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Dear Mr. Bowers

I do apologize for the delays (due to two absences abroad, in Delhi and then in Paris) in my response to your letter of January 21. However, I now enclose the edited version of our interview. Also, my secretary will send you an updated bibliography next week.

I enjoyed meeting you and hope that your studies on the Lucasian Professorships continue to work out well from your point of view.

Yours sincerely,

James Lighthill

James Lighthill

Robert Bruen

April 1, 1993

James Lighthill 1924-

When describing the basic motivation for his life's work, Professor Lighthil said:

" I think the subject I became interested in above all was mathematics.[1] I am a mathematician fundamentally, although I have done many other things. I became very interested in mathematics at a very young age. I can never remember not being interested in mathematics, certainly at the age of three or thereabouts."

He was like many mathematicians, fairly precocious and was always ahead of his age group. Fortunately, he was able to persuade the schools which he attended to have him learn alongside people who were considerably older, which was very useful. This happened from about the age of five onwards. Then he went to one of Britain's famous schools, Winchester College, winning a scholarship there at the age of twelve. A person there of exactly the same him age was Freeman Dyson. They studied together, and again managed to persuade the teachers to allow them to study differently from the general run of the age group. They studied mainly from books, then they both won major scholarships to Trinity College, Cambridge at the age of fifteen, which was much younger than Cambridge normally would do, but Cambridge felt they would not wish them to go up to study until they were seventeen. And in some respects that was rather good for both of them. They continued to study mathematics with great enthusiasm, but it gave them time to study many other things. He developed a very strong interest in languages at that time. They were able to pursue the study of humanities as well mathematics because they had that bit of extra time before going to the university. They had continued to do mathematics, so when they got to Cambridge, it was not necessary to study the undergraduate material at all.

When one comes to Professor Lighthill's office door, one notices that it has his wife's name on it as well as his. She is a lecturer in the department. They met at Cambridge as undergraduates, married in 1945, and had five children. They all do different things, but the youngest is a mathematician, actually a high school teacher in mathematics. She has done a lot of good meterological research with the MET office, all on supercomputers. In the

[1] Bruen, 1992.

end she got bored working with machines deciding she'd rather work with people. The schools were keen to take her in math teaching because they want math teachers who have experience with how mathematics is applied in the real world. She is doing that now and thoroughly enjoying it. This allows the Lighthills to keep in touch with school mathematics teaching.

His wife has been pretty busy of course raising five children, but she always taught mathematics as well, very often in the high school. When she got to the age where it seemed to be necessary to retire as school teacher, UCL was very interested to take her on, because they have students who are not as well prepared as they used to be in mathematics. These are students taking science subjects, biochemistry, physical sciences, etc. She gets them up to an excellent standard so they can really understand the university courses. She does all that in the first term. The fact that they both are mathematicians means they are close in an extra way above the way most married couples in general. She also has a great gift as a hostess, which was marvelous because as the provost's wife as UCL there was lot of entertaining. She is very popular at the college, and tends to go to all the social functions.

Freeman Dyson and Lighthill were both seventeen when they got up to Cambridge, but they both only went to the postgraduate lectures. This actually was very advantageous, because it was during the war in 1941. There was a rule during the war that nobody could have more than two years university education. Then they had to go into the war effort, straight into the war effort after two years, whatever stage they had gotten to. Bright students were managing to get through the undergraduate degree, the bachelors degree, in the two years. At that time they were all working rather hard knowing that they had to go into the war effort. Dyson and Lighthill were both going to just the postgraduate lectures. There were very few other people going to those postgraduate lectures. Nobody had time to take a degree and then go on to postgraduate work So in fact they had some of the greatest mathematicians almost to themselves. They were 2 out of 4 or 5 people in classes given by G.H. Hardy, J.E. Littlewood and of course Dirac, the famous Besicovich, many good mathematicians. The ones that taught him most were Hardy and Littlewood. They were great mathematical analysts. They both believed that their work was only of importance for its own sake. They both believed that their analysis was completely pure mathematics that could never be used at all. There was a very famous book by Hardy, called *A Mathematicians's Apology*, which specifically makes this point. During the whole of his career in applied mathematics, Lighthill found that the training in basic analysis was endlessly valuable and important. He remembered telling Hardy afterwards that he found what he taught him to be valuable in applied mathematics, but he did not think this was ever believed by Hardy.

