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Dons or Crooners?

Popularization is needed not to bring science to intellectuals but to bring it to the great majority.

Eric Ashby

The organizers of this lecture series tell me that you in this hall are a Third Programme audience. Whether this is intended to be a compliment to you or the reverse, it is not for me to say. If you are indeed a Third Programme audience you constitute quite a sizable sample of it. For every one who listens to the Third Programme there are some 1000 people listening to other programs on radio or TV. I want to begin by making it very clear that this lecture is not about you; it is about them—the millions of British people who night after night enjoy Westerns, boxing from the White City, Al Kandy the Crooner, the Lilliput Leg-Show, and Songs Mother Used to Sing. These are important people in a democracy. For every vote you Third Programme people have, they have 1000 votes. For every pound you part with in response to high-pressure advertising, they part with several pounds.

I am going to ask two questions about these millions of British people and then I am going to give sketchy and inadequate answers to my two questions. The first question is this. Is it important that they should know something about science? And the second question is a double one. It is this. If these millions should know something about science, what should they know and how should it be conveyed to them?

The interpretation of science to you and the likes of you is no problem. You have the Third Programme and Pelican books and (if you are very earnest) university extramural classes, and you know how to learn about science from these and other sources. But the great majority of the British people simply cannot tune into these channels of communication, and this lecture is about that great majority.

The Blossoms of Doris Grove

One cannot think vividly about millions of people. Let us think about one family—a fictitious family, of course. They live in Doris Grove, Birmingham (Doris being the name of a city councillor's daughter in the 1890's and the Grove being treeless and paved and no more like a grove than the Sahara desert, but it is neat, and the front-doorsteps are scrubbed every day and the skyline is laced with television aerials). Blossom is the name: Ron Blossom and his wife Eth. He has a good steady job. Except when he is on overtime he is home about 6. Mum puts on the kettle at 5:30, and they get high tea washed up by a quarter to seven and settle down for the evening. There is the telly, of course, which is on all the time. There is the football pool to be filled in. Or they may go to the movies or to the Crown for a drink and to watch the darts. On weekends Ron goes to see the football, or he queues up to get into the boxing. On Sunday the two of them lie in late and share the newspaper, devouring human-interest stories ("Kensington Killer Betrays Radio Star"; "A Scream—and It Was Her Daughter"; "Love United Them after Twenty Years"; "Millionaire's Son Cited in Drug Traffic Case").

If Ron stays up till 11 o'clock the day after tomorrow, you in the Guildhall audience and I will appear on his television screen. He will give us a glance, but we are not likely to interrupt his reading of the tips for next Saturday's races. Why should we? Ron left school at 14. He has nothing against highbrows and scientists but there is no call to be interested in them any more than they are interested in him. "Live and let live: that's my motto" says Ron, and Eth agrees, with the one proviso, that you must be neighborly.

Is it important that Ron and Eth Blossom should know something about science? They are the backbone of Britain. They produce our dollar-earning exports. They beat Hitler. What they decide in the bar at the Crown swings elections and steers trade unions. If they have a choice at 11 o'clock the day after tomorrow between listening to me and hearing Bing Crosby (and if they can be bothered to get up and twiddle the knob), you and I will be turned out of Doris Grove, Birmingham, and we know it.

Let us assemble first of all the arguments against bringing science into Doris Grove. The first argument against doing it is that it is very difficult to do. Some science, of course, has entertainment value, and it is perfectly legitimate to entertain people with experiments and spectacles of technology. Ron Blossom will stop his other activities to watch a rocket launched or to gaze for a few minutes at a film of the Jodrell Bank telescope. But the educational value of science propagated in this way is nil; indeed (as I shall explain in a moment), it can can even be harmful. As soon as science acquires an educational value it becomes difficult

The author is master of Clare College, Cambridge, England. This article is based on one of the three inaugural "Granada Lectures" delivered in Guildhall, in the City of London, in the fall of 1959. The general theme of these lectures, which will be delivered annually, is "Communication in the Modern World." Sir Eric's lecture, together with the two other lectures in the first series (Sir Edward Appleton: "Science and Communication"; Edward R. Murrow: "Television and Politics"), are published in book form in the United Kingdom, under the title of *Dons or Crooners* (Granada TV Network, Ltd.). Distributors: Shenval Press, 58 Frith St., London W.1, England.

