ago and what about our ancestors, for surely they deserve a thought? The hominids around then in this part of the world were Neanderthals, who had evolved in Europe some 20 000 years earlier and were not to disappear for another 90 000 years, when they were displaced by *Homo sapiens sapiens*, Cromagnon man, who almost certainly originated in Africa. By that time the last ice age was well established; it did not end until about 9000 BC.

We can say two things with reasonable certainty about Neanderthal people. Firstly, they did not own motor cars and, secondly, if they gave way to inertia they perished. They were probably also, according to experts at the Natural History Museum, compassionate beings, for there is evidence that their injured could live long lives.

But if there were then no internal combustion engines; no domestic, industrial or power station use of gas, oil, or coal; and no large scale cutting down and burning of forests, what was pushing up the greenhouse gases 130 000 years ago? Surely this is a relevant question, yet the Department of the Environment is carefully silent about that, and with some reason, for the incredibly complex factors involved in climatic change are still not fully worked out.

The two main greenhouse gases—if we exclude the most important agent of all, water vapour—are carbon dioxide and methane,¹¹ and both have been around for

aeons, although methane was a relatively late arrival, probably not reaching significant atmospheric proportions until the Archean era—3·8-2·5 billion years ago—when the first anaerobic methanogenic bacteria appeared.¹² The appearance of free oxygen awaited the evolution of photosynthetic bacteria and plants 3·0-2·5 billion years ago, and oxygen was not to arrive in significant atmospheric concentration until even later: two billion years ago.¹³

The atmosphere that resulted from the planetary accretion which formed the earth 4·6 billion years ago was, it seems, dominated by nitrogen, carbon dioxide, and, as always, water vapour.¹² In greenhouse terms methane is more potent than carbon dioxide and it also is increasing, at 2% a year.¹⁴ Molecule for molecule it is a 21 times more powerful trapper of the earth's reflected heat than carbon dioxide, although chloro-fluorocarbons are 12 000 times more powerful in this respect⁸ and in 1990 were increasing by 5% a year.¹⁴ The fourth significant greenhouse gas, nitrous oxide, is 150 times more powerful than carbon dioxide in this sense.¹¹ It arises in part from the denitrification of soils stimulated by mineral fertilisers,¹⁴ is possibly also produced by lightning, and certainly produced by the motor car. The fifth greenhouse gas is ozone, which is approximately 2000 times as effective as carbon dioxide in retaining the earth's heat,¹¹ although present in far lower atmospheric concentration.

The flatulent hippopotamus

About 130 000 years ago, when temperatures were high in the last interglacial period, it is possible that the surge in methane was related to the increase in area of peat and wet lands following glacial retreat,¹⁵ the methane arising—as it does in rice paddies—from microbial decomposition processes in oxygen deficient, richly organic soils. It has also to be said that the ruminants and the odd flatulent hippopotamus would have contributed their not inconsiderable share. When climatic warming reached its peak 125 000 years ago this large and potentially lusty mammal is known to have frequented the area of Trafalgar Square and even to have trundled as far north as Leeds. Indeed, it extended even further north and west in Yorkshire, for in 1838 its bones were found beneath a layer of glacial clay deep under more recent deposits in Victoria cave above Settle, together with the remains of rhinoceros, bear, reindeer, and ox, all regular methane, and carbon dioxide, contributors.¹⁶ The amphibious hippos would no doubt have kept to their rivers and swamps, but they had for a neighbour an eager collector of left over bones—and a natural tenant of that high cave—the hyena.

Over short distances a hippopotamus can move faster than a man can run, and in my particular part of London it could almost certainly have splashed around faster than today's rush hour motorist can move, for a male hippo in the mating season seeing off a rival from the neighbourhood of Hyde Park Corner would not be constrained, as we are, by queues at traffic lights.

But in this 20th century it is not so much methane as carbon dioxide which is our problem. It is estimated that some 150 000 commuters enter central London by private car during the weekday morning peak between 7 am and 10 am, the average length of their journey being 24 km (15 miles).¹⁷ About 738 000 people come in by train. The carbon dioxide emission in vehicular exhaust at 22 km per hour (14 mph)—a fair average speed for these motorists—is 200 g/km,¹⁸ and this more than doubles when the car is crawling. So at least 1440 tonnes of carbon dioxide are pumped into the atmosphere each working day by these commuters' cars alone. The equivalent figure for nitrogen oxides is 14·4 tonnes and for hydrocarbons 28 tonnes.¹⁸ Nitrogen

Self propelled...

