

N76-15025

John E. R. Wood *

ABSTRACT: Given no constraints on size, the airship could carry almost anything almost anywhere. Economics and practical difficulties arise of course, and the problem then becomes one of relative assessment of the problems and prospects involved in any area of possible application. This must then be integrated with an economic evaluation of the selected project area. A review of the marketability of the airship is given, and the relative energy consumption and speed potential of the airship is compared to other modes and guidelines to areas of initial development are also provided, together with a brief historical review.

GENERAL INTRODUCTION

A Convention such as this represents a long awaited opportunity to examine objectively and critically the problems and prospects of what is, after all, a totally new concept of transport. The term "totally new" will no doubt provoke a certain amount of protest, but it is in fact perfectly justifiable, although it is of course true that an established hierarchy of airships, differing not only in size but also in payload, range and indeed all the other factors which are normally associated with logical series of craft, operated over a period of some forty years. But the operation of these craft must not be interpreted as having been conceived along lines of assessment remotely similar to those that must be considered today.

The airship may have been conceived as a vessel of peace, but it owes much of its early impetus of development to the demands of war. In a period of growing international rivalry between Britain and Germany, at a time when powered heavier than air flight was a thing of the future this was hardly surprising. The period 1900 - 1920 saw a continuous, steady development of the airship with a natural acceleration of this development, as the Great War approached. The great majority of this development was concentrated in Germany, in a Germany that was nationalistic enough, probably justifiably, to feel that it had little to learn from other countries, and that had even less desire to communicate this information abroad.

* Director, Aerospace Developments, London, England.

The partial success, more evident in the manpower it kept 'tied up' in Great Britain for defensive purposes than by any damage they caused would probably have encouraged the Germans to have continued development immediately after the cessation of hostilities, but the hand of retribution was still firmly in place, and anything that smacked of a rebirth of German industry was heavily curtailed.

In these circumstances, the hand, if not of friendship, then at least of partnership, which was advanced by the U. S. A. was too good to miss albeit at the cost of much injured pride. Thus, in the early 20's the Goodyear-Zeppelin consortia came into being.

Let us recap the situation so far. The initial development of these craft took place against a background of Nationalism, at a time when no other form of powered flight existed. Against this background it is easy to understand how a situation developed whereby the design of these craft came to be based upon constraints of money available, and the limitations, or expected limitations of the technology available. It was naturally assumed that development of larger, faster 'better' ships was an economically desirable aim. Market analysis as we know it was virtually unheard of, and the question of designing for overall profitability was hardly considered.

After the war the interest shown in these craft was still based upon the simple fact that civil operation over Trans-Oceanic distances at speeds greater than a liner was unachievable. Therefore speed being an obviously desirable factor, anything that could decrease this time must capture a market! The holes in this logic, even then, should be fairly obvious, how much more so today, with a plethora of alternative transport modes, and opportunities for investment available. (Unfortunately, recent aeronautical experience, particularly in the U. K. indicate that lessons from the past are difficult to learn properly).

Again, designers and manufacturers, anxious to develop what was at the time a unique transport mode, were, to put it kindly, optimistic about the difficulties of maintenance, mooring, running costs, the development potential of these craft, and a whole host of other areas of critical importance to profitability. In the earliest stages, when few craft were operating, and when little or no 'feedback' information could be obtained, this was understandable. When the operating results of these craft were staring these people in the face, it was perhaps less so. Even so, one must not be too damning. There is always a dichotomy between the potential of a mode, and the ability of any particular marque of craft to meet that potential. Then, as now, the dictum was "wait until you see the next one". This problem was aggravated by the fact that much design work carried out by the Germans in the early part of the War was only just being evaluated by other nations (notably, Great Britain) some seven or eight years afterwards. Nowhere was development proceeding from a current 'base level' and administrative failures (and rivalry) meant that much needed information was often not crossing company, let alone country boundaries. A number of small concerns, primarily in the U. S. displayed commendable technical ingenuity in producing airships displaying novel construction techniques. But again one is left with the feeling that many of the originators were not over cautious about minimising the difficulties involved in 'scaling up' such craft to a practical size, and, with the number of craft available to them, the limited financial backing, and the lack of much in the way of 'sophisticated' data logging devices, the claims made for the ease with which such craft could be up-graded must be regarded with caution.