to teach, particularly to a pupil who is not obliged to learn it and who can choose between listening to the teacher, disregarding him as so much background noise like the traffic, or ushering him out of the room by the twist of a knob. Science will not help Ron to earn any more at his job or to be more useful about the house. Furthermore, Ron is tired at the end of a day and he is (as he says) due for a bit of entertainment. Even you and I (let us admit it) find ourselves nodding over a Third Programme discussion between four Oxford philosophers about the nature of causation. Dons have their faithful audiences; why should they go to a lot of trouble to compete with crooners? Moreover, science nowadays is so highly professionalized that, even for the so-called "intelligent layman," science for radio or television has to be severely filleted. Why not leave Ron Blossom alone and accept the view that the popularization of science is something for a small minority of the British people, for whom it is being done pretty well already?

Stratification

Well, in my mind there is one argument in favor of propagating science which overrides these arguments against doing it. It is an unsubstantial argument. I do not know whether I can put it across to you. It is an argument one reaches if one compares Ron Blossom with the common man in medieval England or contemporary Nigeria. His living conditions, his freedom, his security, his expectation of life, and his command of resources are incomparably greater than theirs. He is immune from the despotism of tribe or hierarchy. He lives in a society where the expressions "upper class" and "lower class" have become so obsolete as to be comic, and where the Workers' Educational Association is so short of workers that is has to rely on school-teachers and bank managers and postmasters and highbrow housewives to fill its classes. The social strata in which his ancestors were confined have dissolved. If his son is bright enough, the eleven-plus takes him to grammar school, a state scholarship takes him to Cambridge, and his charm and eloquence may take him into the House of Lords as a life peer.

But something is missing—something which the medieval Ron Blossom possessed and which the Nigerian Ron Blossom still possesses. Ron Blossom has practically no roots in society. He has never seen the house where he was born. He is attached to his near relatives and his near neighbors, and he takes trouble over the house he lives in, but beyond that he feels no continuity with people or place; no continuity with those who run the big industries in the city, or with the professors at the university, or with those who go to the Festival theater in Stratford. He sees the Birmingham *Post* only if the fish and chips are wrapped in it. The people he calls "they" go their way and he goes his. He does not regard himself as part of their world but as part of a world of his mates and himself, quite separate from the scientists and artists and statesmen. The social stratification of tribe or medieval village has gone, only to be replaced by an intellectual stratification which separates don and crooner, master and servant, highbrow and lowbrow.

This is a comparatively new phenomenon in society. Its cause is admirable even though some of its effects are bad. The cause is that nowadays anyone in Doris Grove who is interested in intellectual matters and who has an IQ of 115 or more can, and does, get out of Doris Grove. The laboring classes of our great-grandfathers' day included men of high intelligence. Even though they could not hope to rise above the state of life to which God had called them, they nevertheless understood (through the penny cyclopedia and the mechanics' institute) something of the main currents of English intellectual life. The cohesion of Victorian society (as well as its disruption) owed something to these men, these Tritons among minnows. Nowadays the Education Act withdraws the Tritons; it is a great achievement, but it changes the problem of the mass education of minnows.

And if you look much further back, beyond the Victorian age to the medieval village, you find an even greater dispersion of intellect and artistic sensitivity in society. Every Sunday the peasant at the Mass was (as it were) irrigated from the mainstream of European society. The benefits to him were not only spiritual. His eyes rested on lovely craftsmanship. He heard Palestrina's music. He learned unconsciously something of the standards of art and music and oratory which were the pride of Europe.

It is this cultural cohesion, this dispersion of intellectual ability throughout different strata of society, which is missing from Doris Grove. Its families are no longer brought together by one common Church in a common cultural experience shared with the lord of the manor or the envoy from the court. It is not the Mass but the mass media which nowadays provide the common cultural experience in Doris Grove. And this experience does not pervade the whole of society; what unites Doris Grove does not unite Kensington or Cambridge. The million or so of people who partake of the intellectual life of Britain, those who buy the Pelicans and go to the Proms and read the Listener, and who once upon a time would have shared with the peasant the common culture of the Catholic Church—this minority is untouched by the mass media which saturate the lives of Ron and Eth Blossom. Social stratification is becoming extinct; intellectual stratification is taking its place.

