The Sun Rises in the West

The Rule of Law together with Property Rights: Foundations of Western Law and Liberty

Perth Conference

MANNKAL ECONOMIC EDUCATION FOUNDATION

International Trade & Business Law Review

Background Reading Pack

To *Sun Rises in the West* attendees,

RE: Sun Rises in the West Background Reading List

In putting together a conference such as *Sun Rises in the West*, there are a number of books, journals, poems and plays which can be said to capture the meaning of the conference. To suggest a reading list for an event such as this conference is challenging task. A similar exercise by the Institute of Public Affairs identifying the *100 Greatest Books of Liberty: The Essential Introduction to The Greatest Idea of Western Civilisation* produced much debate and forced me to reflect on my own choices when I wrote the forward for this important book.

Western Civilisation, and even the term itself, is increasingly under attacked. This is not because the hordes at the gate. The hordes are at the gate because the West is losing its belief in itself and even what it stands for. The literature of Western Civilisation is therefore important to revisit, not for nostalgic purposes, because it helps us to chart a path for the future.

The reading list for *Sun Rises in the West* could be voluminous, or simply set the scene. After extensive review and considerable external input, we have opted for the later. This reading pack is meant to serve as an entree to two days of intense discussion and reflection on the accumulated learning of centuries of experiences and thousands and thousands of pages of written texts.

It is fitting that the two background papers in this pack are written by Western Australians. Hal Colebatch's *Reason, Technological Progress and Civilisation* and Einar Vikingur's *A New View of Ourselves Since the Pardoning of Copernicus* are both useful primers for discussing Western Civilisation as they representative of its physical and philosophical journey. Interestingly, both consider the future of humanity, as well as how technological discovery and applied science can provide new opportunities for Mankind. This optimistic future is not guaranteed. The Sun *Rises in the West* is less about the opportunities over the horizon, but rather the future of Western Civilisation and what needs to be done to defend it. I warmly thank the authors for sharing their insights and commend the reading of these articles.

Warm Regards,

Mannkal Economic Education Foundation

Reason, Technological Progress and Civilisation

By Hal Colebatch[1]

[1] Hal GP Colebatch has a PhD in Political Science, MA and Honours in History/Politics and degrees in Jurisprudence and Law. He has lectured part-time at several universities and is the author of about 20 books. His *Blair's Britain* was selected as a Book of the Year in the London *Spectator*. He has written regularly for *The American Spectator Online, Quadrant,* and other journals. In 2003 he was awarded a Centenary Medal by the Australian Government for services to Writing, Law, Poetry and Political Commentary, the only award for this combination of activities. This is an edited extract of his forthcoming book, *Fragile Flame: The uniqueness and vulnerability of scientific and technological civilisation*.

In *What Is Good*? the British historical and philosophical populariser A. C. Grayling, Reader in Philosophy at Birbeck College, University of London, complained about the influence exerted by religion before, during and after the Middle Ages, claiming that, following six or seven centuries from the height of classical Athens to the last flourishing of the Antonine dynasty in Imperial Rome, in the succeeding period: "more than twice as long, the Western world – for most of that time restricted to Europe – lay under the ideological hegemony of Christianity …"[2]

The rather obvious fact that Grayling missed - the elephant in the room, to use current jargon - is that those years (if one does in fact pick a 1,300-year period, say the years 500 to 1800) were marked by progress, development, expansion of knowledge and improvement in the human condition such as to dwarf all the previous progressive achievements of civilisation since civilisation began, with the groundwork laid for all the even greater advances that were about to come. The period of "intellectual hegemony of Christianity" which Grayling evidently deplores was the period of the greatest advance in human happiness, scientific and technological knowledge, progress and freedom that humanity has ever known. G. K. Chesterton remarked in 1904 that Christianity was the religion which had also built the best roads, and asked: "Are you surprised that the same civilisation which believed in the Trinity discovered steam?"[3]

Ancient civilisations in many ways resembled one another far more than they resembled modern scientific and technological civilisation, which is *qualitatively* different. The technological ceiling on human progress since the dawn of civilisation can perhaps be illustrated as follows: Suppose an architect from the great pyramid-building time of Ancient Egypt – about 2,900 BC - was transported forward in time 3,000 years, to the Rome of the 1st Century AD. He would of course notice many differences in the world of men. With the knowledge of hydraulics which ancient Egypt had developed in utilising the Nile flood for irrigation, he would have been impressed by the aqueducts. There was, however, still no use of pressurised water. The use of arches would be new to him, but he would be able to see and understand at once the principles involved. As had probably been the case in ancient Egypt, blocks and tackles of various sorts aided and multiplied the efforts of human muscle in moving and elevating masses of stone. Importantly, brick-making had improved, with fired bricks replacing the mud-bricks which humans had used for thousands of years. The great roads and bridges would probably attract his admiration, if he did not consider them a waste of energy and resources which could have been spent more sensibly building a halfway-decent pyramid. There would be considerably more and stronger metal used.

There would be great invisible differences in ways of thinking and perceiving the world, including the influences of Greece and even of Judea. Perhaps he would hear of the small, odd sect called Christians, whose symbol was a fish – not too outlandish an idea for an Egyptian whose gods were depicted with the heads of jackals, lions, ibises and baboons. Nor would he be surprised if he was told they believed that the soul faced Judgement after death – he believed that himself.

But basically, after 3,000 years, there would probably be nothing about the technology – except possibly for concrete or cement - which he could not quickly understand or which would contain any mysteries for him. Dyed cloth was still an expensive luxury produced by short-lived slaves toiling in fumes and poison in dye-works, for whose chemicals human and animal excrement was a major source. Perhaps the great

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[2] A. C. Grayling, *What Is Good? The Search for the Best Way to Live* (Phoenix, London, 2003), pp. xii-xiii.

[3] G. K. Chesterton, "Why I Believe in Christianity", reprinted in *The Chesterton Review*, Vol. XXX, Nos. 3 & 4., Fall/Winter, 2004, p. 266.

baths would mean fewer fleas and lice for those who used them, if not necessarily for the slaves who stoked the furnaces below to provide the hot water and steam. That steam probably lifted the lids of cooking pots and kettles as it had done in Egypt, and as in Egypt, no-one conceived that it might lift anything else. There were great tunnels under Rome, but there had also been great tunnels under and through the pyramids and under the Great Sphinx and the Giza plateau, hacked out by slaves in much the same way, the slaves themselves dying from inhaling much the same sort of stone-dust.

The most advanced transport was still animal-powered, one of the most glamorous methods of transport and war was still the chariot, ships were still powered by sail and oars, and the whole structure was still dependent upon the sweat of slaves and the lashes of overseers. The most universal and efficient accelerator for both humans and animals was still the whip or for draught animals something crueller. Soldiers still fought with spears, swords and bows and arrows. Beggars still begged at city gates, and the infections of their sores and the mortification of their amputation stumps still spread at about the same rate. Pharaohs were called Emperors but were still regarded as having a special relationship with the gods. He might also hear news that in his own Egypt the ability to build pyramids had been lost.