On the military side, the development of the Akron and Macon must rank foremost in the developments of the inter war years. Anyone who has read Richard Smith's extraordinarily fine book cannot fail to be surprised and heartened by the enthusiasm and progress that was achieved, nor can they ignore the lack of administrative liaison, the funding difficulties, and

the vague feeling that many elements within the project had differing ideas about what function the craft were in fact, designed for. One would venture a guess that far too little planning was done, especially in determining the operational requirements of the craft, at the pre-construction phase. That is conjecture, what is not, is that these craft were, at best, a limited success, and all the while, waiting in the wings and growing larger, more powerful, more potent, was the aeroplane, destined to overshadow the airship almost completely. That this was so was due far less to the undoubted technical failures of the large airship, than to the economic profitability and ease of reaching diverse markets, coupled with the wider throughput, and greater reliability of service which the aeroplane offered at the time.

PRESENT DAY ASSESSMENT TECHNIQUES

Why such a long introduction, simply because many of the basic criteria contained have not been recognised by many of those that support the introduction of the airship as a transport service device. The use of the word 'introduction' rather than 're introduction' is intentional, for reasons which I hope have been made obvious.

The world has come a long way, politically, socially and economically since those far off days. It may be argued that it has not gone the right way, but what is certain is that critical assessment of high cost technology, or of technology that may have wide ranging implications has grown up, fast.

We live in a world of extensive communications, of multi-national corporations indulging in a multitude of differing activities, of rapidly developing markets, and of rapidly escalating costs.

We have reached a stage where the travelling public think little of travelling in an aircraft costing thirty million dollars, which is, as near as dammit, perfectly constructed, and is operated by an organisation massive in its support, training and maintenance facilities. That aircraft is not simply an established part of our transport infrastructure, it is the development not of a single company, but of fifty years of overall aeronautical development, a development which, in recent times at least, has become coordinated internationally in all aspects of its operation to an unprecedented, and uncompleted degree; specifications and safety requirements, of unheard of severity are laid down for everything from a glider to a Jumbo jet by international organisations, and design standards are established long before the first nut and bolt have been put together. In simple terms, everything that flies today, other than the simplest light aircraft, is the high cost product of a high cost, large scale operation, not the smallest of these costs, naturally enough, are due to the heavily increased administrative costs which accompany operations of this scale.

And yet, into this 'new arena' of cost estimation, came a strange body of men, enthusiasts one and all and, in many cases, simply not appreciating the cost of developing the points made above. This is by no means a total observation, but it does apply to a dishearteningly large number of people who are now waving the flag for airships. One of the main reasons for this strange state of affairs is almost certainly due to the fairly distinct division which at present exists within the fledgling airship movement, on the one hand, the engineer, obviously unlikely to have been professionally connected with Lighter Than Air for any considerable period of time, or indeed likely to have been involved in anything approaching a large investment programme of research into L. T. A. and on the other, the marketing man, who is obviously keen on drumming up interest in what is, potentially at least, a very large area for investment. In many cases it must be obvious that each, although passionately enthusiastic, often has little contact with the other, and neither appears to take account of

the other transport modes available, and of the effect the reaction of these other modes to the project would have on the overall potential of the scheme.

There is a bewildering array of designs at present available, ranging from the conventional to the unlikely, with round, flat, double hulled and other hull forms, and power units ranging from diesel engines to atomic reactors. But a question which must be asked is what were the design considerations that produced these ideas? If one sees a 400 ton payload craft for example, why not a 500 or 800, or 200 ton ship. Have the advantages, and difficulties involved in designing for higher speeds and larger sizes been sufficiently appreciated from the vital economic as well as the technical aspects, and to what extent is current aircraft data concerned with areas such as handling characteristics been extrapolated in order to provide even technical justification for the various craft. Most important of all, what markets and products have these craft been designed to cater for? In many cases it would seem that this question has been left alone. The assumption being that, if a craft of a certain size and transport capacity exists, then the market will gravitate towards it. This is a false premise, and represents a classic case of putting the cart before the horse. Without a knowledge of the market then no design can claim proper viability.

