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# THE HUMANITY OF PAPER

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IN OPENING your Third Fundamental Research Symposium, I should like to say two things. The first is how appreciative I am of the honour placed upon me by you, Mr Chairman and your committee. The second is to underline it by expressing the hope that this honour will not be misplaced and to offer an *apologia* in advance, for I have no formal connection whatever with the paper industry. Worse than that—at the time of receiving your invitation, I knew almost nothing about the manufacture of paper; I have still, today, never seen a sheet of paper made.

My apologia, my defence, then is to say that in this world today we may sometimes assume too much that only experts should be allowed to speak. The dreaded question always, in academic meetings, is 'What's your *subject*?' You must be categorised all the time. Amateurism is fondly imagined to be 'out'. Yet the whole history of technology highlights the amateur and his value.

Another characteristic of our modern technological world is the blind acceptance by all men and women of the various technical materials and gadgets that they use every day, without giving one thought to how they are made. They are accepted as part of nature, like the air and earth. Only when they go wrong are they noticed.

I have never seen paper made, but have you, for example, ever seen a transistor made? What is involved in the making of a pair of shoes?—or a packet of corn flakes?—or a simple nut and bolt? This unquestioning, blind acceptance, so universal today, is a sign of our domination by expertise: we hand over. Our education is lacking in this respect; inquisitiveness and imagination suffer and we are the poorer for it. 'The world will never starve for want of wonders, but only for want of wonder', said G. K. Chesterton.\*

Your invitation to me has done one valuable thing then. It has at least obliged me to read something about paper, its history and its manufacture. I

\* I am indebted to Prof. Ritchie Calder for this quotation

am very grateful to you for this. I have studied articles in the *Encyclopaedia Britannica* from chemistry to palaeography, read books, even articles in the *Financial Times*, but I am still an amateur and I ask you to accept me as such. I shall probably tell you nothing that is not already commonplace to you; I shall try only to present the image in my mind conjured up by the word *paper*.

This reading has added to my whole interest in human communication. Hitherto, I have been actively interested in many other aspects. Not only in telecommunication systems themselves, but especially in their various sociological consequences, in both advanced and underdeveloped countries. I have worked actively upon the theory of information and have read widely on the theory of signs, the philosophy of human communication. I have studied human speech behaviour and hearing, normal and abnormal. Yet I had missed this one most important corner of the whole field of communication technology—paper. I ask your attention therefore for my impressions of the subject of paper: to present an image, as an amateur and novice.

Firstly, the sheer aesthetics of it; the touch and feel of paper; its smoothness, crispness. The delight of spreading out a sheet of new writing paper. Mark its whiteness. The hesitancy of making the first spoilage with a pen; folding it. The beautiful simplicity of the golden ratio—or the pleasures of wrapping up a parcel or unwrapping one. The surface texture of an artist's cartridge block, inviting the wet brush. I could go on. Charles Lamb wrote of simple pleasures; those of roast pork, for example. Why, oh why did he not write an essay on the delights of fresh paper?

My next impression is of the infinitive variety of its uses and I suppose that this springs from the remarkable diversity of its physical properties. What other man-made material is so varied? It can be rough or smooth, greaseproof or waterproof, absorbent or not, soft as cotton wool or stiff as board, heat resistant, even fireproof, chemical resistant, opaque or transparent, white or coloured, shiny or dull, strong or weak, light or heavy, ... pulpable, cellular, stiff or flexible, laminated, crêped, loaded, waxed, sanded, embossed, hinged, corrugated, easily folded and pierced, coarse or fine, even made hairy. It can be tarred (and probably feathered, too, for all I know) ... yet, with this plethora of properties, it is composed of two of the commonest materials in nature—cellulose and water. It has one failing, however, as my children have learned from rubbing out things in their drawing books—it is not very resistant to abrasion. Many a tear has resulted from the dirty hole that appears; please do some more research. I am quite serious, for I believe many people like myself think of paper as having every desirable property, except this one.