People would probably live about the same number of years, suffer from the same epidemics, receive broadly similar medical treatment and die comparably painful deaths. Bones were set and other surgery carried out with rudimentary or non-existent anaesthetics, as was child-birth and dentistry. That babies and infants would die in large numbers was taken for granted. People's eye-sight would deteriorate if they lived much beyond their twenties and there was nothing to be done about it. Apart from occasional Queens and Empresses and a few priestesses, women would have no formal power or role in government. As in ancient Egypt, a tiny minority of priests and others could read and write upon scrolls or boards or chisel characters in stone. He might even have seen areas of regression. And this lack of radical technological progress was despite the fact that Rome, as well as having thousands more years of experience and opportunity, was in the centre of the Mediterranean World, able to pick and choose the best of all the surrounding cultures, and was even in some tenuous contact with India and China. Centuries previously it had inherited the great trading empire of the Phoenicians and beyond the Mediterranean had a large presence in northern Europe, Britain, Arabia and the East.

The sense of technological progress was *universally* missing. The low ceiling placed on human physical endeavour and achievement was everywhere undisturbed.

Jump our ancient Egyptian forward again, for about another 500 years, to about 600 AD, and there would be practically no technological visible progress, indeed many areas of regression would be obvious. The old city, the proud Forum of Rome and the Capitoline buildings, would be pillaged ruins. Military men might talk about things called stirrups, which multiplied the speed, versatility and fighting power of horsemen, and which barbarians were using with all-too-much success. The narrow and sometimes steep Roman roads, built for marching troops, were of little use for the carts and wagons that were beginning to grow larger.

But then something unprecedented began. Take our Egyptian forward another 850 years, a small period compared to that which he has already travelled, to 1950AD, and he would be in a world of miracles. We do not know what he would find if he went on another 200 years, to 2150. He might find a civilisation which had reached the stars, where multi-Century life-spans were taken for granted. Or he might find he had come right back where he started from.

History shows many opportunities for technological progress not being taken, over different time-scales and in different circumstances. Indeed, history shows many instances of not merely stagnation but technological as well as social regression. The Aboriginal Tasmanians abandoned bone tools and fishing

and lost the ability to make fire, barbs for spears, boomerangs, bone needles, nets and other simple tools.[4] Populations cut off by the rising sea on the islands of Bass Strait died out completely. Their last days cannot have been pleasant. The fact the Tasmanians lacked animals and plants suitable for husbandry or agriculture is beside the point - the point is that they lost what technology they had. Even without the impact of European settlement in the 19th Century the population of Tasmania may have been heading rapidly for extinction: it was probably down to about 4,000 in a land area of 68,332 square kilometres, almost the size of Belgium and Holland combined. Today it has a population of nearly half a million[5], but is by no means densely settled. The Norse settlements in Greenland, which at one time numbered several thousand people, lasted several centuries, and may have established outposts in North America, died out completely and vanished in the 15th or 16th Centuries. Modern examination of bones from the final period indicates malnourishment. At one time the Greenlanders constructed impressive stone churches, farmsteads and other buildings. When the Norse Kings converted to Christianity there was a bishopric installed there. The cathedral at Einarsfjord, at least, had the sophisticated luxury of stained-glass windows. Near its ruins are those of a banqueting hall which could hold up to 300 people. For several centuries the settlements had contact with Iceland, where records of them were preserved.

Jared Diamond has written that Torres Straits islanders abandoned canoes, while Gaua islanders abandoned and then re-adopted them. Pottery was abandoned throughout Polynesia. Most Polynesians and many Melanesians abandoned the use of bows and arrows in war. Polar Eskimos lost the bow and arrow and the kayak, while Dorset Eskimos lost the bow and arrow, bow drill, and dogs.[6] The adage that if you build a better mousetrap the world will beat a path to your door is false. Technology transfer is not inevitable even when there is the opportunity for it. History ancient and modern is full of examples where it did not occur. Even when new discoveries are made, they may not be applied. There was a lapse of centuries between the discovery of bacteria with early microscopes and antiseptic medicine and surgery.

Even within highly scientific and technological civilisation technology transfer is not inevitable. This has been the case even when there are what should be compelling reasons for it. There are many instances of innovation not being adopted in modern societies with highly educated populations and in situations of intense competitiveness.

This failure to take advantage of the opportunities for technological transfer appear to have happened in Britain *vis-à-vis* Germany on a massive scale and with a whole range of technologies in the 19th and 20th Centuries. One of the culprits responsible was probably British taxation policies. It was not until 1907 that Britain recognised the concept of depreciation of machinery. In the labour-intensive textile industry the tax system was favourable to repair costs, not replacement costs. Peter Mathias, Chichele Professor of Economic History in the University of Oxford, has pointed out that the British government found to its alarm in 1914 that all the magnetos in use in the country came from Stuttgart in Germany, as did all the khaki dye for troop uniforms, and this despite the fact that modern dyes had been largely developed in Britain by William Perkin and others:

> Britain had virtually missed out on the new technology of coal chemistry, the raw material of which formed the tap root of British industrial prosperity and resources. Nor could this be explained by the absence of a market for the products in Britain, or a less favourable demand structure, because Britain possessed the largest textile industry in the world which offered the largest dye-stuffs market in the world, a fact which was demonstrated by the extent of dyes being imported ... Britain had little to do with innovations in petroleum technology at this time … Where chemistry was concerned

[4] The technological deline of the Tasmanians has been the subject of a number of anthropological studies, by, for example Rhys Jones and Robert Edgerton.

[5] Australian Bureau of Statistics.

[6] Jared Diamond, *Guns, Germs and Steel* (Vintage, London, 1998), p. 258.

> Britain was virtually an underdeveloped country open to the economic invasion and exploitation of a higher culture [i.e., Germany].[7]

Britain's failure to modernise its technology had many disastrous consequences in World War I, when it found itself competing with the huge and modern German technological industries in chemicals, optical glass, iron and steel production and a host of other matters. The British Grand Fleet performed disappointingly at the Battle of Jutland, losing three times as many men as the German High Seas fleet and many more major ships, partly because of bad luck, but also because of complacency arising from its glorious heritage and the idea that "we can, or need, do no more" had left it with a number of antiquated and inadequate methods and practices in areas ranging from communication to damage-control.