The results of this present attitude may be summed up as follows:

1. The majority of the largest, most ambitious designs originate from the smaller design concerns. Many of whom are operating on a part-time, unfunded basis.
2. Many of the 'failure areas' of previous rigid airships have not been properly considered. Most notable amongst these areas being the structural inadequacy, high maintenance, and high manpower requirements of the conventional Zeppelin design.
3. There is a tendency to assume that a particular type of construction is "the best" rather than realising that the type of construction which represents an optimum is dynamic and varies with, size, speed, and market.
4. In general, and for a variety of reasons, the unit costs, development costs, and administrative costs of running such a project have been underestimated, in some cases to a ludicrous extent.
5. Very little attention has been paid to "off vehicle" costs, those associated with terminal facilities, maintenance etc.
6. Many organisations have presented the "final model" of their craft, without giving any indications of the cost and extent of the pre-production and prototype programme.
7. The time to in service operation is often so little that it must be considered that in many cases, the design process is assumed to be complete. If the total funding and manpower inputs are examined this will be an unlikely situation.
8. Little attention has been paid to the fact that no airship building infrastructure exists. Hindenburg for example was the end product of an organisation that had been in existence for forty years. (With a very large proportion of the original staff still employed.) The loss of these indefinable advantages which result from the existence of such a 'worked up' organisation are assumed to

be catered for by the rather nebulous term "advances in material technology". These advantages, certainly in many areas, are less than is generally supposed, and often will impose a high cost disbenefit on the craft, which is usually ignored.

Most of the above reads like a roll-call of horror. It might reasonably be inferred that the purpose of this report is to dampen the rapidly growing interest in L. T. A. Nothing could be further from the truth. The airship appears to offer a number of very promising areas for investment and development. The purpose of the foregoing has been to ensure that these areas of development are examined from a suitably critical viewpoint.

ANALYSING THE MARKET

It has already been stressed that there is no single optimum type of airship. It is unlikely at this stage that any single agency is going to finance a world survey in order to evaluate the potential application of virtually all freight movements to the airship. Indeed such an exercise would be purely academic. Reasonably enough, most interest in the use of airships will continue to centre around those market areas that are not providing good enough economics at present, or are failing to meet the demand that is present. This failure may be due either to a lack of availability of the present transport mode or to certain inherent deficiencies in the mode (high running costs, labour intensive etc.) or it may simply be that the market has expanded greatly, and the mode has been unable to expand with it, whilst retaining its initial profitability. There is a second area of very great importance, where markets have developed without the associated ground based transport infrastructure having been developed. This often occurs in areas that have experienced rapid economic growth in recent years, and that have extraordinarily difficult topographical problems (mountains, forests, etc.).

It is likely therefore that the market that will require investigation will be a victim of one or more of the above constraints, and that the market will be suggested by an outside source. The problem that then presents itself is one of comparing the likely costs of meeting demand using an airship with the costs involved using an alternative system.

BASIC CONSIDERATIONS OF THE AIRSHIP

Initially, having decided on an area of investigation, some form of "first pass" estimate must be obtained to determine whether there is any hope whatsoever of using the craft profitably. To this end it may be useful to state some fairly safe assumptions.

1. The conventional airship is slower in airspeed than an aircraft.
2. The trip end facilities required for an airship are less than for any aircraft, and for airships with payload ranges of 2 - 20 tons or thereabouts they are a lot less than for an aircraft of similar capacity.
3. An airships running costs (in terms of fuel costs) increase rapidly with speed, and relatively slowly with size.
4. The annual utilisation of a small airship should be as good as that of a small aircraft.
5. The initial utilisation of a large craft would be unlikely to be even as good as a large aircraft.