Consider too the great diversity of uses that these varied properties give us. The most apparent of these to us public is writing and printing, probably the earliest use of paper and papyrus. Many discoveries of palaeographers have

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been documents and accounts, not only upon papyrus, but upon clay tablets, too. These were of vital social importance to the ancient world. Thus, Pliny, in the reign of Tiberius, said that the failure of the papyrus crop threatened the whole of business life, because accounts and records could not be kept. Legal documents, too, rituals of the dead, religious and civil texts, literary work, property deeds—these were the first uses of papyrus, the making of *records*. It is the power to make records that is the basic reason that the coming of paper had the profoundest influence over the world. You can store messages (as we might say today) and it is precisely this same power that gives computers their great importance. Computers are the logical extension of paper and print. They can store information on astronomical scales and for this basic reason they will determine the course of our lives in future, just as paper and parchment have in Europe during the past millennium.

This sounds like a take-over bid and, of course, it will be so, unless new uses of paper emerge, which they will. In our homes, we may one day plug in to the National Computer Grid, to store all our ever-increasing personal data, bills, receipts, bank accounts, instalment accounts, telephone directories and all like matters. The computer may predict and guide our personal economy. We may plug in our home printing machines to get, among other things, our newspapers, to give us such news as our television sets have not already given us, but these machines will still need something very like paper to print them on. You may well ask whether we are not slowly becoming a race of illiterates, what with all this television, now this data storage and such-like? Shall we need to read in future? To which the answer is quite certainly, yes. Taking Britain (whose figures only are best known to me), our total consumer expenditure on books, newspapers and magazines has remained constant for many years, allowing for the value of money.<sup>(1)</sup> Circulation of books from public lending libraries has doubled in the last ten years, however, during the fastest expansion of television.<sup>(1)</sup> Television seems to be a stimulant to reading: television news bulletins have not taken over newspapers, they provide something quite different. If you question the *quality* of this reading, I can only say that our city fathers, who vote the money for town libraries, are not on the whole given to pornography.

People personally involved in the paper industry may sometimes be apprehensive of the threat of electronics to their growth rate, though I see no clear reason for being so. The paper industry is an old one, but (as I see it) not a traditional one, by which I mean that, in contrast to certain other older industries, it is alert, alive to the values of research, open to changes of method and keen to find totally new applications and markets. I see that profits in the paper and printing industries have been rising faster than the average of all manufactures, at least during the past twelve years.<sup>(1)</sup> Fig. 1 shows what is commonly called a sigmoid or growth curve, typical of a demand accelerating and slowing up to saturation. The history of technology shows that three things can happen when a new technology threatens an established one. Firstly, the new may stimulate the old into greater activity so that its growth accelerates (the bottom of the sigmoid curve). Television stimulating book buying and reading is a typical example. Secondly, the new technology may open up totally *new* and socially useful fields, leaving the old technology to grow and become eventually saturated (the top of the sigmoid curve). The telephone is an example; its coming and phenomenal growth has



Fig. 1—Sigmoid growth curve

still left the postal service untouched and saturated (about 1 000m. letters and parcels per annum in Britain). Thirdly, the new technology may be seen to be so superior to the old that it causes a rapid collapse. The coming of the motor car, after the first world war, caused railway passenger traffic to collapse in a quite dramatic way. The great and regrettable factor in situations such as this is the conflict between economic value and social value, a conflict that we see going on all round us in the so-called advanced industrial countries. Although we are already as rich as Croesus, we go on pretending that we must get richer; our values are still almost entirely economic values. While one country is doing it, all must do it—within the highly industrialised areas. If one industry prospers, it threatens others, whose loss may be a real loss in a human sense. This is still the philosophy of our technological world today and one that you as an industry have to live with—grow or perish.

At present, the paper and board industry is growing steadily and its development lies somewhere on the straight part of the sigmoid curve. The question before you is whither? Up, across or down?

