The last endangered species

Robert L. Park[1]
Department of Physics, University of Maryland, U.S.A.

Trusting science

As the Moon passed between the Earth and the Sun on 28 May 585 BCE, darkness descended over the ancient Greek city of Miletus and the stars came out at midday. What distinguished the eclipse of 585 BCE from every previous solar eclipse was that it had been predicted [1]. Miletus, near the mouth of the Meander River in what is now Turkey, was home to Thales, a pre-Socratic Greek philosopher. Thales had calculated that the dark shadow of the Moon would pass over Miletus, briefly casting the city in darkness. It happened as Thales had predicted, forever changing our view of the heavens.

Based on the measurements of the time, some science historians today question whether Thales could have made such a prediction. The orbital plane of the Moon is slightly canted with respect to the solar ecliptic, and its dark central-shadow, or umbra, which is only approximately 100 km wide, usually misses Earth completely, otherwise we would expect to see a solar eclipse with every full moon. But whether he predicted the eclipse or simply explained it, Thales clearly understood what was happening and used the occasion to state the Law of Causality:

"Every observable effect has a physical cause."

Perhaps the most profound insight of all time, the Law of Causality is a total rejection of the supernatural.

The chain of cause and effect relationships leading to any physical event must begin with a 'first cause', believed by modern physicists to be the big bang, 13 billion years ago. Today, the eclipse of 585 BCE is often said to mark the birth of science, and Thales is honoured as the father.

Throughout our lifetime, our brain seeks to reconcile new information with existing beliefs. Apparent contradictions raise questions about either the quality of the new information or the validity of the existing beliefs [2]. New beliefs are being generated, which puts a brake on the belief process. Because infants have few beliefs, their brain has been characterized as a 'blank slate' [3]. Learning is swift for the young, and beliefs are cast off almost as easily as they are formed. This makes children the favourite targets of indoctrination. Francis Xavier, a 16th Century Catholic missionary and co-founder of the Jesuits, chillingly promised:

"Give me the boy until he is seven, and I will give you the man."

[1]Email: bobpark@umd.edu

Priests have been given far too many of our children. Scientific knowledge does not come from sacred writings or sermons from the pulpit.

The only way of knowing is by scientific observation and testing [4]. It should not be the responsibility of an HEI (Higher Education Institution) to indoctrinate students in the 'common knowledge' of society, a substantial portion of which is superstitious nonsense. Rather, the responsibility of HEIs is to build trust in scientific knowledge by demonstrating its connection to the natural world. Higher education must, therefore, include the unlearning of ideas that violate causality.

As better information becomes available, science textbooks are rewritten with hardly a backward glance. Adherence of HEIs to the principle of scientific openness thus provides a mechanism for scientific knowledge to evolve. Although technological innovation is the principal force for change in today's world, only a tiny fraction of the population has the scientific background needed to recognize when they're being misled. Securing public support for improved programmes and policies often requires raising the level of scientific literacy.

In theory, science journalists serve the public interest by translating scientific developments into less technical language. This 'dumbing down' inevitably results in some loss of precision and the propagation of serious misconceptions. We will examine two dangerous scientific myths that the media has allowed to go virtually unchallenged: the alleged causation of cancer by cell phones and cancer, and the balance-of-nature theory.

Cell phones and cancer

Media coverage

A particularly vexing example is the widespread belief that exposure to radiation from cell phones is harmful and may lead to cancer. The supposed causative agent is microwave radiation. Few people seem to realize that we have already been through this debate with microwave ovens. In going from microwave ovens to wireless communication, all that has changed is the delivery system.