6. The first costs of a small airship (payload range 2 - 20 tons) would, or rather should, be less than for an aircraft of similar size.
7. The first costs of a large airship would be unlikely to be substantially less than for a large airliner.
8. A small to medium size airship would be capable of a far quicker time to in service use than a large craft.
9. The degree of investment required to produce facilities for building and maintaining a large airship would be disproportionately high in comparison to the sums required for a small craft.

With the previous statements in mind, let us now examine the basic steps necessary to evaluate any particular potential area of application.

Historically, there has always been a relationship between the various sizes of craft and the type of construction which represented an optimum for each size range. These were approximately as follows:

Simple "Blimp" type	=	<1000,000 Cu. Ft.
Semi Rigid Type	=	200,000 - 2000,000 Cu. Ft.
"Zeppelin" Type Rigid	=	1000,000 - 8000,000 Cu. Ft.

Nowadays it is suggested that improvements in technical design capability have not only resulted in the coming into being of several new types, but have increased the size range for the craft very considerably.

Simple "Blimp" type	=	<1000,000 Cu. Ft.
Internally Supported "Blimp"	=	1000,000 - 25,000,000 Cu. Ft.
"Zeppelin" Type Rigid	=	1000,000 - 50,000,000 Cu. Ft.
Monocoque (Supported) Type Rigid	=	2,000,000 - 200,000,000 Cu. Ft.

These are generalisations, and do not represent the thoughts of all connected with L. T. A. (Notable exceptions would include the Blimp designs of Argyropoulos and Sonstegaard, which are larger than any sizes here considered) But, in general, they are a fair example of current design trends.

With these basic classifications in mind, the basic steps involved in evaluating "an airship" against any selected market may be considered as follows.

ANALYSING A MARKET. NINE FUNDAMENTAL STEPS

1. Analyse data relative to existing and projected commodity flows for selected markets.
2. Examine the topographical and meteorological data to obtain payload and utilisation figures for a craft.
3. Based on information obtained so far (tons/year and utilisation) construct a graph of number of craft/size of individual craft.
4. Modify this information to take account of a network transport system (i. e. on-going goods with separate pick-up points) if this is required.
5. Examine trade offs between increased speed (greater fuel consumption, different power requirements etc.) and size (trip end facilities, mooring facilities, assembly and difficulties, construction costs, control problems, etc.) relate results obtained to Item 4.
6. Having ascertained size and number of craft required (based on 'conventional' airship types and speeds, determine capital costs for craft, together with costs for trip end facilities.
7. Determine annual cash outgoings for the operation including maintenance, insurance, return on capital, fuel and manpower costs, to provide a total cost/year.
8. Divide total costs/year by tons/year to be operated to give a costs/ton.
9. Compare costs so obtained with costs/ton obtained by existing or projected alternative modes, conduct a risk analysis on this figure, and, based on the results obtained Go/No Go.

The reason for evaluating designs based on conventional theory, moving at conventional speeds, is based solely on the philosophical principle known as "Hackmans Razor", that is Investigate the most likely answers first, a simple enough concept, and one that is frequently forgotten.

MARKET ANALYSIS FOR MILITARY APPLICATIONS

Nothing has been said so far about the potential of L. T. A. to military applications. This is solely because the criteria for evaluation are so very different to those normally applied to civil applications. Much will doubtless be said about military applications during this workshop, and it is an area which Aerospace Developments has investigated at length. Within the confines of this paper, all that may be said is that the inherent qualities of long range, high speed, and good station keeping combined with good payload ability, suggest applications in both A. E. W. and A. S. W. with perhaps less attractive applications for heavy assault craft.

MARKETING

The basic physical parameters which require investigation when assessing the economic viability of the airship have been outlined. There are, however, a number of factors which are somewhat subjective, which determine with equal importance the degree of success which the project will ultimately achieve. These "saleable" qualities may be regarded as "marketing".

PROJECT EVALUATION (Figure 1.)