Now confined, in Britain, to the Natural History Museum and similar ecological niches, the hippopotamus once roamed as far north as Yorkshire, regularly contributing methane to the atmosphere

oxide emissions increase very little at slow speeds, but a car moving at 6.4 km per hour (4 mph) produces five times as much hydrocarbon, soot, and carbon monoxide as it does at 48 km per hour (30 mph),¹⁸ so cyclists may perhaps be forgiven if they overtake rather quickly.

It has been calculated that the average car puts out four times its own weight of carbon dioxide each year,¹¹ and admittedly the 170 000 or so broad leaved trees in the royal parks will mop up a small proportion of this, as will the trees in the many other parks, commons, heaths, and squares of London. But they can do this only in summer, and only growing trees absorb carbon. Dying ones release it, and a site must be stocked with trees forever if the carbon initially sequestered on planting it is to be removed permanently from the atmosphere. Our terrestrial vegetation is patently not keeping pace, and atmospheric carbon dioxide continues to rise, as it has done since 1900.¹⁹

Apart from the plant kingdom, the only other "sink" for carbon dioxide—the oceans and the rocks—cannot possibly absorb it at the rate at which it is now being produced,²⁰ and forest clearance by burning not only drives up atmospheric carbon dioxide but, more seriously, reduces the total amount of vegetation available to mop it up.

Before the industrial revolution the level of carbon dioxide in the atmosphere was 280 parts per million.²¹ Perhaps not surprisingly this was also the highest level reached 130 000 years ago during the last interglacial period—a nice, clean biological maximum. It is now 360 parts per million and rising,²⁰ an enormous proportional increase in one component of our environment. The level towards the end of each of the last two ice ages (150 000 and 10 000 years ago) was 190 parts per million.⁹ Throughout the Vostock ice core record, both carbon dioxide and methane levels correlated closely with temperature—the colder, the lower.

Fuelling the crisis

Recent American work suggests that if we continue to burn up our fossil fuel reserves until they are exhausted, even if forest clearance is now halted, peak carbon dioxide concentrations of 1000 parts per million are probable within the next few centuries.²⁰ If the forests are destroyed this figure doubles to 2000 parts per million.

The potentially devastating consequences of too rapid global warming, not to mention the air quality at ground level in cities, may force us to rein back on our use of fossil fuels long before the known reserves are exhausted. Catalytic converters do nothing to reduce

emissions of carbon dioxide, and they have their own snags and imperfections.

Diesel engines produce significant amounts of sulphur dioxide and carbon particulates, both of which, like nitrogen dioxide, are known respiratory hazards, especially it seems to people with asthma. "In the United States over one quarter of all the chloro-fluorocarbons manufactured for refrigeration are used in vehicle air conditioning units, from which they eventually leak or are vented out,"¹¹ so even some motor cars are now sharing in the assault on the ozone layer.

Bicycles need no catalytic converter and their riders would spurn the idea of air conditioning. Atomic power seems to be increasingly suspect and unsatisfactory for a whole variety of reasons. Our only basic source of energy and continuing life is, as it has always been, the sun and the radiation from it is colossal. The solar energy absorbed by the earth in a month is roughly equivalent to the world's estimated ultimately recoverable reserves of coal, oil, and gas (2×10^{23} J or 4.579 billion tonnes of oil equivalent).²²

Silicon based photovoltaic cells now exist with a conversion efficiency of 15%, and efficiencies of 30% are believed to be possible.⁵ Allowing 50% for spacing, even such present day cells placed on a land area only one fiftieth that of Lake Nasser could—in the hours of daylight—theoretically equal the electrical output of all 12 turbines of the Aswan High Dam—2.1 million kilowatts. And the current energy demand of the whole world could be met if only 0.1% of the earth's total surface—land and sea—were used as a collector to convert incident solar energy at 10% efficiency.²² There is, after all, space and to spare. A twentieth of the earth's land surface can be classified as extremely arid,²³ and many of these areas, which are not habitable, lie at relatively low latitudes where the sun's rays are strong.

The Nile valley, a winding green ribbon of amazing beauty and cultural magic coursing through often staggering scenery, is bounded on each side by thousands of square miles of empty desert on which a positive torrent of solar energy—of the order of 400 watts per square metre²⁴—beats down year after year to sink unharnessed in the sand. A yearning for clean air in our cities and an end to exhaust pipes does not entitle us to too much wishful thinking about the future, but the thought of this country trading with Egypt for totally clean Saharan electricity does have its appeal, for the new non-carbon technologies may well become crucial. Economic factors will no doubt largely determine the outcome, but when London is clogged with electric cars the bicycle will still be needed by travellers who wish to move freely.

