Woods Hole Oceanographic Institution

MARINE TECHNOLOGY TRANSFER AS FOREIGN AID TO LESS DEVELOPED NATIONS FROM OCEANOGRAPHIC INSTITUTIONS IN INDUSTRIALIZED COUNTRIES: A SEARCH FOR AN EFFECTIVE MECHANISM IN THE EDUCATIONAL SECTOR

By

M. Lamin Sarr

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TECHNICAL REPORT

Supported with funds from the Pew Memorial Trust and by the Department of Commerce, NOAA Office of Sea Grant under Grant #04-6-158-44016, and the Institution's Marine Policy and Ocean Management Program.

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Approved for Distribution

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Abstract and Acknowledgment

This study attempts to look at systems of transferring marine technology through education and training and to suggest solutions to the problems that have been the cause of failure in the process. In so doing, the nature of the educational institutions, both in the industrialized nations and in those developing nations where they exist have been reviewed. Inadequacies have been identified at both levels. Inadequacies that stem not only from the educational systems but also concerning government involvement as well as social attitudes. This problem identification is followed by suggested solutions for each case and in some instances such suggestions are supported and substantiated with descriptions of cases where success or at least potential for success have been achieved. This is then concluded with a summary of the finding of the study.

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M. Lamin Sarr

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Marine Technology Transfer As Foreign Aid To Less Developed Nations From Oceanographic Institutions In Industrialized Countries: A Search For An Effective Mechanism In The Educational Sector.

INTRODUCTION:

The transfer of technology in the marine sciences is a multifaceted operation. In most instances it involves all phases simultaneously or in different stages. Some of the most apparent aspects of transferring technology are in education and training, instrumentation and financing projects. However each of these sectors of transferring marine technology for development can be independently undertaken from the others and each can be the subject of a lengthy study by itself. For that reason and for the lack of sufficient time, this study is devoted to only one area - Education and Training.

Education is of paramount importance in the process of modernization. It is the basis of independence and a media through which a national understanding in this case, of the oceans, and a systematic and beneficial exploitation of ocean resources can be undertaken. Education properly nurtured will yield an inherent capability to sustain the independence and dynamic process of modernization in the developing nations.

Education & Training

Conceptualization:

Two words - "Education" and "Training" are the key words in this study and it is important to know how they are used.

Occasionally education and training are being used to depict the same thing and carry the same meaning. Where they are used differently, education is the process of gaining knowledge in a more fundamental way as is given through the system of instructions that are germain to the conventional and traditional school systems. But it surpasses simply acquiring the skills to read and write. Marta Vannucci said that when she talked of education, she did not mean "... only reading and writing because ... the mere knowledge of writing and reading, unaccompanied by education, may be worse than no training at all ...".[1] Therefore education should be stretched to incorporate the training for one to use his/her thinking capacity in a scientific and rational way and to encourage the innovative and adaptable potential of the individual.

Training is that part of the educational system which is less formal and directed towards vocational and technical goals. This could be achieved through formalized institutions like specialized trade schools or carried out much more informally as an on-the-job training system or through observation and participation in practical activities like that which takes place on a cruise vessel. It is more practical and at times does not

necessarily require a minimum basic education like primary or secondary education.

Given such a conceptualization we might ask what the purpose of the two terms are.

Purpose and Essence of Education:

The notion that knowledge is power has made education a very prominent aspiration for the governments and peoples of the Third World countries and "... is widely considered to be a most efficacious instrument for modernization".(2) In this case modernization is the ability to enhance one's people to have access to a much higher standard of living. Modernization which is an ongoing process can be sustained only with proper education. This could be obtained "... by the promotion of training schemes or (better) training programs within the existing educational system to produce technical and managerial personnel".(3) Since the process of modernization is an ongoing process, it is imperative to develop at least a basis for independence because the donor nations will not be able to continually give aid to developing countries ad infinitum. This means that there should always be some very serious efforts made to train people to have the ability to use and maintain, and if necessary design new equipment and technologies. In addition, a more fundamental need - an in-country - training capability must be developed to sustain this dynamic requirement.(4) Another important reason is that development is essentially based on the fundamental principles of education and since there is generally a lack of

trained personnel in the marine fields in the developing countries, and since education as mentioned is an aspiration in the developing countries, it will probably provide the best immediate opportunity for technology transfer.(5) Besides there is a growing interest and importance in the marine sciences. That there is a universal need for scientists in this field cannot be over emphasized.

The Need for Education:

As marine science becomes so important to the survival of mankind as a whole and vital to national interest, the outcome of the third Law of the Sea Conference could leave a large portion if not all of the oceans of the world being heavily guarded and possibly completely closed to marine science researchers who are simply seeking knowledge for what it is worth.(6) This could result in a complete loss of vital information and the chances for man to have any understanding of what constitutes seventy percent of the world surface. This can be countered only by giving the necessary capability, which is basically the knowledge of how this gathering of information can be done, to that portion of humanity who will control a significant portion of the waters of the world. (See Table I.)

Secondly, it is an accepted fact that the proper knowledge and application of the ocean is a very important element for the development of the third world countries because this will give them access to proteins for solving some of the nutrional problems that are inherent to these nations. "...there is no doubt

that knowledge of the currents, water temperature, oxygen levels or any other physical or chemical factors which determine whether a species is present or not, makes it possible to know where fish are to be found and hence to develop fishing effectively." (7)

Thirdly, education is needed because, due to the fact that the ocean and the resources therein have great potential value to all mankind, the developing nations have increasingly become suspicious of any activity being carried out off their coasts by scientists from the advanced countries. They believe, rightly or wrongly, based on their past experiences, of their resources being exploited by foreigners without any regard for the interests and benefits of the local people. Therefore they are becoming increasingly interested in improving their capabilities to conduct marine science activities (mainly for economic reasons) off their coasts by receiving training and education among other forms of assistance in this field. This may be an over simplification, because the needs of each of the developing countries does vary from that of the others, however there is a basic commonality in their demands as summarized in the Bologna report,

> "While the characteristics and priorities of national marine science programs vary considerably, two common aspects were stressed throughout the Workshop:
>
> a. The need to establish a critical mass of properly trained manpower, both scientists and technicians, and
>
> b. The importance of improving indigenous facilities for the education (to the Ph. D./Sc.D. level) and training of additional personnel. These facilities would, of course include appropriate scientific instrumentation, data centers, and specimen collections."