Mathias continues, of the attitude which apparently prevailed in Britain, which may be seen as aversion to Capitalism's "creative destruction" and to "disruptive technology" (The fact such traits of national culture seem very hard to measure does not mean that they are not real):

> Why scrap a perfectly good machine that was superbly made, lovingly maintained and for which the machine-makers still possessed a complete stock of all its parts? At least six engines in breweries which were installed before 1800 still worked a century later. How long these machines lasted was one of the finest tributes to British engineers and one of the worst indictments of British industrialists … In 1872 only 12 persons were reading for the natural science tripos at Cambridge, most of them training to be doctors of medicine. Yet by then 11 technical universities and 20 other universities existed in Germany.[8]

Correlli Barnett has written in similar terms to the effect that British industry by 1914 had in many become ways no better than a working museum of industrial archaeology:

> Here clanked on tirelessly not only the actual machines, but also, not so tirelessly, the techniques and outlooks of 1815-1850 – marvels of inventiveness and progress in their epoch but transformed by the passage of time into quaint memorials of the original Industrial Revolution.[9]

One reason British Generals like Douglas Haig in the First World War resorted to enormously costly infantry attacks on strong German positions was that poor British shell production – a matter not only of antiquated plant but repeated strikes and other industrial disputes and resistance to changing antiquated working practices - left them with no alternatives (Haig was not the incurable reactionary he has sometimes been portrayed as. He would probably never have thought of tanks himself but was quick to recognise their potential when they were developed and ordered hundreds of them). Despite these experiences, and despite nearly perishing again in World War II for broadly similar reasons, Britain continued to accept a steady loss of competitiveness, at least until some reversals took place with the Thatcher Government in the 1980s. Germany in World War II ran an enormous mechanised Army and war economy on synthetic fuel, reaching more than 124,000 barrels per day in 1944, while Britain

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[7] Peter Mathias, *The First Industrial Nation, An Economical History of Britain, 1700-1914* (Methuen, London, 1969), p. 416 – 417.

[8] *Ibid*., pp. 418-421;

[9] Corelli Barnett, *The Collapse of British Power* (Eyre Methuen, 1972, p. 290. Barnett attributed this state of affairs to Free Trade, which in my opinion completely misstates the case and mistakes the cure for the disease. The British Empire was largely a captive market and this exacerbated complacency and removed incentives for competitiveness: in this instance at least the disease, and any possible cure, were both cultural and political rather than economic. Real free trade would have tended to keep British industry more keen and competitive. In any case, the command economies which Barnett, in this book at least, seems to prefer, have done far worse in the long run, as witnessed by the complete economic collapse in the late 1980s of the Soviet Union despite its vast natural resources and educational emphasis on science and engineering.

continued to import fuel oil by vulnerable tankers. This was despite the fact Britain had very large coal-fields and processes for making synthetic fuel oil from coal had been known for many years.

The widespread failure to innovate, even by technologically-advanced societies in intensely competitive situations, shows in many ways. To give particular examples, from the beginning of World War II, Germany used the 88-mm anti-aircraft gun as an excellent anti-tank weapon, probably the best in its arsenal. Britain, whose tanks suffered greatly from the 88, had to hand and on issue a very similar and probably equally capable, mobile and versatile weapon in the 3.7-inch anti-aircraft gun, but despite the German example never used it similarly, even when very short of other anti-tank guns. The Germans never developed a satisfactory heavy bomber comparable to the allied bombers despite having crashed and captured machines to work from.

The tendency to believe that "we can" (or need) "do no more" seems widespread. Partly this can be seen as a state of mind in which the notion of progress and improvement simply is not conceived of - such may have been the case in ancient Greece, Rome, and China. And there is, to be sure, a difference between progress towards something better and mere change for change's sake.

Further, of course, innovation involves risk. When there are not reserves of assets to cushion the effects of failure, failure can be disastrous. In many societies or individual circumstances with limited reserves of assets, particularly in the ancient world, there were good reasons not to attempt innovations. However, the notion that "we can do no more," can also be seen in "action" even when examples of others successfully doing more are displayed.

America proved during World War II that it could build very large numbers of very large ships – such as the "Liberty" and "Victory" ships – in a very short time, using pre-fabrication,[10] production-line techniques, welded hulls[11], etc. Nearly 3,000 of the basic 10,000-ton type of Liberty Ship alone were built, some in only a few days or weeks – the *Robert E. Peary* was launched an incredible 4 and a half days after the keel was laid.[12] By 1945 the average building time was less than 40 days, astonishingly fast. And there were nearly 500 of the even bigger Victory ships. As well as being cheaper and more efficient carriers than the ships built by the older one-off methods with riveting etc., these ships were as safe and seaworthy as any and probably better than most. One Liberty Ship, the *Stephen Hopkins*, sank a heavily-armed German raider, the *Stier*, in an epic gun-duel. Some had problems due to brittle steel but tended to survive them, and though built as an emergency wartime measure the type lasted for many years after the war, the last not leaving service till 1998. This was even more impressive considering that they were built by a labour-force that had little or no experience of welding, and in many cases no experience of ship-building at all. They were also cheap – about US$23-million in 2008 terms. It is important to note in this context that the Liberty and Victory ships were a *British* idea, and some Victory ships were even built in British yards: thus the British ship-building industry had intimate knowledge of them available.

Despite this demonstration of what was possible, in post-war Britain the shipbuilding industry, under pressure from powerful trade unions, but with management and government also lacking determination to improve, clung to increasingly antiquated and inefficient methods, building ships as one-offs, often separately designed, the steel for each cut to different measurements, without pre-fabrication, with hand-riveted plates, with multi-skilling or multi-tasking of labour looked on as an abomination, etc. There was almost no general ethic like the ethic that was consolidating America's industrial supremacy, a great pride

[10] The idea of pre-fabricated ships was not exactly original: the Phoenicians had done something the same with their navy.

[11] The German "pocket-battleships" built before World War II, also had welded hulls (and diesels rather than steam turbines).. Although the whole "pocket-battleship" concept had some serious flaws, this saved a great deal of weight which could be put into better guns, armour, range and sea-keeping qualities.

[12] This was a special propaganda effort but still enormously impressive.

in efficiency, achievement, innovation and success, or even like the ethic which helped ruined, defeated and humiliated Germany, Japan, and Italy claw their way back to fill various industrial niches.

It is hard to give every reason why this was the case, but for various reasons shipbuilding in Britain – which had not long before absolutely led the world – virtually disappeared in a couple of generations.[13] In 2006 the 200-year-old P. & O. shipping company was bought by the Government of Dubai. The Cunard line's 21st Century flagship, *Queen Mary II*, was built in France, and another of its great ships, the *Queen Victoria*, was built in Italy. In 2008, the 116,000 ton P. & O. cruise-liner *Ventura* was ceremonially "launched" at Southampton. It had really also been built and launched in Italy (It fitted the *ersatz* nature of the "launching" that the ceremony was carried out not by the Queen, but by an actress who had previously played the Queen). An even bigger ship, the Royal Caribbean's 220,000-ton *Genesis*, was to be built in Finland. It was not, or should not have been, a question of cheap labour (economically rational in itself). In 2008 neither Italy nor Finland were particularly low-wage countries. It was a spiral of decline: in the 25 years after the Falklands War in 1982, the British merchant fleet continued to dwindle to 295 ships and 16,000 men, losing about two-thirds what was already a radically diminished base – in 1982 there had been 985 ships and 57,000 men. Parallel developments occurred in a number of other British industries, such as car-manufacture. Many firms disappeared and the Chinese came to own Rover, and the Germans Bentley and Rolls-Royce. In 2008 it was also reported that Jaguar and Land-rover, after an interval of ownership by Ford, were to be sold to Indian interests. London's three airports were operated by a Spanish company. My own belief is that free trade is almost always a very good thing for all parties and for a number of reasons, and economic nationalism almost always a very bad one (there are some rare exceptions), but nonetheless this collapse of mere competitiveness (which also may have certain defence implications) is striking. Correlli Barnett, in various works including *The Collapse of British Power* (Eyre Methuen, London, 1972) has made case-studies in this area. Details of Barnett's studies may be disputed – I do not agree with them all - but the overall thrust is incontrovertible.