Freeman Dyson was very much influenced by Dirac's training, as was Lighthill, but Dyson more than him because he went into theoretical physics. It was because of what Dirac taught him about mathematics. Dirac invented the famous Dirac delta function, which is the simplest function, now often called either a distribution or a generalized function. They are two alternative words for the identical concept. Later on he wrote a famous book on generalized functions. That book was certainly influenced by Dirac and he is one of three people to whom the book was dedicated.

Although they went to lectures by Dirac and Eddington, they were both concentrating primarily on what you would call pure mathematics: analysis, algebra, topology, and so on. After the two years they both took both the undergraduate degree and the postgraduate qualification.

Lighthill had felt terribly frustrated, he wanted to be a pure mathematician, he was frustrated by having to go into the war effort, so he thought to himself, "..now why don't I go back and do what I was meant to do?" All his life he had wanted to do mathematics, and then he had this interruption for two years, which actually proved to be much more stimulating and interesting than he had expected. He still felt that the highest interest was in pure mathematics. So after the war, he went back to Cambridge, putting into Trinity College all the papers had written while at the NPL, a total of twelve. He applied for a fellowship at the college, which he got,allowing him to do research. In fact he only spent a short time, attempting some pure mathematical research, then he found people were writing him letters about papers written while at the NPL. For example the great G.I.Taylor, one of Britain's great mechanical scientists, had questions to put to him about things, as well Goldstein himself.

So he got back into fluids, started some quite new work. On the one hand there was incompressible aerodynamics, or low Mach number aerodynamics, and then there was supersonic aerodynamics. He had done a lot with both of those, but nothing in between. So he started some pioneering work in transonic aerodynamics, an interesting and obviously more difficult field. Subsonic aerodynamics is Laplace's equation, boundary layers and such. Supersonic aerodynamics is purely hyperbolic equations and boundary layers, but transonic aerodynamics is equations of mixed type. So it was difficult to find ways of doing it, but he invented a new method then which was based on certain hodograph transformations and mapping the problem onto a different problem which could be solved. He worked on that and on more extensions of the supersonic work to more complicated problems, like delta wings.

Out of the blue came this idea that he ought to be a candidate for the Lucasian Chair when Dirac retired. He thought the people in fluid dynamics at Cambridge felt they would rather like him to be a candidate, because after all George Gabriel Stokes had been a great Lucasian professor. Dirac of course, had been professor for almost forty years, but Stokes had been Lucasian professor even longer. So there was a bit of a tradition in fluid dynamics. In turned out in the end the majority favored his appointment.

This actually happened in April 1968, although Dirac was not due to retire until October of 1969, when he went to Cambridge. Lighthill considers these years to have been a splendid ten years, when he could concentrate entirely on research. There were no administrative duties attached to the post, in fact there were no duties attached to the post at all. The only duty is to generally reside during full term within five miles of great St. Mary's Church.

In Newton's day there was a requirement that he gave lectures and he did give lectures. Somehow during the eighteenth century, those requirements were suppressed. There is this marvelous book *Unreformed Cambridge* which describes the extraordinary chaos to which the university had fallen. According to Lighthill, Cambridge only had to pull up its socks because UCL was founded. It was founded as the University of London, what they now call University College London. It was the third place in England to be founded after Oxford and Cambridge, in 1828. They immediately started being a model university so Oxford and Cambridge just had to reform. They showed what you could do having a university which taught all the modern subjects: modern languages, English law, instead of just Roman law, things like geography and engineering and laboratory science, physiology, and so on.