Using their own language

The officials of the NHS will not so far have found this article easy reading. Papers in a foreign tongue are always difficult, and we must therefore address some words to them in their own language. No civil servants with time on their hands and a need to fill their day or their page will say "use" if they can say "utilise" or "see" if they can say "visualise" or write "start" if they can spell "initiatise." So we must above all eschew monosyllables, even though some of the most charged and poignant lines in all Shakespeare consist of nothing else—but then he had something to say.

The phrases which follow—though altered in sequence—have all come through our practice's letter box from official sources in the past four years, and the sighting of any one of them has regrettably meant the immediate despatch of the whole document to the waste paper basket, for our hours are long and our time precious, and our reading has to be selective. No working doctor can ever be entirely at ease when

dealing with the defensive, stale inertia of a hostile, overmanned and self regarding bureaucracy, but we have to try, for it has the NHS by the throat.

So, to our administrators: "The mediation of interpersonal expectancies in the helper-helpee professions has to be visualised"—you will agree—"in the context of a shared understanding of user empowerment. The a priori decision making process will be facilitated by an integrated approach using an optimum skill mix, and uniform guidelines will help to underpin and complement the process of change. There must be a perceived need to develop finely tuned coping skills within a problem solving and goal setting framework and a supportive environment. By a layered approach, ongoing in-depth strategies will be developed utilising a meaningful protocol of interactive and proactive progressive modules, in which the subjects will be taught didactically and analysed from the collaborative viewpoint. Unfortunately, due to slippage of some of the planned projects, the intended prioritisation of goals may not be achieved, and the necessary initiation and pump-priming may have to be postponed, particularly in the development of consumer-facing skills within the primary care setting and the understanding of children of their place and involvement within the dependency-independence continuum."

Such turgid, pretentious, even preposterous prose has nothing whatever to do with the clinical care of patients and indeed interferes inexcusably with good medical practice, for it and its authors have deflected huge public funds from the known and often desperate needs of ill people and their families. Ask any general practitioner, hospital doctor, or nursing nurse.

George Orwell was right: "The great enemy of clear language is insincerity . . . When the general atmosphere is bad, language must suffer." He further observed: "If thought corrupts language, language can also corrupt thought."²⁵ In Utopia this essay on the writing of clear English is required reading for all government officers; the need for it in present day Britain is obvious.

But to return to the real world in which we and our patients live. We too must look to our credibility, for if as general practitioners we tell our patients to exercise while we continue to crawl round central London cushioned in our cars—the repeated excuse for our late arrival being the traffic or the parking—we could well attract the fair retort: "Physician, wheel thyself."

Concorde; bicycles; inertia

The amount of petrol that I have saved in my 87 000 km (54 000 miles) and 22 years of cycling—an average of only 14.5 km (9 miles) per working day—is of course derisory, and hardly worth mentioning. It is approximately 10 000 litres, and this volume of fuel is burnt up in 23 minutes—at 7.3 litres a second—by Concorde flying supersonically at 2172 km (1350 miles) per hour. Unlike the cyclist, Concorde's fuel consumption varies considerably—from 24 to 18 tonnes per hour—as it burns up its kerosene and gets lighter, and assuming a payload of 100 passengers this averages out at just over 7.7 km (4.8 miles) per litre per passenger. At subsonic speeds, for aerodynamic reasons, the fuel consumption is considerably greater. Cyclists do rather better. In terms of petroleum equivalent their use of energy works out at well over 353 km (220 miles) per litre,²⁶ and in fact is nearer 495 km (310 miles) per litre. Yet my bicycle does have one thing in common with Concorde—nobody, so far as I know, has ever accused either machine of inertia.

In general in this paper I have been discussing inertia in its current colloquial connotation of lethargy or sluggish movement, but its strictly scientific meaning is "that property of a body by virtue of which it opposes

Earth's vegetation cannot remove carbon dioxide as fast as vehicular exhausts produce it

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any agency which attempts to move it, or, if it is moving, to change the magnitude or direction of its velocity." It is ironic that this scientific definition applies most nearly to the least logical and rational of all the groups which we have discussed. The discerning reader will need no guidance as to which group this is, for it is clearly not the ancient Romans and neither is it Neanderthal man.

But I have been fortunate. I entered medicine when the NHS was newly established, and for 35 years it was a privilege to work in it—though not any more. This civilised and once hopeful ideal was put in hand at the end of a long and punishing war by a country which had suffered much, and which, perhaps because of this, was less attuned to greed and more to pity than the generation that now lays down our priorities. It is sad to see its gradual strangulation and the pitiless downgrading of its services.

