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THE IMPACT OF SCIENCE AND TECHNOLOGY ON ENGLISH

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The topic which I have chosen is one in which I have a fairly long-standing interest. I have a sneaking suspicion that few understand the reasons for the choice of a career as a scientist or technologist, and fewer have any idea about what it is scientists and technologists try to do with their daily lives. However, I hope in this paper to move some way towards closing the gap in understanding which exists between most scientists and technologists and what I call, in all humility, the lay public.

What I want to do is to start by defining what I mean by science and technology; then to outline the impact of these two on our daily lives, for undoubtedly they have an impact which goes to the very roots of our cultural heritage. I want then to consider how our language is being affected by the rise of science as the dominant force in our culture and to consider not only the decline of our language as a means for exciting the imagination, but also the rise of language as a medium of 'communication'. I want briefly to consider the effects that science has had on our ability to generate new words to deal with new concepts, recognizing always the ability of a language - any language - to accept new words into

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itself is a measure of the vitality of that language. Finally, I want to turn to the present day backlash against science and technology and to show how the scientific ethos is changing, not because of any criticism, but because there have been fundamental changes in scientific philosophy. I believe these changes must go a long way towards making the scientist far less arrogant than he has been in the past, so that we may well see the day when the distance between science and the arts is not nearly so great as it is today.

SCIENCE TODAY

Now in order to explain what science is today, I want to trace its development. Modern science really started in the 17th Century, when the new freedoms which had been brought by the Reformation led men to enquire more and more into the nature of their environment. This was the era of men such as Copernicus and Galileo. Their findings constituted yet another threat to the might of the established church, but that threat remained no more than a threat, as did so many others like it, until the 18th Century.

One of the greatest figures of that century was Isaac Newton, who may be known best as the discoverer of a theory of gravity, but whose greatest importance probably lies in the fact that he was the first to delineate what has become known as the scientific method. The belief that a man who applied this method could gain an understanding of nature was a powerful blow indeed to the church, and religious mysticism was doomed from then onwards as a dominant philosophy.

In the 19th Century, man himself, rather than religion, began to be threatened. On the one hand, there was a rise in the understanding of the nature of matter, which slowly moved during the course of the century towards the understanding of the matter of life itself. On the other hand, there were the biologists, typified by Darwin, who humbled man by defining his origins in terms of a scientific law, rather than in terms of folk-lore.

The threat against man has been completed in this century, with the discovery that matter itself can be destroyed, and that life and thought also appeared to be governed by a set of explicable rules. It seems almost self-evident that the logic of science, in which theories are proposed, tested, discarded in favour of new theories if the test fails, and accepted as valid if the test

succeeds, can only lead us inexorably towards some truth. And that is what we tend today to view a scientist as, a man who somehow or other has acquired the means for attaining a Truth to which lesser mortals can never aspire.

I suppose that, being a technologist myself, I should not put off any longer saying what a technologist is. He is a relatively modern creation, the man who takes what science has to offer, and turns it into 'things'. Those things are either what we need for life, or else what we are led to believe we need. Of course, technology started well after science. The rise of technology dates from the Industrial Revolution, much as the rise of science dated from an intellectual revolution, known as the Reformation. In its earliest guise, it was largely the technology of things static - what is now known as civil engineering, roads, bridges, canals, and dams. With the passage of time, the interest in things that move grew, and we entered the field of mechanical engineering. Late in the 19th Century, the need for alternative forms of power led to the harnessing of electricity, and the electrical engineer was born. Early in the 20th Century, the rising demand for mobility led to the need for liquid and gaseous fuels, which in due course gave birth to the chemical engineer, who today does far more than simple fuel chemistry - every hour of every day we are touched by something that the chemical engineer helped make. And so, as this century has progressed, there has arisen a long chain of other specialities in engineering, the argricultural engineer, the radio engineer, the aeronautical engineer, and so on, ad infinitum, all of whom take basic physical principles and turn them into realities for us all. There are, of course, the other technologists of whom I am not in the least qualified to speak, the medical technologist based upon the rising knowledge of the science of life, and the production technologist, based upon the scientific understanding of the methods of production.

THE IMPACT OF SCIENCE AND TECHNOLOGY ON OURSELVES

There is no gainsaying that, between them, science and technology have brought a fantastic revolution in our lives. We have grown accustomed to change, with the result that we tend to forget all too readily how far we have changed, or, for that matter, how fast. I think we have forgotten, for instance, how we have 'acquired' longevity. The Bible speaks happily of a

lifespan of three score years and ten, but it is not so many years since such a lifespan was the exception rather than the rule. A book which brought this home to me very solidly was Jack London's *The people of the Abyss*, which describes conditions in the East End of London just after the turn of the century. In that environment, a man was old at forty, and a woman was unlikely to survive more than ten pregnancies in succession, and was therefore most likely dead by thirty-five.