So Lighthill had these nice ten years in Cambridge where he concentrated on lots of fluid dynamics research, writng books. His big book is *Waves and Fluids* which includes acoustics, oceanography, water waves and atmospheric science, and internal waves in the atmosphere. He has also a book on mathematical biofluiddynamics. His best seller is an eighty page book published in 1958 on generalized functions.

The essence of his jet noise theory is that the source is of quadrupole character. If you have a force acting on the fluid it produces a dipole source. There is no net force acting on the fluid in turbulence, but there are stresses. Stresses are equal and opposite forces acting on an element of the fluid, so they produce an equal and opposite dipole which is a quadrapole.

An important new thing happened to him while he was at Cambridge, he met a marvelous new zoologist, called Torkel Weis-Fogh, a Dane, who succeeded Sir James Grey as professor of Zoology. He was a great expert on insect flight. There were other people at Cambridge who were experts on bird flight, so he worked with all of these people. The great discoveries were made in insect flight. Whereas the bigger insects fly like a smaller version of a bird, the smaller insects fly quite differently. They use what is now know as the Weis-Fogh mechanism of flight generation, where they clap their wings. It is also known as the clap and fling mechanism. They clap their wings behind their back, once per wing beat, then fling the two wings open about the common trailing edge. Air rushes into the opening gap, then produces a circulation about each wing. They pull them apart and you have the circulation about each wing, and the motion produces lift on both wings. It's a marvelous mechanism that works instantaneously, because nature abhors a vacuum and the air rushes into this. You do not have to wait for the action of viscosity as you do with a starting vortex mechanism in ordinary aeronautical engineering. It's a wonderful thing for operating fast, for example, the famous fruit fly, drosophila, uses this 200 times a second. It turns them over at the end so they always have the leading edge forward. The angle of attack is always positive. This was just one of many works that Weis-Fogh and he did together on insect flight.

He had a good group on bird flight, including a first rate research student. He thinks the whole area of animal flight has been enormously advanced. It was an interdisciplinary team, zoologists working with mathematicians, with a good engineer and thus had some good experiments.

Concerning the previous Lucasian professors, he has taken a strong interest in Newton, and therefore an interest in Barrow as well, because they interacted. Saunderson was interesting because he was blind and was a good mathematician, besides.

> "There is no doubt that there was a stagnation in scholarship in Cambridge throughout the 18the century, this unreformed Cambridge was really bad. A great pity really. Airy was very good, an interesting man doing interesting things, his analytical works, the Airy Functions, and so on, were great. Of course Stokes was this grand genius, tremendously varied. What he did for viscous flow theory, for compressible flow theory, for water waves, and everything, was in no doubt unsurpassed."

The professorship has a very good reputation, which is why he took it, even though he was very nicely installed in London. He felt when he was offered the chair, it gave him a great opportunity which he took. He thoroughly enjoyed Cambridge for the period he was there, until Weis-Fogh died suddenly in 1974. After that he did not find it quite so interesting. So when he was finally invited to become the head of UCL, he thought it would be fun to run something again, like at RAE.

He is on several of the boards for election of other chairs at Cambridge, but he supposes it's understandable they do not put previous holders on the board of electors for the Lucasian Chair itself. On the whole he thinks Cambridge does a good job in appointing to chairs. The latest one was where he helped appoint a successor to Professor Batchelor. They appointed an excellent man, David Crighton, whom he thinks has taken on the headship of the Department of Applied Mathematics and is doing marvelously. He believes DAMTP is flourishing under Crighton's leadership.

While Lighthill doubts if there is much he can say about the future of the chair, he has a general interest in the past. Wishing to emphasize his almost boundless enthusiasm for Stokes. He loves the 19th century writers, calling them writers because, although they were wonderful researchers, they wrote up their research so splendidly. So for him Stokes' papers are just an absolute joy to read, brilliant writing, which he shares with Rayleigh. And as an acoustics person, he is interested in almost every aspect of acoustics, including hearing. He regards Ralyleigh's theory of sound as one of the great books on sound.

