PACIFIC ISLAND NATIONS: THE WAVE OF THE FUTURE

Ursula Miller-Eisenpress
March 1995

INTRODUCTION

All developing nations are attempting to raise the standard of living for their people through economic development. In the Pacific, unique geography offers challenges to traditional development approaches. Economic plans that have been used to address the needs of countries that have populations in the millions and huge land masses simply are not transferable to many of the Pacific Island Nations (PIN). For PIN to attempt to compete head to head with countries endowed with abundant landbased resources is a paradigm that has had marginal success and should be reconsidered. The vision of the future must turn to the sea where PIN nations have an abundance of resources which will be increasingly profitable in the Twenty-First Century. Advances in marine technologies will industrialize oceans around the world and PIN can position themselves to be strategic to these industries.

One of the most significant marine technologies is Ocean Thermal Energy Conversion (OTEC). OTEC is a multifaceted technology that can support the development of small and large land based industrial plants as well as small and large ocean going industrial plants. The PINs are the quintessential location for this technology which relies on temperature differentials that are abundant in the Pacific. OTEC energy plants can range from small 40 MW plants to large ones with a capacity of 400 MW. Plants can be designed to simply pump up cold sea water or just produce fresh water. OTEC plants can be multipurpose systems that deliver cold sea water for air conditioning, aquaculture, the generation of electricity, the production of fresh water or all the foregoing. Some of these choices have already been successfully implemented while others are still at very experimental stages. This paper asserts that the PIN are capable of steering their growth toward the future industrialization of the ocean by preparing for this eventuality. Part 1 reviews the assets and liabilities of the Pacific today and answers the question "Why ocean resources?" Part 2 discusses available ocean resources and foreseeable ocean industries. Part 3 considers the importance of technology and its transference to developing nations.

While there is no panacea for all that ails the PIN, OTEC has the potential to help all PIN prosper regardless of their geography. OTEC technology promises to bring basic technological services to the remotest of sites as well as provide employment. OTEC can also provide the larger metropolitan cities with the option of building moderate or large scale industries for urban populations. By taking the development path to the sea, all PIN will have the potential to meet the primary needs of their populations as well as some of their aspirations. The following quote refers only to Polynesia and Micronesia but the sentiment is appropriate for all island nations who are on this path and it proposes an alternative approach to their future.

> Pacific Island people will never be able to become self-supporting or to achieve a satisfying life in the modern world by following present economic policies...Greater potential obstacles are the fact that solar and sea-based development has never been proposed as a model to developing island countries by donors or by intergovernmental organization, and that endogenous scientific and technical capabilities are almost totally lacking. Basic reorientation of the educational system is required to remedy this latter deficiency and this, in turn, is unlikely to be feasible until Pacific island people once

again acquire a deep consciousness of the role that the ocean plays, and can play, in their lives and their future.

All this requires a veritable revolution in perceptions and new and imaginative approaches to the problem of development. It may well be doubted whether this can be a realistic expectation. Yet the attempt should be made for the small, weak, but strategically located states of Micronesia and Polynesia that have now obtained legal control over enormous potential resources vital to the Western World. If we do not aid them to develop these resources, others will. (Gopalakrishnan 1984: 11).

PART 1
LIABILITIES AND ASSETS OF PACIFIC ISLAND NATIONS TODAY

LIABILITIES

Geography

Photos taken of the Pacific from space show a massive ocean that is surrounded by large continental masses. What cannot be seen in these photos are the multiple islands strewn throughout this ocean. It is only from a telescopic view that PIN begin to emerge as infinitesimal dots on the ocean landscape. This view illuminates the unique characteristics of the region and conclusions can begin to emerge regarding these islands that are subsumed in the ocean expanse. First, PIN are situated in a huge expanse of water which isolates them from continents as well as each other. The Pacific covers 29 million square km of sea area which is analogous to the size of Africa (Mackensen & Hinrichsen 1984: 4). This vastness is characterized by great distance between continental land masses. From the Bering Strait to the Antarctic Circle are 14,839 km, from Ecuador to Indonesia there are 16,774 km and from Singapore to Panama there are 19,839 km (Fosberg 1987: 2). The Island states themselves are strewn from the Tropic of Cancer to the Tropic of Capricorn. "The distance from the Northern Marianna Islands to French Polynesia, the two most extreme points is 10,000 km (Fairbairn 1987: 2)." Second, the Pacific contains more islands than all the other oceans combined, but their actual land mass is very small and unevenly distributed between PIN. There are .53 million square km of land in the Pacific. Papua New

Guinea accounts for 88 percent of that total and the Solomon Islands, Fiji and Vanuatu occupy 63 percent of the remaining land area (Cole & Tambunlertchai 1993: 219). Given that there are twenty- two PIN, these statistics indicate that the remaining eighteen island states occupy a mere 24,420 square km or 4.4 percent of the Pacific's land area. Third, the ocean affects these islands even within their autonomous states. All PIN are archipelagic except Niue and Nauru. Archipelagic states which are composed of multiple islands means some islands are isolated even within the boundaries of their respective nations. An extreme example of this is Kiribati which is composed of thirty- three atolls over an expanse of 3.5 million square km.(Fairbairn 1987: 2). The sea and its immensity are defining characteristics of the Pacific while isolation and dispersion are the consequence of this feature.

When islands are categorized by geological type, different development options are evident. There are three main types of island formations: continental, volcanic and coral atolls. Each has distinct features which dictate available terrestrial resources. Roughly half of the islands are made of coral atolls and typically fall to the east of the geological demarcation called the "andesite line". It separates islands in the west Pacific that are continental, from the islands to the east of the line, which have evolved primarily from volcanic activity. The "andesite line" represents an economic division between continental islands which have more land-based resources than oceanic islands that are less well endowed. Papua New Guinea and the Soloman Islands are primary examples of continental islands. They have large land masses suitable for large scale development options in forestry, agriculture, mining and industrialization. At the opposite end of the continuum are what the United Nations calls the "geographically disadvantaged developing island countries". The latter are characterized by extremely small land masses, poor soils and scarce rainfall. Kiribati and Tuvalu are good examples. Between these two extremes there is a range of volcanic islands whose resources are dictated by their size and geological features.

The vast difference between the islands is important because their geological diversity precludes any sweeping approaches to PIN development. The atolls and small islands with their extremely limited land resources present economic challenges that are not easily addressed by traditional approaches. The development of complex industrial manufacturing sectors on Kiribati for example would not be appropriate or even possible. On the other hand, PIN that are more generously endowed with land resources may easily conform to traditional approaches of development. In contrast, Papua New Guinea with its ample land mass and population of several million has begun to establish large industrial sectors.

The prevalence of tropical storms must be factored into any plans for the Pacific. By far, the most significant of these are the typhoons. In his article "Biogeographical Aspects of Isolation in the Pacific" Dahl points out the negative impact of climatic conditions. He states: "Other extreme climatic conditions can also be significant limiting factors. Cyclonic storms or hurricanes (typhoons in the North Pacific) can have a catastrophic effect on island fauna and flora, flattening forests and carrying birds out to sea to their destruction (1984: 302)." Kakazu also notes the negative impact of weather conditions. "The dependency on a few export products and markets not only makes these island economies vulnerable to the fluctuations of world markets, but they are also susceptible to natural hazards such as cyclones, floods, droughts and diseases as well as tidal waves (1984: 19)." Many PIN have seen their hard earned development efforts destroyed in a matter of hours.

Another geographical feature of islands is their fragile ecologies. An abundance of rare speciation has occurred in both flora and fauna of Pacific Islands due to isolation and geographical diversity. Both are particularly sensitive to the human activities of urbanization, development, and over-population. While large continental masses can withstand such pressures for longer periods of times, the small islands of the Pacific have already begun to be alarmed by the degradation of their environment.

In summary, geographical features such as fragile ecologies, adverse weather patterns and limited land-based resources are the context in which development activities occur in the Pacific. They have influenced how humans have adapted to these environments and they will shape what their future courses will be.

Demographics

The first aspect of demography that must be considered is population size. Relative to other developing countries, Pacific Island States have populations that range from micro (< 25,000 pop.) to small (> 250,000 pop.)(Shand 1979:11). The total population of the area is 5.3 million people. With its 3.5 million people, Papua New Guinea has 68% of the area's total population. The rest of the Melanesian islands account for 23% of the remaining population (Cole & Tambunlertchai 1993: 218). Only 9% of the Pacific's population is found in Polynesia and Micronesia. This wide range in the size of populations requires that development options be customized for each nation. All the islands, whether micro or small in population must also deal with the pressures of changing demographies.

Rapid urbanization is one of the greatest changes faced by PIN nations. Real and perceived economic opportunities in the urban areas are some of the major reasons for the drift of populations to urban centers in the region and foreign metropolitan areas. Migration to cities has resulted in serious social, health, and economic problems due to the lack of necessary infrastructures needed to support these increased concentrations of populations. Logically, as the urban areas experience unprecedented growth, rural areas are becoming depopulated. As a consequence, government development plans for rural areas are stymied by the lack of labor. Inadequate economic activity in the rural areas further contributes to out-migration. Out-migration to foreign metropolitan cities has also influenced economic development. This trend has become so extensive that for some countries more of their people reside outside of their country than within its borders. For example, "More Tokelau, Pitcairn, Cook, Niue and American Samoans live outside of their country than within (Connell 1984: 307)." These populations influence issues such as remittances, brain drain and depopulation.

Population densities vary greatly among PIN and have different impacts on the quality of life. Typically, the larger a country's land area, the lower its population density. Concurrently, the smaller the land area, the higher the population density. Some PIN are dealing with extremely high density rates such as those in Micronesia with an average of one hundred twenty people per square kilometer, Polynesia nations also have high densities with an average of seventy people per square kilometer. In vivid contrast, Melanesia has only eight people per square kilometers on average. These statistics can be compared to the world average of thirty people per square kilometers. (Global Community Forum 1987: 2).

Population growth is also of concern. The region as a whole has a growth rate of 1.9% a year (Fairbairn 1987: 5). This is considered a very high level by international standards. Increased growth rate has also resulted in a very high percentage of youth. In many countries, workers find themselves with large numbers of dependents to support. For the area as a whole "between one-third and a half of the population are younger that 15 years of age (Cole & Tambunlertchai 1993: 220)." This situation can cause serious social as well as economic consequences .

While PIN governments are faced with increasingly youthful populations, some have insufficient adult populations for labor intensive industries. Governments find themselves with adequate natural resources for a development plan but inadequate human resources for implementation. As a consequence, both in the past and present, some countries have relied on imported labor which in turn has created problems of its own.

Island governments also find themselves unable to train their people because it is not economically feasible. Small population size precludes the development of on-site educational facilities forcing workers to go out of country at their personal expense or that of the government. Unfortunately, when students leave the islands for further education or training, it is not unusual for them to remain abroad. Thus island governments often make substantial investments only to be robbed by a brain drain. This results in a shortage of local technical skills for PIN who must then import expatriate workers.

In summary, demographic issues such as urbanization, population density, population growth, depopulation of rural areas, imported labor, brain drain and youthful populations present challenges for PIN. All influence the quality of life for islanders and influence their futures.

Economics

The economies of PIN are very diverse, and most have to deal with economic variables such as foreign aid, remittances, and trade deficits. Such factors exert tremendous influence on the budgets and development options of island states.

Foreign aid has helped to meet budgetary requirements as well as support specific projects. In his paper "Pacific Island Economies: Development Issues and Growth Possibilities" Fairbain states: "Official development assistance (ODA), both bilateral and multilateral, flowing into the region is estimated at $1,200 million (1985) or approximately $150 per capita, making the South Pacific one of the most heavily assisted regions in the world (1987: 12)." As this quotation indicates, foreign aid in the Pacific is a significant economic factor. Typically, the PIN receive assistance from their former colonial governments. On the average, 40% of the total government revenue is from aid. For some of the smaller islands, such as the Cook Islands and Western Samoa their aid revenue has exceeded 100% of total government revenue (Ibid. 1987: 14).