The first most people heard about a possible cell phone–cancer connection was on 21 January 1993 when David Reynard, whose wife had died of brain cancer, was a guest on the television show Larry King Live. Reynard was suing the cell phone industry, claiming his wife's cancer had been caused by a cell phone. "She held it against her head, and talked on it all the time," Reynard explained. It was the familiar *post hoc ergo propter hoc* fallacy in which correlation is confused with causation. From that day on it seemed the media never mentioned cell phones without raising the cancer question. Repetition is a powerful learning tool; small wonder that the public began to associate cell phones and cancer. In telling the story, reporters rarely sought the views of working scientists. The U.S. was still in a protracted controversy over whether electromagnetic fields from power lines and household appliances are a cause of cancer. EMFs (electromagnetic fields) are ubiquitous in modern society, and for years the public had been exposed to unsupported claims of a cancer hazard from the EMFs of power lines. Scientifically, the claim was preposterous [5]. The frequency of power-line fields, and hence the energy of the radiation, is orders of magnitude lower than for microwave fields, but the public imagined scientists as

having a vested interest in defending the electrical industry, which is simply not the case. Nevertheless, the cell phone–cancer stories had been repeated so frequently that they sounded natural.

It got started in 1976 when *The New Yorker* magazine ran a series of scare stories by staff writer Paul Brodeur about the possible danger of exposure to microwave radiation [6]. A Cold War reporter, Brodeur viewed the world through conspiracy lens, and his complete ignorance of science was apparently matched by that of his editor. Brodeur had stumbled on to the bizarre story that the Soviets were regularly beaming intense microwaves at the U.S. Embassy in Moscow.

Although the U.S. State Department was aware of the bombardment, no one at there seemed to know anything about microwaves, or have any idea why the Soviets were doing it. What could have been the purpose? Nevertheless, the U.S. Embassy staff in Moscow was given hazardous duty pay just in case the microwaves might prove dangerous. That convinced Brodeur that microwaves were a secret weapon, and in a screwy sense they were. He conveyed his belief in the dangers of microwave radiation to readers of *The New Yorker* in two series of articles, *Microwaves* I and II, that later formed the basis of a book that would be a classic of misinformation [7]. It would have been a trivial matter for *The New Yorker* to refer the material to a qualified physicist or an electrical engineer, but that apparently never happened.

It was not until years later when the old Moscow Embassy was torn down, that secret Soviet listening devices were found hidden in the embassy walls. The first question was how had this system been powered over a period of years? Batteries could not be replaced surreptitiously and wires would have invited detection. The Soviets came up with a sort of crude Wi-Fi that took its power from microwaves beamed from a building across the street. The Soviets compensated for the inefficiency of their primitive wireless devices by simply cranking up the intensity of the microwave radiation, which almost guaranteed that the Americans would know they were being irradiated. Even so, there is no evidence that the health of U.S. Embassy personnel was affected by the microwaves.

Still believing that the Soviet microwaves were some sort of weapon, Brodeur made a list of various health problems suffered by the U.S. Embassy staff, and charged the defence establishment with deliberate suppression of the hazards of intense microwave radiation. However, Brodeur offered no information on what health problems would be expected in a group of this age and background. On the contrary, it was the U.S. Air Force that first pointed out the hazards of working in the vicinity of large radar antennas while they are in operation. *The New Yorker* was, and still is, a relatively sophisticated magazine aimed at an educated audience, but not, it seems, educated in science. The scientific evidence that there is no known mechanism by which cell phone radiation could induce cancer has made little headway against the preposterous myth linking EMFs to cancer, much of it created by Brodeur.

The myth has since been reinforced by a new generation of fear mongers, including Devra Davis [8] who warned about the risk of cancer in a 2010 book, *Disconnect: The Truth about Cell Phone Radiation*. Not until the final page of her book does she acknowledge that, "We do not have an epidemic of brain tumors in countries that have used cell phones heavily for more than a decade". She adds that,

"10 years after cigarettes began to be heavily smoked, we didn't have an epidemic of lung cancer". Latency provides her with cover for the awkward absence of any correlation between cell phone use and the incidence of brain cancer. She seemed determined to tease something out of the statistics.