Lighthill very often finds that he worked out problems which people have forgotten he had done them, and then people forgot that they were done at all. Lighthill believes that for "elderly professors like me, it's almost one of our jobs to keep reminding people of the wonderful things that were really discovered long ago by some of these people. You have to keep somehow the collective memory of science alive."

After those two years at Cambridge were up he of course had to go into the war effort. He went into the aerodynamics division of NPL. NPL is a famous lab in Britain, the National Physical Laboratory and it had an aerodynamics division with fine wind tunnels. He went there and was put under the charge of Sydney Goldstein, a famous applied mathematician. Sydney Goldstein, is typical of the applied mathematicians he would have heard at Cambridge if there had not been a war on. But because there was a war on, all the applied mathematicians were working in the war effort, and so Sydney was working in the war effort. He never heard that sort of first rate applied mathematics while he was at Cambridge, with the exception of Dirac. He only heard the pure mathematicians, but then of course he went straight to the National Physical Laboratory and he worked with this superb research supervisor, Sydney Goldstein.

Goldstein said in 1943, it had been decided that the war may go on for such a very long time, that they will end up having to have supersonic aircraft to fight the Germans, they want you to find out everything known about supersonic aerodynamics and take it on from there. Literally they said that to Lighthill, and it was a very good job to be given at the age of nineteen. So he read the work that mostly had been done by German scientists, like the great Prandtl who done a great deal, and Busemann, and there had been some good work by Italian scientists, like Crocco, and a Swiss scientist, call Ackeret.

He had to read these and take them on from there, writing a lot of papers on supersonic aerodynamics in the first year, which were developing ideas about what supersonic aircraft might be like in the future. One can see a tenuous link between the sort of ideas that were coming out then and the ultimate shape which something like Concorde finally took. Lighthill was deeply involved when Concorde finally came about, because at the time he was director of the Royal Aircraft Establishment, which was the other great aerodynamics institution. Then he worked on other things with Goldstein, but the war effort ended sooner than anticipated, and the question was what should he then do? He went to back to Cambridge.

He got the biggest challenge of his life in 1949. In 1949 someone came along from the Ministry of Aviation and said they had these jet aircraft that are used for military purposes, we've these good jet fighters, but the question really is whether jets can ever be used for civilian purposes. The problem will be whether they can be made tolerable to communities living near airports. It was a very good question to be asking in 1949, because they were absolutely miles away from having an actual jet that was a civil aircraft. This man, a man called Irving who was an administrator in the Ministry of Aviation, nevertheless recognized that this was a problem that he ought to be getting people working on. So in a way, this has been one of the abiding influences in his life, the question of how jets can be made quieter and more powerful at the same time. In order to make them suitable for civil transport, they needed more powerful jets than those used in military aircraft, so they needed more powerful jets that were quieter. So he started in 1949 working on that problem. The paper which he then published in 1952 is one of the most cited papers in aerodynamics. The law that it produces is a rather amusing law, it's an eighth power law, Lighthill's Eighth Power Law of Jet Noise. It says that there is a tendency for the acoustic energy that is emitted from the jet to vary as the eight power of the jet exit velocity. For various reasons, the actual power delivered by the jet goes as the cube of the jet velocity, it means there is a sort of efficiency of noise production which goes as the fifth power of velocity. The acoustic efficiency or the ratio of noise energy emitted to the jet power delivered varies as the fifth power of the jet Mach number. So if you can bring down the jet Mach number, the ratio of jet velocity to the atmospheric speed of sound, if you can bring that ratio down, you can have engines that will be more powerful and quieter at the same time. Because it goes as to the fifth power, you produce very big changes in that ratio. Of course it means you need to go to very wide engines, wide-bodied engines, so you can have lower jet speeds with delivery of much bigger thrust.