A great deal of foreign aid money has gone to the establishment of government services. This has resulted in public bureaucracies that local production cannot support and therefore is aid dependent. Employees enjoy wages that are not reflective of locally generated funds yet they continue to increase their demands for better wages as well as more goods. Cole and Parry refer to this in their paper "Selected Issues in Pacific Island Development."

> Dutch Disease-expands government employment beyond local capacity, raising wages and salaries and the supply of public goods; rate of exchange becomes overvalued, biasing the economy against exports and in favor of imports; overall the private goods sectors are discriminated against and constrained (1986: 17).

Shand also discusses such dependency in his article "Island Smallness; Some Definitions and Implications."

> Thus, with objectives of higher living standards and preservation of the integrity of island society, the demand for public sector expenditures can be met only with heavy recourse to external assistance. This inevitably involves sacrifice of one objective-economic self-reliance-to satisfy others-higher living standards and a low net out-migrations (1987: 18).

As these quotations indicate, large public expenditures primarily in the form of civil servant wages cannot be supported by marketplace activities. Island workers' expectations are built on very unstable ground and island governments are attempting to bridge the gap between desires and needs by encouraging the increase of local production and exports. Eventually, government bureaucracies will inevitably have to reflect the true activities of the marketplace if economic stability is desired.

Inappropriate investments stimulated by foreign aid often result in workers who are trained in inappropriate skills. Projects that train an excessive number of bureaucrats, for example, are not training citizens who could take their new skills and develop a local business. Teachers' schools or education departments that produce mostly liberal arts graduates are not promoting economic development. It would be wiser to tie the educational system to the development plan as exemplified by South Korea. Early on in its development, South Korea realized that it needed engineers to be competitive in the new world order. It purposefully expanded its universities engineering departments, increasing the number of graduates from 200 to 2,000 per year. This has had a direct impact on industries that have been attracted to the country. Unfortunately, the PIN have been very slow in promoting this type of agenda.

Foreign aid will continue to be a significant factor in island economies, and PIN need to consider how to manage these relationships. The following quote takes a practical view of this situation and offers a useful suggestion.

> Given these motives and the poor resource endowment of most countries, it is unlikely that aid will decline in the foreseeable future, despite the pronouncements of both donors and recipients to the contrary. Aid resources have become such an integral part of the Region's economies that it is virtually impossible for governments to do without them. Similarly, the aid donors will readily continue to give aid in order to promote their own interests. The problem which the

> recipient countries have to face realistically (both individually and jointly) is to distinguish needed and constructive aid from superfluous and destructive aid (Global Community Forum 1987: 65).

External revenues mask the underlying economic conditions of island states and inhibit analysis of their economies. Remittances like foreign aid are a prime example. "In Western Samoa, private transfers amounted to US$38.2 million, compared with export earnings of US$1.9 million (Cole & Tambunlertchai 1993: 221)." Reviews of imports and exports are muddied by the presence of these funds that are not generated by the local marketplace. Remittances entrench island economies in precarious arrangements that are susceptible to a wide range of external factors.

Internal economic struggles must also be addressed such as trade deficits which are typical features of fragile island economies. Rarely do exports counterbalance imports in PIN. Some imports are used for capital investments which economists hope will increase production. However, all too often the cost of importing more fertilizer or capitol goods for production has reduced export earnings and increased imports. Importation of fuel is a prime example. For many islands, fuel is the most costly import and presents one of the biggest obstacles to balanced trade. This cornerstone of development has in some cases exceeded the total value of exports. Products reliant on fuel for production become uneconomical when their price reflects the cost of this import.

Thus the vast majority of island economies are dependent on external assistance in one form or another. With the exception of Papua New Guinea which has a positive trade balance, PIN must rely on foreign aid and remittances in order to survive.

Summary

PIN development options must address all of these fundamental facts. Smallness has important consequences for most of the PIN. The geographical realities of remoteness, diversity and fragmentation challenge all development efforts in the area. Populations that have limited skills, have an abundance of youth and high consumer expectations complete a formula that is unique in the world. Outside influences such as foreign aid, remittances, the world market and geopolitical dynamics also play into the arena of PIN development. Development efforts at this point cannot claim to have overcome many of these challenges and it would seem appropriate that new and untried approaches be examined. However, in order to shift directions, a new perspective must be adopted. A new paradigm may allow for sustainable growth of these economies.

ASSETS

To shift PIN liabilities into assets, an approach to development that does not parallel the path of developed nations must be considered. Pardo quotes Pierre Cot, French Minister for Cooperation and Development in his article "Micronesia and Polynesia: A

Possible Scenario." It suggests that third world nations need to look within for new development options.

> Development is not synonymous with growth or growth with well-being. An excessively outward-oriented growth can increase dependence and inequality. Third World countries must therefore be able to elaborate this autonomous, endogenous, autocentric development to which an increasing number of them aspire (Gopalakrishnan 1984: 6).

Pardo reflects on what this means to the PIN:

> This endogenous, alternative approach to development, as many have stressed in other forums, is people oriented; it aims at satisfying basic human needs, when possible, primarily through environmentally sound and efficient use of local human and material resources. Implementation of such a policy would imply making full use of those areas of relative advantage that virtually all islands in Micronesia and Polynesia possess in varying degrees; that is, remoteness, the beauty of the environment, the favorable climate and the most important, the Pacific Ocean itself (Gopalakrishnan 1984: 6).

This redefining of Pacific resources is a mandatory paradigm shift. Smallness, isolation and remoteness have impeded development options that larger developing nations have successfully implemented. It appears that for the PIN and in particular the micro states, consideration should be extended to alternative approaches and ideas. It is important that all resources be reassessed and conclusions be based on new paradigms.

Geography

The view that PIN are geographically disadvantaged may result more from an attempt to fit them into present industrial structures rather than a reflection of their actual resources. The following review of geographical assets does not conform to traditional interpretations. It suggests possibilities that may be uncovered through explorations of alternative approaches to development.

As stated previously, remoteness is most often quoted as one of the greatest challenges facing the islands. However, biologically it has some advantages. Wace reviews some of these advantages in his article "Exploitation of the advantages of remoteness and isolation in the economic development of Pacific Islands". He makes a number of suggestions for botanical exports that rely on the isolation of islands. His primary point is that islands are not subject to pathogens that threaten the crops and livestock of larger continental states. Island environments would be useful in production of seed germination as well as livestock breeding. Another option would be the production of high priced ornamentals which can be grown all year long and would be particularly suitable to environments with limited pathogens. It is particularly critical for these crops not to be in adverse biological environments because of the extensive genetic engineering which has increased their susceptibility to disease. Another option reviewed would be the establishment of gene-pools or genetic diversity plants. Increasingly, the lack of diversity amongst commercial crops and herds threatens these species ability to survive the inevitable introduction of some type of organic threat. Developed nations have begun to recognize this threat and are establishing repositories of genetically diverse wild species. The islands would be able to promote their remoteness as an asset as Wace states.

> The easiest places in which to conserve wild or the wild relatives of cultivated plants may not always be within their native ranges, where they are often subject to the direct or indirect effects of economic development of their habitats; but rather in remote situations where they are protected by isolation. Islands offer some advantages for these purposes because of their paucity in natural resources whose exploitation might lead to later environmental manipulation by man (1979: 99).

Other activities that exploit remoteness are "baseline monitoring stations" and weather stations. Baseline monitoring of ocean conditions will continue to grow in demand as ocean resources are increasingly exploited. Weather monitoring will probably be eclipsed by satellites but it is nonetheless worth exploring. While Wace has doubts about these two options, it is appropriate to review these ideas because of the recent increase in environmental organizations in industrialized nations. A number of these agencies have substantial budgets and are active internationally. Many may well be interested in the aforementioned activities to support their goals and might financially support such developments. While these activities will never generate the kind of income that large commercial enterprises would, they do appear to meet the requirements for smallness that many PIN need.

Oceanic remoteness also offers the opportunity for scientific research of ocean species and conditions. Ocean environments that have been minimally affected by introduced species and pollutants offer unique environments for study. Baseline environmental conditions can still be documented in a variety of ways. This information will be essential for the well being of the ocean when it expands its role in industry. Marketing pristine environments to research institutions may be a viable option in the present.

The fact that PIN islands are scattered between East and West must be reanalyzed. Brainstorming and review of this fact must occur so that potentials can be considered. Questions such as: What services are needed to bridge continents? Is there a need for multi-lingual electronic communication centers to facilitate conversations between nations along the rim? Is there a need for multi-lingual resort sites for meeting between companies, governments and other entities? Is there a need for high security and low visibility meeting facilities for which PIN would be ideal? All of these questions require exploration of markets and the identification of needs that are not being met or that will need to be met in the future. This review must analyze present day reality where PIN are consistently ignored as major stop off places. Geographical placement will not reveal its assets if considered within the traditional context of development. It is important that steps be taken to identify non-traditional markets and services.

Social and Political Factors

Pacific populations have several features that could be considered assets for future developments. These populations are well positioned to support the shift to ocean based economies which will require a new type of work force which is flexible and stable at the same time.

The inordinate number of young people previously discussed offer an opportunity to focus this future workforce into high tech, service oriented, or scientific directions. Youth could be directed through government policies towards careers that will support the development plans in the new paradigm. Countries whose educational priorities are in alignment with national development goals may find this youthful population gives them unique opportunities to implement new development initiatives.

Small populations provide PIN with several advantages. First, decision makers are very accessible. This can be important for businesses that might require quick formulation of government policy. New ocean industries would find this particularly attractive since they may be working in a vacuum of standards or traditional protocol and legislative frameworks for their new enterprises. Futurists predict that quick decision-making and flexibility will be the hallmark of successful businesses enterprises. PIN are prime candidates for this feature. A second asset is the fact that PIN are relatively peaceful nations. Small populations preclude the extensive social devastation found in urban areas throughout the developing world. While the islands are experiencing the pressures of urbanization on their societies, they are not nearly as formidable as those found elsewhere; therefore, the overall quality of life is superior to other countries. Third, the politics of island nations are also more stable and peaceful than other countries due to their smallness. This is a fact that business finds attractive for their investment dollars.

There have been some attempts to realign island economies according to small scale economics, however, the majority of efforts so far have emphasized traditional large industries. This emphasis has sidelined attributes such as smallness. Kakazu states:

> There are, however, a number of characteristics of small islands which can be considered as economically advantageous over the larger economies such as the importance of being unimportant in external commercial policy, more unified national markets, greater flexibility, and perhaps greater potential social cohesion (1965: 91).

This quote reveals the advantages of flexibility for small island economies. The ability to shift gears is much more feasible in a small economy than the monolithic structures of developed nations. Flexibility allows change to occur according to new scientific information or the development of new international partners. Mini states that have clarity in their goals and actively support initiatives that support these goals may have the advantage over larger entities whose efforts are impinged by large bureaucracies and watered down visions. PIN need to establish infrastructures that can maximize on this asset which may be the critical advantage for success in the future.