And so there has grown up a lack of intellectual and cultural cohesion between the small minority of the population which is trained for the intellectual life (largely selected for this training by the welfare state) and the rest of the population from which this elite of intellectuals is drawn. Despite all the constraints of the old aristocratic society, the lord of the manor was often close to his villagers and the Russian landowner was close to his serfs. Folk art and folk literature were doubtless less sophisticated than the art and literature of the court, but they were no less spontaneous and genuine. The common man felt himself to belong to one single fabric of society; it is this sense of belonging (I suggest) which is missing from Doris Grove.

Cohesion

How can Ron Blossom be made to feel that he is not merely a spectator of the scientific age into which he has been born but an essential actor in it? How can he be made to feel that the men who make rockets and digital computers and wonder drugs are, at bottom, men like himself? I suggest that these are questions worth asking and that the answer is to make Doris Grove aware of the great forces of cohesion in the civilized world. You and I might not agree as to what these forces of cohesion are. Some of you undoubtedly believe that the most powerful force of cohesion is religion. But it cannot be denied that the cohesive force of

religion is unable to penetrate everywhere in the civilized world; even within our own Commonwealth there are millions who are not persuaded that our religious beliefs are relevant to their needs; millions of our fellow members of the Commonwealth regard us as infidels. The one force of cohesion which is truly supranational is our common faith in science—not in invention, not in the wonders of applied science (which are frequently exhibited to Ron Blossom in the way miraculous relics used to be exhibited in the Middle Ages —and with similar results), but in the way scientists think and work, and in the universality of scientific laws among people of different race and color and religion and political opinion. We may differ with Khrushchev over politics, with Nasser over the aspirations of the Arab world, and with the Irish over religion, but we are in unanimous agreement with all these people over the laws of gravitation and the properties of the oxides of nitrogen.

This is a remarkable fact. Science nowadays constitutes one of the very few bases of agreement among the peoples of the civilized world. It is about the only bridge which firmly spans the gulf between Communist and Catholic, white man and black, democrat and dictator. If Ron Blossom is to belong to this world (and not merely to pass his life in it) he needs to understand something of how scientists think and work, just as his ancestors centuries ago understood something of how the Church thought and worked. Sir Charles Snow has recently made this point vividly in his lecture called "The two cultures and the scientific revolution." A man who cannot describe the second law of thermodynamics (Snow believes) is as illiterate as a man who has never read a Shakespeare play. Some of Snow's critics reject this assertion. They take the view that every literate person needs to have some familiarity with Shakespeare in order to understand his fellow men, whereas familiarity with the second law of thermodynamics can be left to those few who need this knowledge for some purpose or other. This criticism misses the point. Merely to be able to describe the second law of thermodynamics is, of itself, no more or less desirable than to be able to recite slabs of Shakespeare. What matters is that laymen should understand how it is that scientists come to agree with such astonishing unanimity about the law. This is the knowledge he needs in order to feel he is part of the civilization into which he has been born. Indeed, this knowledge is the most promising solvent for dissolving the stratification which separates Ron Blossom's world and yours, a stratification which even democracy has failed to dissolve.

I know that these assertions are not fully enough argued here to convince the skeptics, but we must pass on. If you concede that Ron Blossom should have some inkling of the way scientists think and work, how is this to be accomplished? Certainly not through science as spectacular entertainment. Excellent as much of this is, this sort of popular science affects Ron Blossom in much the same way that acrobats at the circus affect him. He exclaims, "Cripes!" He enjoys the spectacle but his enjoyment rests on the very fact that it is beyond his comprehension. Far from helping him to understand how scientists think and work, this sort of popular science creates in his mind the impression of the scientist as priest, with magical powers. It was T. H. Huxley who said that ideas in science begin as heresies and end as superstitions. Some popularization of sci-