Her heavily promoted, 243-page book was favourably reviewed by the media, and she appeared on numerous talk shows and news programs. Unlike Brodeur, whom she quotes as an authority in support of many of his most outrageous misconceptions, Davis claims some level of scientific credentials, including a Ph.D. from the University of Chicago in something called 'Science Studies'. I confess that I do not know exactly what science is studied in Science Studies, but apparently it does not include even a cursory introduction to quantum theory, without which there is a 'disconnect' between all the fields of science. Any discussion of the interaction of electromagnetic radiation with matter that does not involve quantum theory is either hopelessly uninformed or shamelessly fraudulent.

In particular, Davis seems totally unaware of Albert Einstein's photoelectron theory, for which he was awarded the 1921 Nobel Prize in Physics [9]. It is not a difficult concept for freshman physics majors, but it does require some mental effort.

In 2007, Davis founded the Environmental Health Trust in Teton County, Wyoming "to provide basic research and education about environmental health". Its principal function, however, seems to be promotion of her book. According to industry figures there are approximately 5 billion cell phones in use around the world at present. That is an astonishing number; the total world population just reached 7 billion. Even more remarkable is the apparent failure to identify a single verified victim of cell phone radiation. Is there another technology in the entire world that can come close to the safety record of cell phones?

I began this paper with Thales' discovery of causality. My question now is whether exposure to microwave radiation causes brain cancer? The most obvious way to address the question is to rank individuals according to their exposure to microwaves and measure the correlation between exposure and brain cancer incidence. This is 'epidemiology', an essential branch of modern medicine that seeks to tell us what works and what does not.

Epidemiology

A beautifully designed, nationwide, epidemiologic study of cell phone use and cancer was carried out in Denmark a little over a decade ago [10]. The study included all of the nearly half a million users of cell telephones in Denmark during the period 1982–1995. Users were identified from subscriber lists, and their cancer incidence was determined by linkage with the Danish Cancer Registry. The entire study could have been conducted with nothing but a laptop computer. The large cohort and the rock-solid database make it difficult to take issue with the report's conclusion: "The results do not support the hypothesis of an association between use of these telephones and tumors of the brain or salivary gland, leukemia or other cancers".

But that was then, and this is now. As mentioned, the number of cell phones in use around the world has grown to approximately 5 billion since the Danish study was carried out, according to industry estimates. The majority of adults on the planet, and many children, now have access to cell phones. Most

of them, however, have been using a cell phone for less than a decade. There is a latency period during which a tumour must exist, but is presumably too small to be detected. It could take years or even decades before a mutant strand of DNA forms a tumour large enough to be detected, and few other countries, if any, keep the sort of records that made the Danish study possible.

The same year the Danish study was released, the WHO (World Health Organization) undertook 'Interphone', an ambitious 10-year U.S. $14 million case–control epidemiological study of cell phone use in 13 countries. The objective was to determine whether cell phone use increases cancer risk. Interphone is the largest case–control study of cell phone use and brain tumours yet and includes the largest numbers of users with at least 10 years of exposure.

The final conclusion of the interphone study was that "more study is needed". What's needed, however, is not more epidemiological statistics, but greater reliance on fundamental understanding. It is called 'science'.

Natural law

Science is the process of organizing knowledge about the world into testable laws and theories. Over 10 years ago, I was asked by the editor of the *Journal of the National Cancer Institute* to write an editorial for the 7 February 2001 issue on: 'How science should respond to the controversy over cellular telephones and cancer' [11].

The invitation included a prepublication copy of the Danish study [10] that was scheduled for publication in the same issue of the *Journal of the National Cancer Institute*. The Danish article, you will recall, concluded that: "The results do not support the hypothesis of an association between the use of these telephones and tumors of the brain".

It was reassuring to have this confirmation from the Danish study, but we already knew the answer. In fact, evidence exonerating cell phone radiation as a possible causative agent of cancer had been available for more than 100 years, long before the cell phone was invented. People simply failed to make the connection. Unfortunately, many people still haven't made the connection.

Instead of an army of epidemiologists, imagine one researcher of average intelligence spending an afternoon in the library finding out how much science already knows about the interaction of microwaves with the human head. Libraries are free, and the search can often be conducted remotely with a personal computer.