Relationships between island nations and their former colonial overlord should be reviewed from a more proactive manner. As noted, it is unlikely that these islands will gain any substantial level of economic independence in the near future. The choice is how to use aid more effectively. It is unrealistic to anticipate that aid will not be attached to the self interest of the developed nations therefore opportunity lies in marketing assets to developed nations through an appeal to their self interest. The PIN have an advantage in their relationship with donor countries because of their long historical attachments. In fact, a great sense of regard for Pacific Islanders and a genuine concern for their future is exemplified by the fact that the islands are some of the "most heavily assisted regions in the world" (Fairbairn 1987: 12). Positive relationships with donor nations may ensure more control of donated dollars in the future. The many personal relationships that exist due to long standing alliances are also an asset from this history. These contacts are essential to successful technology transfer as well as the selling of new ideas. Such neutral or positive attitudes towards these political realities create a nurturing environment for growth.

Basic political structures and accompanying legal regimes which exist in PIN will be instrumental in attracting funds to the islands as well as managing island resources. The largest resource available to these islands is the ocean. Continued development of political and legal structures with an emphasis on ocean resources would make PIN forerunners in this arena. Leadership in ocean management could prove to be useful politically and economically. The ramifications of ocean assets will affect all aspects of island society.

The Ocean

Future planning for these island oases should recognize the growing potentials of the Pacific Ocean. Forecasts of extensive ocean exploitation are slowly being realized. Industry is beginning to catch up with research and ocean enterprises are rising. Hawaii has already begun to recognize the potential of the Pacific in its development.

> The industry has grown rapidly over the past decade, from $20 million in revenues in 1980 to $> 62 million in 1989, and generates high employment impacts. It is an industry receptive to national and international investment and participation and responsive to new market opportunities (MacDoncal et al 1991: 1).

Nations that recognize this development potential and begin to prepare for it will benefit the most. Upon review of the many possibilities, island nations could prove to be strategic to a number of enterprises. Leasing of ocean space within nations' Exclusive Economic Zones (EEZ), transshipment points for personnel on manufacturing vessels, recreational and medical destinations for personnel, security forces for ocean enterprises, manufacturing of ocean engineering parts or parts distribution centers are only some of the possibilities. Now is the time to plan the infrastructures for these activities. Gaining a foothold now while the giants of the Pacific Rim are sleeping and the resource is still primarily a PIN asset could mean a "corner on the market " for the PIN.

Hegemony over their EEZs gives island nations access to geographical and biological ocean features. EEZs' have already contributed to island income through the tuna stocks under island jurisdiction. Islands which have easy access to deep ocean water can presently provide the necessary temperature gradients for successful Ocean Thermal Energy Conversion (OTEC) exploitation. The ocean floor surrounding islands offers diverse geographical features which can support activities from OTEC pipes to underwater habitats. Although some of these are future activities, it must be recognized that historically, successful implementation of technologies is reliant upon available infrastructures. Therefore, now is the time to establish these frameworks for future implementation. At this point, no industrialized or developing nation has a stronghold on ocean enterprises; hence the playing field is wide open. It will be those nations that have established the necessary infrastructures to exploit their EEZ's that will be on the leading edge of new developments.

These are compelling reasons for the PIN to embrace new visions of the future. Acceptance of a vision where the ocean becomes the next great frontier would enable these nations to position themselves in a strategic manner. A minimal amount of planning for these eventualities may result in tremendous success in the future. The following quote supports this viewpoint in very elegant terms.

Given this situation and the fact that many of these nations will have significant resources within the proposed 200 nautical mile exclusive economic zone, the need to acquire and understand a technology policy has become an urgent priority. Inherent to this context are a variety of political options and implications...What is significant is that if global development is to proceed unimpeded by hardened bargaining positions and/or dependency relationships, then the small developing states must acquire the necessary expertise and assessment capabilities at an early date if they are to be able to absorb the effects of the projected exploitation of these resources. This is a situation unique in history; when the smallest (and some of the poorest) states will in a short time period become major resource powers upon which the industrialized nations will become relatively more dependent; and, when the potential exists to plan the exploitation of these resources so that benefits (to all parties) can be maximized and distributed evenly. An incredible challenge which requires more than lip-service (Rizer 1985: 20)

Part II

OCEAN RESOURCES

The following discussion of ocean features and wide range of ocean industries provides a vision of an ocean based industrial economy. Cornerstone ocean technologies for this economy are now being developed for use in the future. Preparing for this inevitability means reviewing what exists presently, assessing future activities, and then positioning oneself properly for this transformation.

United Nations Law of the Sea Conference

The beginning of this transformation towards ocean based industrial economies occurred through the international political forum called the United Nations Law of the Sea Conference (UNCLOS). The international community first assembled in 1958 to begin to "...examine the law of the sea,...and to embody the results of its work in one or more international conventions (Nordquest & Park 1983: 3)." The many conventions reached over twenty four years were codified in the Law of the Sea Treaty in 1982. Through this international agreement many ocean resources have come under PIN jurisdiction. Part V which established the Exclusive Economic Zone (EEZ) was particularly relevant to the PIN. The EEZ convention gave nation states authority over 200 miles contiguous to national shores . Through the Law of the Sea (LOS) and its EEZ section some "40 percent of the Pacific Ocean will come under the sovereignty or more limited jurisdiction of coastal states (Gopalakrishnan 1984: 7)." PIN have expanded their marine territories in excess of 30 million square Km by exercising their sovereign rights as established by this convention (Kotobalavu 1987:unkn). Narakobi succinctly discusses the importance of these events for the Pacific in the following quote.

> The Law of the Sea Convention emerged at the right time for the South Pacific Island states. Small in size and lacking direct economic or military muscle, the South Pacific island states clearly stand to benefit from this convention...Nowhere in the world is the Convention more relevant than in the South Pacific where nearly every part is of importance. In this respect the Convention will have significant impact on the development of the island states of the Pacific...Undoubtedly there is no other part of the Law of the Sea Convention which is of greater interest to the Pacific island countries than Part V which establishes exclusive economic zones. Most Pacific Island states apart from Australia, New Zealand and Papua New Guinea stand to gain far more from the 200 mile exclusive economic zone than from any other part of the convention (1984: 374, 376)".

Some scholars assert that the world has a long unsuccessful history of trying to establish binding agreements regarding the sea. They predict that unilateral action as well as bilateral and regional agreements will undermine many features of the convention. However, the assumption of jurisdiction over EEZ's by the worlds' nations implies that Part V is already Common Law in the international legal regime. This sea grab, as it is called by some, secured for the PIN all the resources in their respective EEZ and forever changed the political features of the Pacific. The future of these islands has literally been rewritten by this agreement. Through their participation in UNCLOS South Pacific nations not only increased their resources but also asserted their rightful position in the world community.

As individual PIN gained independence during the twenty four years of UNCLOS negotiations (1958-1982), they entered into the international UNCLOS arena. Through this participation a significant political shift occurred for the PIN. The PIN established themselves as a viable regional political entity called the "Oceanic Group". It lobbied extensively for changes in the preliminary agreements regarding EEZs. Through their efforts changes were made that had significant impact on their islands as well as all islands in the worlds' oceans. The world community acknowledged the political capabilities of this regional group and realized they represented a substantial percentage of ocean resources which helped catapult these new governments into international affairs.

Through UNCLOS, PIN regionalism was enhanced. The international community recognized that the use of Pacific waters and transit through these waters would now have to be negotiated with PIN individually as well as regionally. Fishing agreements between distant water fishing nations (DWFN) and PIN resulted from the establishment of EEZs by the island governments with the support of regional organizations such as the South Pacific Forum and the Forum Fisheries Agency. Negotiation over disputed territories were also expressions of international recognition of island sovereignty and regionalism. Delimitation treaties were negotiated by a number of international entities such as the United States, Cook Islands, Tokelau and New Zealand, all in response to the sovereignty of the area. Clearly, the LOS treaty and its EEZ clause have forever altered the Pacific nations place in the world today. Through participation in UNCLOS, regionalism has strengthened individual PIN to the point that ocean resources are now accessed primarily through international agreements.

Ocean Resources

Subsequent to these historical events an increased appreciation for the potential of ocean industries has been realized. With increased understanding, PIN have chosen a variety of courses ranging from scientific analysis of their individual EEZs to actual exploitation of the area. Geographical features of the Pacific such as the deep cold ocean water, the rich abundance of marine species, the typology of the ocean floor and the massive solar activity of the area offer potential economic returns. In order to be strategic to industries that will use these resources, island governments need to audit existing ocean industries that range from the minuscule to the immense. PIN leaders will also have to broaden their vision to include future potential developments since these will undoubtedly offer the greatest opportunities for income generation in the future.

A review of ocean science and technology companies done for the State of Hawaii by Arthur Young & Company indicates that PIN resources are competitive with Hawaii as sites for these industries. The top four features considered as important by ocean based companies were: "unpolluted ocean water, access to deep ocean water (greater than 2,000 feet), warm ocean water (greater than 24 degrees C) and cloud-free days greater than 80% of the time (1987: 4)." PIN certainly possess all of these assets. This report illuminates the fact that there are companies which represent an ocean science and technology market niche. Marketing to the needs of this niche could generate revenue as well as support the development of ocean industry infrastructures.

Potential mineral resources in the seabed was one of the most heated debates during UNCLOS. Indeed, it was this particular issue that contributed the most to the US position of non-signature. At the time the conference was held, there was a general belief that the potential for ocean mineral exploitation was significant in the Pacific. The primary minerals discussed were manganese nodules and manganese crusts. However, time has proven that this resource is not economically feasible and probably will not be until well into the next century. Despite this fact, marine mining's potential and related activities should not be ignored. The State of Hawaii has done preliminary studies regarding marine mining. Deposits of cobalt-rich manganese have been identified within the US EEZ valued at a possible $80 billion. It is also projected that direct revenues to the State of Hawaii will be in the range of $355-550 million and that 970-985 jobs would be established by this industry. Of particular interest, is the projection that the islands could act as mineral processing sites, transshipment points, research centers, supply bases and ship repair centers (MacDonald & Deese 1987: 2). To date activities around sea-based mineral resources have also identified the tremendous need to assess the geophysical, geochemical and geologic features of the ocean floor. With proper planning Hawaii will be in a leadership role not only for this industry but all others that are in need of these services and information. It would be prudent for PIN to monitor this progress to assess their own capabilities and potentials.

Another resource of the ocean is simply it's size and depth which covers more than 70% of the earth's surface (Takahashi & Matsuura 1991: 1). Controversial proposals such as deep seabed burial of nuclear material, waste management in the form of dilution, diffusion and incineration and toxic waste disposal are all potential activities. It is proposed that because the ocean is so much larger than available land, these activities would have less damaging environmental impact than present practices. While this is very controversial, it cannot be ignored that waste management will continue to plague our world and alternative approaches will have to be researched and implemented.

Pelagic fishing has been touted as a tremendous economic potential for the islands; recent information however, indicates that wild stocks have been massively overexploited. Projections during the 1980's by Woods Hole Oceanographic Institute estimated that the maximum sustainable yield (MSY) per year of fish protein for the world was 55 million metric tonnes. In 1981 the average world catch exceeded 70 million metric tonnes as it had for several years prior to that (Craven 1982: 48). Subsequently, significant drops in levels of harvested species throughout the world has had tremendous ramifications for open ocean fishing industries. In the United States, traditional fishing grounds have been closed because of the serious depletion of their marine resources. International news reports carry an increasing number of stories about crisis in fishing industries around the world. Island nations that have invested significant amounts of money in fishing fleets may suddenly find this resource is very scarce and possibly boycotted by environmental legislation in other countries. The success of the pelagic fishing industry will depend on the adoption of conservation efforts as well as the introduction of ocean farming technologies.

While pelagic fishing, waste management and mineral extraction are industries that rely on the resources of the sea, the oceans physical features will offer even greater opportunities for the future. The ocean has unique physical characteristics that Craven describes in his paper "Concept Paper for Pacific International Center for High Technology Research". The following excerpt from his paper introduces some of the more sophisticated uses of the ocean.