Education and training are thus important and essential aspects of the transfer of technology. And apart from their very positive contributions in building up, in this case a group, of knowledgeable marine scientists and technicians, the training of people in the marine sciences and related fields can influence their ability to make their governments understand the importance of the world's seas. This is an essential factor because government decision makers generally make legislations that govern the seas without the slightest knowledge of the seas or their resources. Or because of a lack of knowledge of the seas, fail to make any legislation at all for the conservation and protection of the marine environment. These governments, usually when they make any legislations or pass decisions, are absolutely irrational and devoid of any scientific analysis. On the other hand, a government, or nation that has a set of people with a knowledge of the oceans, will tend to take much more rational decisions regarding the marine environment, on the basis of factual scientific advice, but above all will become more interested in and aware of the existence of this vast area of the globe. Once this interest is generated, the governments will do more than simply take the waters of the oceans for granted. However, I must not mislead you into believing that interest of the ocean can only be generated when marine scientists and technologists are available. The need for survival can generate a tremendous amount of interest in the oceans, and in fact this element has been the basis of the proliferation of interest among the LDC,

and caused the increasing interest and efforts among the developed nations. Such elements are the need to look for alternatives to land-based resources, both for economic and nutritional purposes. Secondly the high oil prices are not only a motivation to want to produce at a cheaper rate locally, but can bring vast amounts of riches to a nation. But despite all these motivations - which are useful in turning the interests of nations towards the seas - the lack of scientific knowledge absolves irrational actions which in the long run has very adverse effects on the nation concerned. Take Nigeria for example; recently Nigeria put in an order for cement and up to the time of writing there were hundreds of ships loaded with cement waiting at the Nigerian harbor to be unloaded. They have been there for months and would certainly not all be unloaded within a few days. And for each ship day the Nigerian Government has to pay thousands of dollars. This is admittedly an administrative error and a gross one too, but the problem does have a marine dimension as well. If there were a significant marine capability with better port facilities there would have been a better mechanism to unload the ships at a faster rate, and thus reduce the financial cost and possibly other unforeseen costs too. Secondly, Nigeria is an oil producing nation and we all know how great the potential for oil pollution can be during a production process. Such a potential can only be averted with a maximum amount of planning based on scientific analysis and environmental protection regulations that are nationally discerned. But today

Nigeria is highly polluted because of three things as summarized by a leading Nigerian Marine Scientist: (i) the lack of environmental education, (ii) the paucity of environmental laws, and (iii) the repressive attitudes towards reporters.

First of all, he said that environmental education is very scarce and that ecological orientation has just been introduced in high school biology - but even then the teachers of this new course are absolutely ill prepared to have any impact on the attitudes of people. In the universities, the situation is worse.

Secondly, environmental laws are virtually non-existent. Those that do exist are not even known or understood by most Nigerian attorneys because they were mostly written by former colonial administrators who sought to protect their compatriots' industries, and this is reflected by the absence of provisions for monitoring, prevention and abatement or clean-up of oil spills or seepages.

Finally, he claims that the government could be very tough on those journalists who might report oil pollution for what they term as raising unnecessary alarm - as happened in June 1974 at Port Harcourt.[9]

This might be a grim picture but it is the state of affairs. However, there is cause for optimism, because now nations are beginning to realize the value and need for education and it has a high place among the list of priorities in the developing countries and as such they will strive to ensure its availability.

On the other side of the fence also there is room for optimism because the industrialized nations are saying that they are willing to help. Ross and Smith conducted a survey among U.S. scientists on this issue of Technology Transfer, and their conclusion is that "Scientists from the U.S. who have participated in cooperative educational programs have been very enthusiastic as a whole. The interests of developed and developing countries again seem likely to converge in educational programs."(10) This does not indicate that there was no cooperative effort before. As a matter of fact technology transfer in all its phases has long existed before the phrase was even coined. As far as education is concerned, there has been a variety of forms.

History:

Historically, cooperation in training and education have existed over a long period of time, and have followed a variety of forms. There have been instances where this training was conducted abroad for students to undergo advanced studies in the institutions of the advanced country. In other instances, foreign professors have been imported to the recipient country where they conduct the training of local students.
Also there have been shipboard training fellowships and joint research programs.

Training Abroad:

The first system of training, consisting of training students of local origin in the universities of the industrialized

nations differ among other things in duration and kind. Students are often accepted into institutions for formal academic training leading to a degree or a series of degrees in a marine science field of their choice. For example the Woods Hole Oceanographic Institution accepted 69 foreign students in the Institution's four main educational programs between 1968 and 1973.[11] These include students in the joint Ph. D. program in oceanography with MIT, the postdoctoral program (including some in Marine Policy and Ocean Management), the Summer Program, and special programs (which are generally a type of independent study project with one of the resident scientists).

Where the students follow a long-term course of study the program has been successful in providing the individual with a high level of education and under the proper circumstances, i.e. upon returning home, the student obtaining a job commensurate to his background and having the appropriate tools and equipment to work with, he would be able to hold his own with his counterparts in the industrialized nations. Such training and facilities as were provided to him in the industrialized nations institution could cause a break through in marine science in the student's country if it is tied to the needs of his country.

The problem in this case is that when students receive their education in the industrialized countries, they are generally put under the guidance of professors who at best might

be familiar with events in the developing countries only on an academic basis. In reality, they are not attuned to the most practical needs of these nations. The result is that students may receive the wrong emphasis in their training and are inculcated with knowledge that is often least relevant to their real needs. At the end of their training, what the institutions turn out is a group of semi-intellectuals who go back to form elitist classes (if they go back at all) in their own countries, totally out of touch with the realities of their environments. Gunar Myrdal said that, "Students so trained might just as well stay on in this country and swell the 'brain drain'. If they go home, they will either be unemployed or thanks to their 'connections' get administrative positions for which their education in the U.S. has not fitted them ...".(12)

Another problem that has to be contended with in this system of training the student abroad has to do with two factors. (i) The relevance of the curriculum, and (ii) the type of equipment to which the student is generally exposed.

The curriculum the student is usually subjected to is usually designed to meet the academic and practical needs of the student from the nation where the institution is situated. It does not reflect a conscious effort to incorporate subjects relevant to the foreign student based on an evaluation of what could be applicable to the foreign students home needs. I am not blaming the institution for this, the problem lies in the fact that the enrollment of a foreign student from a particular country cannot be predicted, thus it is impossible to prepare a separate curriculum on any given country on the basis of a

student's arrival from that country. Under the circumstances, the integrated system is the second best that is available. At least under this system, the nationals of the host country will study things that are relevant to their needs while the foreign national from the developing country will at least have the basic scientific facts which are universal.

The second problematic factor that has to be contended with is the type of material and equipment to which the student from the developing foreign country is exposed. He is in many cases taught with very sophisticated instruments that are highly expensive and rare. These instruments quite often are last seen upon the students' graduation for they are not available in his home laboratories if they have any laboratory at all. This generally leads to frustration and lethargy. The student fails to function as a scientist after spending a lot of his lifetime studying and a lot of money from whatever source which his nation cannot afford to waste.

These are accute problems in this system of training which call for drastic measures to improve the situation, and make this aspect of technology transfer a viable matter.

If institutions in the industrialized nations really wish to help developing countries to develop their marine science capabilities in this area of education and training, I would suggest that institutions in the industrialized countries encourage the establishment of regional departments that would specialize in the study of the marine scientific problems of the region of their

choice. The Latin American Oceanographic Center at Oregon State University could be used as an example.

At Oregon State University, the creation of a Latin American Oceanographic Center has attracted students from Latin America - Chile, Mexico, Peru, and Brazil. In addition at the time of Victor Neal's report,* they expected to have students from Ecuador and Venezuela. The students generally work for the M.S. degree in one of the special fields offered: Physical, Chemical, Biological and Geological Oceanography. At the time of Professor Neal's report, one student had completed the Ph. D. and several others were working for it.(13) Such programs clearly has great potential and could be beneficial both to the donor and recipient nations if well organized and coordinated.