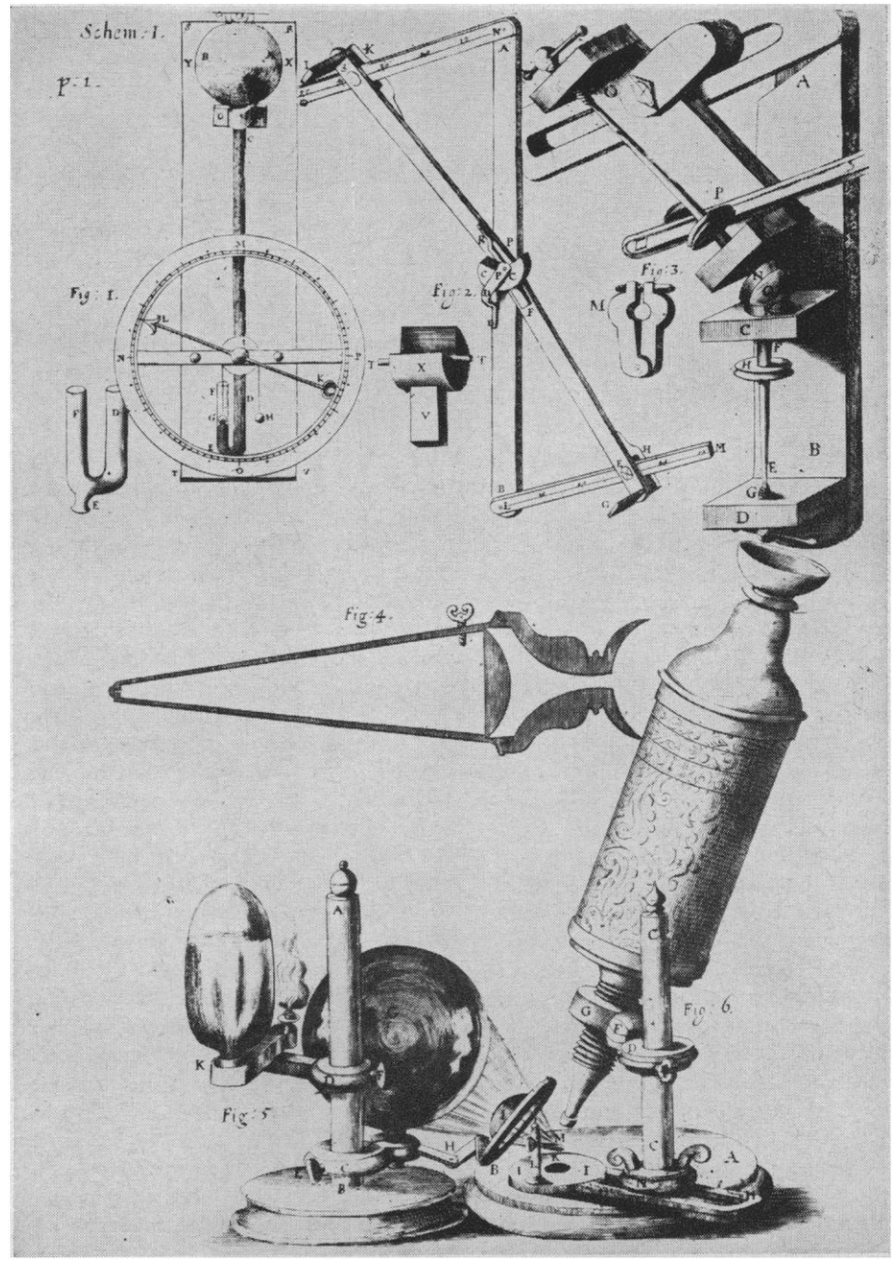

Fig. 1. A drawing by Robert Hooke, reproduced in *Micrographia* (1667). (Top, left) Hooke's barometer; (top, middle) an instrument for measuring the refraction index of liquids; (top, right) Hooke's equipment for grinding the lenses for his microscope; (bottom) Hooke's microscope. [Science Museum, London]

ence encourages a superstitious attitude towards scientists. This helps to harden, rather than dissolve, the intellectual stratification of Britain. Worse than that, it creates a new deference to authority in intellectual matters. Now the greatest single contribution which scientific thinking has made to Europe is the setting free of Europeans from the despotism of authority in intellectual matters, and it would be a sad state of affairs if the very tyranny which was banished by science should be revived in the name of science.