> There are many other unique physical characteristics of the ocean which, if employed by society, would constitute valuable "ocean resources". Indeed, the use of the ocean for the deployment of secure invulnerable deterrent systems, is a prime example of one such ocean resource. In this instance it is the opacity of the ocean with respect to all but the lowest frequency electromagnetic radiation and all but the highest energy nuclear particles that provides the screen behind which submersibles can hide. This quality also makes the ocean a rich scientific resource for such projects as project DUMAND. This is a volumetric array of Cerenkov radiation detectors which, deployed on the bottom of the ocean, act as a telescope to record the high energy neutrinos and muons that emanate from the farthest regions in space. The national and international significance of this capability should not be underestimated since this facility can study particles whose energy is higher than the highest energies generated by the billion dollar super-collider and can see farther into space than any optical telescope.

> A corollary to the opacity of the ocean for electromagnetic phenomenon is the transmitibility of acoustic signals. Acoustic imaging (acoustic tomography) is thus a capability not available in the atmosphere or in the solid earth. Other characteristics which may prove to be significant includes the ability of the ocean to store large volumes of carbon. Inherent in this capability is the storage of the excess carbon dioxide which is generated by industrial processes and which plays a major negative role in the so called "greenhouse effect".
>
> Just as there has been a manufacturing in space program, so should there be a "manufacturing in the ocean program". Pilot programs have already demonstrated the efficacy of carbonate concretion by electo-deposition a construction material, the use of high pressure in the curing of concrete and the possibility of utilizing implosion energy for deep ocean tools and processes. Many other properties could be cited. For example a) the saline character of the ocean makes it an ideal electrolyte for "salt water batteries" or other electrochemical processes involving ion exchange, b) the large quantities of heavy water in the ocean make it the only meaningful source of this potentially valuable energy fluid (1989: 8).

These oceanic features stimulate visions of the future. Humans will inhabit the sea much as we do the land today. There will be industrial parks with an array of manufacturing activities. Offshore tourist and recreational facilities will include artificial reefs, underwater parks, and an abundance of activities reliant on the oceans features and qualities. Research facilities will be constructed in strategic areas to study and monitor the ocean while the military will establish bases on the high seas rather than depend on the politics of nationalism. All activities will be performed on open ocean platforms using OTEC energy to support their work. While these visions seem fantastic there are many scientists who are already developing the variety of technologies to make all this and more feasible. The potential for PIN is tremendous. Leasing income, R&R facilities, scientific support services, industrial support services, transportation services and the myriad of activities that accompany human labor are all potential growth sectors that nations can begin to plan for. Through scientific breakthroughs related to OTEC technologies, PIN will find themselves ideally located to compete in future services and industries.

Ocean Thermal Energy Conversion

The history of OTEC is dominated by scientists. A French physicist, Jacques d'Arsonval, began research on OTEC in 1881. Experiments by d'Arsonval were followed by another French scientist, G. Claude. Due to engineering flaws both scientists experienced failure. Despite their setbacks the concept remained alive. In the US, increased interest for alternative energy in the wake of the oil crisis of the 1970's resulted in OTEC research receiving funding. In 1972, the National Science Foundation funded projects which were then continued under the auspices of the Department of Energy (DOE). Elsewhere in the world other countries such as Japan and France continued to experiment with the concept. Japanese scientists were successful in running an experimental energy producing OTEC plant on the island of Nauru in 1981-82. Kyushu Electric constructed a 50kWe plant in Kagoshima and the University of Saga has tested a 75kWe thermal simulation plant. Experiments are also being conducted by consortiums of international governments and corporation. Sea Solar Power Corporation has already proposed 25 OTEC power plants to a variety of countries and anticipates that the first will be operational in 1995 (Takahashi & Trenka 1991: 662). While smaller power plants are already being marketed by Sea Solar Power Corporation, larger plants are still in the research and development phase.

In the middle of all this activity is the State of Hawaii. It became a forerunner in OTEC research for two significant reasons. Under direct US control, Hawaii was the best geographical site for OTEC implementation and the government of Hawaii actively supported these efforts through financial and regulatory support. On the island of Hawaii, OTEC research at the internationally recognized facilities of Keahole Point has stimulated interest around the world regarding ocean technology and made it the premier site for OTEC research. Funding for this three hundred and twenty-two acres next to Keahole airport was established in 1974 by the Hawaii State legislature for the Natural Energy Laboratory of Hawaii (NELH). Initial research was conducted to develop and demonstrate solar and sea energy potentials including OTEC plants. During this research a series of serendipitous discoveries showed that OTEC could support a variety of entrepreneurial activities. Researchers realized that the cold water associated with OTEC energy plants could be used for air conditioning, drip irrigation and mariculture. These byproducts of the OTEC energy plants proved to be as successful or more successful than the generation of energy. The results of these ongoing experiments make OTEC the most feasible technology available for substantial economic development of the ocean in the near future as well as in the 21st century.

The PIN are the quintessential location for this technology and it's related research. Therefore, PIN stand to benefit the most from these early activities. In fact, the Pacific International Center For High Technology Research (PICHTR) has suggested that a number of Pacific sites meet the following essential requirements for OTEC implementation and experimentation (Thomas & Hillis 1991: 24):

> 1) A source of warm, nonpolluted surface seawater relatively close to shore. The mean annual water temperature should be at least 25 degrees.
> 2) A steep offshore slope that reaches depths of 600-100 meters within a few kilometers of(f) shore. It will permit temperature difference to be about 20 degrees C, the minimum necessary.
> 3) An on shore site close to the water that is suitable for major construction activities and to sea level.
> 4) An offshore topology that is suitable for deploying the cold-water pipe.

This multifaceted technology which relies on a renewable resource will be instrumental in the settlement and exploitation of the ocean. Fledgling technologies and industries of OTEC are presently dominated by scientists who have long understood the tremendous potential that the ocean and sun offer as the following quotes indicate.

> The ocean is the largest solar collector and energy storage system on Earth and the only renewable energy source large enough to supply a significant fraction of total human energy demand. Tidal, wave and ocean thermal energy can all produce hydrogen from seawater. Hydrogen, as a transportable fuel, represents the energy bridge by which these vast ocean resources can be utilized by civilization...
>
> As mankind's energy base gradually shifts from complex hydrocarbons, mined from the Earth's crust, to hydrogen, mined from seawater, civilization's emission of carbon, sulphur an nitrogen compounds into the atmosphere will be greatly reduced. We will use a fuel that is clean and abundant, whose extraction energy is

> inexhaustible as long as the tide rise and fall, winds blow over the ocean and the sun shines on tropical seas. (Krock 1989: foreword).
>
> ...On an average day the 60 million square kilometers of tropical seas absorbs an amount of solar radiation equivalent in heat content of about 250 billion barrels of oil...If a multinational array of OTEC installations converted less than a tenth of 1 percent of the energy stored as heat in tropical surface waters, they would generate at least 14 million megawatts, more than 20 times the current generating capacity of the US. The same technology could also provide fresh water, refrigeration, air conditioning and a medium for culturing fish. (Penney & Bharathan ?:86).

These two quotes indicate that initial interest for this technology stemmed from its potential to address growing energy needs of the world. The technology has been revolutionized by the discovery that byproducts or co-products of energy producing plants have great commercial potential. In the following description of OTEC plants and spin-off industries reveals that there is a great deal of opportunity for PIN.

OTEC Energy Plants

There are two primary types of OTEC plants. These are open cycle plants (OC-OTEC) and closed cycle plants (CC-OTEC). Recent research has also developed a hybrid system. All rely on solar technology that takes advantage of the theory "that a heat engine can operate between two heat resources at different temperatures and produce electricity"(Yuen 1981: 1). The heat resources that these systems rely on are the temperature gradients found primarily in tropical seas. Cold Arctic water that lies at depths of 3,000 ft (1,000 meters) in the tropics is pumped to the surface while water warmed by solar energy is taken up from the ocean surface. Twenty degrees C temperature difference is enough for the generation of electricity which will be the focus of the first review of the industry. Once this gradient is located then each type of energy plant uses this resource in different ways.

The simplest definitions of the different plants are those offered by Takahashi and Trenka in their article "Ocean Thermal Energy Conversion: Its Promise as a Total Resource System (1991: 2)."

> In the closed-cycle OTEC system, a working fluid with a low boiling temperature, such as ammonia or freon, is used. The fluid is heated and vaporized in a heat exchanger by the warm surface sea water. The steam produced drives a turbine generator. After passing through the turbine, the working fluid vapor is condensed in another heat exchanger cooled by water drawn from the deep ocean. The working fluid is then pumped back through the warm water heat exchanger and the cycle is repeated continuously (Figure 1).
>
> In the open-cycle system, sea water is the working fluid. Warm water from near the surface of the sea is pumped into a flash evaporator in which the pressure has been lowered by a vacuum pump to the point where sea water boils at ambient temperature. This process produces steam that drives a low-pressure (0.35 psi) turbine to generate electricity. After leaving the turbine, the steam is condensed in a heat exchanger cooled by cold, deep ocean water and produces desalinated water (Figure 2).
>
> In a hybrid system, electricity is generated in a closed-cycle stage, followed by water production in a second stage. In the second stage, the temperature difference available in the sea-water effluent is sufficient to produce desalinated water by means of a flash evaporator and surface condenser. Thus, the hybrid cycle maximized the use of the thermal resource by producing both electricity and desalinated water...Coupling this second stage with an open-cycle OTEC plant double the output of desalinated water (Figure 3)

Research at Keahole point on each of these systems has shown that plants which only produce energy are at this time marginally economic. Small South Pacific islands where the cost of energy is one of the highest in the world are the most likely candidates for economic success. However, there are a number of costs that must be minimized even for these sites before profitability can be realized. Expenses for electrical generation that negatively impact profits are the pumping up of cold water to the surface which entails deep water pumps, pipe materials and construction technologies. Some of the other systems that need technical improvement are the steam water systems, the mist evaporators and the turbines. Experiments regarding system components were presented at the First International Conference for Ocean Energy Recovery showing that research is being conducted in engineering, environmental sciences and the economics of the various OTEC systems. Each team articulated that much of the component technology is off the shelf and primarily needs refinement in order to be more economic. All the scientists were confident that continued research would result in technological breakthroughs that would eventually mitigate the expenses of OTEC plants.

At this point however, the economics of producing large quantities of energy from these plants and their ability to make a profit or break even has remained elusive. Several factors account for this situation. First, technical innovations that must occur to make the systems cheaper are still in the process of being made (i.e. laminated ferrocement for construction, aluminum vs. titanium in heat exchangers, use of elastomeric fabrics for pipes). Second, is the fact that the price of fossil fuels at this time is low enough to continue to be cheaper than OTEC for most countries. The cost of fuel is instrumental in the comparison of both resources and analysis must be done on a case by case approach which results in a wide array of potential scenarios . Although the fear of depleting oil reserves appears to have subsided with peace in the Middle East and the identification of new oil deposits, there is growing concern regarding the long range availability of fossil fuel resources and its negative environmental impact. However, before OTEC can compete with fossil fuels as a significant delivery system of energy it must first demonstrate it's ability to perform on a large scale. This factor of technical but not commercial viability is the third point. While many of the technical experiments have been very successful, investors are reluctant to spend their capital on such a technology. Research and Development (R&D) must be conducted around issues of scaling, operation, reliability, performance, maintenance costs, integration with local electrical, water and cooling systems before any commercial company is going to invest millions of dollars into a plant. It will undoubtedly take partnerships of private, public and multinational entities in order to generate the funds needed for the R&D of large scale energy producing OTEC plants. This has been stated as the major roadblock to implementation of large energy producing OTEC plants.