The center need not be independent and isolated from other marine scientific departments. Rather it will remain in close contact with other parts of the institution and students participating in the regional center program will be required to take their basic science courses from the already existing departments of the institution. The center will be used only for specialized courses that have direct relevance to the study of marine science and the conduct of marine research in the area where the student came from. Each student when enrolled in the school will be expected through a contractual arrangement (written or assumed) to take some form of specialization on a regional or national basis. In fact I will advocate that the industrialized country

institution and the Government or an appropriate establishment in the student's home do the coordination for the selection of the students that might want to enter the program.

Also since at any large university or institution with marine scientific inclination there is a likelihood to find a sufficient number of scientists interested in any given region, it will not be too difficult to staff the center. Those scientists who are scientifically interested in the region could easily be located in the center providing them with research and teaching facilities. Another way of staffing the center, even though it will be a bit costlier, but quite ideal, is by bringing scientists from the countries within the region to the center and providing them with the necessary facilities to run the center with the supervision of the base university. They will then be encouraged, in fact required to periodically take their sabbatical to go back to their region to study and update their science with regard to the area. Students who might not only be foreign nationals of the countries of the region but also nationals of the host country that are interested in the region and allowed to participate in the program will be encouraged to join research cruises to the region. This will not only help the foreign country in the development of their marine science capability, it will also almost always ascertain the institution doing the research of an easy access to the coastal waters of the states within the region in an era of a consent regime for scientific research as

provided by the Law of the Sea Single Negotiating Text.[14] It will also allow a flow of information to and from both the recipient and donor nation. Psychologically, it will also make the recipient countries feel that they are also contributing to the overall effort rather than just being given handouts. I believe this will yield a very positive result with proper direction towards a well-defined long-term objective. In the event of a country requiring a particular research to be carried out off her coasts, students from that nation pursuing advanced degrees wherever possible should be set to the task under the supervision of an experienced professor. This will not disrupt their study plans, in fact it will be part of their field work training. To top it off, they will be encouraged to design whenever possible, low-cost instruments adaptable to their local needs. At the completion of their study period, the individual student would quite likely have an array of simple and cheap but effective sets of instruments which the institution under which he or she studied will allow him to take home with him at a low price - possibly paid for by his home government or whatever his home affiliation might be. Then upon returning home, not only would the problem of relevant and applicable education have been solved, but also the old complaint of not having the gadgetary with which the student was trained available at his home laboratory would be settled with the availability of instruments that were designed for and successfully tested and used by the student. This undoubtedly will go a long way to answering the

questions of appropriate technology in the technology transfer issue.

Training the student abroad in an industrialized nation has another phase with considerable potentials. This is the system of training that is conducted through the independent study project system. This is a part of the education process taken up at the Woods Hole Oceanographic Institution as mentioned earlier in this study. The system is based on the student working on a project of his own interest under the supervision of a resident scientist. It is worth encouraging such types of programs because it has advantages that could be beneficial to both sides of the transfer process. As far as I am concerned, all I can see in this type of program is meritorious on the condition that it is well planned and the student's interest well defined.

In planning the program, it is necessary for the industrialized country institution to have a framework with which programs like this can be effected. Essentially I am advocating that such programs be made institutional concern yet flexible enough to allow scientist-to-scientist arrangements. But such individual arrangements even though might not be impeded by the official hierarchy, will have to be reported to the institutional body officially responsible for the programs to be blessed. At the same time it will be an added ingredient if the authorities from where the student comes are made aware of the project so that easy working conditions will be made available to the student upon his return home. The reason why it is necessary

to make it an institutional affair is that with the backing of the institution the work of the student will be awarded a stronger recognition. It will also allow the student's home institution room to make modifications of the project if necessary. Modifications that might be useful both to the student as an individual and his community. It will also allow the host institution a chance to get information that otherwise might have been too expensive or difficult to get.

One merit of such a program is based on the fact that the student will work on a project that is of local significance at the same time of personal interest. This project would have been highly defined and possibly one that the student has worked on over a long period of time but need facilities that are not available to him in his local setting in order to complete his work satisfactorily.

Quite likely the student might have been able to collect data with the tools available to him at home but needs some other instruments to synthesize the data in order to come up with decent results. It could also stem from the lack of local experts in his line of interest who will be in a position to give him the proper guidance he needs. But once he has defined his objectives with possible local help, the student will then try to utilize these amenities that are available only in the industrialized country institution that will make these things available to him.

A program of this nature is worthy for its potential not only to benefit the student and his national need but at the

same time will have far-reaching effects on the students' supervisor as well as the host institution as a whole.

The program will undoubtedly help the supervisor to at least increase his knowledge on this particular problem which he most likely has not had the chance to look at closely, and will give him an added perspective on how local scientists view the problem.

Programs like this will make information available not only to the supervisor, but since it was made official, to the institution as well; information on a specific issue that might not even have been considered by the institution.

Finally, such a program will keep the student and thus his home counterparts aware of what has been done or not done in that subject. This could raise other side interests that could spill over into other scientific activities in his country. And with the proper incentive, it can lead nowhere else but towards more scientific curiosity and therefore more science and a growth towards a strong marine science capability in the developing country.

Exchange of Scientists and Joint Research Programs:

The transfer of technology, especially in the marine sciences can also be facilitated through the exchange of scientists and joint research programs.

The exchange of scientists like other areas in the educational sector of technology transfer process, has variations in duration and type. But one of the most common systems is a short-term visit from both sides of the project. A scientist from the developing nation would be invited to visit and tour the facilities of an industrialized country institution for a few weeks, and in return

a scientist from the advanced industrialized nation would visit his counterpart's country and possibly carry out one or two short projects in the local laboratories. There are two main problems in this area of cooperation: (i) the duration of the exchange is generally too short, and (ii) scientists from the developing countries are exposed usually to the wrong kind of materials.

Generally when scientists from advanced industrial countries go to less developed countries, they are there for an average of one to two years. This is a short time in any kind of development process, and is not usually enough to build a working foundation by learning the language and culture of the people and to plan their programs around such vital knowledge. Essentially, these scientists have to work to fulfil goals they had already formulated before arriving at their destination. Thus they work on areas or with methodologies that are of little significance to the locals. On the other hand, scientists coming from the less developed countries are usually given tours of institutions that are involved with dynamic and progressive scientific programs, whose characteristics are constant changes, innovation and inventions of technologies to conduct their sciences. This exposure leaves the visitor at the end of his tour to feel like he received antiquated knowledge. The material they see has no relation to the things they use at home.