The experience of the West in spreading scientific and technological civilisation through colonialism was so varied as to suggest the whole concept of colonialism is a category error. Of course the Asian country which modernised most rapidly and successfully – Japan – was never a colony at all. Nor was Ethiopia, possibly the least successful example of modernisation in Africa (There was a largely ineffective Italian occupation for a few years). The US achieved independence at the beginning of the Industrial Revolution when its own technology was quite backward, but was culturally prepared not merely to adopt the Industrial Revolution's technology but to multiply it.

Asia, especially after World War II, has in many ways modernized and adopted scientific and technological civilisation with spectacular success. Changi Airport and the rail-system of Singapore, for example, put London's Heathrow and tube to shame: clean, swift, efficient and – a notable point – beggar-free. This has been accomplished in a tiny island state completely without natural resources. India has produced an astonishing roll-call of mathematicians, astronomers and physicists.

The psychopaths who created the killing fields of Cambodia were also heavily influenced by French anti-rational, anti-Western and anti-Christian intellectuals, including most notably Jean-Paul Sartre (whose philosophy seemed to centre upon questions of existence in a world without God and the assertion that "without God anything is permissible"[14]) and his semi-disciple, Franz Fanon.

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[13] *Australian Warship*, No. 37, 2007. See also various works by Correlli Barnett, including *The Collapse of British Power* (Eyre Methuen, London, 1972).for some detailed case-studies.

[14] Sartre's philosophy can be summed up in his *Existentialism and Human Emotions* (Philosophical Library, New York, 1957), pp. 21-22: "God does not exist, and we have to face all the consequences of this … everything is permissible if God does not exist, and as a result man is forlorn, because neither within him nor without him does he find anything to cling to."

The rise in Asian living standards has been achieved despite some corrupt and undemocratic regimes. Suharto's Indonesia was often damned as a brutal kleptocracy, but under Suharto, unlike his predecessor, the grossly irrational Sukarno, it made great advances towards being a modern State, with all that that implied in terms of health, happiness and life-expectancy. The people, as Christopher Koch put it in *The Year of Living Dangerously*, no longer had to bathe in sewage while the ruler built grandiose monuments. While corruption in Africa, to put the matter in very general terms, seemed to stop the wheels of progress, corruption in Asia seemed at times to lubricate them. Even relatively small countries like Taiwan, Malaysia, Singapore, Thailand and South Korea, as well as Hong Kong, have impressive records of research and invention, as well as the development of highly sophisticated and efficient industrial processes.

Thailand's Mahidol University, to give one example, is distinguished for its role in the sciences and in medicine. Many of its faculty and alumni have been recognized with awards including four Magsaysay awards, eight Outstanding Scientist awards, twelve Outstanding Invention awards and eighteen Outstanding Research awards presented by the National Research Council of Thailand, as well as many research abstracts, with the medical faculty being especially active.

Whether or not modern Asia's scientific and technological culture is original, imitative, or has become part of a global scientific and technological culture, is not really a very important, and perhaps not even a real, question: the great positive point is the fact of the many achievements of Asian scientists and technologists, both in their own cultures and as part of the international scientific community.

The British colonising effort (itself *ad hoc* and partly accidental) spread scientific and technological civilisation with great success in the United States, Canada, Australia, New Zealand and certain other societies. The Maoris in New Zealand and the Chinese in Hong Kong and Singapore (themselves also colonizers) in different ways proved ready to adopt much of the culture of their fellow-colonialists.

In India Gandhi adopted the spinning-wheel as a symbol of the rejection of Western technology, and it still appears on India's national flag. However, and after a few million unnecessary deaths and many million lives unnecessarily wasted in poverty, misery and stultification, his heirs have dropped this ethic, even to the apparently excessive extent of launching space programmes[15] and acquiring nuclear weapons and submarines. The Indian "middle class" is now reputed to number up to 300 million.

It was a great failure in Africa. However, those parts of Africa which had the most contact with scientific and technological civilisation and, economically, with modern capitalism became far better off than those with less, such as Ethiopia. Biafra appeared to have some chance of becoming a truly modern State before it was crushed in the Nigerian civil war, apparently with the connivance of the British and French governments of the day.

The French colonising effort was, in this regard, also largely a failure in Africa. The Belgian possession of the Congo seems to have no concern with anything beyond exploitation and the German colonising effort in Africa, while marked by at least some enlightened individuals and plans, was aborted by the First World War (The Germans in East Africa drilled the natives into first-rate troops who fought a relatively modern war effectively. When the war ended in 1918 the very small German Army there, of whom the African infantry were the backbone, was still undefeated though opposed by forces many times its size).

The colonisation of South and Central America was carried out by a Spain which was crippled by backward economics and was itself notoriously slow to adopt technology. Feuds between church and State over treatment of the indigenous inhabitants etc. contributed to the sluggishness of South American development. It was in many ways a mirror-image of Spain. The magnificent if ruthless energy and

[15] Whether or not a space programme can be justified for a country which still has hundreds of millions in desperate poverty is a matter for debate. Certainly satellites can help agriculture greatly by providing more accurate weather forecasting and other information.

enterprise of the Conquistadors was not complimented by the commercial energy and enterprise seen in North America (some have suggested this was due to a lingering Muslim influence on Spanish culture). Similarly, the Portuguese colonisation of Brazil was carried out by a country whose exploring energy and initiative had been one of the wonders of the world but which lacked either man-power or *continuing* technological energy.

Japan, and more slowly China, which were never colonised, adopted science and technology through their own efforts. The Islamic cultures, whether colonised by the West or not, in modern times invented and contributed very little to science and technology. This seems largely true even of religiously moderate Islamic societies. The last Shah of Iran, who had modernistic ideas of eventually not burning his country's oil resources for fuel but using them to create a great high-tech chemical industry, was overthrown by a medievalist regime. Sir Vidias Naipal wrote in 1981 of an Iranian leader:

> "He said" – this was from *the Tehran Times* – "the religious leaders were trying to enforce the rule of Holy Prophet Mohammed in Iran. During the days of the Prophet swords were used to fight, now they had been replaced by Phantom aircraft." Phantoms, not American, not the products of a foreign science, but as international as swords, part of the stock of the great world bazaar, and rendered Islamic by purchase. [16]

On the 21st Century the Iranian Government was building special small guillotines for the amputation of limbs under Sharia Law.[17]

This paper has argued a number of connected propositions: that scientific and technological civilisation is not merely rare but unique on Earth (and Fermi's "Great silence" at least suggests that it is very rare if existent at all anywhere else); that it has been achieved slowly and as a result of the coming-together of certain human, social religious and other factors, many of these also being rarities; that it does not exist in a moral vacuum but depends upon a certain framework of moral/religious values; that despite many perversions and abuses it has brought enormous benefits to Mankind; and that it is now under threat from several directions.