That trend is what made jet aircraft possible. It would never have been environmentally possible without a reduction in the noise. The noise was really horrifying and severe from the original military aircraft. Jet aircraft has become increasingly quieter, and that has made the whole development of jet transport possible. This is one area of work that he is still involved in.

When Goldstein became professor of applied mathematics at Manchester University, and Lighthill joined in there, and went on with this work. He put together a splendid team of people there. Then suddenly Goldstein got bitten by the call to Zionism, he was an enthusiastic Zionist. In 1950, he went to Israel where he became the top academic at the Technion, the technical university at Haifa. Lighthill was chosen to succeed him in 1950 as the professor of applied mathematics. For the next nine years he ran this very good group of applied mathematicians. It was great fun doing that, they were by no means just theorists, they had a first rate laboratory which they called the Fluid Motion Laboratory, which had good supersonic wind tunnels, shock tubes and low turbulence tunnels. It was well equipped, with separate people to run the experimental equipment, and he worked closely with them. They were always working inspired by the latest experiments and taking the theory on from there. For example, with jet noise, he was working with a very good man who was measuring jet noise. Similarly, with the shock waves, they were doing a great deal of work on shock wave dynamics. They increasingly became involved with hypersonic aerodynamics.

At the end of the 1950's, Lighthill was rather unexpectedly invited to direct the Royal Aircraft Establishment at Farnborough, a big place with about 8000 employees. Its mission was like that of NASA Langley, a sort of overall aeronautical research establishment with out stations, the main base was at Farnborough, but they had an important airfield at Bedford with large supersonic wind tunnels. So he threw himself into administrating this place which he considered rather interesting, since he was only 35.

It had departments covering everything from chemistry to electronics, but was centered on on aerodynamics and structures. They were just developing what became the Harrier, the vertical take-off aircraft. They were also developing the Concorde, and trying to move Britain forward as fast as possible into space science, as well as lots of other projects.

While he was there, he could not actually do research himself, but it was perfectly feasible for him to write long review articles, although he was administering this large place. It was quite feasible because he had rather good bibliographical services at his disposal. These review articles were not just summing up what other people had done, it was more taking his own view of it. Some of his better reviews were written at that time of subjects like jet noise. For example, he gave the Wright Brothers Lecture in the USA on jet noise. After about five years, he felt that perhaps it was just about right. Although he had really enjoyed working at the RAE, and they enjoyed him looking after them, it was time to do something else.

Perhaps more interesting was the change in the direction of his research. He felt in 1964 when he left RAE, he had enormously enjoyed 21 years working with aviation and aeronautics, but he felt that he did not really want to spend the next 21 years doing that. He felt that perhaps much of what aeronautics would achieve for mankind was well on the way to being achieved. He personally felt that aeronautics has altered the human condition completely, made the world a neighborhood. All that was well underway; one did not feel that the big advances were going to come in aeronautics after that, and perhaps it would be more interesting to do something different. So, although he had kept a strong interest in certain aspects of aeronautics, primarily aeroacoustics, he has not really worked since then in other aspects of aeronautics.

He decided to move into other subjects, one was oceanography, which has gradually expanded to become the sciences of the earth's fluid envelope. He likes that phrase, the earth's fluid envelope, because it includes the atmosphere, the oceans, the groundwater, the rivers, and lakes. That has been a big interest since 1964. The other thing he became interested in was biological applications of fluid dynamics. As matter of fact he had been begun to work on these earlier.