Let us take this possible threat from the electronic industries-television,

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radio, telephones, computers and all such information technology. Take comfort that this technology has grown so fast (mainly since the end of the second world war) that the various growth curves can best be described as explosive; during this time, we have seen no catastrophic collapse in our newspaper, magazine, book and other paper-based industries. Not even a kink. If the electronic technologies were going to have disastrous effects, they would have done so long before now.

For sheer inventiveness, electronics has had no equal in history. The flowering of this industry has made all others look like weeds. Consider the facts for a moment—crystal sets in 1920 to a national television service here in 1937; air and marine radio navigation by 1940; the first transistor was announced in 1948, then the first sputnik only nine years later, with only another nine years to world-scale satellite communication. Computers have emerged during that same brief time, until today they dominate the entire industrial scene. In so-called cybernetics, too (the simulation of learning and other animal behaviour), we are now forced to use such terms as *dummy neurons, artificial intelligence* and *man/machine communication* to explain what is being done. This is an inventiveness never before approached, both in its variety and in its rapidity.

Let us look at two curves that symbolise this information explosion. Fig. 2 shows the growth of transatlantic telephone channels, both line and satellite, going beyond today into the officially predicted future.<sup>(2)</sup> Fig. 3 shows the Telex traffic growth—this is a system of world-wide telegraphy that beats the clock, for messages can be printed out (on paper) while you are asleep. There is another example of information explosion—the growth of computer capacities—entirely during the last 20 years. There are many similar growth curves that I could bore you with. The important thing is that this explosion of techniques for recording or transmitting information or messages has not affected the steady, growing demand for paper in any marked and sudden way.

I read recently that paper is preserved better when refrigerated. A copy of *Tales of Mystery and Imagination* by Edgar Allan Poe (Everyman Edition) had been left behind by a geologist of Scott's 1912 Expedition to the Antarctic and was found there in 1959, nearly half a century later. Tests at the Manchester College of Science & Technology<sup>(3)</sup> have shown that the pages are 'noticeably brighter than those of the same edition obtained from secondhand bookshops'. It seems not surprising that natural ageing of the paper could be slowed down by reduced temperature, since paper is an organic material. I have often felt the yellowing of my own newspaper cuttings to be a defect. What possibilities are there? When the question comes up of preserving archives or of storing today's knowledge for the benefit of future historians, it

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is microfilms that are usually mentioned. Could we not store actual books and paper documents in the antarctic? It's a very big refrigerator.

Writing and printing and other ways of storing information are but a few of the varied uses of paper. My impression of paper, as a layman, is of its infinite and diverse uses. Look at what we have already-paper for wrapping things, from the heaviest protection to the finest tissue, for drawing on and, for 500 years now, for blotting with; paper for blowing your nose on and



circuits on the North Atlantic

Fig. 2—Official prediction of telephone Fig. 3—Outgoing Telex calls per annum from Britain to Europe

wiping your spectacles, for drinking straws and cups, for the Japanese art of origami; for cuffs and collars, for insulating electric cables, for cement bags; papier maché—what better way of packing eggs? For protection of the male at breakfast time (as Jane Austen remarked upon). For computer tapes, for postage stamps, for lighting bonfires. You can, literally, make money out of paper. (I believe that a lot of other people's money is printed in Britain.) Wars have been decided by 'scraps of paper'; Edmund Burke it was who in his speech on conciliation with America, 1775, said, 'I have in general no very exalted opinion of paper government.' What cannot you do with paper? 'Read, mark, learn and inwardly digest', said Francis Bacon, a bookish man; he was not actually recommending that you should eat the stuff-though

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curiously enough the Egyptians did (strictly speaking, they ate the pith of papyrus, often cooked and we eat paper, too, in the form of sausage skins). They used papyrus also for making sandals, as tow for caulking ships, for rigging and even for making light boats—and, of course, it was used against them for hiding the infant Moses in. What other material is so versatile?