Continued research helps to alleviated the concerns of investors and promote the viability of the technology. Internationally, a variety of entities are continuing to explore energy producing OTEC technology. The Japanese success on Nauru ended with their scientists indicating that a commercial power plant would be technically feasible at the right site. The OTEC Association of Japan has surveyed Christmas Island, Viti Levu, Bali and Lombok in Indonesia as well as the Federated States of Micronesia as potential OTEC energy plant sites. PICHTR is collaborating with General Electric of Britain, the Aluminum Company of Canada, Makai Ocean Engineering and Hawaiian Renewable Systems to develop a 500k closed-cycle or hybrid plant (Takahashi &Trenka 1991: 660). Extensive research on total CC-OTEC and OC-OTEC systems continue to be conducted at Keahole Point where these systems are proving their technical viability. However, this research on small scale plants at Keahole has revealed new technologies that may make both large and small OTEC energy plants competitive in the near future. The generation of fresh water and access to deep cold ocean water has resulted in the creation of spin-off industries. Following is a review of each of these resources and the industries that have evolved from their use.

OTEC Industries

Research on energy producing OTEC plants has shown that fresh potable water is a co-product of OTEC plants. Scientific articles which reviewed OTEC experiments indicate that production of fresh water is feasible for all OTEC plant designs. Nihous, Syed and Vega wrote an article "Conceptual Design of an Open-Cycle OTEC Plant for the Production of Electricity and Fresh Water in a Pacific Island" which explored two plant designs (1985: 215). The options were: "an OC-OTEC power plant producing about 1.15 MWe and 27 kg/s of fresh water, or an OC-OTEC power plant fitted with a second-stage flashing unit, with a net power output of about 1.05 MWe and a total fresh water production of 55 kg/s. " They proposed that both designs were viable and could be implemented according to the priorities set at individual sites. However, other scientists support the view that hybrid OTEC plants are the most appropriate technology for producing both energy and water. Scientists Thomas and Hillis wrote that hybrid systems were the most efficient at producing fresh water in their article "Hybrid Cycle Adds Potable Water to OTEC Areas in Short Supply." The following is their short review of this system.

> It combines desirable features of both closed cycle and open cycle OTEC in that it produces the fresh water of the open cycle and the power of the closed cycle. The hybrid cycle has several important advantages over the open cycle:
>
> *A commercially available ammonia turbine can be used to produce electrical power. The open cycle requires a large-diameter low-pressure turbine, which has not yet been developed.
> *Condensation takes place at a higher pressure, thereby decreasing the size of the equipment required while also reducing the parasitic-power requirements for removing non-condensable gases.
> *The power water ratio can be adjusted to meet local requirements.
> The hybrid cycle's advantage over the closed cycle is that it is capable of producing fresh water(1989: 35).

Rabas, Panchal and Genens also supported this view in their article that hybrid OTEC plants were the most efficient design. They believed that future plant designs would be dictated by determining whether energy or water generation takes priority. These theoretical designs have potential for implementation at island sites where fresh water can be very scarce. Through the generation of fresh water in conjunction with energy production the ability of OTEC plants to be economical on small Pacific Islands improves.

At Keahole Point, an open cycle experiment called the Heat and Mass Transfer Scoping Test Apparatus (HMTSTA) produced 8,000 gallons of fresh water per day. The salinity of the water was 86ppm which is one-fifth that of the available tap water at Keahole making this highly desalinated water. Researchers Thomas and Hillis indicate in the aforementioned article that a small plant would use "60,000 gallons of warm sea water per minute for every megawatt of electrical power it produced. About 1/2% of that seawater would be converted to fresh water, or roughly 600,000 gallons per day per megawatt (Ibid.: 37)." They also provide an analysis of an OTEC plant in comparison to fossil fuel costs.

> A plant capable of desalinating 5 million gallons of water per day and generating 10 megawatts of electrical power is estimated to cost $5,500-6,500 per kilowatt of installed capacity. The unit price for electrical power would be competitive with fossil-fuel power provided that the fresh water could also be sold at regional prices. The water cost alone has been estimated to be less than that of water produced by fossil fuels multi-stage distillation plants` (Ibid: 37).

While there is still a great deal of research needed to make these systems economical for large plants, the idea is so promising that researchers continue to try to minimize costs in anticipation that OTEC will be realized. PICHTR indicates that small PIN will be the first to benefit from these developments because of their high cost of fuel and fresh water. The successful deployment of small OTEC plants on PIN would put this technology in their hands prior to industrial nations thus creating an opportunity for these nations to be leaders in OTEC technology. At the same time, the displacement of water and energy imports with locally available resources would also offer economic benefits that would enable these countries to get a head start in an ocean based economy.

One discovery regarding this resource was its potential use in air conditioning. Van Ryzin and Leraand in their article "Air Conditioning with Deep Seawater: A cost-Effective Alternative (1992: 43)" report that air conditioning systems of 1,000 tons or more which use this seawater are economical. The systems they analyzed would pump up 6 degree water from a 650 to 700 meters depth using high-molecular-weight polyethylene pipes. The water would be pumped through a heat exchanger then a circulation pump after which the water would be pushed through the air conditioning system. It would then be discharged back to the ocean. Air conditioning through this technology can result in substantial savings. "A conventional air conditioning system uses 800 to 900 kilowatts/1,000 tons for the refrigeration unit...Depending upon the length and size of the (OTEC) pipeline and the size of the fresh water distribution system, the pumping costs are about 750-150 kilowatts/1,000 tones. This corresponds to a 80% or greater savings in chiller electrical power (Ibid.: 38)." Scientists at Keahole Point have demonstrated the feasibility of this technology by air conditioning two of the Natural Energy Laboratories main buildings with cold ocean water for several years.

This activity has been conducted in conjunction with an energy producing plant. Research at Keahole indicated that using air conditioning as a co-product displaced energy generated at the plant for other uses. "...cold water from an OTEC electric power plant, when used to provide cooling, displaces more than 10 times its electric capacity for the air-conditioning load (SERI 1990: D-5)." Air conditioning impacts economic activities such as tourism, transshipment of marine organisms and air conditioning for local consumption (industrial, commercial, residential and public facilities) and could be used as a stand alone system. Air conditioning is one of the greatest potential assets of deep ocean water particularly for PIN who must import expensive oil for this technology.

Another use for cold water has been the growing of cool weather plants. Cold water pipes whose ultimate destination is to tanks used for aquatic species are placed on the ground. Cold water condensation around these pipes provides drip irrigation for agricultural crops. Corporations at Keahole Point have successfully grown strawberries, lettuce and alstroemeria flowers. Restaurants in the area have already begun to use some of these products in their dishes. Little research is available regarding the economics of these activities; however, it would appear to be a by-product that could help make OTEC economic, particularly for islands whose import of fresh produce contributes to trade imbalances.

The other byproduct of cold ocean water is mariculture. The fact that there is no clear definition of mariculture attests to it's relative youth. Following are two attempts at defining this technology.

> ...the production of shellfish and finfish from coastal mariculture and aquaculture and extraction of food additives such as pigment carotenoids and marine colloids. Another element is the rearing and dissemination of juvenile in larval forms of shellfish and finfish for stock enhancement...The current practice of capturing native or wild species will finally be replaced by managed systems as native species are depleted by overfishing and/or pollution of habitats (Ocean Resources, Sea Technology 1992:17)
>
> Aquaculture has been defined as the husbandry of aquatic organisms. In the broad sense of the term, it includes the cultivation of all aquatic organisms, whether they be plant or animal in any aquatic environment. Thus, mariculture, brackishwater culture, as well as the culture of organisms in freshwater environments, can be included in this broad definition of aquaculture (Uwate 1990: 1).

This paper defines mariculture as the farming of aquatic species whether on land, upon ocean facilities or in the open ocean. Whatever definition is used the concept should not be hindered by the marginal results of aquaculture attempts in the islands. Science has continued to solve problems in this field and new technologies are extremely encouraging. The preliminary success of mariculture research and products at Keahole indicate that it has great commercial potential. The island nations have an advantage in this industry because of their pristine ocean conditions and the potential of tying this industry in with early implementation of OTEC. The Natural Energy Laboratory of Hawaii (NELH) has already been very successful at Keahole in growing a number of aquatic species in conjunction with OTEC. The following quote details the resource.

> The ability to provide flexible, accurate, and consistent temperature control; high-volume florates; and nutrient-rich seawater relatively free of biological and chemical contaminants leads to a natural synergism that can be translated into a marketable product. The cold seawater contains 200 times more nitrates and 20 times more phosphates than surface seawater. Marine life already grown in this environment at the NELH include salmon, trout, nori (seaweed popular in the Japanese diet), opihi, lobsters, abalone, and both macro and micro algae. The values of these products are high enough that the costs of production can be recovered and profitability ensured--even considering the high cost of the deep-ocean pipeline (SERI 1990: D-5).

Another mariculture possibility is the artificial upwelling of nutrient rich cold water generated by OTEC plants in the open ocean. Places of upwelling where cold ocean water is driven to shallower water are rich in nitrate, phosphate and silicate which encourage the growth of phytoplankton, a species used in mariculture activities. These areas account for 0.1% of the ocean space yet produce 44% of the worlds' commercial catch (Takahashi & Trenka 1991: 663). Open ocean OTEC barges could generate artificial upwelling areas which would support biomass and fish plantations. It is anticipated that the fish schools would be contained through maintenance of temperatures and nutrients to specific areas. A preliminary experiment on a mariculture related OTEC barge has been conducted by a Japanese scientific team in Toyama Bay. The initial report indicated that the OTEC barge performed up to expectations. This team is continuing to explore the possibilities of open ocean mariculture. It is anticipated that mariculture will become critical in addressing the protein needs of the ever increasing world population whether or not pelagic stocks become depleted or regenerate through conservation efforts.

A mariculture industry that has tremendous growth capabilities is that of biotechnology. "New products from the sea stand as one of the most exciting and potentially significant uses of our biological ocean resources...marine organisms are vast in number and have been largely unexploited, their potential for biotechnology development is great (Ocean Resources 1992: 18)". While the ability to develop and process biotechnical products may be beyond PIN capabilities, market research now may reveal which organisms are most likely to be exploited so that mariculture activities can begin. This technology will have applications for food, pharmaceutical and chemical industries. Algae is already being farmed by Cyanotech at Keahole Point. Phycobiliprotein is one of the products from this farm which can be marketed for biomedical purposes. These algae fluoresce red or blue which are used for labeling monoclonal antibodies. At $10,000 a gram phycobiliprotein could prove to be a very lucrative product. Astaxanthin is another product that Cyanotech is growing. Astaxantin is used to give salmon the pink color that consumers prefer as well as being a potential coloring for the cosmetic industry. (Loupe, ?: 25). Mariculture products can generate the kind of profits needed to compensate for the liabilities relevant to PIN economies.

Polyculture is one of the innovations resulting from mariculture research activity. Ocean Farms of Hawaii which grows salmon, abalone, sea urchins, and oysters has developed a synergistic approach to their cultivation called polyculture. The company has four ponds. One pond has salmon and the kelp together because the kelp generates oxygen for the salmon while the salmon waste is used as fertilizer for the kelp. Oysters in the ponds help to keep them clean by acting as filters. In the other ponds the abalone and sea urchins are fed the kelp. Polyculture is an exciting approach to the growing of aquatic species and hopefully further research will prove it to be economically viable.

The growing of nori proved to be one of the most successful experiments at Keahole Point; so successful that commercial operations soon followed research activities. The early experiments on this product resulted in astounding findings. The biomass growth rate of these plants was 40 to 45 % per day. These plants were literally growing inches per day. Seaweed is used extensively by Japanese in the production of nori which is used for wrapping sushi.

