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# SHIP RESEARCH IN AUSTRALIA?

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*As a result of further demand the present paper is given a second printing in November 1977. Developments in the 4½ years since it was written must modify some of the argument and conclusions. The most significant change since the first appearance of the paper is the withdrawal of Australia from larger shipbuilding. However it seems that little modification is required for the proposals to meet current research needs of the remainder of the ship industry.*

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CONTENTS





## SYNOPSIS

The need for research support for Australia's maritime industry is studied. The components of the industry are examined and appropriate research disciplines are named. Ship research is revealed as a conglomerate of sub-disciplines from a wide range of applied research topics. After a brief outline of ship research abroad, a proposal is made for the establishment of an Australian Ship Industry Research Council and allied activities.

## 1. INTRODUCTION

"Ship research in Australia? You must be joking!"

Indeed 'research' tends to be a dirty word in much of Australia's embattled manufacturing industry. It is introduced here not to raise the scorn of the practical men who 'know it all' but because the author believes that many of the ills of the ship industry can be sheeted home to the happy anti-intellectuality which characterises so much of our commercial and industrial endeavour. It is also considered that the pace of change is now too great to enable us to go on as we have; i.e. to trade entirely on experience in a period when that particular asset is depreciating even faster than the capital assets of the industry. It may seem odd too, to be preaching research at the end of a decade of criticism of unbridled research and when it has been shown that the correlation of research expenditures with industrial success has often been unconvincing. However, research management is now much more sure of what it can deliver and care should be taken not to indulge in obsolete criticism of research.

One is used to the not unreasonable comment that an overseas-owned manufacturing industry will obtain most of its research from an overseas parent. However, most of our ship industry is locally owned and lacks munificent parents elsewhere. An important component of it has consisted of uneconomic manufacturing maintained for defence and other reasons by subsidy and nominal import prohibition in the face of the most elementary facts of comparative advantage. In such circumstances one might have thought that expenditure on appropriate research would have been insisted on regardless of opposition. A fraction of the tens of millions of dollars poured into subsidising duty-free imported contents of locally built ships would have paid for a great deal of research: for in-depth studies of costs, investigations of overseas developments in the whole range of disciplines from transport operations research to ergonomics and industrial relations in noisy dirty industries, etc. Instead we have become so rusty in some areas that when things go wrong, we have to pay consultants to tell us who to consult. This is no way to achieve the degree of independence which is being paid for in higher-than-world costs.

In fact, the view that the ship industry can be secured as part of an industrial infrastructure suitable to the needs of a modern expanding state by merely guaranteeing jobs for seamen, stevedores, boilermakers and painters and dockers is fraught with risk. Neglect of the professional and intellectual end of the business, including a necessary level of research, is inevitably causing us to fall further behind - behind in terms of world development and, perhaps as bad, in comparison with more successful local industries which tend to drain bright men away from the ship industry. The author believes that the profession and its educators must carry much of the blame for this state of affairs but hopes that it is not too late for endeavours such as the present symposium to effect a change for the better.

The present situation might be summarised by noting that private enterprise has not extended itself significantly in ship industry research but that there have been signs of change within the government sector,

particularly in respect of transport economics and of defence. At the same time there have been far reaching developments overseas and in this country to make research more effective. Following on sections on the ship industry, on ship research and on the position abroad, some suggestions are made in this paper for a low-cost approach to dissemination of research information and ship industry research in Australia.

## 2. THE AUSTRALIAN SHIP INDUSTRY

The scope of this symposium clearly includes all aspects of transport related to the use of ships. The communication flow and the dollar flow among the components of what may be called the ship industry has been examined by Hallett (1971). The parts are listed below, together with the type of research disciplines which appear to be relevant. They are listed in reverse order to what is implied in the title of the symposium to reflect the realities of the dollar flow in the industry. However, all parts are interdependent, and serious weakness in any one may be enough to kill one or more coastal trades. The author realises that this is not an original observation so much as a description of past events.

### 2.1 The Shipper

A shipper looks primarily for low freight rates, punctuality and no insurance claims. He may also have special packaging or similar requirements, though these are sometimes negotiable with the shipowner, port authorities and to a lesser extent, with the stevedoring sector.

These are the principal requirements of a shipper and he would use a railway, road or pipeline if the freight was low enough and as it is in the shipper's dollars that all other sectors of the ship industry are paid, the basis for selection of proposals to assist any part of the ship industry must be related to the associated required freight rate to the shipper.