It is likely that any collapse of technological civilisation will be so gradual as to be hard to perceive. Lowering living standards may be disguised as ecological concern. Degradation of the environment will be blamed on technology and the retreat from technology accelerated – the only possible cure will be labelled as the cause of the disease. Centres of government will be the last to be affected by falling living standards, and one can imagine, as in some science-fiction dystopia like the final *Quatermass* story, the centre of a great capital city carrying on apparently much as normal for a long time after large area of the countryside have reverted to more primitive conditions. The final phase of the collapse, however, will be unmistakable.

Again, a largely unexpected development of the 21st Century has been a great decline in human fertility in the developed world. In much of Europe the numbers of children being born to the native populations are at present below replacement level, and all over the world, including much of the under-developed world, populations are aging. This may not be a catastrophic, or even necessarily a bad, thing in itself – without getting involved in the religious aspects of the matter, it is obvious that population cannot keep increasing forever and it seems logical that a smaller population will potentially make environmental and resource conservation easier. However, there is also an obvious danger that a smaller working population will not be able to support a larger population beyond working age. Nightmarish scenarios such as the institutionalised killing of older people or a reduction of their standard of living to poverty and squalor

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[16] V. S. Naipaul, *Among The Believers: An Islamic Journey* (Picador, London, 2003, first published Andre Deutsch, London, 1981), p. 42.

[17] *The Salisbury Review* (London), Summer, 2001.

have been put forward. The only way to tackle this problem seems to be to have the proportionately smaller working population of the future produce more – and this can only be achieved by improving technology, not instead of the other positive aspects and ethics of civilisation, but in partnership with them. Only more efficient production can prevent an economic shrinking as the working population shrinks. This is by no means impossible, because the story of Western civilisation so far has been the story of increased production, and there is reason to hope that production efficiencies (and pollution-control) in India and China will also continue to improve. We no longer need to destroy trees for fire-wood as mankind has done since the beginning of history and continues to do in too many places, and there is hope that as technology advances pollution may decrease. Ships and locomotives no longer belch coal-smoke, and the streets of great cities no longer smell permanently of horse-droppings. It was a pleasant surprise for me, having grown up with images of the coal-mining areas of Wales as a wasteland of reeking chimneys and slag-heaps, to be driven through it by a proud Welsh friend and to see how so much of the landscape was green and restored.

This, however, depends not only upon the scientist and technician but also upon the artist playing a positive role. It needs an art and ethic that directs Mankind's spirit towards beauty and achievement rather than to Nihilism and destruction.

Just after I had written the above, I came upon an article by Dr Mike Alder, of the Department of Mathematics and Statistics at the University of Western Australia, on the rapid decline in mathematical ability among university students:

> [W]e in the West are busily dismantling the infrastructure [of scientific and technological education] ourselves. Logic has not been taught in the schools for over a hundred years and Euclid was phased out in the second half of the twentieth century. Euclidean geometry was once regarded as being important because it combined two key elements: the intuitive perception of carefully isolated elements of the world, and the logical arguments which justified and organized them. It has been at the centre of the West's intellectual tradition for two and a half thousand years, but it could not survive the amateurish educationalists of the last century.

Being able to argue with clarity and force is not considered particularly desirable by present-day Alcuins. The kind of thinking which produced the world we now inhabit in the West is not being maintained in our schools. Our traditions are being lost. The technology which depends on science which was new and fresh a century ago will keep on going for a while, but the whole machine is slowly grinding down. We are still the beneficiaries of technological advances at a great rate, but the underlying process which led to the technology is being destroyed.[18]

Scientific and technological civilisation, as expressed in the contemporary West, is under attack from several directions: by ideologies of deconstructionism and nihilism opposed to both the intellect and to the concept of truth (and therefore to any search for truth), by the lowering of intellectual and educational standards, by the resurgence of "New Age" superstitions and paganism and by primitivist Islamism, as well as by the kind of irrational Christian "fundamentalism" which denies the findings and validity of science. The enemies of civilisation *are* enemies and must be regarded and treated as such.

Atheism, although claiming the scientific heritage, may also present dangers to scientific and technological progress: its ultimate implication is a universe without purpose or meaning, and, like the postmodernism to which it is closely related, it ultimately deprives Mankind of motives for existence, improvement or the search for truth, knowledge and even goodness.[19] It is arguable – though the

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[18] Mike Alder, "The Decline and Fall of the West*," Quadrant*, June, 2007;

[19] Also, we are seeing today a working out of the axiom often attributed to Chesterton (though scholars have not been able to find it among his writings): "When men cease to believe in God they believe not in nothing but in anything." Edmund Burke said something very similar in his *Reflections on the Revolution in France*.

argument may be impossible to resolve and wanders into highly abstract areas of philosophy – that atheism, by postulating a random or deterministic universe, and a deterministic explanation for all events, including human brain-events, finally cuts away the ground from Reason itself.

Another attack on scientific and technological civilisation is the persistence in some Catholic and other Christian writing of medieval economic ideas and notions about economics and therefore, inevitably, about technology, which it tends to see as an enemy. Much of this has close similarities to the Marxist slogan "From each according to his ability, to each according to his needs," a doctrine which, when an attempt was made to enforce it in the 20th Century, brought slavery and poverty to a third of the world and killed about 100,000,000 people. Indeed the nostrums these prescribed for achieving something called "social justice" (which generally means something which somebody thinks a good idea at the time) generally revolve around economic coercion to overcome the defects of human nature and impossibly-detailed and dictatorial Utopian planning (there are at times cases when intervention is needed but these are limited).[20]

This often appears to be coupled with sheer economic ignorance. In the book *Life to the Full*, a modern collection of Catholic essays on human rights, we find one Garrick Small, senior lecturer, School of The Built Environment, University of Technology, Sydney, writing:

> [W]hen un-Christian businessmen obtain labour-replacing technology, the result is lower wages and elevated unemployment.[21]

This is more-or-less the reverse of the truth. Labour-replacing technology, whether installed by Christian or un-Christian businessmen, actually results in lower *prices*, greater production and greater economic activity, meaning greater opportunities for all (a wealthy and ethical society should be able to re-train or otherwise compensate those whose skills become obsolete). A sensible employer pays the highest wages he can, at the risk of otherwise seeing his workers go elsewhere.

Further, the new jobs technology creates are generally better than the ones it destroys. Who wants to be a sailor before the mast in a sailing-ship, going aloft in a gale off a lee shore, or even a fireman toiling in the stoke-hold of a coal-burner? Monks, and we owe the survival of civilisation to them, once spent their lives and their eyesight copying manuscripts. Now they can make more accurate copies at the touch of a button, and we and they may be grateful for the fact. Anyone who thinks animal-drawn ploughs, or for that matter hunting and gathering, is a better way of raising food than modern farming might, in the words of Chesterton, "just try it and see."