As previously mentioned, Cyanotech Corporation is growing microalgae such as astaxanthin and phycobiliprotein at the HOST park at Keahole Point. However, one of their biggest successes has been the production of spirulina. This product is used in the health food industry for a source of vitamin B and beta-carotene. It is predicted that the market for beta carotene alone is $250 million dollars annually. Spirulina is also 69% protein and has a 90% absorption rate by humans compared to beef at only 20%. This characteristic could help alleviate protein needs of the worlds population. Cyanotech was able to produce 14,000 pounds per month of spirulina. While this is just a fledgling industry the success that it has already experienced and its projected potential make it an exciting industry for the near future.

Shellfish is another product being grown at Keahole Point. A great deal of research is being conducted on Maine lobsters. Experiments have resulted in the production of lobsters within three years compared to their wild counterparts which take up to seven years to reach maturity. This is accomplished by maintaining the water temperature at an even 70 degrees so that the lobster don't hibernate three months out of the year. While this product could not compete in Maine because it costs too much to produce compared to wild catches, it does have some advantages in the Pacific. Being close to the markets in the East makes it competitive with Maine lobsters and the fact that this lobster is available all year long at a fixed price. It can also be asserted that wild catches have dropped significantly and may not be available at commercial levels in the near future. Opihi, abalone and sea urchins are other shellfish products being experimented with at Keahole Point. Most of these products are still at the earliest state of development but all appear to have potential in specific markets.

Ocean water is able to support mariculture because it offers features that are difficult to find elsewhere as the following quote indicates. "In the deep ocean waters that we pump up, there are no pesticides, there are no sewage organisms, there are not biological organisms such as worms, there are no shellfish-poisoning organisms, no heavy metal, no agricultural run-offs. Our products are absolutely safe for human consumption (Lomont 1990: 21)." Keahole Point was chosen because it's water had these features and it's success exemplifies how profitable mariculture can be.

Corporations at this site are producing 13% of the fish harvest in the State of Hawaii but earning 25% of the wholesale market. It is predicted that within the decade this industry will grow to $70 million which is tremendous growth from 1989 when the revenues were $21 million. Income generation now as well as in the future will be from the production of these products as well as consulting, research, education and training (Lomont 1990: 30). The success of the initial phases of these products and the growth of NELH indicate that business continues to be keenly interested in spin-off OTEC technologies. Mariculture activity also offers hope that energy producing OTEC plants will be economic in the near future when accompanied by these spin-off industries.

The ocean has begun to reveal its bounty to mankind. In Hawaii, the State has been quantifying this bounty through research conducted by the Ocean Resources Branch of the Department of Planning and Economic Development (DBED). Its research indicates that Hawaii's ocean industries have begun to expand rapidly which would support theories that PIN should look to the ocean. A great deal of Hawaii's activity has been associated with ocean research and development. "Ocean R&D revenues in Hawaii were reported at $62 million in 1986, having grown at 11% per year since 1981. Private research revenues were estimated to be $12 million in 1986. Private research had the highest average rate of revenue growth (46%) of any of the 19 ocean industry sectors in Hawaii during this period (MacDonald & LaBarge, 1990, pg. 1). Another market research project by DBED reviewed six different ocean industries and concluded that while there was a wide range of growth amongst the industries none were declining and all were growing. These reports support strong public funding and suggest that ocean industries have the potential to displace or replace Hawaii's traditional industries of sugar and pineapple. PIN could take a similar path as Hawaii and address the economic realities that each of them face.

Scientists have known for quite some time that the deep ocean water has unique characteristics of coldness, purity and nutrient abundance. However, it has been because of OTEC research that practical applications for these features have been discovered. Tests using cold ocean water have been conducted as a co-product of an OTEC plant as well as a stand alone resource. Some researchers indicate that in order for this resource to be economic, it must be de-coupled from OTEC plants. As discussed, others are incorporating these co-products in the analysis of how to make OTEC plants economically feasible. Both of these approaches recognize that cold ocean water is a resource that can be exploited now for economic gain. Continuing research by scientists of cold ocean water for use in air-conditioning, agriculture and mariculture will accelerate its use as a stand alone resource or in conjunction with energy generation.

PART III

TECHNOLOGY TRANSFER

Ocean resources are the most logical path to PIN development. As already stated some resources can be exploited now, while others will be part of the future. Inherent to these development choices is the successful acquisition of ocean technologies. The process of acquiring any technology is complex and demanding of all parties involved but essential for developing nations. To support their development goals the PIN must understand and analyze their capacity to choose and absorb technologies associated with these goals. What PIN cannot do is ignore the importance of these technologies to their future since they hold the key to economic progress.

Technology

Technology can offer great promise to developing PIN and technology imports should be thoroughly considered and supported by political, social and legal systems. Defining technology for themselves is one of the first steps that must be taken by PIN since the word has a variety of definitions that range from manufacturing tools to know how information. Each nation must clarify its definition in order to maintain control of its introduction. Following is a quote from a UNIDO report that defines technology and states the important role that it plays in the development of countries.

> Technology is one of the prime motive forces of development. Whether the need is more food, better education, improved health care, increased industrial output or more efficient transportation and communications, technology plays a decisive role. It consists of a system of knowledge, skills, experience and organization that is required to produce, utilize and control goods and services. Technology is critical to development because it is a resource and the creator of new resources, is a powerful instrument of social control and affects decision-making to achieve social change.
>
> Technology is not neutral; it incorporates, reflects and perpetuates value systems and its transfer thus implies the transfer of structure. Technology is both an agent of change and destroyer of values. It can promote equality of income and opportunity or systematically deny it. It follows that technology not only influences society but also that society imposes limits on the choice and development of technology (UNIDO, 1981, Pg. 3).

This knowledge of technology's impact on society comes from analyzing the development of the West. Through technological innovations, the Western world experienced significant transformation of key economic indicators within a hundred year period. A summary review of western economic development gives a context for the present day economic environment.

In 1875, in what is today's industrial nations, almost 90 per cent of all energy used was generated through the effort of people or animals. None of the capitals of these countries had the equipment that is commonplace in modern developing nations capitals. A tremendous amount of growth happened in an incredibly short period of time. Within a hundred years, per capita output increased sevenfold which can be compared to 6,000 years of previous human endeavor (Unctad 1982: 3). This increase was in the industrial sectors as well as in the agricultural sector. While agricultural output increased, its significance in the market decreased. Prior to 1875, agriculture accounted for more than 50 per cent of market activity while industry was only about one fifth of the market activity. As nations began to transform, agriculture dropped to less than one tenth of market activity while industry rose to about half of economic activities. One factor was the tremendous increase of output per agricultural worker which reflected the contribution that technology had made in this industry. Typically, with this evolution there was a concomitant drop in agricultural workers, a pattern that even today is seen as an indicator of progress. Another historical trend was the reversal in the market between consumer goods and producer goods. During the industrial transformation of the western world there was an increase of goods being produced that would be used for the production of other goods while goods for direct consumer consumption decreased. Consumer goods production dropped from approximately two third of total industrial output to less than one third. "The reversal of the relative shares of consumer and producer goods has been a common feature of industrial transformation in nearly all the countries that are now developed (UNCTAD 1981:3)". This reversal as well as other economic indicators did not occur in a uniform manner amongst the nations rather they were based on the "domestic effort to imitate, adapt, develop and create technology (UNCTAD 1981: 4)".

These changes in economic indicators were feasible because of technological advances as well as the formation of new skills by the workforce. Skill formation was an integral part of the transformation of these economies as the following statistics point out. In 1875, only a small percentage of the school age population had access to education which was dominated by theology, law, and medicine. In the early 1900's, industrial nations had few students at the university level. Attendance ranged from 0.8 students per 1,000 population to a high of 4 students per 1,000 population. By 1975, all industrial nations had over 25 students per 1,000 population attending universities which compared to 4 per 1,000 population in developing countries (UNCTAD 1981: 5). Skill formation was essential in the interplay between science and technology which characterized western development.

Another critical factor in Western development was the shift of governments role whose primary duty had traditionally been law and order as well as defense. During this period of transformation, industrial nations encouraged government involvement in the economic development of their countries. Government activities ranged from creating necessary infrastructures which included economic planning to direct financial assistance to industry. Despite the relative youthfulness of this idea it is now assumed that government will play an integral part in the economic development of any country.

Equally significant during this time was the growth of the scientific base of these countries. Prior to 1875, relatively few people were considered scientists and only a narrow field of topics were under some kind of study. In 1976, it was reported that "90 percent of all scientists and technologists who have ever lived are living today, 90 percent are working in developed countries (Boczek 1982: 49)". Today no one doubts the importance that science has had in the development of technology and the growth of the western economies.

The history of the Western world's development has been used as a blueprint for Third World Nations. Nations progress are now measured by their per capita output, the percentage of the market dominated by production goods, government involvement in the market, how significant agriculture is in the economy as well as the level of skill formation in the country. While these benchmarks are not inclusive of all possible indicators, they do offer a stark look at the unprecedented historical growth of Western nations and provide guidelines for analyzing growing economies. Like other developing nations, PIN rely on these historical measurements to track their economic well being and progress. However, today's developing nations face challenges unique to the present time. Eventually, the free wheeling early years of invention became less flexible and less accessible as pioneer inventors strove to protect their investments and countries attempted to secure their markets. As a result developing nations now face a new set of challenges which include not only the mastery of technology and its transfer but also the successful acquisition of technology. The primary owners of technology today are the transnational corporations.

Transnational corporations are recognized as primary vehicles for the dissemination of technology. "Transnational corporations have been responsible for approximately 80-90 per cent of the technology transferred to the developing countries and much of the third world has been dependent upon transnationals for acquiring and expanding their technological development capability (UNIDO 1981: pg. 5)". This fact has many inherent problems for developing nations. First, integral to the production of goods for export and local consumption is research and development (R&D). Third World countries find it disconcerting that 95% of all R&D is done in developed countries while the remaining 5% is done in the developing nations where 70% of the world's population resides (Bozcek 1982: 1). Developing nations are technologically dependent on this R&D and must negotiate for their most basic technologies. This means dealing predominantly with transnational corporations whose priorities are considerably different than theirs. Multinational corporations are interested in research that will produce products which will eventually create profit for the corporation. One of their major markets is that of armaments which accounts for over 50 per cent of available money for science and technology in the world. The remainder of available R&D money goes to nonessential goods for resale purposes. Approximately 1 per cent of the world's available R&D money is used to address the problems faced by Third World nations (UNIDO 1981: 7). This is a classic example of the dilemma when two sides of the technology equation have different priorities and goals. Secondly, it is through R&D activities that one of the most important aspects of skill formation occurs. The ability to manipulate a technology typically comes as a result of being involved in its invention. Third World nations find themselves alienated from the process of innovation therefore their ability to develop appropriate skills is significantly hampered. This is particularly acute in the areas of engineering and design. Third, most of the industrial world has legal regimes that protect the right of transnationals to own their inventions through the patent system. Third World nations find that acquisition even of essential technology can be prohibited by this system. Fourth, transnational organizations are typically unconcerned with the development of national infrastructures. At the same time, these entities are the ones who own cornerstone technologies needed for these developments. Fifth, in several key industries such as pharmaceuticals, electrical hardware, agricultural machinery and electronics, virtual oligopolies exist. The ramifications of this for Third World Nations is that they have few choices for the suppliers of these products and these entities can drastically affect prices of commodities or even prevent access to technology. Clearly, access to technologies which are so essential to Third World development are greatly hindered by these factors yet multinational corporations also have restraints that offer obstacles to transference.