Cancer is the uncontrolled replication of mutant strands of DNA. Mutagens include: nuclear-particle radiation, numerous reactive chemicals, a few viruses and EMF radiation at wavelengths shorter than the blue end of the visible spectrum. That includes the UV region, X-rays and gamma rays. What these cancer agents have in common is that they can create mutant strands of DNA. The UV region begins at the blue limit of the visible spectrum. Although UV does not penetrate very deeply, it is the major cause of skin cancer among humans.

In 1905, which is often called 'Einstein's miracle year', Albert Einstein theorized that the recently discovered photoelectric effect could be explained by describing light as consisting of discrete quanta, now called 'photons' [9]. This was a sharp break with the classical treatment of light as a wave in the 'ether'. The energy

of a single photon, Einstein posited, is equal to the frequency of the light multiplied by Planck's constant. All of the energy of a single photon must be absorbed, a fraction of a photon has no meaning; it is all or nothing. In this experiment, therefore, photons behave as particles. The energy of the ejected photoelectron must therefore equal the energy of the incident photon minus the energy binding the electron to an atom, which is called the 'work function'. Einstein predicted that there would be no photoemission at photon energies below the work function of the metal, typically 4–5 eV. This was truly revolutionary. It would be another 19 years before Louis de Broglie would predict in his 1924 Ph.D. thesis that as waves can behave as particles, particles can behave as waves [12]. The theory of wave–particle duality that is the essence of quantum mechanics was thus complete.

Many physicists refused to believe Einstein's photoelectric theory, including Robert A. Millikan, who at 37 years of age was already considered by many to be the world's leading physics experimentalist. Although Millikan believed Einstein's theory to be wrong, he agreed that it must be tested, and spent almost a decade constructing the apparatus for the test. To Millikan's surprise the experiment, when it was finally done, agreed perfectly with Einstein's prediction [13]. As a result of Millikan's confirmation, Albert Einstein, the world's greatest theoretical physicist, was awarded the 1921 Nobel Prize in Physics for the photoelectric effect, i.e. wave–particle duality. Robert Millikan, perhaps the world's top experimental physicist, was awarded the 1923 Nobel Prize in Physics 2 years later for confirming Einstein's photoelectric theory.

Einstein's theory is confirmed again every time modern electronic technology (cell phones included) makes use of wave–particle duality. Currently, that happens countless times every day. So, from Einstein's brilliant insight and Millikan's irrefutable experimental confirmation, we have known for almost 100 years, that electromagnetic radiation below the UV is non-ionizing, and hence cannot be a cancer agent.

Openness builds trust

The great virtue of academic science, setting it apart from all other areas of human activity, is that it is 'open'. Academic scientists are free to look for cancer-inducing mechanisms in microwave radiation, but I would not know where to tell them to look. Neither is there is any reason to believe that such a mechanism exists. The energy of a photon, as Einstein surmised, is given by the product of the frequency and Planck's constant. Although multi-photon processes are possible, even a two-photon process is highly unlikely. It would require the order of 1 million microwave photons, working in unison, to ionize the carbon–hydrogen bonds of DNA, for which there is no known mechanism or evidence. It would, in other words, be quite impossible.

However, industrial and university scientists study at the same universities, belong to the same professional organizations and generally publish their papers in the same journals. As a result, cultural differences between scientists in academia, industry and government, are not as great as you might expect and in the course of a career scientists often move freely from one to the other. It is openness that gives science, particularly academic science, the credibility that we call trust.

The balance-of-nature theory

There are, sad to say, many myths that masquerade as science [4,5]. Always a colourful storyteller, the Greek philosopher Herodotus, often referred to as the Father of History, sought to illustrate how negative feedback in natural processes might lead to stasis. He told the story with his now familiar metaphor of a balance between predator and prey; it was a memorable metaphor, but it was also wrong. Perhaps Herodotus was a better teacher than a scientist. In any case, there were no studies of predation against which to test the balance-of-nature theory. If the predator is a step faster than its prey, extinction would seem to be a more likely outcome than stasis.