There are constant political pressures to divert money away from scientific research, and, in a democratic society, into short-term vote-buying. In 1970 NASA's budget was 0.3% of GDP. By 2008 this had shrunk to 0.12% of GDP.[22] The capacity to reach the moon had been lost.

While it is to be hoped that the Internet and other advances in information technology will have a positive

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[20] Another silly obsession of some of these thinkers is the "living wage." Unfortunately it cannot be worked out what a "living wage" is or who is to pay or calculate it. Are a childless, abstemious, healthy bachelor with a freehold house and a private income, and a heavy smoker and drinker, with a wife, many children, mortgage or rent commitments, health problems, no assets and a taste for foreign holidays entitled to the same wage if they do the same amount of work? If the one with the greater need is to be paid a greater wage, how is this to be calculated, and by whom, and why should any employer or corporation with a duty to its share-holders employ him if it can get the same amount of work from someone who gets (i.e because he needs) a smaller wage? This is even before we begin to take into account such factors as different costs of living in different areas and countries.

[21] Garrick Small, "The Right to a Living Wage," in James Franklin, Ed., *Life to the Full: Rights and Social Justice in Australia* (Connor Court, Victoria, 2007), p. 102

[22] Stephen Hawking, *Cosmos*, 24 September, 2008. Of course, many space enthusiasts believe NASA spends its money inefficiently in any event.

effect in preserving and spreading scientific and technological civilisation, it would be wrong to take this for granted or to become complacent about the future merely because these technologies exist. There are several reasons for this caution, including the fact that the Internet cannot be expected to teach ethics or civilisation, wisdom or good conduct. It can only make knowledge of greatly varying quality available, to use a cliché which is here only too appropriate, for better or worse. There are concerns that children brought up with computer-games and the Internet will lack reading skills and prolonged attention-spans, as well as a lack of ability to discern between true and false information. There is no linear certainty about the future.

Science and technology, including of course information technology, are not ends in themselves, only great "enablers," and if, like other things good in themselves but only a part of the "Tau," they become treated as the whole, or as ends in themselves, the result is folly and futility at best, and disaster at worst. Scientific and technological civilisation implies a balance between many values. We live longer, healthier, more comfortable, and, if we choose, more interesting, lives than any previous generation, to an extent beyond our ancestor's dreams. We have, moreover, in modern civilisation, been given a taste of the enormous abundance, health and opportunity which the future may bring to our children.

The end, or the radical dilution, of this scientific and technological civilisation, or the general down-grading of Reason (which perhaps comes to the same thing) will guarantee for Mankind a regression, fast or slow, into a second Stone Age, or a reimposition upon human life of the low "ceiling" under which so much of humanity has existed: a ceiling which will become steadily lower and more crushing as Earth's fuel and other resources become exhausted or harder to extract. The existence of modern technology such as IT might mask this decline for a time, without necessarily preventing it. Scientific and technological civilisation is a unique – one might say miraculous – gift to us, the legacy of many of the greatest minds the human race has produced, but also the result of what looks like the repeated and improbable workings of Providence.

I believe any second Stone Age, or non-industrial, Age will be terminal. Humans may live brief, stultified, animal existences filled with pain and terror, perhaps for a time under the rule of war-lords or shamans, this epoch ending, as supplies of easily-obtained metal and fuel give out and the environment is denuded to provide the bare necessities of existence, with animal lives like those of the African savannah-dwellers from whom humanity sprang, this in turn ending, as happened with the inhabitants of the Bass Strait islands, in extinction. Earth will be part of Fermi's "great silence" forever.

I also believe that the continuance of the spiritual, scientific, humanistic and technological heritage of Western/Christian civilisation, whether by the historical "West," or others, may give Mankind a truly wonderful world and perhaps, sooner or later, the stars.

A New View of Ourselves Since the Pardoning of Copernicus

By Einar Vikingur

This essay is dedicated to Harry Harrison, who once wrote a short story which contained a startling idea.

Copernicus was recently pardoned by the Polish Catholics for pointing out some five hundred years ago that the earth was not the centre of the universe. From a physics point of view Copernicus was on the money, but could he have been wrong from another perspective: can a convincing argument be mounted for the case that humans, as a technological civilisation, are alone in the universe, and that the earth therefore *is* the centre?

I think this argument, which goes counter to both common wishful thinking and the prevailing opinion, is actually rock solid, and I think it imposes on the human race some striking duties. Put simply, if we are alone then we should do something as a result of it. However, as I will explain, doing something about it is extraordinarily difficult and it is so for reasons which you might not expect.

Perhaps I should just come out with it up front: I reckon the human race is a one-off, that we are the highest beings in the universe, and that therefore our primary goal should be our preservation. It is a moral duty, an obligation, firstly to ourselves and secondly as a repayment for the unlikely sequence of events which led us to this point. I am going to explain to you just how unlikely we are, or indeed how unlikely beings like humans are. We are a miracle, in the literal sense of the word – an improbable event.

For you to savour this essay you need to recalibrate your head with respect to time and distance. Instead of thinking of miles and furlongs you must work in light years, that being the distance travelled by light in one year. In one second light travels 300,000 kilometres, which is about seven times around the world. It takes about three seconds to travel to the moon, and about eight minutes to travel to us from the sun. The nearest star is about 4.2 light years away, and if you can picture that you are recalibrated for distance.

As for time, our smallest unit needs to be a thousand years, but you need to be able to accept concepts such as this one: if the universe is 13-billion years old, then ten million years is a blink of your eye. If you accept that, you are recalibrated for time. In terms of human context, we began to record things about five thousand years ago, the Aborigines colonised Australia about 60 thousand years ago, and Europeans arrived in Botany Bay one fifth of our smallest time unit ago – and yet the Pilbara is four billion years old.

As far as distance is concerned, we should focus on our backyard, our own galaxy, which belongs to a cluster of galaxies which itself forms a tiny part of the universe. The Milky Way is about 100,000 light years in diameter, and it looks like a rotating fried egg with spiral arms. Our sun sits about two thirds from the centre, on a spiral arm's edge, in a most congenial spot. As I will explain later, humans partly owe their existence to being domiciled in the beneficial conditions which obtain in a thin doughnut (or annulus) which encircles the blazing and deadly galactic centre about 30,000 light years away.

Having set the scene, I would now like to talk about aliens, or more precisely, the lack of aliens. After that, I want to explain how ludicrously unlikely it is that you exist, both from astrophysics and biological points of view. We then need to examine space travel, not as dreamers but as the engineers and social planners dealing with the problem. Lastly, I want to draw some conclusions about humanity's duty over the next five or ten million years. If you think this statement is a bit odd, you need to return to the previous paragraphs and recalibrate again.