Research disciplines of interest to shippers would include transport economics and inter-modal studies, research information on new developments elsewhere.

### 2.2 The Shipowner

Dollars flow from the shipper into all sectors of the ship industry through the hands of the shipowner. He must provide an adequate service at a low enough rate. As it is he who must provide the service and, hence, should know more about it than anyone else, the primary position of the shipowner in policies affecting the ship industry becomes self-evident. In other parts of the world, his crucial role is often supported by teams with understanding of such research disciplines as operations research, including market research, the assurance sciences re reliability and maintenance problems and ship technology itself.

The local shipping industry is challenged by a long list of handicaps such as

high capital costs;

high capital-induced costs such as depreciation, interest, insurance, dividends;

high operating costs, viz. loading and discharge, crew, maintenance, bunkers ('high' relative to other maritime nations);

geographical factors, trade imbalance on some routes, inadequate docking facilities, especially for larger ships;

problems of competition from rail and road;

requirement to purchase more expensive locally built ships, even if sometimes only after a long run with chartered tonnage brought onto the coast under a temporary import permit.

Thus, shipowners would be expected to be enthusiastic about any activity that has potential for improving their financial, economic and technical performance. In addition to the research disciplines of value to the shipper, wise shipowners keep themselves up to date in developments in

operations research - see Appendix II for details of the Planning and Development Division of ZIM Israel Navigation Company Ltd.;

the assurance sciences in respect of the physical operation of ships and maintenance and reliability problems;

technological ship research in respect of marine engineering and naval architectural progress towards better ships - to help shipowners evolve better specifications;

ergonomics to help design the best work environment for ships' complements and of course

industrial relations.

## 2.3 The Stevedore

The stevedoring sector consists of a number of companies responsible for the loading and unloading of ships and, in some cases, the preparation of cargo for loading and the distribution of cargo after discharge. As is the case with most of the labour-intensive sections of the industry, technological development has brought about considerable redundancy so that there is a feeling of job insecurity on the part of union executives and members alike. This situation tends to lead to industrial unrest which can be extremely disruptive, costly and bad for morale, thus tending to worsen the situation as greater attempts are then made to reduce the labour force. These difficult labour problems must be considered in any proposals for the industry to ensure justice to both sides.

The stevedoring sector deals mainly with shipper, ship-owners and port authorities by all of whom its members are employed. Because of the high cost of cargo-handling, efforts are being made continually by these employers to reduce the size of the stevedoring sector.

An increase in the number of coastal ships would be beneficial to this sector but in the overseas trades where Australian participation would probably take the place of foreign operations, there would be virtually no effect other than that due to the growth of trade. Thus, of itself, the decision to build more Australian ships would not have a great effect on the stevedoring sector. There could, however, be an effect depending on the technology employed if standard designs were to become more common, particularly in the general cargo sphere. Here, a trend towards greater labour productivity, rather than elimination of labour by the use of sophisticated capital equipment may be beneficial to all parties but, as things now stand, greater reliability and a willingness to increase productivity on the part of the stevedoring unions is required.

The appropriate research disciplines are ergonomics, operations research, materials handling and, not least, industrial relations.

## 2.4 Port Authorities

The port authorities are generally concerned with providing facilities for the loading and discharge of cargoes and for the maintenance and provision of other port facilities such as dredging. The portion of freight rates consumed in cargo handling operations is large because the ideal of designing the port and the ships using it as a system is usually impossible to achieve. (The reader will think of some obvious exceptions in North-West Australia and elsewhere.) In general the port has to 'put-up-with' the great variety of in-port performances of its customer ships. This is not to say that there is no room for combined economic, queuing and other operations research to develop better systems and to develop graded charges to encourage owners to cooperate in the evolution of such systems.

## 2.5 The Shipbuilder/repairer

The role of the shipbuilder is to provide reasonably well-built and not-too-expensive ships, on time, for the shipowner and likewise for ship repair. In spite of the affirmation by many governments over the years of the "..need for the maintenance of an efficient shipbuilding industry..", the industry has not kept up with the national growth in productivity over the period and has failed to prosper. A joint investigation by representatives of the Australian Shipbuilders Association and the Australian Council of Trade Unions, 1971, attributes lack of prosperity to "... too few contracts, too many strikes, not enough government aid ...". The present author would have added some other factors such as employment of far fewer than world average of professional engineering and other graduate expertise per hundred men in the work force, and consequent inability to benefit from world research and development in production science, cost studies, industrial relations in noisy dirty manufacturing situations, etc.