First, multinationals find themselves in situations that do not lend themselves easily to pure capitalists philosophies where profit is the only yardstick. They are attracted into foreign markets by the specter of possible profits and then are confronted with very real social issues which often result in poor financial returns. Multinationals find they are being held accountable for these issues that are traditionally not considered under their purview. Corporations are designed to address business needs and corporate goals. Despite the tremendous power intrinsic to owning most of the technology in the world these structures are poor vehicles for social initiatives. Expectations by developing nations that corporations can address their pressing social problems is not reasonable. Secondly, R&D of many technologies is a very expensive process. Corporations would be unwilling to make these investments if their right to profit from these expenditures was not guaranteed. Without the protection of the patent systems R&D would be severely affected and innovation hampered. Third, corporations do the majority of their research in their home country. This policy negatively influences the ability of Third World personnel to be part of the innovation process; yet corporations find the liability of conducting this phase outside of their home base too risky.

The issues outlined above highlight some of the constraints faced by corporations. For the successful transference of technology, both the recipient and the provider of the technology must address the needs of the other party or the process will be greatly hindered.

The gap between the goals and responsibilities of these two entities will only be reconciled through international, regional and individual efforts. This dialogue will be confronted by a group of entrepreneurs on the one hand that are driven by profit margins rather than altruism or equity; on the other hand they will have governments who discourage corporations with a plethora of rules designed to control them. Meetings by non-government groups (NGO) and governments have attempted to reconcile some of these issues and make recommendations. One of their primary suggestion is that the corporations be "good citizens" in the countries in which they are doing business. Corporations must be sensitive to the culture that they are working in, as well as support or at least be neutral in the development goals of the nations they are exporting to. It is equally important that corporations make long term investments in these countries and communicate this commitment to their employees. On the other hand, Third World governments must understand the motivation of corporations to make a profit and recoup their costs. They must also recognize that it is the host countries responsibility to establish the rules of conduct so that corporations are relegated to the role of obeying the rules rather than being expected to understand the complex needs of recipient countries. However, Third World nations must be careful not to restrict the free flow of information essential to technology transfer through unnecessarily burdensome legal regimes. Governments of developing nations must also take the initiative to establish the necessary infrastructures so that technology can be absorbed.

The most important infrastructure for development is energy. Energy consumption patterns are indicators of a countries growth. For example, developed nations consumed over 80% of the worlds energy in the 1970's yet only represented 30% of the world's population (UNCTAD 1980: 5). The total amount of energy consumed by private transportation in the 1970's by Western nations came close to equaling the total energy needs of developing nations (Ibid: 6). These patterns illuminate the fact that robust industrial economies consume significant quantities of energy. Given this fact, developing nations must pay special attention to this sector because of its pivotal influence on all other industrial sectors. Because many developing nations are in geographical locations best suited for the exploitation of solar energy particular attention should be paid to these technologies especially OTEC. Energy was a turnkey industry for all the developed nations and a technology that must be mastered for progress to occur.

Present day technology is unique in human evolution as the historical overview indicated. The owners of technology have in their possession the keys for development. The transfer of technology begins within international contexts and proceeds in a most ambiguous environment relying on a matrix of processes that can become overwhelming and chaotic. Guidelines and perceptions are the primary tools in the management of technology transfer. Following is a discussion of some of these guidelines and perceptions.

Technology Transfer

There are two primary participants in the process of technology transfer. The first is of course the entity that has the technology and secondly the entity that wants to acquire the technology. Each of these parties can be individuals, academia, corporations, governments, regional organizations or international organizations. Oftentimes there are several of these parties on each side of the transfer equation. Typically, all involved have their own agenda, priorities and capabilities. This simplistic view of technology transfer is presented because the process is exceptionally complex and there is little consensus as to the definition regarding the process or of technology itself. The following quote describes the situation.

> The technology to be transferred often is not a fully formed idea and has no definitive meaning or value; meaning is in the minds of the participants. Researchers, developers, or users are likely to have different perceptions about the technology, which affects how they interpret the information. As a result, technology transfer is often a chaotic, disorderly process involving groups and individuals who may hold different views about the value and potential use of the technology... Transferred technology is the result of an unplanned mixture of energy (participants), solutions looking for problems, choice opportunities, and problems looking for solution. The model is not unidirectional. Feedback helps participants reach convergence about the important dimensions of the technology. Both problems looking for solutions (technology pull) and technology solutions (technology push) are encountered (Williams & Gibson 1990: 16).

In today's world, much of the pulling and pushing of this process is occurring between the developed Northern nations and the underdeveloped Southern nations. The conflict between North and South has to do with the emerging idea of the new international economic order (NIEO) in which the concept of making the resources of the high seas available for the common heritage of mankind was first proposed. Through dialogue at UNCLOS, North and South wrangled over issues relevant to marine technologies, particularly deep sea mining and its related technologies, as possible high seas resources. The North objected to any mandates or suggestions that the pioneer investors (those who did the initial R&D and early exploitation of the resource) would be in any way constrained in their activities through the implementation of international legal regimes. For the North, such ideas were anathema to their political philosophies and impractical because Northern governments do not exert that type of control on business. The South, including PIN on the other hand represented the interests of countries who yearned to bring into balance the bounty of the North with the poverty of the South. They recognized the importance that technology had played in the growth of the North and understood that extensive exploitation of the sea offered them the opportunity to join this technological development from the beginning. Sea bed mining was the primary issue that prevented the United States from signing the treaty yet it was because of this issue that technology transfer became one of the major discussions at UNCLOS.

The astute understanding of these issues by the South or the Group of 77 at UNCLOS motivated them to present their position to the United Nations. They were successful in getting the adoption of a Declaration on the Establishment of a New International Order (NIEO, 1974). The following Declaration excerpt lays out the principles that would offer guidance in the transference of technology to the third world.

> ...such order should be founded on full respect for a number of principles among which are the principle of "preferential and non-reciprocal treatment for developing countries wherever feasible" and the principle of "giving them access to the achievements of modern science and technology, and promoting the transfer of technology and the creation of indigenous technology for the benefit of the developing countries in forms and in accordance with procedures which are suited to their economies"...efforts should be made "to formulate an international code of conduct for transfer of technology corresponding to needs and conditions prevalent in developing countries; to give access on improved terms to modern technology and to adapt that technology, as appropriate, to specific economic, social and ecological conditions and varying stages of

> development in developing countries; to expand significantly the assistance from developed to developing countries in research and development programs and in the creation of suitable indigenous technology. to adapt commercial practices governing transfer of technology to the requirements of the developing countries and to prevent abuse of the rights of seller", and " to promote international cooperation in research and development in exploration and exploitation, conservation and the legitimate utilization of natural resources and all sources of energy (Bozeck 1982: 17).

The Group of 77 successfully pursued this agenda through UNCTAD which has been involved in transfer issues from it's inception. Through UNCTAD the Group of 77 has promoted the creation of a Code of Conduct for transfer related issues. There has been great progress of the code but challenges presented by philosophical differences exemplifies some of the intrinsic problems of reaching an international agreement regarding technology transfer. Yet individual nations must confront these realities as they attempt to acquire the necessary technology for their development.

Another important issue for the Group of 77 is the unpackaging of technology. This is referred to throughout the literature of technology transfer because of its impact on skill formation, affordability and appropriateness of technology. Boczek defines unpackaging as "the capacity of the recipient developing country to unbundle all the components of a transaction in order to assess properly the costs and benefits of the operation (Boczek 1982: 11)". Developing nations are concerned that their inability to dissect incoming technology aggravates their dependence on developed nations for technology and inhibits the ability of developing nations to increase their capacity to adapt imported technologies to local conditions. The Group of 77 are keenly aware that skill formation and innovation are the direct result of manipulating technology. Roadblocks which inhibit their ability to unpackage and explore technologies is seen as a direct threat to their development.

While most of the participants in transfer processes are unaware of many of these issues they are nonetheless intricate parts of the discussion. Transfer participants represent a phenomenal economic activity. "Provisional estimates by UNCTAD indicate that in 1968 the direct costs (for technology transfer) of 55 developing countries amounted to about $1.5 billion and were expected to rise to $9 billion by the end of the 1970's (Boczek 1982: 59)". (Indirect costs would increase this number but firm statistics are difficult to find) For many developing countries this represents a significant percentage of their budget, so for them, this is a real economic issue not only for reasons of development but also in terms of fiscal management.

Economic realities, complex dialogues and legal regimes create the context out of which technology transfer occurs. While the process of transferring technology does not yield easily to any clear-cut procedures, there are some common elements to transfers. The following parameters to the transfer process were developed by the Council of Americas and their Fund for Multinational Management Education (de Cubas 1974: 2). They have been embellished here to include additional issues that are relevant to particular points.

First, the process of transfer is by nature a people oriented process. While the tools themselves are typically quite concrete the information flow is dependent upon that nebulous phenomenon called human relations. Bechtel corporation which has transferred technology to many developing nations considers the human element as essential to the successful transfer of technology as the actual technology. They refer to the important features of an effective consultant as one who has a supportive family, an ability to be patient, and a sensitivity to the impact technologies can have on societies. Bechtel corporation recognizes the culture shock aspect of introducing new technologies as the following quote indicates.

> The essential nature of Bechtel's technology was defined as the ability to manage complex technical input to produce results of high quality on time and on budget. To do so requires a discipline, goal-oriented management system. Introduction of such systems into a different society can often present problems of culture shock. In many societies, elements of the system are alien concepts, such as fixed working patterns, a faster-paced lifestyle, formation of working teams with shared responsibilities, checking on someone else's work, and delegation of responsibilities and authority...Successful recipients of such advanced technology transfers in addition to technology proficiency must be adaptable, have a willingness to accept new ideas, methods and systems, and have or develop the wisdom to know and acknowledge what they do not know (Shelp, Stephenson, Truitt & Wasow 1984: 165).

This quote speaks eloquently to the fact that the human element is one of the more complex parts of the process and must be fully considered. It will be humans that initiate the process and will nurture it to its full potential.

Second, technology transfer does not end once the switch is thrown on at the plant or when the training is done. Transfer continues for extended periods of time particularly in countries where the infrastructure is inadequate for the continued training needs of personnel or for the successful modification of the technology to local realities. Both sides of the equation need to have clarity regarding the duration of the transfer and the operational and maintenance needs of the future. Without such clarity projects are doomed to failure.

Third, technology transfer is multifaceted. Attempts to corral the process inevitably leads to conflicts as well as failure. There are so many avenues through which information is transferred, person to person, corporation to governments, corporation to corporation, etc. that rules and regulations that try to approach all these relations through standardization would only act to stultify the process.

Fourth, as already mentioned the process of transferring technology is very expensive. Modern technology with all of it's complexity continues to skyrocket in cost particularly for the development of new technology. This fact affects both sides of the technology transfer and can greatly inhibit the availability of a technology as well as the ability to purchase a technology.

Fifth, the transfer of technology should be built upon past experience. In the historical overview of western development, countries benefited from each others efforts which helped launch many late comer economies into the modern economic system. Developing countries of today do not have the luxury of starting from scratch. They must adapt what is available now and concentrate on making it appropriate for their situation.

Sixth, transfer of technology rarely has any similarity to pure science. While research at the university level is essential to the development of products and technologies, these entities typically do not have the necessary structures to successfully participate in technology transfer.

Seventh, the ability of the recipient to successfully absorb and use a technology is often dictated by the availability of infrastructures upon which to build. While government can hinder transfer efforts through destructive legal regimes they can also facilitate the process by actively developing industrial, educational, research, banking and legal infrastructures.

Eighth, the lack of widely accepted definitions for the process hinders successful arrangements. Terms such as patent, trade marks, brand names, etc. do not have internationally accepted definitions causing confusion and misunderstanding. Research into this topic exemplifies this point. There seems to be little international consensus about essential processes so parties on both sides of the equation must clearly define their terms to minimize misunderstanding.