I think it is true to say that the scientific culture is dominant today. Science may have destroyed man's image of himself, but it has concluded a Faustian bargain and holds out for us, if not eternal life, at least a far longer one than we would otherwise have had. As the dominant culture, it has attracted unto itself most of the creative force which is available in the pool of mankind alive today. The cynical will perhaps agree readily with this, and point to a dearth of creative art, or music, or sculpture, or even literature. I think there is a risk the cynics may be right, if only because science and technology have all the hallmarks of the traditional creative pursuits. They require, for instance, an extended apprenticeship during which time the aspirant scientist is virtually confined to barracks, where he slaves for his professor or tutor and has to pay for the privilege to boot. Once he gains his second or third degree, he is accepted into a scientific community, which he finds full of all the petty jealousies, the temptestuous histrionics, and the strange personalities which are associated with any other artistic pursuit. Truly, science and its handmaiden technology have all the trappings of the creative crafts.

THE OBJECTIVITY OF SCIENCE

However, when they actually come to do their science, the scientists subscribe to the idea that they can be strictly objective in their work. They are sustained by the belief that what they observe or what they report can be done with such detachment that concerns for ethics or for other people either cannot or else need not touch them. Of course, because the scientific philosophy is so dominant, the influence of this type of thinking is contagious and we have the unedifying sight of everybody trying to adopt the same ghastly detachment. In scientific writing, the philosophy shows up as an impersonality acting in the passive sense. Surely the bureaucrat is merely apeing this when he says things like: 'with

reference to your letter reference X42/gm/AX5MTs/G9/24 of the present date, I have to inform you that the Department is of the opinion that the instrument referred to therein is not a Group III hazardous substance' (Quoted from a recent letter). What he is doing is trying to hide behind an impersonal veil, to substitute the Department for himself.

I am not suggesting that science is responsible for this type of bureaucratese, but merely that the misapplication of the method of science has brought a terrible sense of detachment to much that is written today. I am certain that the insidious insistence on the avoidance of *I* in what we write is leading inevitably to an emasculation of our language. *I* may have opinions, but *I* may not express them, only the department may.

The essential thing is, of course, that we need opinions. We need them so that our ideas can be stimulated, or so that our imaginations can be fired. Somehow, the rise of science has been associated with the demise of the imagination, and with it has gone much of what is good in English literature. Why else would a recent poet have said 'Publishing a volume of poetry is like dropping a rose petal down the Grand Ganyon and waiting for the echo'? Poetry, which should stimulate and inspire, has fallen into an abyss dug by Patience Strong. And it is not only poetry which has suffered. The robustness which characterised the writings of Stern or Fielding when they laid the foundations of our English novel has faded to the pallid purple of publishers such as Mills and Boone, an interesting phenomenon in which the opinions of the publishers seem to matter more than those of the authors. Not even the best-seller brings relief in this desert; a man by the name of Daniel J. Boorstein summed it up when he said: 'Best sellerism is the star system of the book world. A best seller is a celebrity among books. It is a book known primarily (sometimes exclusively) for its wellknown-ness'.

COMMUNICATION

I think another unfortunate aspect of the rise of science has been the rise in the belief that written English is a form of 'communication': somehow or other this word has acquired a latter-day aura in which there is far less a sense of the imparting of knowledge, and far more a sense of sharing or participating than there used to be. At its simplest level it is the sharing of in-jokes between the headline writer and his reader. When this works, it is fair enough; but all too often it goes

awry - the tale is told of the writer of the caption 'Time flies' above a story about an Oldest inhabitant; the subeditor commented: 'You can't, they fly too fast'. You may say that there is nothing much wrong with this form of communication; but it is not so very long since a Canadian professor called Marshall Mcluhan took the idea of 'communication' to the ridiculous extremes, and become famous overnight. 'The medium is the message', he proclaimed, and then proceeded to ask questions such as: 'Why have the effects of media, whether speech, writing, photography or radio, been overlooked by social observers through the past 3 5000 years of the Western World?' Apparently nobody told him that in Rome a camera was something quite different, or that the Romans were perfectly adequate orators, for that matter!