A number of local shipbuilders have entered into technical cooperation agreements with very reputable overseas builders. Such agreements appear to have been unable to prevent the Australian partners from making losses on tenders, even for ships with a high imported content being built at well above world prices. This would seem to bear out the writer's contentions listed in Section I.

## 2.6 The Designer

The designer's lot is unenviable. He must clearly be very close indeed to the owner in order to appreciate the full significance of his requirements. On the other hand, he should be in a shipyard in order to achieve the many savings which are possible when a ship is designed with production constantly in mind. Yet to be effective, he must work with a team bigger than could be justified by a single owner or shipyard. This calls for very lagr shipowning - or building - organisations or independent operation based on much above average capacity to cooperate with people. The designer who attempts to 'lay down the law' to owner or builder will not go far. In any case, the detailed design of a ship is best done by the shipyard which is to construct it.

At the same time, he should be studying world developments by reading, observation, discussion and travel. He should have knowledge of the ever-growing output of ship technology without being overwhelmed. He should be constantly busy doing project studies using both simple computer techniques and the most sophisticated optimisation methods. He must understand the market and be ready with ideas.

Thus it is not surprising to find overseas consultants establishing themselves here. They are able to bring in 'know-how' and a knowledge of world progress in their fields. However, the author would consider it a matter of concern if we came to depend exclusively on general consultants - as distinct from specialist consultants.* Again, this would reduce the maintenance of the industry to a matter of maintaining blue-collar jobs - or, in Tariff Board terminology, merely diverting scarce labour resources from more efficient industries - rather than the maintenance of a degree of independence from others, commercially and for defence reasons, Research areas of interest to the designer are listed in Section 3.2.

## 2.7 Naval Ship Development and Operation

There are naval analogues, albeit far-fetched in some cases, for all the sectors of the ship industry listed so far and they need to draw on similar research disciplines in addition to the wider area of defence research which is beyond the scope of this paper. However, it is worth making reference to naval ship development because the last decade has seen a growing interest in appropriate local design and research, the very period which could become known as the last which saw any significant Australian contribution to design and development of our merchant fleet; i.e. if current trends continue.

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* It is not generally understood that many major consulting firms pass on a good deal of their specialised work to specialist consultants. One can travel in Europe and find numerous specialist consultants show off their "Australian" work, subcontracted by supposed expert offices in Australia! Thus it would seem that where overseas consultants do much of their work locally and train local men, they could be encouraged. Where they merely farm out work to other companies abroad, they prevent us from developing what could be vital contacts.

## 3. SHIP RESEARCH

### 3.1 Basic and Applied Research

The Oxford Dictionary defines research* as 'a search of investigation directed to the discovery of some fact by careful consideration or study of a subject'. It used to be fashionable to consider a hierarchical connection of elements such as scientific research/development/design/production/marketing/operating/maintenance and repair. This left no scope for the inventor - or the social scientist - and no great respect for the practical men staffing most of the chain. In any case the movementof ideas up the line, i.e. finally setting a research problem was much more frequent than the passage of ideas down the line, i.e, finally leading to commercial application. S o it is no wonder that a gulf was created between research and its useful application.

Much has been written about research and its relation to the real world. For example, Mansfield (1969) writes in his book on the economics of technological change

> ... first, there is basic research, which is aimed purely at the creation of new knowledge ... The principal bastions of basic research in our society are the universities. Second there is applied research, which is research expected to have a practical pay-off ... Third there is development, which is aimed at the reduction of research findings to practice ... The distinction between research and development is often rather hazy. The differences between them relate primarily to the orientation of the work, the degree of uncertainty in a given problem, and the length of time the work can be expected to proceed without demonstrable pay-off ... although research and development are not the same things, in a particular project, a hard-and-fast distinction between research and development may be very difficult to make.

The author works in a University** and publishes 'basic' research findings from time to time. He is fortunate in being able to drop a basic problem if it is beyond his capacity to solve. However, he believes that some applied research activity by government and industry is essential, not only to create a cadre of persons who can understand the work being done in other parts of the world, but also to support the limited development we must have. His perhaps oversimplified view is that the meaning of research has now broadened to include most, if not all, non-immediate predictive activity to support planning in an organisation including the digestion of research information from others. It is the detailed work associated with one's forward thinking.