The balance-of-nature cannot be discussed without a mention of the Gaia hypothesis in which all organisms and their inorganic surroundings are believed to be closely integrated, resulting in a single self-regulating system that maintains the conditions for life on the planet [14,15]. Balance is somehow assumed to be 'good' and humanity has a responsibility to helping to maintain it. It is not clear whether Gaia should be characterized as quasi-religious science or a quasi-scientific religion [16], but either way it is not much help in making decisions.

It would be difficult to find anyone who has not heard of the balance-of-nature theory. Not only the general public, but even many scientists accept the balance of nature as a fundamental natural law [13]. More dangerously, the concept came to dominate the field of ecology, even governing the management of natural resources. This 'nature knows best' doctrine began to crumble in the face of global warming, which is driven entirely by overpopulation [17]. The entire balance-of-nature concept is now dismissed by almost all ecologists. As life exists in a state of unstable equilibrium, small fluctuations have unpredictable consequences [14]. Malcolm Gladwell [18] captures this in his best-selling book '*The Tipping Point*'. Nature is chaos. The widespread belief that violation of some non-existent 'balance-of-nature' law puts the world at peril is constantly reinforced by the media.

Take a minute to do a Google search for current news stories that use the expression 'balance-of-nature'. Just go onto Google, click on 'news' and type in 'balance of nature'. In any given month you can expect to find 10–20 comments in the mainstream media on the importance of preserving this non-existent balance, with no explanation of what will befall us if we do not.

Extinction

As I write this in the Spring of 2011, there are 5487 known species of animals belonging to the Class Mammalia, including of course, *Homo sapiens*. Of these, 1141, or approximately one in five, are listed by the IUCN (International Union for Conservation of Nature) as 'threatened with extinction'. Of the estimated 5 billion species that evolved over the eons, more than 99% are already extinct and will never again be seen [19]. As the Earth continues to undergo both natural and anthropogenic change, Darwinian evolution by natural selection presumably guarantees eventual extinction [20]. That is why we have palaeontologists.

Palaeontologists have identified five major extinction events over the past 540 million years, during which the number of species of all classes declined

by over 75% in a geologically brief interval [21]. These extinction events mark the end of the Ordovician, Devonian, Permian, Triassic and Cretaceous periods. There must have been earlier mass extinctions, but the soft-bodied creatures of earlier eras left little evidence in the fossil record.

Scientists theorize that the Cretaceous–Tertiary extinction took place 65 million years ago, the most recent (fifth) mass extinction was caused by a massive asteroid impact (Chicxulub crater in Yucatan). It brought an end to the reign of the dinosaurs, leaving warm-blooded animals (mammals and birds) as the dominant species resulting in the eventual evolution of *Homo sapiens*. This asteroid explanation, first suggested in 1980 [22], should be noted as the most lucid and compelling account of what came to be known as the Alvarez hypothesis, after the father-and-son team of Nobel Prize-winning physicist Luis Alvarez and his geologist son Walter. It demonstrates that the most articulate expositors of scientific progress are frequently the scientists most responsible for the advance.

Scientific creation

Among palaeobiologists there is a growing conviction that life on Earth is now entering the sixth mass extinction event [23]. Previous extinction episodes have presumably been initiated by catastrophic natural events, such as increased volcanism, changes in sea level or asteroid impacts. Now numbering almost 7 billion, the human population has doubled in the 43 years since Paul Ehrlich wrote his best-selling '*The Population Bomb*' [24]. *Homo sapiens* is thriving, at the expense of wild species. Ehrlich warned that millions of people could starve by the end of the 20th Century if the population continued to grow at the 1968 rate. However, although the world population continues to grow, doubling in the 43 years since publication of '*The Population Bomb*', starvation has actually declined. Hunger may be at the lowest level in history.