"The Whole World's a Stage" as Shakespeare said, and likewise what one sees depends very much upon where one sits. In any airship operation there are likely to be three main "characters" and the prime requirements that each will have in the project, in isolation, are shown in the illustration. There are other factors which may well be advantageous to the project, yet which have nothing to do with the basic requirements of either the customer, the operator, or the manufacturer. A prime example of this is the degree to which current aircraft designs are being factored around "environmental" considerations. (Quietness, low pollution, etc.) Such factors may actually decrease the attraction for the operator (higher running costs), the manufacturer (higher development costs) and the customer (higher freight charges) and yet, the degree to which the craft can meet these external constraints can significantly improve the market penetration of the type. It is the function of the marketing aspect of such a project, as defined here, to make the main partners in any such venture aware of the importance of these external factors.

It must also be remembered that the development of any new transport mode provides a great opportunity in terms of marketing simply because it is a new mode, especially if it appears that this new mode may be established at a relatively low cost.

The financial climate is also likely to have an effect on any military development. It is easy to see that, if funding overall is fairly tight, then a project stands a far greater chance of receiving financial support if it can be cross justified across civil applications as well. The basic design of "an airship" is remarkably similar for any application, be it carrying cargo or Sonar gear. It would, for example be a very difficult job to justify the B.1. bomber as being suitable for use by the Timber Industry also. It is not likely to be so difficult for an airship!

THE "TRANSPORT EFFICIENCY" OF THE AIRSHIP

The functions of illustrations 2, 3 and 4 (Ref. 1) is simply to show that we are living in a world where fuel costs are likely to rise, and where oil fuel is likely to continue to be required in ever increasing quantities for transport use. Figure 5 shows the dramatic increase that has occurred in air transport which suggests that the "marketability" of air transport is based on subjective as well as objective appraisal and that the decision to go by air is influenced by powerful advertising pressure. As fuel costs increase so the trade off between the fuel costs involved and the speed (often perceived rather than real) and charisma of "air travel" will be examined even more critically. The prospect of the airship, with its low fuel consumption, its lower initial cost, and its ability to use low grade fuels effectively must inevitably be considered further. Figure 6 is an attempt to rate this efficiency in relative terms, based on information collated by Bouladon of the Battelle Institute. It reveals a craft with transit speeds of an express train, or double that of heavy ground transport operating under idealised conditions, with a fuel consumption barely greater than the lorry, yet without the necessity for the massive investment in roads and railways that conventional

systems demand. It is an aircraft in the true sense of the word, offering good access capabilities, with the possibility of remarkably low fuel costs and, at least in the smaller sizes, low trip end costs, surely a concept worthy of further consideration.

CONCLUSION

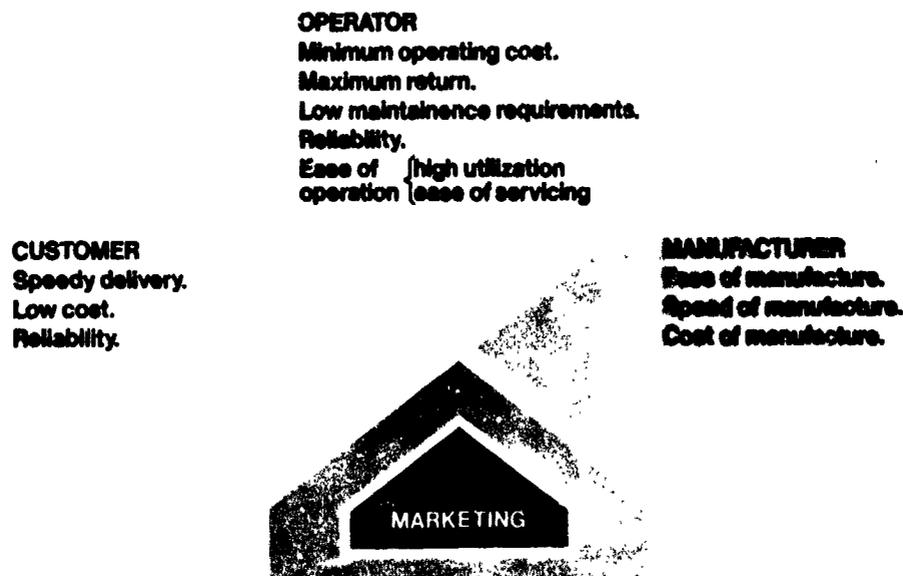
This has been a brief discourse, couched in general terms for a general public, but I hope that it has shown that much time, effort and money has already been spent on examining the application of L. T. A. to a wide variety of operational areas. There is no such thing as an "ideal" airship. Each case, and each application MUST be considered in its own individual light. There are many areas of such evaluation that will remain subjective, at least for a considerable time, but the ability to interpret these areas, and to ascribe to each of them their relative importance does exist, and should be utilised. The Chinese have a proverb, "The Flower must Grow from the Seed". It will require very little investment to ensure that this first small seed is well planted, and from this, and this alone, will the true potential of this exciting phase of transport development be discerned.