How, then, is Ron Blossom to be made aware of science? First of all (of course) by a first-hand acquaintance with experimental science at school. Ron's son was fortunate enough to go to a secondary, modern school, where he had a good deal of practical science; but if he had been bright enough to qualify for a grammar school he would have had to decide at about the age of 15 either to drop science or to drop languages and history; our education system is too inflexible to permit him to pursue both to an advanced level. As a result of this policy thousands of young people leave grammar schools every year without enough knowledge of science to maintain even an amateur interest in it, and of course they are virtually ineligible for further study in science and technology, all on account of a decision made for them at about the age of 15. I am familiar with all the arguments for specialization at school. They are arguments which seem to me to evaporate in the face of the accomplishments of Russian education. There, in the ten-year school, every child takes every subject. All who complete a ten-year schooling are acquainted with the foundations of science. The organs of mass communication in Russia can and do assume such acquaintanceship. And yet, no one would pretend that this broad foundation of education diminishes Russian accomplishment in science and scholarship.

But this is by the way. We are concerned here with the popularization of science for adults, especially those who live in Doris Grove, through mass media, especially television. I have (I hope) made the point that these mass media are already bringing science effectively into the homes of people who have some knowledge of science, and whose training enables them to learn more; but this is only a very small minority of the British people. If Ron Blossom is to have an inkling of the ways scientists think and work, new techniques of popularization need to be worked out. This is not the place to discuss these techniques, but I want to leave with you two modest suggestions.

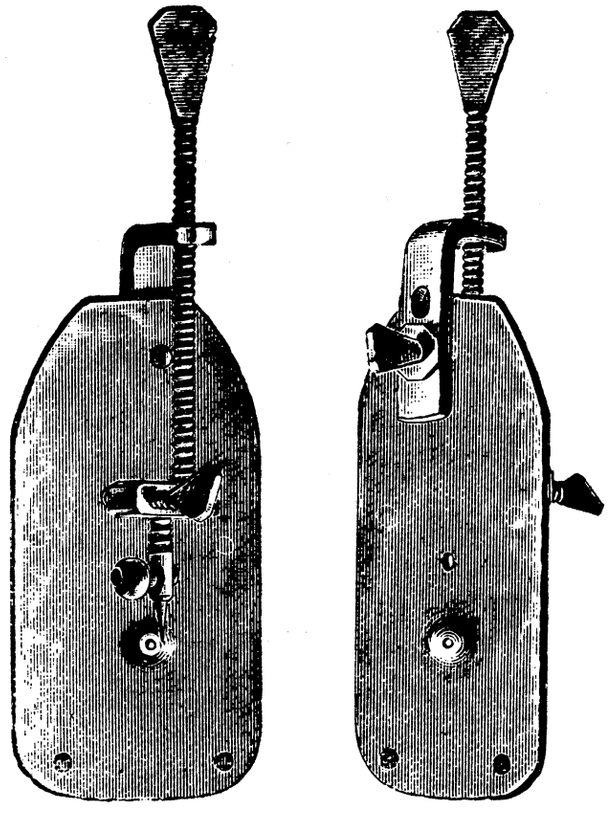

Fig. 2. Anton Leeuwenhoek's microscope. [Science Museum, London]

Craftsmanship in Science

The first suggestion is that more emphasis might be given in television programs to the part which craft and technique play in science. All of us who have worked in laboratories know how much we depend on technicians. Indeed, if you examine recent episodes in the history of science you realize how many major advances are due not to new ideas but to improved techniques and craftsmanship. Now Ron Blossom is himself a skilled mechanic. Craftsmanship is something he understands. One way to make Ron Blossom feel he is an integral part of the scientific age would be to persuade him that some major advances in science are impossible without men like himself—the technical staff in the laboratory and in the instrument works. He could be made to realize that a lot of science is not highbrow thinking at all but just good craftsmanship. This is not wishful thinking; I have talked to skilled workmen in Russia who have just this attitude, carefully nurtured by the Russian mass media. Indeed, this solidarity between the man who works with his hands and the man who works with his brain is a significant ingredient in the cement of both American and Soviet society.