There was nothing wrong with Ehrlich's calculations, but even as he was writing '*The Population Bomb*', an Iowa farm boy named Norman Borlaug, armed with a Ph.D. in agronomy from the University of Minnesota, was developing high-yield, disease-resistant varieties of grain and introducing modern farming methods throughout the world. It is now called the Green Revolution.

Sometimes referred to the 'best man who ever lived' for having saved 1 billion lives, Borlaug was awarded the 1970 Nobel Peace Prize as the 'Father of the Green Revolution'. In his acceptance speech, however, Borlaug emphasized that it would all be for naught if the population continues to grow [25].

Fertility

The necessity of restraining human population growth was understood more than 200 years ago by the Reverend Robert Thomas Malthus, a Vicar in rural Surrey, who kept the local census records. Bob, as he was called, came from a prominent and educated family and studied economics and mathematics at Cambridge University. He applied the calculus, invented by Isaac Newton a century earlier, to solve the population equation. The population of an isolated region tends to increase exponentially. Malthus was dismayed by how quickly exponential growth would outstrip the food supply. Whereas the population increases exponentially, he argued, the food supply increases linearly at best.

In 1798, Malthus published *An Essay on the Principle of Population* anonymously [26]. It quickly became one of the most important books of all time, and Malthus put his name on subsequent editions. Both Darwin and Wallace acknowledged his help in the theory of evolution. His observation that all creatures tend to produce numbers of offspring far in excess of replacement was cited by Charles Darwin as one of the key insights leading to his theory of evolution by natural selection.

Forty years later, Belgian mathematician Pierre-Francois Verhulst, added a term to the Malthus differential equation to reflect the finite 'carrying-capacity', i.e. the number of people that a region can support [27]. Verhulst's equation is sigmoid: the population of a newly settled region may initially grow exponentially, but it flattens out as the 'carrying capacity' is approached. A population close to the carrying capacity will live shorter lives, perhaps owing to starvation, infant mortality, infertility or hanging for stealing bread. Whatever the immediate cause, the population will stop growing. None of the choices are likely to be popular.

Malthus, who was a firm believer in human perfectibility, personally chose to practice abstinence and thought it should be encouraged throughout society as a test of virtue. Needless to say, he had few followers. Attempts to proscribe sex have been notoriously unsuccessful even among the 'celibate' priesthood.

The pill

More offspring than are needed for replacement serves to ensure survival of a species during lean periods. Evolution accomplishes this in some species with large litters; but in *Homo sapiens*, evolution did it with big libidos. Development of a safe and effective contraceptive, therefore, became the most urgent priority on Earth.

In his acceptance speech for the Nobel Peace Prize [25], Borlaug emphasized the importance of an "effective and humane means of decreasing the rate of human reproduction". It was a reference to the combined oral contraceptive, better known simply as the pill. It may one day be recognized as the most important invention of the 20th Century.

The steroid hormone progesterone was known to inhibit ovulation, but the cost of obtaining it from animals was prohibitive. However, Russell Marker, an organic chemist at Penn State University, synthesized progesterone from a wild Mexican yam, making it 200-fold cheaper [28]. With financial support from Katharine Dexter McCormick, the first woman to graduate in chemistry from MIT (Massachusetts Institute of Technology) and scion of the McCormick spice fortune [29], a team assembled by Gregory Pincus, a leader in hormone research, experimented with combining progesterone with oestrogen to reduce side effects. The combined pill was approved for use as a contraceptive in 23 June 1960.

Among the advanced nations of the world, the pill brought an end, at least for a time, to the nightmare of starving masses. It also proved to be a boon to the economy as women took control of their own reproductive processes, allowing them, less encumbered with children, to enter the workforce. But one problem is always replaced with another. Ironically, starving masses have been replaced with an almost worldwide obesity epidemic. Science is now called on to find a solution to a worldwide eating disorder.

Concluding remarks

Science is now solving problems that have tormented *Homo sapiens* for 200 000 years. The advance of science in the last century raises the prospect of transforming Earth into something close to paradise, at least for *Homo sapiens*. There is, however, a problem we have not yet addressed: the directions to get to this earthly paradise are written in mathematics, differential equations in particular. Mathematics is the language of scientific progress. The public, unfortunately, does not generally speak that language and shows little interest in learning it.