At Manchester he had done some work on micro organism locomotion. He had a very good research student working on that , so they started the subject that he was later to call flagellar hyrodynamics. While he was at Farnborough a professor of zoology, Sir James Grey, came to see him, and said he hoped he would take an interest in fish swimming. He put some interesting questions to him about that. Lighthill did in fact write a short paper on it, but he found he did not have time to keep on with it while he was running RAE, so it went to one side. He came back to back to fish swimming in 1968, somebody wrote to him and said it would be a good idea he would write a general review of this subject. He actually wrote a rather comprehensive review of aquatic animal locomotion, which has become a standard work. He got very interested in the whole animal kingdom from the point of view of aquatic locomotion and how they generate the thrust to move through water. There is tremendous variety going right through the micro organism to the fishes and the cetacean mammals.

There was another thing that fascinated him when he was at RAE. Farnborough had two famous institutions in it, which were just next door. There was the Royal Aircraft Establishment, which was aeronautical engineering and there was the Institute of Aviation Medicine, which had superb doctors who worked on breathing apparatus for pilots and all sorts of things that are concerned with what pilots can take in the way of G's. Today they do aero-space medicine. He found that one of the hardest problems was getting the two institutions to collaborate effectively. You had the engineers who were working on breathing apparatus for pilots, but the doctors said it was much to complicated for anyone but the doctors to understand. The was a real art needed to try to get cooperation between engineers and doctors. In a way he thought that was a bit of a challenge, and there was even some fluid dynamics in it also. At Imperial College, he set up a physiological flow studies unit, in 1966, which was concerned with the cardio-vascular system and the respiratory system. There were doctors, physiologists, engineers and mathematicians all working together in this unit. It is real a success story, recently celebrating its silver jubilee , where it went over all the things it managed to achieve. The director was a man called C. G. Caro who directed it for the first 25 years. Now he is nominally retired, but he is still working there, though someone else has taken over direction. The whole secret in these interdisciplinary studies is to set up teams of people who have the expertise in the component disciplines and they must learn each others language. He has written many articles about the art of getting this kind of thing done. They can not learn the subject of the other person, because it is much too complicated to learn the discipline, but you can learn the language and then you can communicate. Then the team can work very well as a whole. Lighthill feels that is no good saying jargon is a mistake because jargon consists of technical terms which describe important ideas for which there are no ordinary language words. You have to have jargon, but you have to learn the jargon. So they had to learn the biological jargon. They had to learn the mathematical jargon, and so on, so the biologists would know what the mathematicians were talking about when they said Fourier series and the mathematicians would know what the biologists were talking about when they said nephron.

Lighthill is working with NASA at the moment, because although they made a great success technically of Concorde, it has consistently performed very well and it has not had accidents, it has done everything it promised to do, there have not been many Concordes flying, for various reasons. They always anticipated that the first generation of supersonic transport would not be very economical. You never get it with the first generation aircraft, you never get very good economics with the very first one off, it's good if you can them to work technically correct. They always anticipated the second generation would be the one beginning to show very good economics. Since he does not think Europe will do it, he is concentrating on helping NASA on their high speed civil transport project, HSCT.[2]

This is specially designed to minimize the level of supersonic boom noise, which he thinks is a good objective, because, although his own feeling about Concorde is that the supersonic boom level on the ground is not terribly objectionable, (it sounds like a couple of friendly handclaps), nevertheless it would be more acceptable to fly it over ground if you could bring down the overpressure of the supersonic boom by a factor of four or so. And that looks quite feasible with the HSCT design, but the problem will be getting the engine noise down, and this involves a high Mach number jet. You can notbring the Mach number of the jet down, so you've got to use some other method, and in fact that's a subject that he is working on at the moment.

He is rather proud of his aero-acoustical contributions, because they have clearly influenced the whole development of civil aviation, because they made it possible for jets to be more powerful and quieter. And it was mathematically difficult to solve the problem. You have turbulence which is hard enough anyhow, then you have to decide what noise it generates. Turbulence is in a way a vortex phenomenn, an incompressible phenomenon. Somehow the noise is by-product, working out how the noise is generated as a by-product of the turbulence involved some of the subtleties of what he regards as the essence of applied mathematics: Taking a problem where there is no recognized mathematical formulation and trying to work a good mathematical formulation.