It would have been more beneficial if these periods of visits were extended to a greater length of time and the scientists from the developing countries, in addition to whatever

relatively short-term projects they want to do, be given refresher courses in their fields and the new technologies being used in those fields. With regard to scientists from the advanced nations visiting the less developed countries laboratories, their visits should not necessarily be based on individual programs. Rather a series of individuals could participate in a mutually agreed upon, institutionally directed program over a long span of time. Simultaneously, locals would be trained to take over the programs when these scientists are through with their venture. Most effectively such a system will have greater impact if the cooperative effort is directed toward a specific problem. Such specificity will make matters easier to evaluate achievement and failures and besides, will give a more visible benefit than mere abstraction. Such types of programs can be successful and indeed have been successful as in the case of the one that took place between the University of Washington and the Catholic University of Valparaiso (UCV) in Chile.*

In 1967, funded by the Rockefeller Foundation, the University of Washington and UCV entered into a cooperative program for the general purpose of alleviating a number of interrelated problems in Chile. The major objective was to upgrade the fisheries and food technology program at UCV as rapidly as possible. To do this, a vital step of identifying the problems at UCV was taken. This process of problem identification was made cooperatively with UCV personnel rather than through the classical expert evaluation and reporting to UCV people what was wrong with

their institution without letting them have an input in the process. In their search they concluded that there were three basic problems to be contended with in order to achieve their objective. One problem they discovered was that the level of teaching was inadequate. Another problem was that the staff was also inadequate and that the few that were doing the actual teaching as faculty members were not trained well enough. A third discovery showed that there was a tremendous lack of effective technology for the effective exploitation of fisheries resources.[15]

To alleviate these problems, three developmental phases were taken. This developmental program was deliberately directed towards upgrading the fisheries and food technology program at UCV. In order to reach their objective, the task was divided into two general steps - to improve the academic and training level by increasing the competency of the teaching staff and improving on the University's infrastructure; and also to improve on the instrumentation aspect of the program. Even though these are two distinct steps, they overlapped in their implementation.

The first phase of the program constituted the training of five UCV faculty members at the University of Washington for six months. This period was spent between course work and direct experience with local fisheries. However it is worth noting that this training was planned so that it would have relevance to Chilean fisheries problem, especially as it is related to the UCV program and to the faculty member's area of expertise.

Then shortly after the first trainees returned to Chile, Dr. Liston went there for three months to help establish new courses and to teach these courses jointly with the newly trained faculty members. During this time also, Dr. Liston reviewed the entire curriculum of the school, helped to plan further changes and to see how the newly revised curriculum could be implemented. Eventually, three more University of Washington faculty members took three-month leaves of absence and went to UCV. Each of these carried out similar programs in his own area of specialization. In addition two University of Washington graduate students participated in the project. Most of the University of Washington people that went to Chile worked at a variety of levels which included, teaching of students, teaching and consulting with UCV faculty, giving seminars to all interested persons in the area, and performing simple research projects with both faculty and students.

Some of the UCV faculty were selected shortly after these initial activities were put into operation to undertake Master's Degree programs at the University of Washington.

The second phase of the program dealing with the instrumentation and equipping of UCV also got into full operation simultaneously with the training of the UCV faculty for their Master's Degree at the University of Washington.

Each Chilean that came to the University of Washington was given an allowance for books, small equipment, and thesis research costs. At the conclusion of his studies, he carried the books

and equipment back to Chile with him and thus was able to function there immediately in his newly-trained role. The thesis topics that they followed were made relevant to Chilean problems. In addition, faculty members from the University of Washington took books and equipment appropriate to their needs in Chile, even to the point of supplying some of the materials and small equipment for classes to be taught in Chile. According to L.S. Smith, "These kinds of purchases largely circumvented the worst equipment shortages there ...".[16] In conclusion, I will use Dr. Smiths' words to evaluate the success of the program:

> At the present time, seven years after its inception, a tally of the changes at UCV is impressive. The degree awarded to students graduating from the school has been upgraded from a two to a four year degree, making the degree equal to that of most of the engineers and similar professionals in Latin America. The faculty has more than doubled, and almost every faculty member has at least six-twelve months of specialized training beyond his basic four-year college degree. Well over half of the Fisheries and Food Science Faculty already have or soon will have Master's degrees. Other South American countries rank the school as the best in South America and are sending students to Chile for undergraduate training.[17]

Training Programs in the Recipient Country:

Most of the discussion was centered around programs centered in the institutions of the industrialized nations. That simply exemplified a single site out of two apparent locations. The other area where the education and training programs are to be located is in the recipient country. Without being able to locate the facilities or its desired products to the recipient country the process will stop short of being a legitimate transfer

process much less a successful one. Yet for this to happen as desired, certain conditions will have to be met. These conditions are included in the inclusive phrase - "Proper Infrastructure" will have to be established.

The Right Infrastructure:

When I make reference to building the proper infrastructure, I explicitly or implicitly include not only the putting up of buildings for educational purposes, but also building the right political climate, and the development of social attitudes to absorb a program of this nature.

The Political Climate:

The political climate of the country will have to be favorable to marine scientific development and has to be supportive of marine scientific educational programs which will be the basis of an active and dynamic progressive marine science program in the country. To begin with there should be a policy based on a scientific and rational evaluation of the critical importance of marine science and a realistic appraisal of the cost. Then a national commitment will have to be undertaken to achieve this, with the realization that it will not be easy as it has never been easy to be good at something. However to do this, politicians and policy makers must be sensitized to the values of the ocean sciences which has always been misconceived by most governments, especially governments of the developing countries, because,

> "... most of the decisions concerning marine science capability and marine resources exploitation are made by persons without proper knowledge of the problems.

> As a consequence, 1) marine sciences have not been considered with due priority; 2) poor planning (in educational, basic and applied research as well as technological development) and lack of continuity in programs occurs; 3) a notable shortage of well-trained personnel at the scientific level and of qualified technicians is present everywhere; 4) minimum efforts have been made for proper exploration and resource evaluation, and the necessary scientific background has been neglected, particularly in fisheries, without realizing that to create a scientific and technological capability is a long-term process which requires patience; and 5) a very small amount of funds has been invested." (18)

Therefore as Ross and Smith put it,

> The education of local scientists by training programs should, if possible, also reach administrators and politicians. The better they understand the benefits and shortcomings of marine science, the easier should be the development of marine science training and research institution within the country. (19)

I will emphasize that the availability of such programs not be conditional as Ross and Smith put it, but be made possible by making provisions for it in the budgets and national policies towards the development of marine science in the developing countries. Realistically, politicians with their busy schedules will not be able to participate in rigorous full-scale formal scientific training programs, but they should be in a position to occasionally participate in seminars and workshops set up to inform them of the nature of marine science, its values, progresses and failures made, plans for the future and its potential socio-political and economic impacts. However the administrators who act usually both as administrators and advisors should be given the opportunity to have a relatively indepth knowledge of the marine sciences through short-term training programs in marine affairs,

through long-term formal training for advanced degrees in marine policy or through the opportunity to carry out research within a marine scientific community on social, political and economic matters that are related to the ocean uses. With politicians and administrators exposed to marine science at this level of intensity, certainly it will not be hard to see a growth of interest in this area and hopefully will give this new science proper encouragement. This will also lead to a higher intensity of government involvement in science programs. Government involvement resulting from this level of consciousness and sensitivity generated by the training schemes for politicians and administrators as mentioned above would enhance the scientific and political systems to absorb a transfer product through educational and training programs. It will prompt government to set up rules and guidelines, standards, and other effective mechanisms for the training of local scientists. This way it will be easier to extract funds from the government for equipment including buildings, salaries for faculty, scholarships and other incentives for the students such as employment opportunities at the conclusion of one's studies. In essence there will be better planning both short term and long term with all the implications rationally calculated. In instances where governments had taken active roles in the education and training of local scientists, whether institutional, local or at a national level, the results have been commendable. For instance, at the University of Karachi