Paper has good heat-insulating properties, as any tramp or boy scout knows; has it real potentiality for clothing? Disposable clothing perhaps. For disposable bed-linen? They have paper houses in Japan; why not here? Seriously, have paper and board not more application to building structures? If not houses and bungalows, then portable, folding garages or other small temporary buildings-garden summer houses or folding beach huts, for instance. I am very serious on this point and would emphasise it by referring again to the Japanese art of origami. May I take this opportunity of asking you to press upon architects the possibilities of such a material as paper, in particular for interior structures of buildings. Rooms, offices, halls and other living spaces are still mostly designed and made, once and for all, in a certain shape. Its true that removable walls are used and folding screens and the like, but these are very elementary. To illustrate my point, here is an artefact made out of a single square sheet of paper. It is a simple one and looks something like a Chinese pavilion or perhaps a medieval tent for a jousting field. It has three sides, but look—you can open it readily by moving the walls and go in. If you get tired of that shape, you can fold it another way that it now has four sides and a flat roof. This is merely an illustration. Does origami have possible value to architecture, especially to interior structures of houses?

I have not yet seen the idea of reinforcement applied to boards-wire strands or mesh, for example. It may be available, but I have never seen it on sale. Paper and board are very light and various surface finishes can be produced. Can variants be made upon conventional wallboard with various finishes? They may be; but I as a possible user have never seen any. Are paper and board inherently prone to damage by abrasion? Paper and board seem to me to have remarkable properties of lightness and strength; the widespread use of boxes and packaging testifies to this. I feel that there may be a vast range of other artefacts suited to paper and board—not only domestic articles, toys, clothing, perhaps some furniture, but wholly new artefacts, just round the corner. The plastics industry is one that has flourished upon new artefacts-some good, many horrible. Paper and board should not seek to copy these: they have totally distinct physical properties and in many ways are aesthetically superior. It is these distinct properties that should be exploited. A paper bag and a plastic bag, for example, serve totally different purposes.

Plastics may be put into adhesive or chemical union with metals and other

materials. Can paper or board? Can they be combined with plastics or wood? It seems to me, as an engineer, that the various materials we have—say, metals, plastics, ceramics and paper—each possess distinct and unique physical properties, but that it is only in recent times that we are coming to exploit these in combination for the construction of new artefacts. In earlier times, we had the metal industries, the timber industry, the plastics industry, the paper industry and so on. At research and development levels is it fair to say that they are slowly uniting? Within the field of electronics, the same thing has happened, though, I believe, much faster. We now combine magnetic properties, electric properties, mechanical properties into a single subject called *materials*. It is taught as the physics of materials and research has led to a host of totally new devices in electronics.

I should like to end with some reference to a most important, unique aspect of paper—or rather of the industry—its economics, again speaking as a lay man. The figures most readily available to me are those relating to Britain. (I am aware of course that this is an international symposium, so please forgive me.) I hope that my points will be relevant to other countries as well.

It seems to me to be an industry ideally suited to automation, to continuous production by automatically controlled plant, using small on-line computers that could include in their operations prediction of raw material demands and market demands. The cement industry is one rather like it in these respects; so is the steel industry. The paper and board industry is like steel in another economic respect, in that it depends utterly upon recovering its own waste. I believe that Thames Board Mills Ltd. uses clean recovered waste paper for 85 per cent of its production of packaging board. Over the whole industry, some 30 per cent of the material consumed is recovered, which means that any piece of paper has a good chance of being used three or four times or so. So it should be, for most uses of paper and board are ephemeral, when you think of it.