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* It also quotes the Pall Mall Gazette of 29th September, 1883 to illustrate use of the word 'researcher': "... by what means are we to decide whether the money paid to the researcher is being spent upon research?".

** In fact,there are a handful of university teachers in Australia who have created an international reputation for themselves out of all proportion to their numbers in ship hydrodynamics, ship manoeuvrability and ship structures.

3.2 Ship Research Topics and Allied Disciplines

The author's listing of research disciplines relevant to different sectors of the ship industry, Sections 2.1-2.7, include

> Assurance sciences, cost studies, defence science, ergonomics, industrial relations, intermodal studies, materials handling, operations research, production science, transport economics and ship technological topics.

Different readers will find different gaps in the list such as ocean engineering and meteorology, thermal and electrical sciences, etc. Although both merchant and naval shipping are of ancient origin, they now operate near the front line of what is technologically feasible and, as in all such cases, it is impossible to write down an exclusive list of relevant disciplines in this interdisciplinary age.

Ship development centred topics may be listed as per the headings used by the British Ship Research Association's monthly Journal of Abstracts :

Ship Design

> Ship descriptions; design and economics; structure and materials; hydrodynamics, performance

Ship Construction

> Shipyards, docks, launching; management sciences, production, techniques, equipment, outfitting

Ship Machinery and Systems

> Prime movers: turbines, i.e. engines, nuclear power, boilers, main machinery systems; auxiliaries: equipment and machinery, deck machinery, auxiliary systems; thermodynamics, heat transfer; fuels and lubricants; power transmission; automation, instruments, measurement, control systems

Ship Operation

> Operation and maintenance, ship management; corrosion and fouling; vibration, noise measurement, sound-proofing; cargoes: properties, handling, transportation; marine safety; navigation

Miscellaneous

The lists of this section are large enough to make it plain that no country can proceed with high level ship and ship industry development independently of all others and effective channels for exchange of research information have been created in many of them. Equally there will be no scope for any independent development or operation for countries which reject all research. A subsequent change of policy could only be implemented after a long learning period.

## 3.3 Organisation of Ship Research Abroad

The way in which ship research is conducted elsewhere and the manner in which ship research information is disseminated can be readily found. However, the available space does not allow a careful listing even of what is known to the author. It would be useful if a detailed study were made or sponsored by an appropriate arm of government. Short comments on some facets of the issue are given for eight countries listed in alphabetical order.

CANADA. The government of Canada, through several programmes of the Department of Industry, Trade and Commerce, encourages industrial research but so far they have proved to be of little significance to the shipbuilding industry. Facilities are available at the National Research Council for various types of research, particularly tank tests and allied hydrodynamic work. The latter is sufficiently well regarded by the International Towing Tank Conference that the 14th conference will be held there in 1975.

HOLLAND. The best known contributions to ship research come from the well known Netherlands Ship Model Basin, N.S.M.B. at Wageningen. However, recent years have seen the emergence of strong system consciousness and serious attempts to mount refresher courses and conferences designed to update the professional members of the industry and to introduce them to non-technological concepts such as operations research. Details are given in Appendix I of this paper of topics discussed during a one month post-graduate course held at the Delft University of Technology in 1969 and during the four day symposium, also at Delft in 1972. Readers are urged to look through these topics and to note their maritime system orientation. The Dutch government has recently set up a 'maritime institute' to manage the optimal investment of available funds for all forms of maritime research.

ISRAEL. The author was quite unaware of efforts in that country until he met a travelling professor from the Israel Institute of Technology who referred to joint activity with the ZIM line in operations research. Further enquiry produced an informative reply from the deputy managing director, planning and development of the line, which is reproduced in Appendix II. Readers will note the close connections which appear to have been established between academic and applied research by appropriate secondment of staff - as teachers or students.