REFERENCES

1. Bouladon G. Raes Review (May, 1974)
-

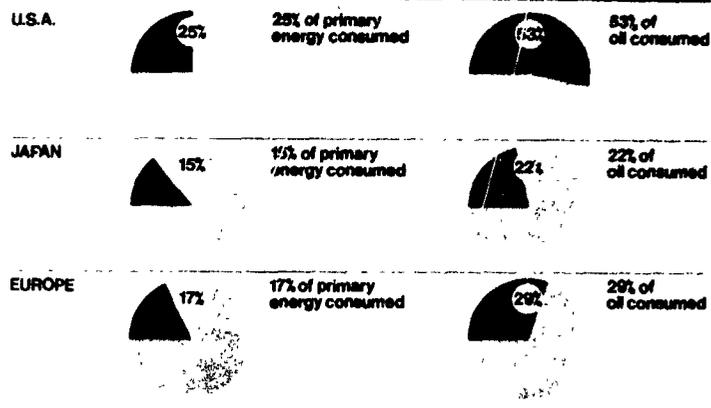
PROJECT EVALUATION: THE FOUR VITAL FACTORS

FIG.1



TRANSPORT IN TERMS OF ENERGY CONSUMPTION

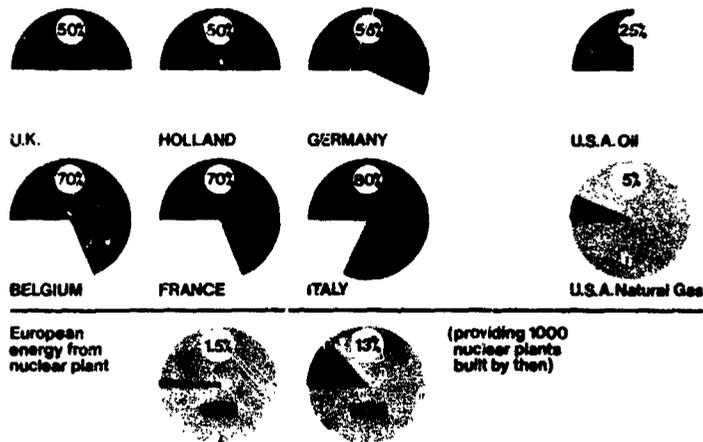
FIG. 2



(N.B. only direct consumption is considered here)

IMPORTED ENERGY DEPENDENCE

FIG. 3



AVAILABLE OIL SUPPLIES

FIG. 4

Maximum oil production is likely to occur around 2000 A.D. and should be approximately 5 milliard tons/year

Non substitutable oil requirements (mainly in the petrochemical industry) will total 2 milliard tons/year