Recovery of waste paper seems to me therefore to be a matter of great importance and a subject demanding continual research. I see from the Annual Abstract of Statistics that Britain's consumption of waste paper has (most commendably) increased over 50 per cent during the last 10 years. Speaking as a layman, there seem to me to be three distinct lines of further research. First and most important is education of the public. To most of us, waste paper, cartons, boxes, etc. are old, used and dirty things; we screw them up, burn them, throw them in the dustbin—litter we call it, scrap, finished with and we leave them in the train or pay someone to get rid of them or light bonfires with them. The very word *waste* paper instils this attitude, which must be changed. How do you do this? It was done in war-time. In future, I shall wince every time I read the words LITTER BASKET and try to imagine a new label-RAW MATERIAL RECEPTACLE. Secondly, research into automatic segregation of pulpable and non-pulpable scrap is needed. The presence of impregnants or laminates (so-called pernicious contraries-delightful term!) can wreck large batches of new paper. Perhaps closer working between the waste industry and the paper industry is needed. If non-pulpable scrap can be separated, it might itself be further classified according to the different types of pernicious contrary present. If so, I would ask, cannot new processes and uses be found for these materials—quite new artefacts—rather than try to remove the offending substances? Thirdly, a glance at an economic atlas shows me that the bulk of the world's softwood trees lie in the temperate belt covering Canada, Scandinavia and the USSR. Britain and Europe have little; America has little in comparison. Cellulose and water may be very common substances, but both are being rapidly depleted in just those areas where the present demand is highest. Afforestation is going on in this country and I believe also in the USA. I imagine that research is sure to be going on to produce very rapid-growing trees. Paper and board is for many countries therefore an industry greatly dependent upon importing. I read in the Annual Abstract of Statistics for last year that Britain, for example, imported woodpulp worth £115m. (and an equal value of finished paper and board), whereas recovered waste saved us no less than £60m. This is a large sum in our economy; other countries may show proportionate sums.

As literacy improves in the underprivileged countries, so presumably will their demand for paper increase and market prices rise—and this means half the people of this world. For them to progress, their need for paper will rise just as ours did.

Rather than pride yourselves, in your industry, that this 30 per cent recovery of waste paper is a great achievement, perhaps it might instead be salutary to invert this idea and to think of yourselves as an industry that loses 70 per cent of its good raw material. It's like burning coal, which (in principle at least) is a disgrace, for 70 per cent of the heat goes up the chimney. Paper and board are not, on the whole, consumed by use. The reading of a newspaper leaves that paper untouched; the opening of a box or a carton does not destroy it. Yours is not in great part a consumer industry, nor is it a capital industry; in principle, it is a service industry, supplying short-term needs, often very short. Speaking of boxes and cartons, there is one aspect of the layman's image of your industry that is adverse and that I feel obliged to mention—that very often he feels that the packaging costs more than the contents and that it is unnecessarily showy and elaborate. He may be quite wrong, of course, but my suspicion is that he is frequently right.

It is true that, in my amateur way, I have advocated more inventiveness to produce wholly new artefacts from papermaking pulp that, it could be argued, would be consumer goods, using up your precious raw materials. The economic value of artefacts is likely to be out of all proportion to the cost of their raw material and, anyway, such artefacts are eventually finished with and could be returned for repulping.

As a user of paper, cartons and boxes and as one who is shamelessly addicted to the lighting of bonfires, I have been forcibly impressed by learning of the international organisation that aims to recover them, Le Bureau International de la Recuperation. Fourteen member countries I see—no less—and a title in French, too! In my innocence, I had the idea previously that I was saving the dustman work by burning the stuff. I had no idea that local authorities were actually interested in the rubbish; let alone that they worked *with* the paper industry, as the feedback link of a closed circuit process. Not national it seems—but *international*! I can assure you that there are millions of ignorant citizens like me. Public education is needed.

I have tried today only to give to you some impressions of a layman, forced to confess his ignorance before an audience of experts. Much of what I have said may be common knowledge to you; it may be error or prejudice. If so, I shall be very pleased to be corrected. On the other hand, this exposure of my ignorance may serve to spur you on in your task of educating the public. You cannot really blame us; our whole present-day industrial culture and economic system teaches us that consumption and waste are meritorious, that we grow rich on them. We cannot do so in the long run; in the case of paper, not even in the short run. So, 'Waste not, want not', as my grandmother used to say.

I would now like to come to the point and declare open this your Third Fundamental Research Symposium. I do so now and wish you all a most successful meeting—but wait a moment. Perhaps it would be most appropriate if I drank a toast to the success of your conference. Let'me do this in a way that respects your professional interests; I will spurn the customary glass and drink in a more suitable vessel (a paper cup)!

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