in Pakistan, there has been very little, if any, government support until the late 1960's. However, in 1970, recognizing the importance of marine science to the country, the Government of Pakistan agreed to help establish a center for advanced studies in marine biology at the University of Karachi. Even later, in 1973, they incorporated the project into federal plans to develop higher education and research in specialized fields. Now the center "... is reconstituted as a 'Centre of Excellence', and renamed the Institute of Marine Biology and is financed and supported fully by the Federal Ministry of Education".[20] In Brazil science activities have been in operation over a long period of time at least since the 1930's, but the major turning point occurred in 1951. At this time Brazil created the National Research Council, a federal organization that is analogous to the National Science Foundation in the United States. Through the awards of grants and fellowships in Brazil and abroad, the National Research Council made it possible for the start on further development of research groups all over Brazil. The National Research Council made it possible also for some institutions to establish graduate study programs. To make these new programs viable and to upgrade the standard of science in Brazil, the Commission for the Training of University Professors was created in the Ministry of Education and Culture shortly after the National Research Council came into operation. To uphold the standards of science and a high level of productivity, and to ensure that the investment was not wasted, the Brazilian Government set some very

high standards for the Education and Training of Scientists in Brazil. These standards were reached through rules which determined that "... only those degrees are valid which are awarded by an institution recognized by the Federal Council of Education, a body which consists of University Professors, Educators and other specialists interested in education and for research. This body is very strict and careful in recognizing graduate institutions, especially as far as institutions with 'Ph. D. rights' are concerned".(21)

I can only say that this has helped Brazil not only to be a leader in marine science among the developing countries, but in science in general. Brazil certainly is a case of success in the technology transfer process.

Finally, one other reason why governments involvement in the education and training of local scientists to meet the critical need of qualified marine scientists for the development of science, either applied or basic, if the two can be differentiated, is the need for planning to have a successful program. As Cox put it, "...now there appears the phenomenon of unemployed technical graduates, plus a 'brain drain' of scientific specialists and technicians from underdeveloped to industrialized countries".(22) To meet this challenge careful planning is necessary and there is no one who could do a better job at it but the national government since in the developing countries, the governments are the main employers. Therefore in the national policies towards marine

science and technology, and the training of scientists and technicians, should be incorporated through a systematic and growing employment policy for graduating scientists through the creation of jobs and work conditions that will utilize the educational background of the young graduates. It is only this way that these problems will be avoided and attitudes changed to a more positive outlook.

Social Attitudes:

"One explanation long popular is that education is of the wrong kind, having a literary and legal bias when technical graduates are needed".[23] This was simply a reflection of the priorities of the times. There was need to develop a mass of administrators in the developing countries to replace the departing colonial administrators with local people. However this priority has changed over the years with more emphasis on technical and economic development, and education is to some extent being directed towards this area. In fact this is what has led to the call for the transfer of technology in general. However the old attitudes that were developed along with the previous educational priorities still prevail.

Still fresh in the minds of the locals soon after independence was gained, was the image of the colonial expatriate who lived in bungalows and very special quarters far more comfortable than the dilapidated houses of the indigenous people. The colonial administrators being seen receiving monthly salaries

that most of the local people could not earn in at least a year and generally seeing this foreigner having a much better standard of living because among other things he has had a better education, it is no wonder then those locals who had the opportunity to receive good education tried to emulate their colonial counterparts and perpetuate a club whose aim is to preserve the interest of its members without much regard for the nation. And even though the educational directors have been changed, these attitudes have not been changed. The educated elite have tasted the way of life their colonial predecessors had lived on and are determined to cling on to it without doing much work. The result is that whatever economic benefits accrue, it goes to only a handful of people leaving the mass of people struggling to survive. But now that there is a call for technology transfer in the marine sciences in particular, for economic development, attitudes will have to be changed for the process to be successful. The reason is that "An important variable between education and economic growth is attitudes - toward work, toward what constitutes fair rewards, and toward the future of the nation and the individual's identification with it. Education without any change of the economic environment does not change attitudes ...". (24)

With the new priorities for modernization and economic development, a new set of attitudes - positive attitudes toward work must be developed by the people. At the same time government policies and attitudes must incorporate the creation of

suitable job opportunities for those who are going to be trained as marine scientists and technicians in the process of transferring technology and developing marine scientific and technological capabilities in the developing nations. At the same time the educated elites of the developing countries must cease comparing rewards they can get for their jobs in their countries to the pay they expect to get if they work in industrialized nations. One thing must be realized, that is the level of remuneration in the developing nations is based on the cost of living there which is much less than that of the industrialized nations. However, the salaries these educated elites will receive should enable them to live at a level proportionally comparable to how they would have lived in the industrialized nations.

Finally, in changing their attitudes, the elites in the developing nations must try to identify themselves with the problems and needs of their nations rather than seeking personal agrandissement. This is not only for the nation, but for their own interest. If they fail to be concerned with their nations, they will undoubtedly not survive too long. Their education and privileges will end up with their becoming victims of dysfunction and destabilization.

Therefore the education and training of marine scientists and technicians in the technology transfer process must be carried out with the new set of attitude or simultaneously with the changing of attitudes to a more positive outlook. But if by and large, the education and training of marine scientists and technicians in the transfer process "... functions so as to maintain

prevailing value-patterns and the existing social structure, educational expansion creates dysfunction".[25]

Increased University Role:

The development of marine scientific capabilities through the educational aspect of technology transfer should be instituted in the universities of the recipient countries. "Educational programs instituted in recipient universities or incorporated in the transfer program itself may assist the recipient country to develop the institutional and social flexibility and adaptability that would facilitate implantation of 'ready-made' technology over a historically speaking, compressed time period."[26] It is therefore crucial that developing countries incorporate as part of the transfer package the establishment of marine science centers in their universities. Fortunately the universities have been the focus of national marine science activities and will probably offer the most suitable environments for the absorbtion and adaptation of the new technologies to be transferred as well as for educating and training local scientists and marine technicians. Therefore, now that the interests of nations in the oceans is growing, the role of the Universities must also expand. "The Universities are the fountain heads of all academic, fundamental and advanced research activities. Each developing country must develop centers of advanced study in marine sciences, particularly in coastal institutions, provided with facilities for fundamental and advanced research. Such centers can provide

specialized training and can develop research capabilities among the young talented scientists to meet the requirements of the country."(27) This is however a point at which very careful planning and evaluation of what the needs and priorities of particular individual countries are in setting up these centers. Such planning and evaluation will take into account the fact that most of these nations that are going to be the recipients of the transfer product have different levels of marine scientific and technological capabilities. There should be questions such as, what area of marine science a nation wants to develop - applied and resource related - fisheries, petroleum aquaculture etc. or fundamental science, and whether they want to develop only one aspect of the marine science package - Physical Oceanography, Biological Oceanography, Chemical Oceanography or any one area of oceanographic science activities? Then on the basis of these and other factors of evaluation, assuming that other social, economic and political evaluations have been undertaken, must the transfer process of establishing marine science institution in recipient nations be established.