Lighthill is very fond of his biofluiddynamics, understanding that not everyone would be, but it seems to be quite important. He gave in the United States the Rayleigh lecture to ASME which was the biomechanics of hearing sensitivity. It is his latest biofluiddynamics, about the cochlea,

[2]Rosen, 1993.

the inner ear and the fluid mechanics in the cochlea. There again it is quite a problem to find out how to formulate the problem. He thinks that most people in hearing regard that lecture as a good summary of they know of the subject.

The other area is the geophysical fluid dynamics area. On the whole, he has been doing that particularly with relation to problems that really matter to people in tropical countries. He has something called Monsoon Dynamics, where he organized a meeting and was one of the editors of the proceedings. More recently he has become more involved in tropical cyclones, that is hurricanes and typhoons.

Ten years ago they had a very good meeting called Intense Atmospheric Vortices. Now. He has been organizing an international effort in this field with special reference the problems to Asia. He has chaired in Beijing in October of 1992 a symposium on tropical cyclone disasters. This was organized jointly by ICSU, the International Council of Scientific Unions, with the World Meteorological Organization: The Joint ICSU-WMO Symposium on Tropical Cyclone Disasters. He chaired that, gave the introductory survey on tropical cyclones and chaired the final panel discussion that led to recommendations on what they needed to do next. This was largely a need to improve the initial data because, although everyone knows supercomputers have made a great improvements in forecasting and satellites have made great improvements in forecasting, yet actually they do not work to well together. Supercomputers for the initial data need three dimensional data, the satellites only give you two dimensional data. So there is the question of bridging that gap, because you will not improve the forecasts, now, anymore unless you improve the initial data that goes into the computer programs.

There are a fair number of good weather stations on land, radiosonde stations but there are not any at sea. They have decommissioned most of the weather ships The satellites do not make up for it. The radiosonde stations give you the vertical distribution of wind and the satellites do not. They worked out what they think is a sensible recommendation of what needs to be done in this field. It is unmanned aircraft or autonomous aircraft, small ones, 3 meter span dashing about. It is a low cost intermediate technology solution. They feel that the third world countries particularly want cheap things that they can mess about with themselves and get data. Madagascar, for example, has six tropical cyclones a year hit its coast. There was practically no data available for the south of the Indian Ocean. They think that these can be produced for 10,000 dollars unit cost, because computers have gotten so small, the on board computers that pilot the aircraft. Then there is the GPS system telling you exactly where you are and your ground speed. So then you can work out the wind vector, fly at right angles to the wind vector and make your way into the eye of the storm. It's all very exciting, but there are a lot of good people working on this, and he has confidence in them. They have recommendations in that field. Warning is so important, because you can create shelters, shelters for their most valuable property as well as for the people. For example in fishing communities, you have got to have a proper shelter for the nets as well as the people.

He has just come back from Calcutta where they had a very good meeting on how to educate people to respond properly to an early warning. India is slightly better than Bangladesh from the point of view of getting results. After that monsoon dynamics symposium they made recommendations for the setting up of centers for atmospheric sciences in major universities in India. They have those in Delhi, Bangalor and Calcutta, which are really doing good work. The world weather watch, WMO, has a good network which picks up Delhi. Delhi is one of the centers for the weather watch network, and he thinks they are getting data. Of course, India has a good satellite of its own, Insat which is feeding into the network. This is a very interesting area, so he enjoys all that too. Since he does not have any administrative activities, he has plenty of time to do things like that.

He is writing an enormous number of papers at the moment. The next lecture he is giving is at NASA Langley in memory of great Theodor Theodorson, who was a great Langley scientist, in April of 1993. It has quite a lot of new research in it because he has been attacking very high speed jets, which send out an assemblage of conical shock waves. The eddies have been convected supersonically and the sound field wave is therefore like a supersonic boom, an assemblage of conical shock waves. Then he found that there is an interesting phenomena of how these conical shock waves interact with each other. You get bunchings and unions, and such.