I have long been amused by the Drake Equation, a mathematical sleight of hand which, regardless of input, always shows the keen believers that our galaxy teems with intelligent life. I call it a sleight of hand because one can make the Drake Equation show that even we do not exist, by selecting desirable values for the various factors. Since humans can hardly deny their own existence, despite the determined and convoluted efforts of many philosophers to do so, the utility of the Drake Equation's answers cannot be used as a proof of anything other than desire. For every 'proof' which says we are sure to have a million clever alien races about our neighbourhood, someone can produce proof to the contrary with the same tool.

What is more, via the Search for Extra-Terrestrial Intelligence (SETI), we have been sweeping the skies for signs of cleverness for several decades with no results whatsoever. It is true that only a tiny fragment of the galaxy has been covered, but with each passing moment the chances diminish for the hopeful ones. They will persist for long decades yet, and the passion of many will rise in direct proportion to their failure, but eventually they will have to bow to the very high probability that we are alone.

SETI advocates, I grant, might be looking in the wrong part of the spectrum, as they use radio and perhaps should be using lasers or whatever. They may just need another ten thousand years of work, or perhaps we should be sending out a message rather than just listening, and waiting for someone to respond. As an amusing aside, a serious broadsheet in Britain recently ran a competition to find an appropriate message we should broadcast for all those aliens out there. Numerous entries were considered, and the clear winner was this one: "Two thousand years ago we had a very enlightening visit from the Creator's Son – has he been to see you yet?"

Another telling bit of circumstantial evidence for our loneliness is the Fermi Paradox, in which the great Italian physicist asks the question "if aliens are so numerous, where are they?" Despite those who think aliens built the Pyramids and now specialise in crop circles, and the frequent assertions of UFO sightings and alien abductions by earnest folk, the fact of the matter is that there is not a shred of evidence of any kind whatsoever for any aliens ever having visited us. If anyone entertains the tiniest beliefs here, they ought to consider the amazing number of people who claim to have been abducted by aliens for the sole purpose of sexual intercourse. Whilst humans hardly know how aliens would think, I expect that if humans were hovering in an anti-gravity saucer above the planet Meta-Luna, having sex with the locals would not be a top priority for them. The possibility of delusion cannot be ruled out for those who claim UFO sightings and alien abductions, let alone moments of passion with all manner of beings.

Since aliens who reached us would have scant reasons for hiding themselves, there are strong grounds for concluding that they have never been here. Perhaps they cannot execute interstellar travel, they do not want to do it or they just have not made it here as yet – but if these three reasons could be eliminated then we would have to conclude that no aliens exist.

The first explanation is problematic as interstellar travel is so very difficult, but it is not impossible. The second explanation can be eliminated because interstellar expansionism, even if not desired, would eventually be forced upon a race whose sun was nearing extinction, an event as common as garden snails in the galaxy. The third explanation can be eliminated because an expansionist race, travelling at a reasonable fraction of the speed of light and establishing colonies and then launching again, could easily cover the whole galaxy off in a few million years. If thousands of technological civilisations developed in the past 13-billion years, any number of them would have had to take to the stars or go extinct as their home stars ran out of fuel. And none has been here, to our knowledge, and yet we live on real estate which demonstrably suits water, oxygen and carbon based life very well.

We could speculate about all kinds of life forms, and our own planet's astonishing variety might at face value attest to the likelihood of alien beings whose provenance lies in silicon or chlorine, and who like to swim in liquid methane. I think quite the opposite, as carbon based life is what has already succeeded and no theoretical work has ever produced convincing arguments to the contrary. I place no faith in the existence of intelligent wraiths or clever crystal formations, beloved of fantasy writers.

The earth itself is a most improbable thing. To begin with, the formation process of our type of galaxy can create a zone where the probability of having metals is higher than that of the rest. The Milky Way's annulus of metallicity is where our solar system formed and this gave the earth a metallic core with a floating rocky crust. The core generates heat via decay of radioactive isotopes, slightly unstable forms of stable elements, and the molten core drives tectonic plate movements which form a part of the mechanism which regulates atmospheric temperature over geological time. The metallic core also generates the earth's magnetic field, which forms a shield of deflection for harmful particles and radiation inimical to life.

We are far enough from the galactic core not to be scoured by its intensity, and luckily have probably never been sterilised by a nearby star exploding into a supernova. The earth derives its energy from a sun which is not only an unusually stable one, it has been so for billions of years. Our orbit is also in the very narrow zone which permits the existence of liquid water, the basis of all life as we know it – the planet needs only move outwards or inwards by a few million kilometres to freeze to an ice ball or boil all the water off.

The solar system was given a gas giant, Jupiter, outside our orbit, and it was like designing a comet, asteroid and debris vacuum cleaner to order for us. The first 500 million years of earth's existence were molten and boiling because of the heating effect from the kinetic energy delivered by constant bombardment from space. Slowly but surely the vacuum cleaner's gigantic gravity sink created cleaner skies, and the earth cooled enough for a crust to form.

Then another most improbable thing happened: the earth collided with another body, the size of Mars, and after a bit of a merge, spin and dance we had the moon. And the moon does two things few know about – it absorbs some of our spin energy as a gravitational dance partner and slows us down, and it also keeps the tilt of the earth stable at about 23 degrees off the vertical. If the moon did not slow the earth's spin, the surface would suffer ceaseless winds of hurricane strength – picture it simplistically: the solid surface moves faster than the atmosphere. The oceans, lashed by winds, would generate constant waves of enormous size and energy; tsunamis are pond ripples compared to it. And as for the tilt, that is what gives our planet the seasons when coupled with the slight variation of the orbit around the sun each year. The moon has been the enabler for stable weather and regular seasons, for billions of years and we got it by the most remote chance.

The galaxy contains perhaps as many as 200-billion planets, and in the past few years detection by our astronomers has become precise enough to confirm that a lot of them are rocky ones like earth, Venus, Mercury and Mars. The rocky planets which are likeliest to contain metals would generally be in the thin galactic annulus we inhabit, limiting the suitable candidates for life greatly across the Milky Way. When the hopeful speak of uncountable planets upon which intelligent life could form, they are wrong. The number is restricted by processes of galactic formation billions of years ago, both in terms of metallicity and rarity of stable suns. The number is very likely to be tiny, perhaps only in the millions.

Moreover, the chances of having enough metals, with enough radioactivity, to generate tectonic plate movement, the chances of having a debris vacuum cleaner on hand, the chances of a collision or capture which creates a moon, the chances of sitting in an orbit which permits liquid water, the chances of having a strong magnetic shield, the chances of having a stable sun – and all at once, this is improbable to a very extreme degree. Not impossible, as it happened for us, just unimaginably improbable.

Two immediate observations would be that it is no wonder aliens are not popping up, as good home worlds are hard to get, and secondly, how lucky are we?