In theory, the media is responsible for translating and communicating the findings of science to non-scientists, but translation is not easy in a world carved into 133 sovereign nations. Moreover, political boundaries are penetrated more easily than the superstitious barriers that exist between the world's religions.

Our direction is often set by people using maps that do not correspond to any existing terrain. The world desperately needs more people educated in mathematical science. Meanwhile, scientists must accept the primary responsibility for communicating their knowledge to the general public.

Comments by Denis Weaire[2]

When called on to voice an opinion on this or that, I generally begin with "on the one hand...", in the true manner of the academic. Whenever I am in Stockholm, I am particularly reminded of the possibility of silver linings in clouds, by the sight of the great ship Vasa. It sank immediately after being launched. But now it is a major tourist attraction, finally repaying the King's heavy investment. Something similar is happening in Belfast, birthplace of the Titanic, another icon of utter disaster. Let me suppress this tendency to equivocate, and say at once to Robert Park: you are right. We are sinking fast. Where are the lifeboats?

- How have we arrived at the state of affairs that you describe, in the era of mass higher education? Why has the quality of public discourse and debate (and hence policy) declined?
- Why, in particular, has the very language in which we share ideas and perceptions, and absorb a liberal education, fallen into such decay?

George Steiner once deplored the deterioration of German, as it was increasingly debased by ugly ambiguity and jargon. He failed to note the similar case of English, which might have negated his thesis that there were peculiarly Germanic reasons for the trend. Let me give you an instance of linguistic torture from recent personal experience, within the cloisters (well, in fact it was the gym) of my university. I spied a large hole in the ceiling, and near it a notice of apology. It did not say "there is a leak". Instead it coyly confided that "we are currently

2 School of Physics, Trinity College, Ireland (Email: dweaire@tcd.ie)

experiencing leak issues." Such all-too-common circumlocution dilutes and degrades meaning; it is not just clumsy.

Why is it so prevalent? At one level the answer must lie in the influence of the media in which we are all immersed and by which we are increasingly conditioned. (McLuhan was right, too.) But deeper still lie the forces that drive and control the media, particularly television. Its vastly expensive advertising campaigns aim not just to sell, but to seduce. Better to avoid precision of language when trying to create a vague ambiance of well-being around a lipstick or a French fry. Our addled brains are increasingly tuned to the tastes of the global village, sharing pleasure and panic instantly with millions.

Ideally, the university should be the antidote. There, the individual should learn to define, to reason and discriminate, and to measure modern progress against ancient wisdom. Are we failing in this mission? Our lectures do not yet incorporate the commercial break for a word from our sponsors, but there is a Rupert Murdoch Professor in Oxford.

A few years ago Lars Engwall and I organised a Hercules workshop, *'The University in the Market'* with which the trajectory of these present thoughts intersects (see [31]). One by one, the speakers commented sceptically on present trends. A common theme was the overwhelming growth of managerialism, the culture of fastidious micromanagement that has proved so successful in many commercial contexts, such as the supermarket. It now invades all aspects of our lives, including our colleges. Although not explicitly oppressive, it leaves little room for creativity, discretion or trust at the level of the individual. Authority is remote and obscure (Orwell was right as well, except for the date). Managerialism is presumably the proud product of the university business schools; at present, the most popular major in the U.S.A. is business.

On the other hand: once upon a time, *e pluribus unum* (of many, one) was a fine motto for human betterment. Perhaps it should now be reversed: *ex uno plura* (many out of one)? Or soon we shall have to adapt Rousseau to say: man was born free but is everywhere watching the same TV channel. However, just as these notes are being written, the *News of the World* has been closed down and the mighty media empire to which it belonged is under widespread attack.

Hope springs eternal in, and for, the human soul. There, I warned you that I would see another side of things, eventually.

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