JAPAN. The most depressing feature of Japanese ship research for the outsider brought up in an Australian/British tradition is not the breadth and depth of the activity so much as the comradeship and ease of communication between researchers and practitioners. Each 'side' has clearly been ready to see what are the often contradictory views of the other. Research, development, production, marketing are seen as part of a continuous process of two-way information flow. But for science to be effective in the whole process, it needs isolation as well as communication: the researcher at the basic end of the chain cannot continually change the direction of his work at the behest of market and production needs. Perhaps the scale of the Japanese ship research operation is too large for us in our generally sub-critical mass situation to learn many lessons from - though we must surely be able to know and understand its output! The author will therefore merely refer to the most readily available recent account of it, namely Shiro Kan (1972) and present his outline of merits and demerits - exactly as printed in the reference.

"Merits :

(a) Thick layer of senior shipbuilding researchers; eight universities in Japan have naval architecture departments and send out a large number of prospective naval architects and marine engineers each year.

(b) Consolidated research institutes of private enterprises, major shipbuilding companies have their own research institutes and are making constant efforts for the development of new techniques.

(c) Joint research for technical development; many useful joint research are being effectively carried out with the close cooperations among shipbuilding companies, related manufacturing companies, shipowners, universities, scientific societies and research institutes.

(d) Effective aid extended by the Japan Shipbuilding Industry Foundation for the promotion of development research.

Demerits :

(a) No support from Japanese Navy; Japanese shipbuilders can no more expect the support of the Japanese Navy with its vigorous research activities. To make it worse, government investments in shipbuilding techniques research are much smaller than private investments.

(b) Too much relying on foreign technical know-how; more efforts should be made for the development of Japan's own unique techniques.

(c) The techniques research system of the shipping circles is not yet completely restored ...."

NORWAY is known as one of the world's foremost shipowning countries. Its ship classification society 'Det Norske Veritas' developed a substantial applied research department some years ago and began to lead the field in several significant areas. The towing tank laboratory of Trondheim is also of world class. Norway is mentioned here because of the recently established so-called S.D.S. project set up jointly by the shipowner organisation and by government. Its principal concern is how to use the output of a range of specialised research organisations - working in depth 'vertically' - in maritime application - i.e. with the very broad interdisciplinary 'horizontal' requirement of the practical situation. A typical team consists of a distinguished research naval architect on secondment from Det Norske Veritas, a control engineer, a business systems expert and a sea-captain - again on secondment.

From the point of view of application, the work of such a team carries very much more promise, in the author's mind, than larger teams of experts working in government research laboratories. The notion of secondment of people from different backgrounds into project oriented teams is not new but it is practised remarkably rarely. It has very much to commend it.

UNITED KINGDOM efforts in research are quite well known in Australia and need not be detailed here. In the past they have been better known for their technical excellence in special fields than for their success in finding and attacking weak links. Strong attempts are underway to improve matters and tradition in ship development and in shipbuilding is being supplemented by large doses of modern method. Also, the number of graduates per hundred men employed is increasing correspondingly. The monthly Journal of Abstracts of the British Ship Research Association is a particularly valuable medium of dissemination of research information (see also Section 3.2).

UNITED STATES. In recent decades the U.S. has been far more significant in the development of naval ships than of merchant ships. This is reflected also in the type of research which has been sponsored. It has been advanced - technology oriented and at times far ahead of what could be applied in the merchant field. However, the fruits have been there for the picking. The considerable progress made since the amendment in October 1970 of the Merchant Marine Act 1936 has certainly not been independent of the upgrading of engineering and planning staffs in the ship industry inspired by Navy work. At the same time a very useful Maritime Research Information Service was set up under the auspices of the National Research Council. The original area covered included; cargo operations, cost reduction, pollution control measures, large ship design, ice breaking, environmental efforts, computer applications, other maritime research. The author has been in correspondence with its director and is able to say - consonant with one of the themes of this paper - that we should be able to come on the circulation list providing there is some return of research information.

YUGOSLAVIA is mentioned as an example of a smaller country with a strong ship industry. All of its research activity is concentrated in the Brodarski Institut, Zagreb which employs a total of 400 persons to cover the range from operations to technological research.

Yugoslavia is one of the 25 countries with membership of the International Towing Tank Conference, based on possession of an adequate sized model basin for ship development. Other minor countries in that league are Argentine, Austria, Belgium, Brazil, Denmark, Finland, India, Israel, Korea and Turkey.

These descriptions of what is done elsewhere contain practices to emulate and to avoid in about equal measure. In view of the different mix of constraints and opportunities existing in Australia, we shall have to evolve our own patterns if we will - for innovation, for keeping in touch and indeed for survival of the industry.