Establishing National Marine Science Centers:

Since the universities will be increasing their role as mentioned earlier, the new marine science centers will necessarily have to be based within the university infrastructure where universities exist. This will reduce the cost and need for new buildings as well as equipment that is necessary for the training of the students. For example the necessity of having to buy

laboratory equipment for the use of students who would be taking the basic sciences prior to specialization will be cut down since they will be required to make use of those facilities that are already available within the university systems. For those nations without universities three things must be done. (1) They will have to establish marine science centers in their countries to receive the transfer product. (2) They will have to send their trainees abroad for training, at least during the initial phase of their marine science development programs. For economic reasons the training of these students should be done in their neighboring countries' institutions. (3) They must utilize the facilities of the regional marine institutions to their utmost possible (regional centers will be dealt with after this section). And if the regional centers are successful, maybe there will be no need for national marine centers at least for the poorer nations.

The assumption up to this point has been that these nations do not have marine science activities or established institutions. However, certain nations, in fact many of the developing nations, do have marine science institutions and are actively engaged in marine scientific activities. However, occasionally there is a lack of strength or a total absence of one of the areas of marine science. For example, they might be weak in the area of geology and geophysics and would like to develop their capability in this area possibly for practical and economic reason such as being able to extract petroleum off their continental shelf. Whatever the need, the establishment or strengthening of such a

department will be vital to their national needs and a transfer of technology in that area will be useful for both their short-term and long-term needs.

On other occasions, countries might have very specific problems that they might want to solve. These problems are invariably applied in nature and are largely relatively short term in form. For example there might be a desire to improve the local fisheries technology. These certainly do not necessarily need the establishment of a center for fisheries technology for the short term. However to sustain this technology over a long period of time, it will be necessary to establish a center to learn fish population dynamics, fisheries biology and the physical, chemical and other oceanographic factors that influence the movement and changes of fish life and the necessary technological changes to maintain an optimum or maximum sustainable yield in fisheries. At this point, one might observe that many of these nations will not be able to establish these marine centers for lack of adequate funds and or human resources. And in that case it is worth while to consider the concept of regional marine science institutions. "While political realities (intra-regional rivalries and intra-national competition for sources of funds by existing marine science institutions) reduce the likelihood of such an institution being established in the near future, the regional institute concept certainly merits further consideration."(28)

Regional Centers:

The concept of regional centers to be established for the development of marine science capabilities in the developing

countries is gaining increasing popularity. It is embodied in the informal negotiating texts of the Third United Nations Conference on the Law of the Sea.[29] It received considerable attention at the Bologna Conference in 1973,[30] and has been a subject of considerable discussion. Even though the concept has been questioned on political reasoning, it embodied elements of hope and success. The creation of regional centers is viable because of certain inherent advantages - but advantages which could be realized only after certain conditions have been met in the establishment of the centers.

The centers will have to be set up based on a functional approach minus the aim for an eventual political integration. Short of a spill over into the political field, functionalism will be a suitable form of cooperation through the regional centers since it will refrain from undermining the sense of nationalism among the members of the region. Functionilists believe in working for cooperative solutions to social and economic problems. "The functional approach is, in general, perfectly compatible with the continued existence of the nation state since it calls for no more than cooperative solutions to common problems."[31] With that kind of approach - restraint on the political forces, the centers could be successfully established under certain other conditions:

The centers must be established according to the "Common Heritage" concept and well administered to carry out their functions neutrally and effectively.

The centers must not necessarily be used to replace already existing national institutions; rather, they should complement the national institutions and help to strengthen them. In addition the centers could help develop national institutions where they do not exist within the region.[32] If such guidelines are followed the centers would most likely avert the kind of political problems that skeptics fear would impinge on the viability of the regional centers. In addition the setting up of such regional institutions will undoubtedly generate certain advantages.

The centers will be able to attract financial support from funding agencies more easily than would several small individual national institutions.

Members of the region will be assured of a very high level of services from the centers for a significantly smaller financial contribution than that which would be required for a national institution.

There would be a bigger talent pool to select from than a national community would be able to offer its individual institution.[33] In essence,

> Such an institute would ... utilize the combined resources of the region's governments to purchase expensive equipment and support a broad-based marine research program. In this way countries which otherwise would not have had sufficient funds to establish a large marine science capability would share in the institute's general research and training benefits, and also utilize the institute for specific projects of national concern -- all for a fraction of the institute's total cost.[34]

Setting up the Centers:

The site of the regional center must be decided by a conference of scientists from the region. Such a decision must however be based on very rational scientific calculations. Yet, born in mind, must be the spirit of cooperation and a desire to free the center from political competition. Therefore the coastal nation in the region with the least military and economic strength should be seriously considered to be the site of the center. This will ensure little internal political meddling with the center. At the same time it will be a guarantee for a neutral and effective functioning of the center. In addition the center will help in the national economy of this little nation by providing jobs for the locals in the unskilled sector of running the institution. The center will also provide new revenues to the country through taxation (this country's tax system would most likely be more acceptable in the area).

Initially few national scientists from the region will have to be seconded to the center to get it started by conducting basic research with the help of foreign scientists familiar with problems of the area. They will gather information by collecting and coordinating what information of the area already exists and at the same time getting primary information through research activities. This pioneer group will also be responsible for the basic administration of the center. While this is being carried out more scientists will be undergoing training within the national institutions of the region and abroad in order to return and

assume roles as both educators and researchers for the area. On the basis of the newly collected information, and newly-trained scientists, a curriculum for the education and training of local scientists, and a timetable of research activities will be set up with enough flexibility to be able to absorb new specializations, changes and specific national demands from the center.

Among all the various departments of the center there must be an extention department made up of scientists and administrators trained in marine policy matters for comprehensive and objective evaluation of projects.

Training Scientists in the National and Regional Institutions:

With the institutions set up, a crucial problem now is how to train local scientists in both the national institutions as well as in the regional institutions.

In the past, according to David Ross and Leah Smith, the most common method of training oceanographers had been to obtain basic training and then specializing in one of the natural sciences. Later on during one's career, to become interested in applying that specialty in the marine field. Therefore they suggest that one method which is not commonly used but does have a considerable potential is to re-train scientists from other fields to do oceanographic work.(35)

National Institutions:

The educational and training programs in the national institutions will undoubtedly overlap with that of the regional centers. But the two programs need not be competitive, rather they

must be complementary to each other. In the national centers, training will be directed towards solving those problems that are local. In a general way it will be directed mainly towards applied science and must include in addition to the scientists technical people as well as other users of the coastal water such as fishermen. The training of these people must be centered around a well-defined curriculum based on the needs and problems of the nation.

The Regional Institutions:

On the other hand, the regional institutions must train their scientists and technicians with a regional perspective. The training program in the regional centers will be more diverse and will encompass a greater degree of basic training. Yet these regional training programs will not fail to reflect, in fact will emphasize the overall regional needs. In the event that a student desires to specialize in an applied field related to a given national area, he could be sent to that nation's institution to work on his area of interest after completing his basic advanced studies in the regional center. This should not prove difficult because the assumption here is that there will be intensive cooperation between the regional and national institutions.

Summary and Conclusion:

Education is a fundamental necessity to sustain the dynamic processes of modernization and a basis for a genuine independence.

° Education will probably provide the best opportunity for technology transfer because it is one of the areas of converging interests among developing and developed countries' scientists.

° In the developing countries, education in the marine areas is needed desperately to understand the marine environment which will enhance scientific and rational uses of the oceans and a beneficial exploitation of the ocean resources.

° Cooperation in education and training has been in existence over a long period of time. However little of this has had any significant positive impact on the developing nations. This is because the methods utilized were faulty for various reasons.