Just how lucky we have been from an astrophysics point of view is expressed in a single idea: the earth provides a friendly environment for life for millions of years at a stretch. Creating simple life is a piece of cake – only a few weeks ago did scientists announce their creation of self-replicating life from chemicals out of bottles. There is strong evidence which shows that the earth began to throw up primitive organisms within a few million years of initial crust formation, perhaps as long ago as 3.8-billion years. Since that moment, through a series of morphing earths driven by volcanic activity, calamities from the sky, stabilisation of the land and water ratio, settling of the large-scale control mechanisms for atmospheric changes such as the formation of oxygen, life has evolved to produce a technological civilisation.

Scientists have not formed a confident narrative of how we got here, but enough is known for me to conclude that if you thought the astrophysics improbabilities were great, well, I am afraid you and I are even more unlikely. The planet has thrown up life many times, in the most bizarre forms, and mass extinctions have happened many times as well. One imagines that each time some lines survived, and

were given another few dozen million years of evolution to produce the next crop – and the formation of complex life can only occur if millions of years of stable and friendly conditions exist. Simple life almost certainly exists upon numerous planets throughout the galaxy, but complex life such as a multi-cellular organism is quite another matter. Intelligence is a further step upwards, and most likely a very big one.

About 65-million years ago, to pick a popular incident, a large asteroid hit the Gulf of Mexico. That cataclysmic event, extended volcanic eruptions and the consequent cooling of the climate eventually killed off the dinosaurs which had been the dominant life form for the previous 140-million years (and remained very stupid the whole time). It probably took millions of years for the dinosaurs to pop off, and during that time the mousey little warm-blooded mammals got on with the business of generating you and me. The asteroid hit was highly improbable, thanks to Jupiter, but it gave us the starting gun – and modern humans emerged less than a hundred thousand years ago, in a spurt at the very end of an endless sequence of rolling dice.

Our line was so precarious that at one stage we may have been reduced down to just a few thousand individuals clinging to life during the last ice age. And here we are with a beautiful, if patchy, civilisation, and it has happened very fast. A different body line with intelligence could easily have emerged on earth, and I would argue that any intelligence eventually embraces technology because it is a logical consequence of enquiry into the physical world. However, there is no need to speculate about pygmy elephants with dexterous and digitised trunks and large brains and their version of Mozart – we are the ones who made it. It was for us that any number of random genetic mutations occurred and then prospered because they conferred an advantage in the competition for survival.

Let us now look at space travel, and the first thing I should state is that building and powering ships which could take us to the stars is something which we could do today. We can already produce ion drive propulsion units, powered by the sort of reactors used in nuclear submarines, which could accelerate large craft to high sub-light speeds over several months or years. There are many high engineering and design hurdles, and as such craft would have to be the largest structures ever made they would have to be assembled in orbit - the costs and complexities would be unprecedented.

The political will required to accomplish such a feat would also be unprecedented. Such a Herculean labour would only be done by harnessing the entire world to the goal, for many centuries. The reason why the craft would have to be gargantuan is that long term space travellers would require the extraordinary protection from space radiation and particles normally afforded by being on the surface of the earth.

In the absence of the earth's atmosphere and magnetic field, the only known way of affording this protection is a layer of soil several metres thick. This means that the only ships which could be used by humans to traverse interstellar space over the centuries required for flights would be gigantic self-contained arks lined with soil, spinning cylinders or cigars, and able to provide an environment for many thousands of individuals. The spin would simulate gravity, the protective soil would grow food and recycle the air, and the scale of the craft would be large enough to foster a society which could be held stable for the long journeys.

As the arks would deliver people who would be descendants over many generations from the original crew, the level of protection needed for genetic material would have to be commensurate with that given on earth. The only other way, apart from using soil, would be to generate magnetic fields around a spaceship strong enough to deflect particles and radiation. However, the power consumption and equipment size and mass needed for this render the solution impractical. Engineers cannot easily recreate a magnetic field as effective as that generated by an entire planet.

It is such a prosaic issue to introduce into these big questions: soil! – but the fact remains that humans came about because of the special and multiple layers of protection from space given by the earth. If some of us leave earth for extended periods, we need to duplicate the protection. For example, all plans for permanent lunar ground stations describe them as buried several metres beneath the surface of the moon.

It is true that what I call 'undiscovered physics' may provide different protective solutions, but I consider it unlikely as the current situation is driven by unalterable fundamental laws. This is indeed dangerous territory, as the laws of Newtonian physics were thought to be the final word until that unusual patent clerk, Albert Einstein, got to them. I shall most happily be proven wrong, but so far String Theory, Alternative Universes and undetectable Dark Matter do not fill me with anything more than a sense of wonder.

The powering of interstellar craft is governed by Einstein's space-time laws, which prohibit travel at beyond the speed of light. As much as we might like to imagine hyperspatial travel, popping in and out of normal space and other devices of science fiction, I am afraid reality is most likely to be bound by the laws we have already discovered. The 'slow' speed, coupled with the damage caused to living things by space radiation and particles, says that we would have to set off in protected arks.

The arks could not be preceded by faster and smaller reconnaissance craft, and would therefore leave for journeys which could take centuries and yet there would be sparse knowledge of what awaited them at the end. For example, should a rocky planet be found, would it meet the criteria necessary for us? If it did not, but came close, would the crew be willing and able to devote ten or a hundred thousand years to terra-forming the planet? Or would they leave the planet as it was but alter themselves via genomic tweaking to beings who could live there? Or would they set off again? Is it possible to believe that we could construct a stable society in a spinning cylinder in a great emptiness for eons of time? Come to think of it, why would anyone be willing to leave earth in the first place?

The low odds of finding suitable planets, around a suitable sun, either for immediate occupation or for terra-forming, could be improved greatly by detective work by astronomers before departure. Such work could be refined during the journey by ark-based astronomers. Further, arks could leave in both directions around the metal-rich galactic annulus and work their way around the core. I have done a number of simple calculations, making assumptions about speed and distance plus time needed for terra-forming, time needed for building arks on new planets and the special problems posed by the long hops needed to get from spiral to spiral. Despite some conservative time and distance assumptions, but maintaining a constant pace which never falters, the task could easily be completed within ten million years. Humans, by then evolved in all sorts of directions but still the cleverest things in the universe, would meet at the other side of the galaxy.

We would leave Mother Earth for one of two reasons. The first one would be to preserve the race from certain extinction because of the sun's demise as it goes through its natural lifecycle. Fortunately, all the signs put that off for several hundreds of million years still, so we can relax unless something unusual occurs such as the straying into the solar system of an astronomical body large enough to disrupt the planetary orbits or damage the sun. This event is most unlikely, and would take geological time to be consummated and several genetic samples, large enough to seed new homes, would be able to escape in arks.

The second reason for sending out arks would be an acceptance of the near certainty that not only are we unique as humans, we are the only technological civilisation in the universe. From that startling conclusion would flow a philosophical debate about our duty, our highest purpose, our responsibility to preserve and perpetuate the race in the same way we are driven to have children. To do that we must go to the stars, because we only have one home now and having all our eggs in one basket is not prudent.

Despite our many flaws, we are too precious to be allowed to go extinct.