## 4. SHIP INDUSTRY RESEARCH IN AUSTRALIA

### 4.1 What we need and what we have

Action can presumably be determined by evaluating the difference between what we need and what we have! It follows from what went before in the paper that

we need

(i) to know our long term goals in all sectors of the ship industry and to establish mechanisms which will ensure that economic, social and political factors take their proper part alongside technological parameters;

(ii) to work towards a situation in which capital, labour and material inputs into the industry reach a level of productivity of the same order of magnitude as that achieved elsewhere and that we work to maintain any such parity; for this we must be able to measure and analyse our efforts critically;

(iii) to have capacity to sort out significant overseas developments from the trivial as far as their possible application to the Australian scene is concerned;

(iv) to get good communication among our small population of researchers and forward thinkers;

(v) to be able to assembly interdisciplinary teams for specific project studies; most of our organisations are of subcritical size and cannot do this alone;

(vi) capacity to undertake research and development work on specific defence projects;

(vii) to maintain and develop our own research efforts in at least a few areas - to make the minimum contribution to world research normally required from those who wish to draw on that pool.*

we have

(i) in private industry - shippers, shipowners, stevedores, shipbuilder/repairers and a few designers who have demonstrated by their survival through several trying decades that they have been able to master such a succession of short term problems that they are unlikely to take kindly to others coming in to tell them how to secure their long term prospects! It would be inaccurate and impudent to suggest that they have been less than concerned for the future. However, it does appear that, as a group, they have not been particularly interested in using the better research developments from abroad or in securing their future in a cooperative way.

(ii) in government -

divisions in the Australian Defence Scientific Service with capacity in a number of technological areas and also in operations research;

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* An ordinary visitor to an overseas laboratory or institute will be given a short tour and no opportunity to ask questions in depth. However, if he is able to give a seminar on his own, perhaps quite limited research, he is usually made to feel at home by the staff and is able to carry away a great deal of knowledge of the real work of the organisation.

the recently established Bureau of Transport Economics whose great potential is yet to be fully realised for, and by, the ship industry;

a Department of Secondary Industry which has responsibility for establishing policy consistent with those for other manufacturing industries towards fostering "a rationalised and efficient industry". It was briefly called to the rescue by our new Government and administered the Shipbuilding Division for a short period. Shipbuilding Division has now reverted to the Department of Transport with its heavy burden of concerns for transport as such. However, the Department has experience in coping with the possible conflicts between suppliers and users of transport equipment;

a Department of Navy with strong technological interests, keen to foster local design and sponsoring students at Australian universities to increase the proportion of graduates - and even running some applied research contracts in universities on such topics as ship structures and ship hydrodynamics.

(iii) in universities - approximately 700 members of academic staff in faculties of engineering and 800 in economics/commerce. About one third of their time is available for research. The proportion of these men who are interested in maritime research or could become so is of course small but their contributions could be significant. In Australia, university staff are sometimes more au fait with world research in their sphere than with local applied work. To the extent that this is true also in relation to ship industry research it represents a potential ready for tapping. At the same time, the dissemination of research information is eased by these men's acceptability within the "invisible colleges" which nurse progress in innumerable subdisciplines of interest.

4.2 What next?

Next we should attempt to match needs and resources for research at minimum incremental cost! The needs listed in Section 4.1 are not impossibly onerous; the available resources are scattered and unco-ordinated but not minimal. A Zagreb type institute would cost much more than a reasonable proportion of local value added in shipping and shipbuilding, etc. - nor would it be justified while there is expertise distributed as just described. We also need to ensure both satisfactory links with world research information in the field and satisfactory digestion of the material which is often highly specialised; i.e. to serve it to the appropriate workers in usable form at the right time. Finally, we need to consider in which areas to make our limited contribution to world research in order to "buy into" the most appropriate "invisible colleges". This can often be done by relatively inexpensive encouragement of groups of university staff and their research students.

The need for communication, co-ordination and consultation appears to emerge as having the highest priority. Such disparate elements as private and government enterprise could certainly be brought together to achieve this, once the potential for greater efficiency is understood. A pattern for action suggests itself as follows.

4.3 Australian Ship Industry Research Council

It is recommended that a Council be set up by government with membership from each of the sectors of the ship industry listed in Section 2, appropriate government departments and authorities and some university members, to ensure that major areas of relevant research are covered. The Council should define its own views concerning the situation sketched in this paper and make properly costed recommendations to a Minister or Committee of Ministers.* Suggestions for subsequent activity might be as follows.