° To rectify this, new systems of training must be generated. Systems that will reflect the needs of the developing nations as perceived by them and must be undertaken cooperatively both abroad and at home. This new system of cooperation will need the creation of new set-ups in the industrialized countries' institutions and in the developing countries.

° In the developing countries, an infrastructure capable of absorbing and adopting the transfer products must be created. The political climate and social attitudes must be compatible with the development of marine scientific and technological capabilities.

° Finally, the establishment of marine regional institutions merits serious consideration for economic and scientific efficiency.

FOOTNOTES

1) Marta Vannuci. "What Has and Hasn't Been Successful In Past and Present Efforts To Increase Marine Science Capabilities In Latin American Countries." In Report of the Marine Science Workshop, Bologna, 15-19 Oct. 1973, Washington D.C.: Johns Hopkins University School of Advanced International Studies. p. 23.

2) Robert W. Cox. "Education for Development" in The Global Partnership:International Agencies & Economic Development", Edited by Richard N. Gardner and Max F. Millikan. New York: Frederick A. Praeger, 1963, p. 310.

3) J. Liston and L. Smith. Fishing and the Fishing Industry - An Account With Comments on Overseas Technology Transfer. (MIT Sea Grant Report under Contract No. 81713, 1974).

4) ibid p. 66.

5) David A. Ross and Leah J. Smith. "Training and Technical Assistance in Marine Science - A Viable Transfer Product". Ocean Development and International Law Journal, vol. 2 No. 3 1974 p. 231.

6) If the LOS conference decides on a 200-mile limit, and this is likely, coastal waters will be less accessible to scientists of foreign nations. (See The Columbus O'Donnell Iselin Memorial Lecture, entitled Ocean Policy and Scientific Freedom, delivered by Paul M. Fye on Sept. 11, 1972 to the Marine Technology Society). In addition, the establishment of an international regime for waters beyond national jurisdiction will certainly not be free of restrictions against researchers.

7) Jean-Louis Marsard. The Transfer of Technology in the Marine Science. U.N. Document SC-75/CONF. 208/Col. 22, 22 Oct. 1975. pp. 11-12.

8) Report of the Marine Science Workshop Op. cit. p. 3.

9) A conservation with Dr. Idoniboye-Obu, Professor of Marine Biology at School of Science and Technology in Port Harcourt who is currently associated with the MBL at Woods Hole.

10) David Ross & Leah J. Smith, Marine Technology Transfer Product - Marine Science (MIT Sea Grant Project under contract No. 81713, 1974).

11) David A. Ross, Cooperative Research Programs at Woods Hole Oceanographic Institution. In "U.S. Marine Scientific Research Assistance to Foreign States," - Proceedings of a Conference; 2nd edition. Published by the National Academy of Sciences, 1975.

12) Gunar Myrdal, "The Transfer of Technology to Underdeveloped Countries". Scientific America September 1974.

13) ibid.

14) United Nations Document, A/conf. 62/WP.8/Rev. 1/Parts I, II, & III. 6 May, 1976.

* A Cooperative Training Program Between The University of Washington and The Catholic University of Valparaiso. A paper presented by Lynwood S. Smith at the Conference on "U.S. Marine Scientific Research Assistance to Foreign States", op. cit.

15) ibid.

16) ibid.

17) ibid.

18) A. Ayala-Castonares, The Enhancement of Marine Science Capabilities Future Direction. In the Bologna Report op. cit. p. 63.

19) David Ross & Leah Smith. Marine Technology Transfer Product - Marine Science in MIT Sea Grant Project op. cit. p. 46.

20) Syed M. Haq. Development of Marine Science Capabilities In Asian Countries With Particular Reference to Pakistan, in the Bologna Report, op. cit.

21) Gerhard Jacob, Scientific Training In Brazil. A paper presented at the AAAs meeting in Boston Feb. 18-24, 1976.

22) Robert W. Cox, "Education For Development" in The Global Partnership. Edited by Richard N. Gardner and Max F. Millikan, Fredrick A. Praeger, published, New York, 1968.

23) ibid.

24) ibid.

25) ibid.

26) Karl-Heinz Szekielda. Aspects of The Transfer of Marine Technology To Developing Countries. Ocean Economics and Technology Office, Department of Economic and Social Affairs. United Nations, New York.

27) Syed M. Haq. Development of Marine Science Capabilities In Asian Countries With Particular Reference To Pakistan. Op. cit. p. 56.

28) Report of the Marine Science Workshop. ibid, pp 8-9.

29) UN Document. Op. cit.

30) See Report of the Marine Science Workshop. Op. cit. pp. 8-9.

31) Lindberg, Leon N. and Scheingold, Stuart A. Europe's Would-be Polity:Patterns of Change in the European Community. Prentice Hall, Inc., New Jersey 1970.

32) Sarr M. Lamin. "The Viability of Regional Centers for Marine Science and Technology Development." Neptune (in print).

33) ibid.

34) Report of the Marine Science Workshop. Op. cit.

35) Ross David and Leah Smith. "Training and Technical Assistance in Marine Science - A Viable Transfer Product." Op. cit. p. 223.

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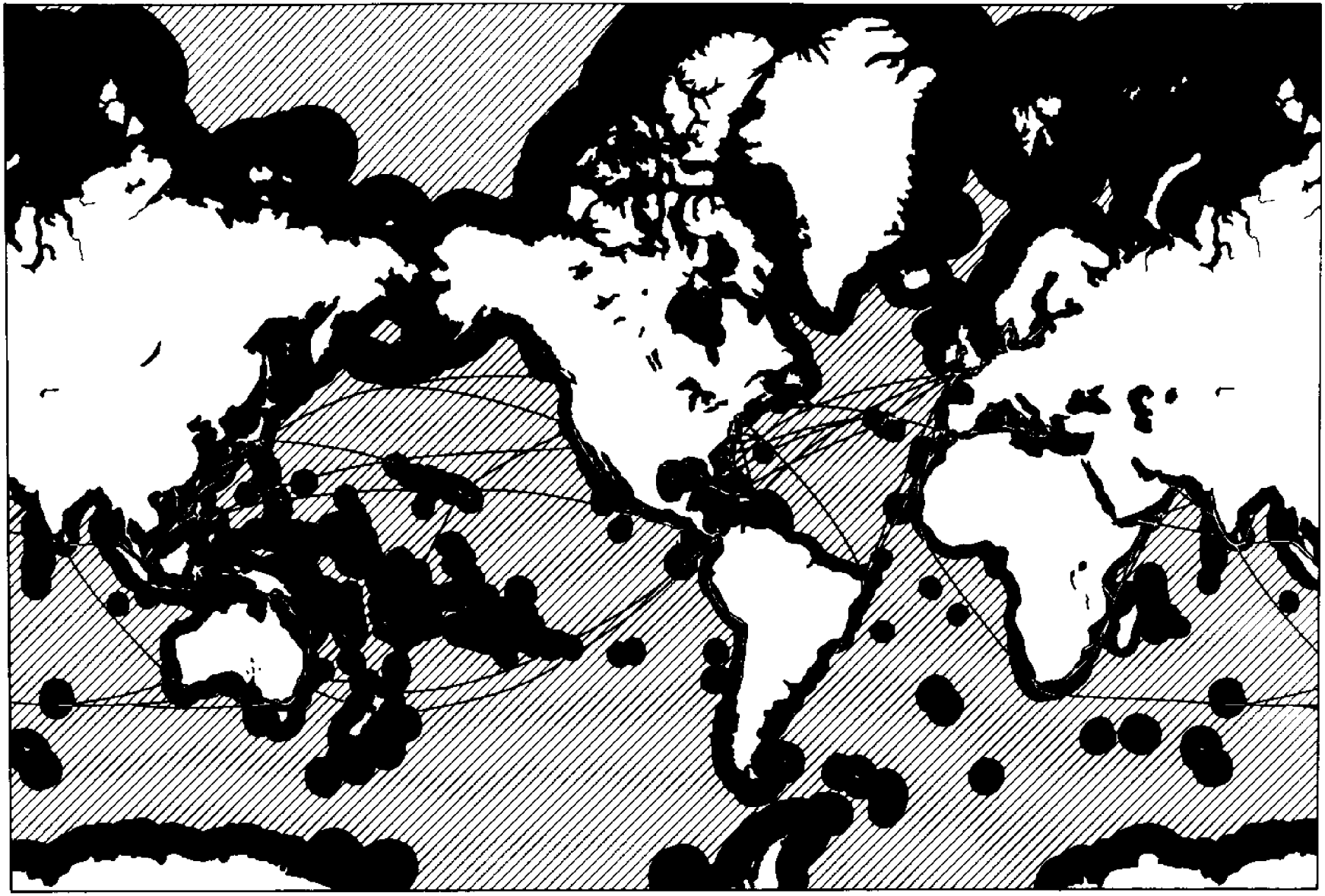
Table 1