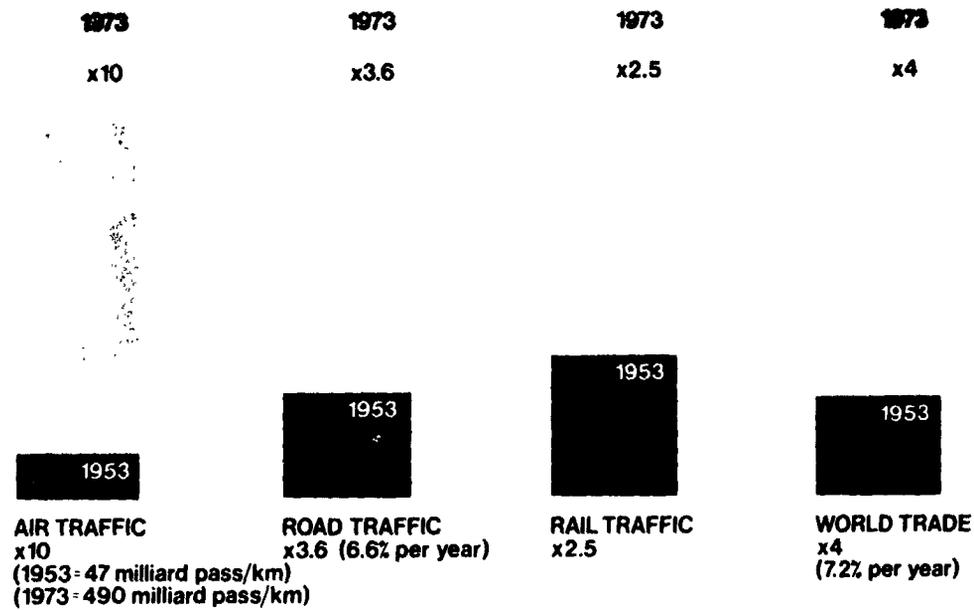


Therefore, remaining supplies will be 3 milliard tons/year. This represents only 14% of world energy consumption and is a deficit of 1.5 milliards over present demand, PROVIDED THAT

ALL OTHER CONTRIBUTIONS TO ENERGY SUPPLY ARE DEVELOPED AS OUTLINED ABOVE. This is, to say the least, unlikely.

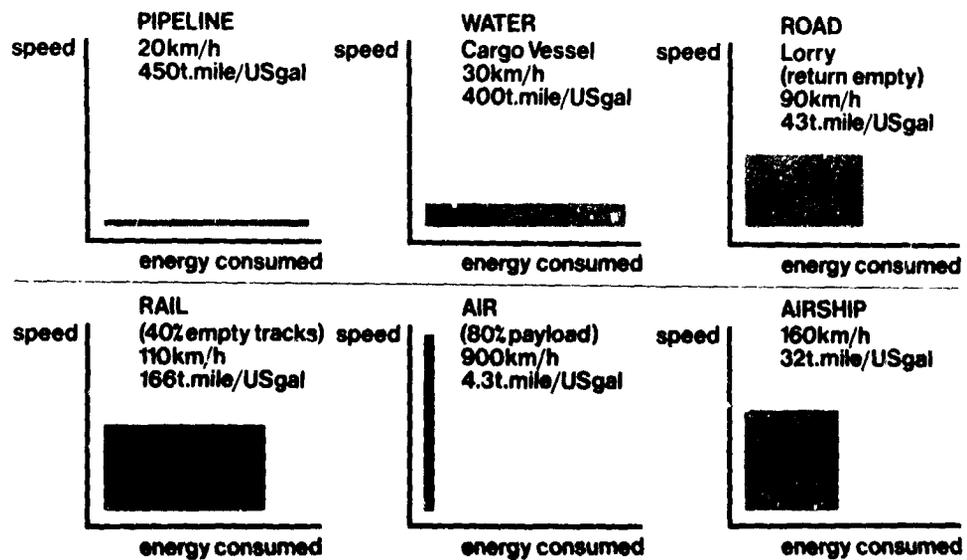
GROWTH OF WORLD TRAFFIC 1953-1973

FIG. 5



SPEED AND ENERGY CONSUMPTION TRADE-OFFS

FIG. 6



BOULADON/BATELLE