After he retired from the Lucasian Chair, he was just able to fit in this ten–year job as provost of UCL. It was an exciting period, a challenge to keep a good place good in difficult times and make it become even better by making good appointments. When he retired, he looked back over 110 full professors where he chaired the committee that selected them. He realized that the college had really been changed quite a lot as result of bringing these people into leading positions. They made some very, very good appointments. they are all feeling quite good today, because UCL has come in just behind Cambridge and Oxford in the list of research ratings for the country. UCL is of course is like a university, it has about 10,000 students against Cambridge's 12,000 or so. It also has a very strong medical school, great science, engineering, humanities, and social studies. It has done extremely well in all those areas in these ratings, as it did on two successive occasions when he was provost. It was doing extremely well and is still doing extremely well, so he is very pleased that they managed to lay a good foundation. He does not think the numbers of students are important at all. During his fellowship the total amount of research support from external sources exceeded that of Cambridge, but still less than that of Oxford, so they were very pleased. for Lighthill it has been a great challenge to run UCL. When he took it over, they were just beginning to merge with University College Medical School. He realized that the clinical side of the university was not nearly as strong as the scientific side, but he managed to have a merger between our medical school and neighboring medical school, called the Middlesex Hospital Medical School. Now they are the University College Middlesex School of Medicine, a very powerful school.

When he retired they appointed a superb man in his place, Derek Roberts, a good FRS with a lot of experience in industry. Of course during his time, he was terribly keen that the college have the closest possible academic industrial relations. That seems to him to be a frightfully important thing in applied science, you must have really good relations with industry. So he was able to get industry to endow lots of chairs in the college at this time, which he thinks it is awfully important. He felt that when they appointed a first rate industrial scientist as his successor it was a compliment. It meant that they had actually absorbed the message he was giving. He and Lighthill see completely eye to eye about many things. After he had spent a few months looking around the college, Roberts said to him that he thought the right policy for the college was to expand out of difficulties. Lighthill suddenly realized that was a very good description of what he had been doing for the ten years while he was provost. He managed to keep it going marvelously, so the college is going from strength to strength. There was no problem with his moving up to a little office on the eighth floor of the mathematics department. Since Roberts and Lighthill see eye to eye, he is not in any way embarrassed by his being around. It's nice for Lighthill, because although he does not do anything administrative within the college, he attends lots of social functions and keep in touch with his all his friends.

He does not think he could call himself a very religious man, he has a very great respect for religion, and for religious people who also respect other people of other religions. Being a very international person, he has met a lot of Hindus, Muslims, an so on, and he does respect all those religion, except when they show a lack of tolerance for others. The recent incident in India where the mosque was torn down was terrible, as is the conflicts between Protestants and Catholics. He thinks it is a great mistake in universities and he must blow the trumpet of UCL because they were set up to be completely secular, to exclude theology as a subject of the college. They were set up to have religion not involved at all, for example, they have no chapel. They are a secular university and that seemed a good idea at the time because most conflicts at that time were of religiousorigin. If they had dinner at UCL, there was no grace said. They are a completely secular institution, and as a result, a very friendly institution. They are famos for the fact that the college is such a friendly place. There is no such cause or possible source for animosity. They do not have political science, either. They not only exclude theology, but we also exclude politics as a subject for study. They have courses in hard social studies, such as economics, anthropology, geography, law, town planning, and these sort of things, but they do not have basic sociology or politics, because they regard those subjects a bit theological.

It is no good asking Lighthill about Stephen Hawking, because he does not really know his work particularly well, he prefers practical applications in mathematics, rather than speculating about the first ten to the minus something seconds of the universe. Cosmology seems to be almost too close to theology to be interesting. "It's not quite like science, but more like creation myth or something".

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