The Council to continue to review the progress of Australian ship industry and to oversee a number of activities.

The Council to meet on only a few occasions per year after a period of initiating these activities - its detailed work being done by a small number of technical committees drawn from successful working level engineers and scientists with a leavening of university membership. Ad-hoc panels with similar membership would be created from time to time to consider and report on interdisciplinary and other problems as they arise.

The Council to be instrumental in setting up and coordinating the work of research information units within existing organisations or de novo; e.g. the Bureau of Transport Economics in respect of that discipline, practical operations research techniques, optimisation methods, etc.; the Division of Mechanical Engineering, Aeronautical Research Laboratories in respect of marine propulsion and auxiliary ship systems; the Production Section of the Shipbuilding Division in respect of cost studies in shipyards, etc. Other areas such as ship structures might need to be covered by small units attached to existing research cells in universities and elsewhere. Determined efforts to be made to ensure the usefulness of the units to users - including planned methods of feedback. The research information units to be put on a two-year trial in the first instance.

The Council's activities would be bound to create a climate of communication, common concern and system consciousness. This might be reward enough for those who serve it. However, the Council should also be enabled to advise government on the spending of limited funds for applied research - and research information gathering as inferred above. A healthy industry would be expected to contribute matching funds according to a formula to be worked out in light of likely benefits to be gained.

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* The author is somewhat troubled by the question as to which Minister the Council should report to - and it should be made to report annually. The Ministers of Defence, Secondary Industry and Transport are all concerned as might be the Minister for Science. Also, it is hoped that it is not too much to expect the simultaneous goodwill of three of four permanent heads of departments!

The reader might wish the author to have produced a more stirring plan of action than the setting up of A.S.I.R.C., associated technical committees and research information units! However, little is gained by over-enthusiasm. In view of the small scale of the industry, the proposals of this paper appear to him to be the maximum that is currently feasible - and also the minimum prophylaxis to prevent further decline of the ship industry as a whole.

## REFERENCES

R.J. Hallett: Preliminary Investigation of Requirements for an Australian Standard Ship Program, University of New South Wales Report Nav/Arch 71/6, 1971.

E. Mansfield: The Economics of Technological Change, Longmans, Green & Co., London, 1969.

Shiro Kan: Shipbuilding Techniques Research System in Japan, Japan Shipbuilding and Marine Engineering, Vol. 6, No. 5, 1972, pp. 7-14.

# APPENDIX I

## TOPICS FROM DUTCH REFRESHER ACTIVITIES

### A1.1 Design and Economical Considerations in Shipbuilding and Shipping

Report of Postgraduate Course at University of Technology, Delft, May 1969 - published by H. Veenman en Zonen N.V., Wageningen for Royal Institution of Engineers (The Netherlands)

I. Selection of Design Data

The choice of basic design principles for a liner operation, increasing the scale of operation in liner shipping, operations research for ship design, computers in ship design, application of an optimisation algorithm to ship design.

II. Shipyard Production - Operational Research

Statistical analysis, operational research, operations research in the field of production, operations research as a tool in shipbuilding management.

III. Ship Propulsion

Unsteady lifting surface theory, cavitation and cavitation damage, ducted propellers, hydrodynamics of controllable pitch propellers.

IV. Seakeeping and Manoeuvring Qualities

The dynamical behaviour of a floating drilling platform, rolling and roll damping, simulation of ship manoeuvring qualities.

V. Strength of Ships

Design stage prediction technique for ship vibrations, the finite element method in ship design, permissible stresses and their limitations.

VI. Engine Room

Propulsion systems viewed as energy transforming and transporting systems, thermodynamic principles of thermal energy converters in view of modern systems analysis, control aspects of ship propulsion by steam, system dynamics and control aspects of a gas-turbine frigate propelled by two c.p. propellers, optimization of a diesel propulsion installation with adjustable screw, a practical example of a remote control system.

VII. Behaviour of Ships under Service Conditions

Ship model correlation and service roughness allowances, sustained sea speed, optimal routing of ships, some practical experience with vessel behaviour in a seaway and ship weather routing.