There is one area where science has had a beneficial effect upon English as a means of written communication, and that is in the area of the pure transfer of information. Whether we like it or not, the language of science is English, and the English by which scientists communicate must be understood by people whose mother tongues range from Czech to Chinese. It has led to an extraordinarily brusque sort of language, with short sentences and a limited vocabulary. Nevertheless, it is a remarkably efficient means for the transfer of information, and as an example I will present you with a short section from a computer manual:

> When an expression has more than one arithmetic operation, the order in which the operations take place depends upon a hierarchy. An expression is scanned from left to right. Each operator is compared to the operator on its right. If the operator to the right has a higher priority, then that operator is compared to the next operator on its right. This continues until an operator of equal or lower priority is encountered. The highest priority operation, or the first of the two equal operations, is performed. Then any lower priority operations on the left are compared to the next operator to the right.

I think you will see what I mean, how every word tells and how each sentence is made to carry a single idea. You probably found it extremely difficult to follow; but then it was not English to be spoken, but English to be read. You may say that it is little more than a recipe, but I must tell you that it is far better than any recipe I have ever come across. It flows on for page after page, with an impeccable logic, never repeating itself, and with never a word out of place. Compare it

to a typical recipe: 'Pour the cider into a saucepan and add all the ingredients. Heat, then leave to cool. Peel, core and quarter the apples and fry them in the butter. Dust with the sugar. Add the cinnamon and grated lemon'. You see immediately that the nasty word *all* in the first sentence was more than misleading, it was downright expensive.

Parenthetically it may be remarked that, as a scientist, I am singularly aware of the pitfalls inherent in the word *all*. It was the mathematician, Bertrand Russell, who was led earlier this century to a new class of problems, based upon the concept of *all*. One of his more famous propositions is that of the barber in the little country village, who shaved all those who did not shave themselves. The proposition is put in impeccable English, and in apparently impeccable logic, until one asks 'Who shaved the barber?' Such problems soon make one aware of the potential fallibility of all languages.

NEW WORDS FOR NEW CONCEPTS

I said earlier that I believe the rise of science had affected our ability to create new words. For hundreds of years, we have turned to the classical languages to find dead words which we can resuscitate to express new concepts. The scientist has made as much use of this facility, this pool of words to be borrowed, as any other group in society. For instance, the lightest element known to man, hydrogen, comes from the Greek for 'water' and 'being born', while the heaviest natural element, uranium, comes directly from the Greek *urania*, meaning literally, 'the heavenly one'. But, of course, the number who can claim a working knowledge of Latin or Greek is falling rapidly. The young scholar of today is driven by the very success of the scientific culture towards scientific pursuits, and Latin and Greek are now truly dead. Suddenly, we are being forced into acronyms and their like to express new concepts. There are words like 'transistor' from *trans*fer, and re*sister*, and words like laser, which was originally an acronym for *l*ight *a*mplification by the *s*imulated *e*mission of *r*adiation. The trouble is, that such words have no links with our cultural heritage, and as a result they are bland and unemotive to us. Compare, for example, the word 'clone' which comes directly to us from the Greek, meaning 'twig' which I feel is a far stronger word and evokes overtones of colonies - perhaps this is why people get so worked up about cloning. Similarly, the word 'fission', formed from the past participle of the

Latin verb *findere*, meaning 'to cleave' or 'split', has readily acquired a strongly emotional note, not shared by phrases such as 'chain reaction', which is perhaps mercifully passing into the background of our consciousness. But the modern tendency to invent acronyms for some scientific marvels seems to me to be the ultimate folly. LED's or LCD's, which today show us either the time or the results on our pocket calculators, are actually the result of the combination of very deep scientific understanding and a very high level of technology, yet we can hardly be moved to wonder by a collection of apparently random letters. There are hundreds of similar examples about us - consider, for example, RNA, RDX, FN, and SI.

I believe that one of the most horrible examples of our latter-day word-making is a combination of the passiveness of which I spoke earlier with an often-incorrect attempt to use a Latin root by means of the suffix *-ize:* 'Make certain this has been diarized'; 'It was hypothesized that this could be systematized'. The list is endless, and shows a remarkable lack of feeling for the beauty and power of the English language and a total lack of concern for the individual. The language has been 'sanitized for your protection'.

There are many other examples where we are losing our ability to revive old words for new concepts. I personally feel that the dropping of 'radio' in favour of 'wireless' is a mistake; after all, we were able to invent 'telephone' where the German, lacking a convenient pool of dead words, was forced to use *fernsprecher*, or 'far-speaker'. It may also be remarked, that there is a growing tendency, particularly in scientific English, to avoid the invention of new words in a very Germanic way, by stacking nouns and adjectives ahead of a main noun. Lacking the inflections of German, we are forced to use rigorously commas and hyphens to ensure that such stacks can be interpreted correctly. I have been keeping an eye open for examples of this sort of problem, and I recently found the following stack of nine, which I believe to be a record:

> A progressive saturation selective population inversion nuclear magnetic resonance experiment.