The Romans, too, had assets of some value before their civilisation also declined, and not least an exemplary clarity of language. In a previous paper I suggested that modern *Homo sapiens* was beginning to evolve, at least in cities, into two distinct subgroups *Homo se propellens* and *Homo (urbanus) vehiculo constrictus*.⁴ Perhaps we should now widen this latter subgroup to *Homo urbanus inertia constrictus*, a term which time will quickly shorten to plain *Homo constrictus*.

We do not yet know whether it will be the construction of their environment, their arteries, or simply of their outlook on life that finally does for these pitiable creatures. It could well be a combination of all three, but their enfeebling inertia will lessen their numbers and by end of the Holocene they will be gone. There is every reason to hope that *Homo se propellens* (and *Puella se propellens*) will survive, and they will deserve to. They will walk, or run, or ride their bicycles. They will not pollute. Their fuel will be endlessly renewable whether it be caviar, cucumber, or chips, and the key to the future will be in their hands.

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Another kind of flying doctor

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My first reaction was disappointment, particularly as the hints from the family had suggested that the Christmas present was to be different that year, and somehow special. It was certainly smaller than usual. My family looked pleased with it, expectant, waiting for my reaction as I unwrapped . . . a cheap toy aeroplane mounted on a card! Which unthoughtful act had merited this snub? Disappointment turned to pleasure, then curiosity when the card proved to be a voucher for a flying lesson. Then excitement . . . a pilot—the imagination took flight; this was the stuff of schoolboy daydreams . . . but back to earth: this was only a 30 minute trial flight. Would the reality be like anaesthetics was supposed to be—95% boredom and 5% panic? Well I was going to find out—but not just yet. Enthusiasm waned as a I experienced the first (although in reality about the only) frustration of this pastime—the British weather. I'd almost forgotten about the Christmas present by the time the weather seemed good enough for me to enjoy it, some five months later in May. Excitement returned as I drove into the airfield. Then came more disappointment—the aeroplane was tiny, flimsy, much older and, well, scruffier than I'd expected (we've since become good friends and I hope she'll forgive this confession—as with so many serious relationships first impressions aren't necessarily reliable).

These cosmetic considerations were soon forgotten as we taxied out to the first of a series of surprises—you steer with the rudder pedals, the car driver's instinctive turning of the control column being contemptuously ignored by the aeroplane. Speeding down the runway is like driving at speed on a deserted motorway—only more slowly. That was the next surprise. We took off at only 60 mph and cruised at 85. The next half hour was a condensed mixture of powerful, at times conflicting, sensations and emotions: freedom and claustrophobia; elation and fear; the sinking abdomen and exhilarating stimulation of the semicircular canals; happily though, no nausea.

That first half hour is make or break—you either hate the experience or feel the first stirrings of an addiction. The next surprise shouldn't have been a surprise at all. Every addiction is expensive. Perhaps I could have kicked the habit before it really took hold and set me back a four figure sum for a private pilot's licence. Well I couldn't, and it did. The syllabus looked onerous. Yet anyone involved in teaching medical undergraduates or training postgraduates could usefully look at the logic and clarity of the programme for the private pilot's licence laid out by the Civil Aviation Authority. (As in medicine, acronyms, abbreviations, and mnemonics abound.) Lessons on the ground as well as in the air mean that knowledge and skills are acquired concurrently. These were taught and examined in an orderly sequence. But the first hurdle is the medical—fail this and you'll have to find another pastime. It is not too rigorous, although it was a relief to see that my first serious electrocardiogram was normal. The Civil Aviation Authority's medical examiner was a local general practitioner and former colleague, so throughout our half hour consultation I heard about the heartaches of fundholding between reading letters on the Snellen charts and numbers on the Ishihara's plates.

Next came the choice of club and type of aircraft. A high wing plane affords a good view of the scenery, and the Cessna 152, ubiquitous and readily rentable in Britain and around the world, is a very forgiving trainer. The Edinburgh Air Centre, which has a small fleet of these, proved a good choice of flying school. Four of the five ground examinations comprise multiple choice questions, with a pass mark of 70%. The other is an oral. The textbooks available for each area of study are friendly, clearly written, and well illustrated. (Authors of medical textbooks could usefully browse them.) The Trevor Thom series of

A chance to enjoy the scenery (here, the Forth bridges as seen from a Cessna 152 (inset) at 2000 feet)