There is time for one example to illustrate this approach. A basic problem in biology is to understand the structure and function of the cells which compose living organisms. The idea that living things are made up of cells, and that growth takes place by the repeated division of these cells, is not much more than a century old. Since the idea was first put forward, dramatic advances have been made in our understanding of cells, in particular, in our understanding about the part they play in heredity. Of course some of the advances are due to leaps of imagination in the minds of biologists, but others—a great many others—are due simply to improvements in the making of lenses. The lens grinder and the instrument maker produced a microscope with better resolving power. The biologist used the new instrument and inevitably saw more than anyone had seen before.

Let me illustrate how this happened.

It is nearly three hundred years since a 32-year-old scientist from Oxford, Robert Hooke, published descriptions of objects he had seen under the microscope: a flea, a louse holding on to a human hair, and a piece of cork. Of the cork he says: "I could exceedingly plainly perceive it to be all perforated and porus . . . these pores, or cells . . . were indeed the first *microscopical* pores I ever saw, and perhaps, that were ever seen." This is the first time the word *cell* is used in this context. Hooke's microscope (Fig. 1) is now in the Science Museum in London. It magnifies only about 30 diameters, and no biologist, however ingenious, could expect to see through it more than Hooke saw.

Eight years later there came to the Royal Society in London the first of a number of communications from an amateur scientist in Holland, Anton van Leeuwenhoek. He recorded astonishing things: bacteria in scrapings from his teeth, animalcules in pond water, and—most important of all—the fact that living cells were not empty but had contents of some kind, "a little clear sort of light in the middle," as he called it. This "clear sort of light" was the nucleus which holds the keys of growth and heredity. Leeuwenhoek's observation was a landmark in the history of science. He saw the cell nucleus because he was a wonderful craftsman; he knew how to grind exceedingly small and highly magnifying lenses. Indeed, we are told that on one occasion he took even a grain of sand and ground it into a lens. Hooke's microscope magnifies only about 30 diameters; but Leeuwenhoek's microscope (Fig. 2) magnifies about 275 diameters, and it is possible to distinguish details under it which are only about 1/10,000 of an inch apart.

That was in the 1670's. It was over a hundred years before a better microscope was made. The reason for this is simple. When craftsmen made more powerful lenses, or combined lenses together to give higher magnifications, the image became blurred and a rainbow of colors appeared around the object. This was because very thick lenses behave rather like prisms. They split light up into constituent colors and they prevent the image from forming in one spot. So all attempts to distinguish more detail in cells failed, until it was discovered that if two lenses are combined, one of crown glass and the other of flint glass (the two kinds of glass refract light differently), then the blurring and coloring of the image are much diminished. These were called achromatic microscopes. They were available to biologists in the 1830's. They were much more convenient to use than Leeuwenhoek's microscope, but in fact their magnification and resolving power were not much better. However, this sort of microscope did enable biologists to see as a blob the nucleus inside a living cell, though not much else of cell structure could be recognized.