JARGON

So far, I have tended to concentrate on the effects of science on our language. Technology, too, has had its effects. At the simplest level, it suffices to

note that every branch of technology generates its own particular vocabulary, or 'jargon'. This is inevitable whenever a relatively closely knit group of people talk among themselves to the exclusion of outsiders. I do not find jargon deplorable, except whem it spills over from the group concerned into the world at large. Such spilling over is inevitable when the technology concerned is successful, and the products of that technology begin to affect us all. What is perhaps regrettable is that jargon is transferred not by those who recognize jargon for what it is, but by the marketers of technology and their agents, the advertisers. Suddenly our washing is filled with enzymes; our toothpastes with fluoride; our lounge-suites with polyurethanes; and our cars with molybdenum. These are just a few examples of the way in which the jargon of chemistry is spilling over into our lives. I don't think we are any better for the information; certainly our language has not been enriched in any way by the invasion. There are a myriad of other areas of science and technology, each with their own particular jargon, and each at some stage likely to bombard us with jargon in an effort to sell. I am sure the examples I gave are familiar to you all, and you may doubt for a moment that they are really jargon. But, think, do you know that your washing powder contains an enzyme? Can you taste the fluoride in your toothpaste? Can you feel the difference between the new polyurethane and the old polyether? Does your car really go better with molybdenum? All these things are really hidden from you; the jargon of science has been used to blind, not to educate.

MEDIA FOR COMMUNICATION

As I said earlier, the transfer of scientific jargon to our language is probably the simplest way in whch technology affects us. I think there can be little doubt that the major effects arise from the products of technology; radio, television, tape recorders, gramophones, the cinema, and even, when it works, the telephone. These are the things which bridge oceans, which link cultures so diverse that they may have only a common language, English, and that English often barely recognizable. It is far too great a task for me to attempt to describe the effects of such powerful means of communication. It must affect the way we speak and the way we write just as it affects the way we dress. There can be no doubting the strength of these weapons, and yet I believe the variety of such technological

tools can only grow in the future. We have by no means seen the end. Already, machines are available which will scan the printed page, and read aloud each word. Of course, the computer's voice lacks inflections, but there seems to be no reason in principle why it should not be programmed to modulate its pitch as it 'reads' each sentence, just as you or I do.

You will notice that the first thing I mentioned in this regard was the computer. Indeed I believe this to be the most powerful tool that technology has available to it. All of us are aware, to some extent, of the power of the microprocessors which are available today. We have only to look at the modern pocket calculator, or digital watch. Many of you may also be familiar with word-processing machines, which look almost like an ordinary typewriter, but which permit every imaginable form of editing of a written script, and which can even be used, in some advanced forms, to check spelling without requiring recourse to a dictionary. It seems fairly certain that many computers will play an ever increasing role in our lives. Some prophets predict that there will be ten or more in the average household before the end of the century. They will control such things as our washing machines or cookers, and may well be incorporated in our telephones. They may perhaps take on unusual roles such as drawing up shopping lists for use, or checking on our visitors to make certain they are friends. I am not certain how they will affect our language, but I am convinced that they will affect it. The British Post Office recently took a most significant step, in making available by a combination of telephone and television screens, immediate access to a huge 'data bank'. In this bank are stored such things as the latest weather predictions, the latest stock exchange prices, and the latest sporting results. Such a system, if widely used, could certainly sound the deathknell for our newspapers. This would mean the loss of our leader writers - while I by no means agree with all their opinions, I would far rather have them around, writing daily with a clear lucidity which comes from a lifetime of practice, than not to have any (including those which I dislike) available at all.

THE REVOLT AGAINST SCIENCE

Thus, I believe that science and technology are going to continue to have an impact on our language. But, what of science and technology? Are they going to remain the dominant forces in our culture which they have

become in this century? There are already signs of a popular revolt against the scientific ethos and the further growth of technology. You could perhaps point to the rise in the interest in such unscientific things as astrology, or health foods and natural living, and you might perhaps also point to the evident success of the environmental movement in bringing technology to heel. There are many who have accused science and scientists of hubris, that is, intellectual arrogance and insolence. There is undoubtedly a growth, in countries such as the United States, in governmental controls over advanced scientific research, aimed at protecting the public against the worst excesses of apparently irresponsible scientists. The growth of nuclear power has been slowed, the evolution of new drugs has been stopped, to all intents and purposes, and research in genetic engineering has been brought under rigorous control.