Hypothetical 200 n.m. area

Subject to International Seabed Authority

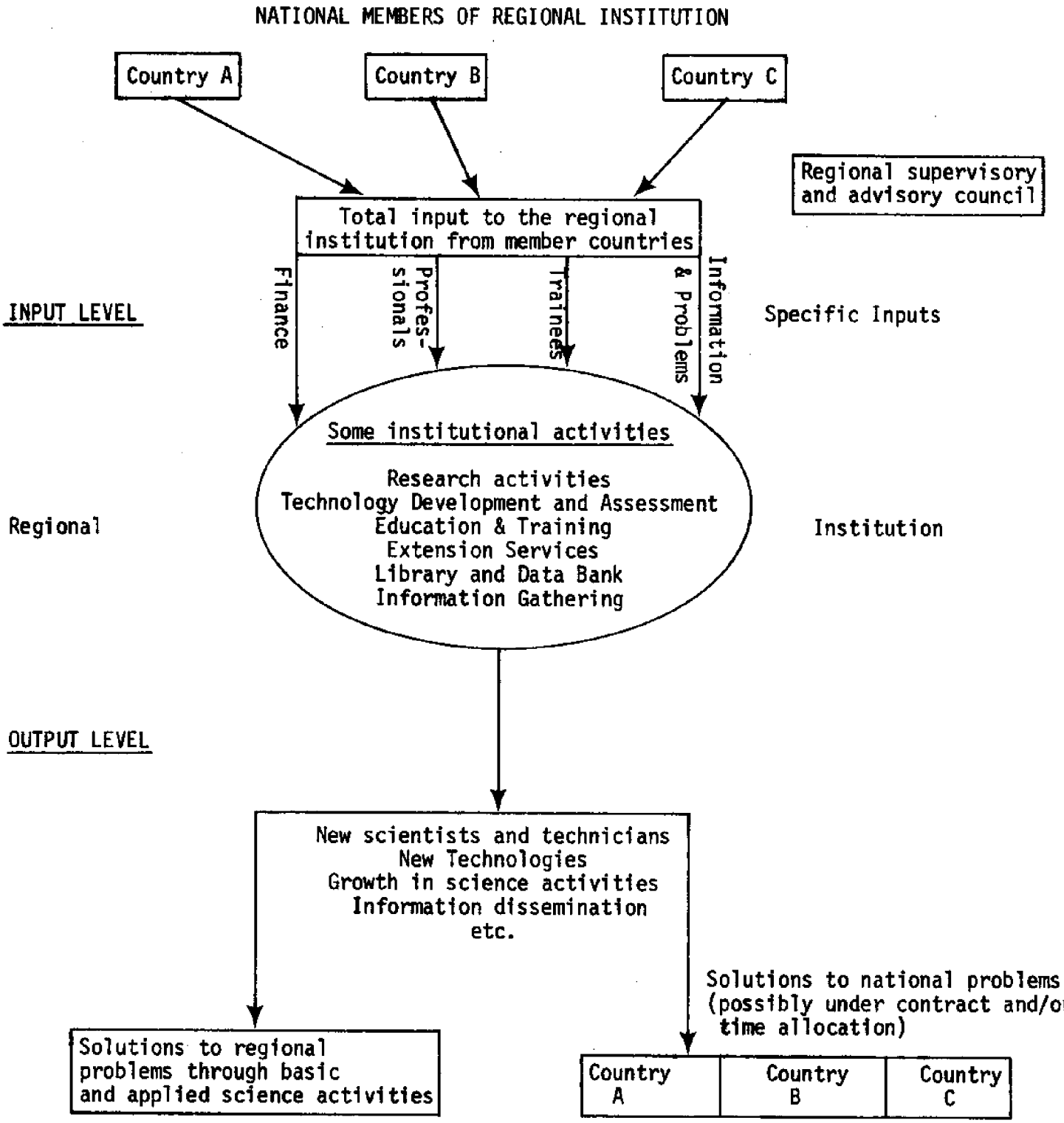
Major sea lane

THIS CHART SHOWS, FOR DEMONSTRATION PURPOSES, MAJOR SHIPPING ROUTES AND THEIR RELATIONSHIP TO A HYPOTHETICAL 200 NAUTICAL MILE AREA. IN ADDITION IT SHOWS WHAT COULD BE SUBJECTED TO THE INTERNATIONAL SEABED AUTHORITY.

(Adapted from Ocean Pollution Factor map. Office of the Geographer, Department of State.)

TABLE 2

INPUT-OUTPUT SYSTEMS OF THE PROPOSED REGIONAL INSTITUTIONS FOR MARINE SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT



A Partial List of Possible Funding Sources For Marine Technology Transfer Projects

Inter Governmental Oceanographic Commission

Organization of Economic Cooperation and Development

International Bank For Reconstruction and Development

United Nations Development Program

The European Development Fund

The European Investment Bank

The Interamerican Development Bank

The Central American Bank for Economic Integration

The Asian Development Bank

The African Development Bank

The World Bank

United Nations Educational, Scientific and Cultural Organization

The Food and Agricultural Organization

International Finance Corporation

The International Monetary Fund

International Development Association

United Nations Environmental Program

The United States Agency For International Development

The Ford Foundation

The Rockerfeller Foundation

Some U.S. Institutions That Would Most Likely Participate In International Marine Cooperative Programs

The Woods Hole Oceanographic Institution

Lamont-Doherty Geological Observatory

University of Alaska

Scripps Institute of Oceanography

Duke University

University of Miami

Oregon State University

University of Rhode Island

Texas A&M University

University of Washington