PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

Opening Address

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I very much welcome this opportunity to provide this opening address.

It is only a little over 25 years ago that we were able to look out and see a bright new star, Sputnik 1, moving across the sky. At the time, it was just a miracle of technology and few people realized that mankind had been given the key to a whole new resource like that of the land, sea and air.

I think it is particularly appropriate today in these surroundings and in the shadow of Sir Harrie Massey's death to underline that British and Commonwealth scientists were among the first to realize the potential of space. The British space industry first became established in the early 1960s when it was commissioned to build the Ariel series of science satellites for the forerunners of the Science and Engineering Research Council. The very genesis of the space industry we now have was in our space science programmes and particularly today, and in rememberance of him and his role in organizing this present meeting, I would like to pay my own tribute to Sir Harrie Massey, F.R.S., and to his very great and pioneering achievements in space science. Through his enthusiasm and ideas Sir Harrie inspired a whole generation of space scientists worldwide.

Perhaps because of this early acceptance of space, Britain was also quick to appreciate the potential of satellites for communications; its first links were set up in 1966. It was, after all, an Englishman, Arthur C. Clarke, who first pointed out the potential of the geosynchronous orbit to provide worldwide high quality communications. The U.K. went on to establish its space credentials by being the first Western country after the U.S.A. to design, build and operate its own geostationary communications satellite and we learnt (and then unlearnt!) how to make launch vehicles.

It has been said that this is the decade in which space exploitation has become more important than space exploration. I think it can be rewarding to look back at the key forces in this area before we look forward (the main point of this meeting).

First, I think that it is because space activities have now become an area of mature engineering. It might perhaps be a point for discussion by those following me on whether the time needed to achieve safe, reliable and economic access to space was underestimated just as, early on, remote sensing was oversold. We have had the tremendous achievements of the Apollo programme and the Voyager missions to the outer planets, but both in the U.S.A. and in Europe the development of commercial space transportation systems has taken longer and proved more costly than originally envisaged. Even so, in both places we are now having to consider whether the systems we have in development will have the capacity, economy, flexibility and adaptability to meet our needs into the 1990s. So perhaps a first conclusion is that our first 25 years in space operations have been experimental and exploratory and we still have some way to go.

This points too to a challenge: that future space systems will need to be increasingly evolutionary in their capabilities as new requirements and possibilities emerge.

Second, I think we need to recognize the critical importance of getting to the operational stage with space systems. It is at this point that private investment can begin to take place and commercial benefit result. Because it is only when users can depend on the availability of a particular space or satellite service today, next week and next year that the proper conditions for investment in the systems and reliance on their services can exist. We can see this clearly in communication satellites, where not until we had the assurance of an intergovernmental body, Intelsat, plus continuity of satellites and services could worldwide satellite communications really develop. The same pattern of commitment is possible once there is an adequate promise of operational continuity and service is seen in the reliance by the weather services now put on satellite observations and the way they have taken this routinely into their forecasting machinery. Now we can look back and realize that this was the route that has given us world-wide television coverage and enabled us to have near universal international high quality telephony on a direct-dialling basis.

My third observation may seem initially obvious, that is that space technology does not stand still and that it is necessary to base policy and planning on a lively awareness of this. The problem with space is that the advances have been so rapid and radical that what seems inconceivable becomes commonplace within a fairly short time.

Of course the sums involved in research and development are rather daunting, but by working cooperatively through the European Space Agency, Europe has been able to establish considerable competence and capability in space technology and to keep ahead of new requirements. A good example of such cooperation is in the development of a new large satellite, Olympus, which will be ready to meet the new market demands of the 1990s and in which U.K. industry has a leading role.

With the Olympus satellite project we had in fact very much market-led objectives, but I suspect that with some of the other radical new possibilities that arise in space, you have sometimes, as Mr Beggs of N.A.S.A. has commented, to be prepared to go out and do things without knowing what the results are going to be, otherwise you will never make progress. We are perhaps over tactful in seeking to gloss over a problem that has recurred repeatedly in the past in developing new satellite applications, that the prospective customers say that they have grown and prospered without the new capabilities and services space has to offer.

A related facet evident from our past attempts to provide a regulatory environment for satellite services and on which I would welcome views is that we have to be alive to continuing bounds in technological capability outdating principles that had previously been thought to be fundamental. In the early days it no doubt seemed self-evident that the role of satellites was intercontinental communications linking national telephone systems by using very large dishes.

Perhaps we needed actually to see Armstrong and Aldrin taking their first steps on the Moon to realize that satellite communications had in truth released television from being a local area service, and to mass the market forces to repeal early communication legislation in the U.S.A., which did not foresee and frustrated the domestic use of satellites, and to achieve the great liberalizing regulatory breakthroughs there of the 1970s. I think for the same reason we will have to look carefully through the 1980s at the institutional arrangements (Intelsat, Inmarsat, and soon Eutelsat) that we have established to organize services and share the cost of space

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facilities. These bodies have been extraordinarily valuable in developing effective and reliable worldwide services and the oldest of them, Intelsat, has shown the importance of a dynamic approach to its mandate and the changing environment of telecommunications. We can learn from this for the future in considering proposed developments in space applications from whatever source, whether institutional or private. The ultimate goal is to enhance the exploitation of space services and to offer a wider choice to the end customer. There is a key economic point here in that, especially in the space field, the earnings to be made from providing services based on using the space systems will often vastly exceed the earnings of the manufacturers of the space hardware while requiring a much smaller capital base.

I hope too that we will always have the courage to learn from missed hopes. We have just had the first flight of Europe's Spacelab. I applaud the courage, skill and endeavour of the crew and all who have contributed to its successful first flight. But we need also to be concerned at the patience of those university and other experimenters who have waited since 1978 to fly their ideas and to whom the prospective future costs of using Spacelab in a continuing way are very daunting. *Nature* (**305**, 655 (1983)), in a recent provocative editorial has called Europe's Spacelab a monument to the past; neither an outright waste of money nor a potential platform for better things but a reminder that software (in the sense of forethought) is more important than developing superlative hardware. Time will judge, with perhaps the dominant factor being how we come to see the importance of space processing.

Looking to the future I would urge a focus on how our space industries may develop up to the turn of the century and on what will be the key technologies and commercial opportunities that will shape their growth. Will it be more communications, sound broadcasting by satellite as well as d.b.s., or space processing or remote sensing, or navigation and search-and-rescue systems?

To encourage you, I think the evidence is that the markets are now materializing outside North America and that they will be large ones. Europe now, collectively, has a large market base, industrial know-how, a rapidly developing need for satellite-based services, a launch capability and sizeable influence in international satellite organizations. For the U.K. I can give you a clear message: my central goal is now to bring space to profit and to pursue space policies in which commercial objectives are prominent.

Let me return now to my starting point. We are fortunate to be living at a time when a totally new world resource has suddenly become available. It is as though the first heavier-than-air flight has just been made. None of us know where it will lead, but we can be sure that even those with the clearest vision can today only see a very small fraction of the ultimate potential.

Can I conclude by inviting a focus on two inter-related issues. How to achieve an effective mobilization, area by area, of the resources of those on the space side, who can foresee promising commercial possibilities with those of the prospective customers, i.e. how to stimulate the latter to plan and make a commitment to participate. Also, I should welcome a focus on the concerns and obstacles that may deter private sector, and indeed public sector, commitment to business opportunities in space.

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