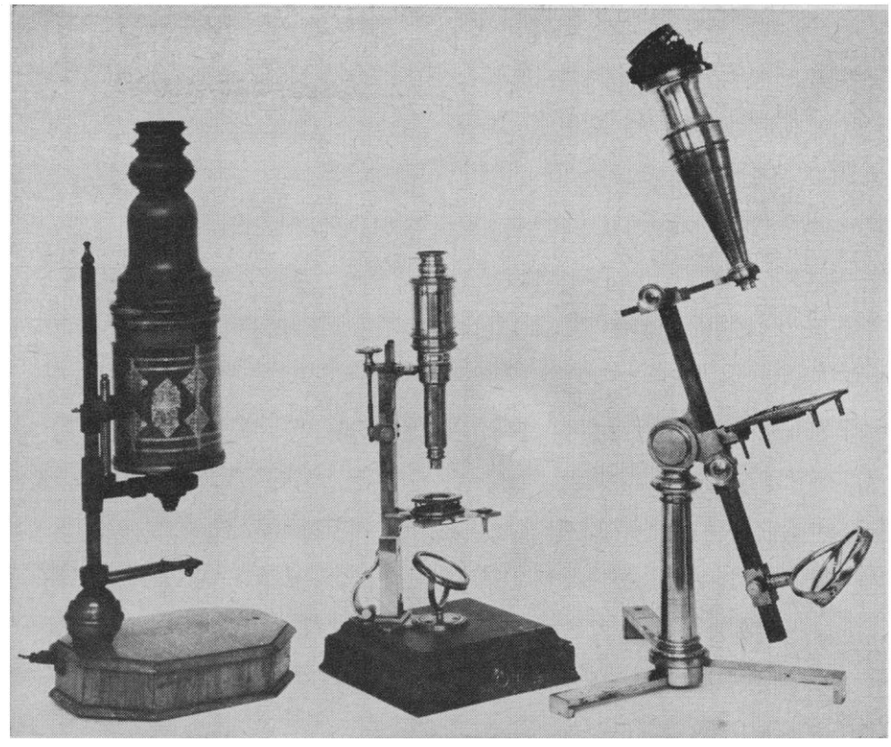

Fig. 3. Development of the microscope of the stand-pillar type. (Left) Marshall microscope; (middle) cuff microscope; (right) Adam's "Universal" microscope. [British Crown Copyright, Science Museum, London]

Finally, in 1886 technicians succeeded in making lenses out of new sorts of glass containing boron and phosphorus, which, when combined, refract light in such a way as to eliminate the rainbow effects and to give clear images over a wide field of vision. About the same time it was discovered that if the light rays between the object and the lens do not pass through air but pass, instead, through a drop of liquid which has optical properties similar to those of glass, then larger and clearer magnifications can be obtained. These lenses were called apochromatic, and when biologists looked through them at certain sorts of dividing cells they saw—they could not help seeing—the so-called chromosomes which carry the material of heredity. I said "finally" because by 1890 the craftsman had reached his limit; he could not, however skilled he was, make a more highly resolving microscope, because the distance between details which could be distinguished was approaching the average wavelength of visible light, and no lens will improve matters at that stage. And so, in principle, conventional microscopes have remained unchanged for the last 70 years. Almost every advance in our understanding of the cell has behind it some advance in technical skill, either in lens making (Fig. 3) or in the staining of the material to be observed. It was not until the craftsman had reached his limit that new *scientific* ideas (such as the use of ultraviolet light, which has a shorter wavelength, or of electron streams, which have what is tantamount to a vastly shorter wavelength) were brought to the aid of microscopy.

If Ron Blossom could be persuaded to watch a program vividly arranged on these lines, I wonder whether he might begin to realize that some of this science which has become for him an object of superstition (its very mystery is part of its attraction) is, in fact, inside and not beyond his world. It would (I believe) be healthy for him to realize that a man in an apron polishing a

lens was one of the principal actors in the drama which disclosed the secrets of human inheritance—the sort of man who might quite well have lived in Doris Grove.

Of course, there is nothing novel about this suggestion. The place of craftsmanship in science was one of the frequent themes of T. H. Huxley when he became a proselytizer for science a century ago. "If," he said once, "the most nimble-fingered watchmaker among you will come into my workshop, he may set me to put a watch together, and I will set him to dissect, say, a blackbeetle's nerves . . . I am inclined to think that I shall manage my job to his satisfaction sooner than he will do his piece to mine."

How the Scientist Thinks

And lastly, here is a second suggestion for popularizing science: it is (in a word) to debunk the popular superstition which has grown up about the way scientists think. If any of you read the lower kinds of science fiction (as some of the neighbors in Doris Grove do), you will know what I mean. In this sort of fiction the scientist's mind works with unimaginative, unswerving precision, grinding inevitable conclusions from unambiguous facts. And although science programs on radio and television do not descend to this sort of stuff, they do tend to be "success stories." (Who ever heard of a science program on the *failures* in science, the false scents, the blind alleys?) And so the folk in Doris Grove come to regard scientific thinking as something quite different—qualitatively different—from ordinary thinking. And by virtue of this misunderstanding they misunderstand also much of the age in which they live.