However, I do not believe that these are more than passing influences. Already there are signs that living with 'appropriate technology' is becoming far less attractive than it was; that people who have been told everything which is in their food are happy to settle for food, uncritically, and unlabelled; that protecting the environment is one thing, but that halting the filling of a dam which will bring both power and work to thousands, in order to save the home of the snail darter, is something quite different; and that, when times get hard, one is prepared to look in any direction for help, even in the direction of those tainted knights-in-armour, science and technology.

Thus I do not believe that the scientific ethos is going to change because of external forces. What I think is going to happen is that science is going to change of its own volition. There are already signs of this. The relativistic philosophies of Einstein are permeating our thought to a far greater extent than ever before. Scientists are no longer nearly as happy as they were to believe in the absolute truth of a theory; rather, they recognize scientific revolutions as transitions from one point of view to another; Newton was not wrong about gravity, but by the time Einstein came along, our knowledge had extended to the point where we needed a broader theory which included, as a limiting case, Newton's theory.

This may not seem to be such a marked change in viewpoint, but in fact, in its deepest sense, it is

revolutionary. No longer can the scientist lay claim to a method of attaining the ultimate truth; instead, he can merely lay claim to having accepted a particular set of ground rules, which he may change, as time goes by, to suit himself, rather than to attain some higher level.

UNCERTAINTY AND SCIENCE

Perhaps the keynote of this century has been uncertainty. Scientists have recognized since the early 1920's that there is an underlying uncertainty behind time and space. In its simplest terms, the Heisenberg uncertainty principle may be expressed as saying that if you want to know where something is you can only describe its position provided it is standing absolutely still. However, if something is moving, then you can measure exactly how fast it is moving, but you can never tell where it is. Uncertainty is extended in engineering terms as we learn to an ever greater extent how essential it is to use statistical techniques. For instance, we can no longer speak of the strength of something, but must speak of its probable strength, usually with a number of qualifications behind it, such as the conditions under which the strength is to be measured, the temperature, and the history of the specimen to be tested, and then we must express the strength with certain error limits on our estimate.

I think another part of our uncertainty has come from our ability to deal with a lot of very large numbers, the ability given to us by computers. Suddenly, we do not have to deal with individual units in isolation, but we can consider the collection of units which goes to make up a system. We have found that even quite a small system can behave in completely unpredictable ways, and that an insignificant effect, in an individual unit operating in isolation, can come to dominate the behaviour of a system which includes that unit. As the system grows, either in size or in complexity, then the behaviour of the system becomes even more uncertain. I have a nasty feeling that engineers are far more aware of this uncertainty that is inherent in a system, than people such as planners; those pseudo-scientists, the economists; and possibly also the medical profession. This is because the systems with which an engineer happens to deal are still relatively small and relatively uncomplicated. Even so, engineering systems all too often show quite unexpected effects. For this reason I believe one must be very careful about accepting breakthroughs

in technology. Too many breakthroughs have, with passage of time, been shown to arise as an artifact of the system, and not to be real or achievable at all.

One has to be extremely cautious when dealing with very large systems. There is the very interesting example of the economic model of the world, which was published as *The Limits to Growth*. This model appeared to show that the world was heading for a total breakdown in its raw materials and food supply early into the next century. Unfortunately, when the model was very carefully analysed, its predictions were found to be extremely sensitive to such things as the level of agriculture in South America, and the availability of shipping in the late 1970's. I think this illustrates what I mean when I say that apparently insignificant factors in an individual area can have a very marked effect on the behaviour of the system as a whole. Of course, when one comes to consider a system as large as the human body and as complex, one faces an almost indescribable task in trying to determine its performance from first principles. Uncertainty must rule our understanding of the body and its behaviour.

It is also noteworthy that there exists a comparatively unknown theorem proved by an American mathematician called Godel, which says that 'The machine cannot understand itself'. This may sound rather Delphic, and I should perhaps explain that he is using the words 'machine' and 'understand' in a rather special and restricted sense. Philosophically, however, what he is saying in effect is that there is the ultimate uncertainty, we can never ever hope to understand ourselves.

So I think you will see what I mean when I say that science and technology are busy changing of their own accord, and not in response to the various external forces which have been attempting to change them in recent years. The scientist and the technologist are becoming daily more aware of the uncertainties with which they must live, and of the fact that they have no particular claim on higher truths. The uncertainty within which they are having to operate is making science and technology far more like any other creative pursuit. I am certain that this must close the gap between science and the arts, but not before science and technology have had a major effect upon our language and our culture.