VIII. Cargo Handling

Commodities, transshipment of general cargo, transshipment of bulk material, the impact of operational changes on the design of the modern cargo vessel.

(These topics were covered in lectures by 36 authors.)

A1.2 Development in Merchant Shipbuilding : Design. Production. Management

Symposium 30th May - 2nd June, published by Delft University of Technology, Department of Naval Architecture, 1972.

Paper headings were :

The ship as an integrated system, the role of the electronic computer in the integrated ship design, modern approach to integrated ship design, statistical approach to the analysis of longitudinal stresses in a simplified ship's girder due to a long crested irregular oblique sealoding, development in marine engineering, cost aspects in liner shipping, marketing problems (i), management and operations research, aspects of costs - building costs, marketing problems (ii), operations research, aspects of modern shipbuilding technology, application of numerical control for production, application of network analysis to the allocation of capacity and to project cost control, management problems in shipyards, the essence of enterprising: set your course and formulate your strategies, is there a future for the West-European shipbuilding industry?, how should the shipbuilding industry be organised?

(These topics were covered in lectures by 20 authors.)

## APPENDIX II

## PLANNING AND DEVELOPMENT DIVISION OF ZIM ISRAEL NAVIGATION CO. LTD.

Letter to author from deputy managing director, planning and development, 31st December, 1971.

"... The Planning and Development Division which I am heading in ZIM consists of three permanent departments: Management Science, Economic Research and Corporate Planning. At present these departments consist of the following staff :

| | | |
|---|---|---|
| Management Science | - | 7 industrial engineers of whom one is a D.Sc. candidate and the rest M.Sc. candidates, all in Operations Research. |
| Economic Research | - | 5 economists/statisticians, two of whom are M.B.A. candidates and two M.Sc. candidates in Operations Research. |
| Corporate Planning | - | 2 industrial engineers and one economist of whom one is a D.Sc.candidate in Operations Research, one is a M.Sc. candidate in Operations Research and one a M.B.A. |

Under my responsibility is the ZIM Container Project, which will turn into ZIM CONTAINER SERVICE in March 1972.

The division is operating partially in a form of ad-hoc projects where various disciplines are grouped into teams for specific tasks. I have also taken experienced non-professionals into these teams in order to benefit from the experience and know-how (in shipping), as well as from the practical outlook of these people, who are sea captains, accountants, engineers, etc.

The following is a list of some past and present activities of the division :

- Designing the layout and control system of the ZIM container yard in New York.
  This work included: defining service levels, evaluating queues at the gates and thus average waiting times, etc., evaluating parking arrangements, designing LTL sheds and evaluating loose cargo storage techniques, etc.

- Designing and carrying out of experimentation (in progress now) regarding the carrying of citrus in reefer containers.

- Evaluating a system of tug/barge movements for bulk cargoes.

- Designing the layouts, systems and future developments of container ports in Israel (on behalf of the Israeli Port Authorities).

- Evaluating the total transportation system in Israel, pertaining to export/import movements, including rail, road, distribution pattern.

- Developing a data base for the company.

- Developing a simulation model for line operations - now in use in one of our lines - operating close to 40 ships.

- Developing a model for forecasting world bulk demand and supply.

- Developing marketing research, forecasting and marketing techniques.

Some of these activities as you may well notice, are connected to ZIM CONTAINER SERVICE, and a few of the people working on these subjects, if so suited and inclined, will assume line positions and be responsible for implementing their planning.

As for your question regarding links with other bodies, such as universities, etc. ZIM is carrying approximately 70% of the Israeli foreign trade and as such, it is a major factor in this section of the economy, though it is now a semi-privately owned firm (only 30% owned by the Government). This fact influences very much the links with other bodies. For instance, our group is designing Israel Container Parts for the Israel Port Authorities. This, because of the know-how accumulated by our company and the fact that we are the major client of the ports. We also look at the total distribution system in Israel and determine eventually road and rail facilities, distribution centers, regulations, etc., all this in conjunction with the relevant Government and Non-Government bodies. We are in constant contact with the Israel Shipping Research Institute, and I personally sit on their academic board.

Our connection with the Israel Institute of Technology and other universities is by the fact that most of our people are students, instructors, etc. (We grant each man one day a week off for studying or teaching). We have a regular monthly meeting to which we invite Professors, Scientists, etc.to give lectures on their particular subject and we use people in universities for consulting work, mostly in the capacity of a referee."