Popularization along these lines is not easy, and I am not sure how successful it might be. But it would be worth trying, because it takes the mystery out of science and it might convince the more intelligent Ron Blossoms that ideas come to scientists just as they come to him—spontaneously, illogically, as flashes of imagination—and that the ideas are fragmentary and of very little use until they are checked and stabilized through observation and experiment. Between the idea and the observation there has to be craftsmanship, technical skill, mechanical invention—all processes Ron Blossom could understand. And he would realize that the eye is an unreliable instrument which can be deceived by the mind. There are defects of intellectual vision as well as of optical vision. Even very intelligent people are liable to see only what their day and generation have taught them they ought to see, and the history of science is strewn with lost opportunities. The French astronomer Lalande discovers a new "star" (which was really the planet Neptune) but crosses out his observation because two days later the "star" had shifted its position, and so he postpones the discovery of Neptune for half a century. Darwin hunts for the laws of inheritance and actually publishes in 1868 a good example of Mendelian segregation in snapdragons (30 years before biologists rediscovered Mendelism), without realizing that he has stumbled upon the very thing he is seeking, a missing link in his theory of evolution by natural selection. Copernicus observes new facts about the motions of heavenly bodies but is obsessed by the necessity to square his observations with the dogma that heavenly bodies must move in circles. One could multiply examples, but I shall end by illustrating how this second need in the popularization of science—the need to emphasize the tentative, groping way in which scientists think—might be put across to Ron Blossom.

Nearly 300 years ago, in Holland, Johan Hamm saw for the first time the spermatozoa which are formed in the reproductive organs of male animals. He told his compatriot, Leeuwenhoek, what he had seen, and Leeuwenhoek in due course described many spermatozoa. For a long time we have known that it is these spermatozoa which carry the father's contribution into the egg of the mother, but nothing of that was known in those days. Some thought they were simply the products of putrefaction, like mites in a cheese. Others thought they were parasites. Others, again, believed in the doctrine of preformation (that is that the whole animal—or man—exists fully formed in the embryo and merely unfolds), and they regarded the spermatozoon as the animal—or man—in miniature. Now the extraordinary thing is that many of these scientists (honest men, and sometimes very distinguished men) saw under the microscope what they hoped to see and what would fit their theory. Thus, Hartsoeker, a preformationist, drew, in the head of the spermatozoon, a man in miniature. Pouchet, as late as 1847, was so convinced that spermatozoa were parasitic organisms that he actually *saw* and drew the digestive system. So did two of his contemporaries, Valentine and Gerber. Just as the microscope of the day suffered from chromatic aberration, so these scientists suffered from intellectual aberration. Both kinds of aberration concealed the truth, and it was not until biologists were sure that the spermatozoid was the father's essential contribution to heredity, and to the production of a fertile embryo, that observers began to see precisely what a spermatozoid looked like. Since then—that is, since our intellectual aberration was eliminated—knowledge of the structure of spermatozoa has increased as the techniques of microscopy have improved.

Worth a Try

In these lectures, Sir Edward Appleton has spoken of the techniques of communication through radio and television and the revolutions in technology which can now bring any event or activity into the homes of millions. Edward Murrow has spoken of the response of these millions to political and social propaganda conducted through these mass media. My contribution to the series has been to discuss whether these mass media can be used to explain how scientists think and work—used in such a way as to reach people who normally are attracted only by programs which provide entertainment. I am under no illusion about the difficulties of this sort of popularization. When Faraday lectured on a candle and Huxley on a piece of chalk, they were doing precisely what I advocate here. But they had audiences which did not have to choose between coming to the lecture or watching a television program at home, and their audience was enriched by people of the sort who nowadays would have won state scholarships and become scientists themselves. Our contemporary problem is not to bring science to the intellectuals—that is already being done well and effectively; it is to bring science to the great majority of the British people who have not been selected for grammar school education, in such a way that they feel themselves to be an integral part of the scientific age and not merely gaping onlookers. It may turn out to be too difficult. The burden of this article is that it is at least worth trying, and that it requires fresh techniques.