These basic elements of technology transfer provide guidelines for decision making regarding the introduction of a technology into a particular market. The intricate process of a successful transference would depend on a very comprehensive implementation of these guidelines. However, it is critical that decisions regarding the introduction of cornerstone technologies or significant industrial technologies be made with these perceptions in mind. Far too often governments spend significant financial and human resources to develop goals while the technological blueprint for these goals is ignored. These blueprints are the tools used to control the introduction of critical technologies into markets. Lack of clarity regarding the natural progression of technology acquisition related to a particular goal can lead to inappropriate purchases and failed implementation of said goal.

CONCLUSION

This paper proposes that OTEC is an appropriate technological introduction to PIN because it has the potential to address the unique needs of the South Pacific. OTEC technology can be adapted to function on a small scale or a large scale depending on the desired activity. Much of OTEC hardware consists of established technologies which only require further refinement to make it competitive with existing comparable technologies. The successful transfer of this technology will rely on the right questions being asked prior to implementation and the right environment being in place for the absorption of the technology.

OTEC

OTEC will revolutionize ocean industries. Countries that have scientific, legal, social and economic infrastructures which support it's development will greatly benefit from their initiative. It is imperative that PIN consider this transformation as they ponder their future. The main question for these islands is: Can they absorb this technology? Their initial review should begin with defining what part of the OTEC technology they are considering. OTEC can offer energy independence, fresh water abundance, appropriate industries and combinations of these. Determining which options best meet their development goals and then establishing what technologies need to be imported would be the next logical step. Technology independence and the self reliance inherent to that status will increase as the PIN consider specific questions related to each OTEC option. This very process will help to ensure the development of indigenous technology intelligence regarding OTEC.

Consideration of OTEC as a source of energy would have to compare the cost of fossil fuel plants with OTEC energy plants. This comparison would need to include non-monetary issues such as energy independence, the fact that in an oil crisis these islands would be the last recipients of oil, the possibility that remaining oil reserves may not be able to support the development goals of the third world nations, and the negative environmental costs of fossil fuels. Questions regarding the financing of such a system would have to determine who would own the utility (private, public, local, international?). Costs related to the operation and maintenance of the plant would have to be projected as well as the cost related to the development of skilled labor for the technology. Using spin-off OTEC industries to offset costs should also be considered in this analysis.

Both stand alone OTEC energy plants and spin-off OTEC industries must be scrutinized with the same set of questions. These questions must review specific physical aspects of the technology as well as the broader social, political and legal issues. Careful development of the questions will ensure that clarity will pervade the decision making process. Following are only a few of the possible questions that could be considered in the adoption of OTEC technology.

Legal and political issues can either nurture or destroy the process of transfer so PIN must determine what their present situation is and make adaptations if necessary. PIN must consider what their relationship with transnational entities will be? Have they clearly defined what a good corporate citizen is by establishing the necessary laws and regulations to ensure that these entities are an asset rather than a negative influence? What type of industries will be attracted to this resource and what will the legal parameters for these industries be? What about open ocean industrial plants that will manufacture a variety of goods from clothes to energy industries. Will they be allowed to traverse the EEZ of these nation's much like commercial and military ships do today or will they have to pay a tax? What about stationary foreign owned plants within the EEZ. Will the island governments demand a percentage of sales or would this scare away investors? What if OTEC plants have components that traverse traditional fishing grounds? What if OTEC empowers members in the society that have not traditionally been politically powerful i.e. those who own poor traditional fishing grounds whose very paucity of fish make it an ideal OTEC site? How will countries monitor environmental factors of fledgling industries in experimental states? What if the implementation of a plant is destructive to rich fishing grounds yet offers the potential of replacing the loss protein as well as generate exports? While the LOS helped establish an international legal context for ocean resources each nation will need to develop laws specific to their situation. Since PIN are the quintessential location for this resource it is likely that they will be among the first to be confronted with the legal issues related to extensive exploitation of the sea. It would be very timely for PIN to begin consideration of the many legal and political facets involved in ocean industrialization.

The ability of PIN human resources to technically absorb OTEC varies widely. The vast majority of this technology is "off the shelf" so the identification of needed job skills should be feasible. What must be addressed is the inadequate number of islander ocean related scientists. PIN will need these scientists to work in ocean industries as well as evaluate, monitor and develop ocean industrial activities. Participation in the early stages of OTEC experimentation would allow for the growth of endogenous technical skills and encourage consideration of ocean studies. This participation could also lead to innovations that would make the technology more appropriate to PIN. Participation in the experimental process is more feasible now than in the future when patents, trademarks and research will be hidden behind legal doors. By participating in OTEC experimentation at this point, islanders can be a part of its development and establish those human relations so important to technology transfer. Each PIN will have to ascertain the level of technological sophistication that they are capable of absorbing. Some PIN will want personnel to become superficially knowledgeable to help guide government policies while others will want to develop a cadre of scientists or engineers to deal with technical aspects of the technology. Given that PIN have limited scientific capabilities they will undoubtedly have to rely on some of those long standing friendships as well as philanthropic organizations to begin the development of endogenous technical skills.

The international context for OTEC ownership is still very flexible. Identification of the parties involved and their present legal status will help ascertain who is most accessible in terms of sharing information and training. Answers to the following questions would pinpoint whose available for help and what constraints they are operating under. Who is doing the research? Is there technical support available for the long run? Is it the scientific community, entrepreneurs or governments that are engaged in this research? Each one will have established legal parameters that protect their efforts which means the island nations must discover under what conditions the technology is available. Who owns what patents and trade marks? Have any type of licensing agreements been made and what were the terms of those agreements? Are there individuals who own part of the technology? Which countries are doing research and what are the pros and cons of working with the different legal regimes?

Some of the most important questions are those associated with the societies that are absorbing the technologies. Are the islanders interested and committed to this technology? What part will expatriate workers play in the implementation of this industry? Will the islanders be motivated to learn the necessary skills? Will islanders be willing to commute to ocean sites for work or be willing to be on ocean vessels for extended periods of time? Will these employment patterns aggravate or alleviate existing social problems? How will the islanders deal with foreign workers? What is the availability of skills related to ship building and ocean transportation? Will industries involve night shifts and graveyard shifts? If the technology means more and better education, increased mobility, more leisure time and an improved economic environment how will the culture deal with these changes? There is no blueprint that PIN can follow that will alert them to the inevitable social consequences of OTEC technology transfer. Island governments can take the initiative to clarify cultural values and incorporate these into institutional decisions yet the decision to revere these values will in the end belong to the individuals in the society. While the area of social impact is one of the more intangible aspects of technology transfer it is possibly the most critical. Without the interests and support of the island populations few technologies become more than rusty oddities in the island landscape.

While oil is the cornerstone resource for developed nations industrial complexes the equatorial band around the world will constitute the futures cornerstone resource. It would be foolhardy to underestimate the importance of this resource and the technologies that can utilize it. Presently, OTEC is primarily in the scientific arena which has been traditionally more accessible than the marketplace. This accessibility can be a great asset for endogenous skill formation, development of important human relationships and preparation for the adoption of this technology.

The Pacific Island Nations

Economic indicators suggest that many PIN are still at the earliest stages of development. Agriculture and in particular subsistence agriculture still dominate a number of the islands economies. Few if any of these economies manufacture more production goods than consumer goods. School curriculums do not contribute to industrial skill formation and infrastructures are at the earliest stages of development. These facts are indicative of the relatively recent entry of these economies into the global market and their delayed exposure to modern technology. PIN entered the world of modern technology without requesting it. During World War II, PIN found themselves subject to some of the most advanced armaments and inventions known to humankind. From the complex science of aircraft to the deadening realities of nuclear testing, Pacific Islanders were involuntarily thrust into the world of high technology. They had little control over these advanced systems and even less ability to absorb them. It has only been within the last fifty years that these islands have begun to successfully absorb various technologies that complement their national progress. Their ability to do so is reflective of the assets available to them particularly the growing availability of infrastructures.

One of the more concrete assets of PIN is the existence of energy infrastructures in the islands. Energy plants bring electricity to the islands for industrial as well as consumer needs. While some PIN have limited electrical infrastructures, the very presence of electrical grids means these countries will not have to start from scratch should they want to expand their systems. The smallness of their systems also means that they have more flexibility should they decide to use new or alternative energy technologies.

Most PIN have established educational infrastructures through the creation of primary and secondary schools. The sophistication and quality of these systems vary widely amongst PIN. While a limited number of students advance to the higher grades the existence of such systems encourages continued development of these institutions. Through individual or government initiative PIN students also have the option of attending regional educational facilities. PIN must continue to encourage the development of necessary industrial skills through these educational systems. Technology plans can help these governments delineate what skills are needed for their specific goals and government initiatives can be implemented to fill those needs. Analysis of developed nations patterns to see what type of ratios indicate technology competence i.e. 4 engineers per 1000 population would facilitate the clarification of educational goals. The continued development of educational infrastructures is a need that exists throughout the area and will undoubtedly benefit greatly from regional solutions.

PIN have created necessary legal infrastructures through the establishment of constitutions, sets of laws and court systems. Politically, all have established their preferred forms of governance with a diverse representation of political systems throughout the area. These are the infrastructures that will exert control over the increasing number of technology imports. Marjoram indicates that imports are entering these markets at a significant rate. Marjoram states that:

> Of more importance, but less media interest is the rapidly increasing amount of technology being transferred into the region, signifying an increasing technological dependence. Technology enters the region as imports and aid. Technology imports represent around 70% of total technology transfer, with aid constituting around 30%. Technology represents about 50% of total imports-including such things as plants and machinery, fuels and transport machinery (1990: unkn).

Technology exists within an international political and legal context that does not feel the presence of these small entities. This system is a complex matrix as the following quote indicates.

> The international economic system is a complex mixture of dynamic forces, of active and potential conflict. It is characterized by unequal specialization and exchange reflected in an inequitable international division of labor. The system, with its tendencies towards the internationalization of capital and the transnationlization of production has inherent forces that tend towards the marginalization and fragmentation of the developing countries. Within this system, modern science and technology are becoming ever more hierarchical, centralized and specialization oriented. Scientific innovation and technology development are dominated by transnational structures, and very sophisticated military industrial complexes, a near global network of agro-business, and a network of universities and research institutions, all of which are highly interpenetrated and mutually reinforcing (UNIDO 1981: 21).

Given this context, alternative approaches to technology acquisition must be considered. Kakazu pointed out the advantage that these small economies have in the fact that they are completely marginalized in this international system. Using this advantage PIN could create development goals which would exist outside the parameters of the global market. Entry into the global market would be initiated only in necessary areas. An example of this is the use of alternative energy sources. Solar power technology has advanced to the point that many individuals in developed nations are choosing to be independent of the electrical grid. While this is a choice for residents in the developed nations it is a necessity for island states. Energy infrastructures that are independent from outside resources would obviously be an ideal situation for PIN but more to the point it would address the reality that PIN cannot mimic larger developing nations nor developed nations in the establishment of their infrastructures. PIN will have to independently decide what forms of technology dependence are necessary and which can be substituted with alternative options.

Transfer of technology is not the activity of academia rather it is a function of the marketplace where entrepreneurs are the main brokers of transfers. An article in Island Business called "Banking on Ideas Men" discusses the role of the entrepreneur in technology transfer.

> We can advise a government on how to work out policies to attract and regulate technology transfer. But it comes back to entrepreneurs. It is the entrepreneurs who start ventures that create livelihoods and generate revenues and as such, RCTT assists policy-makers in evolving schemes that would provide a favorable environment for entrepreneurs (1993: 44).

This reality reverts back to the fact that transnational corporations are the gatekeepers to technology advancement in the marketplace. PIN have little recourse but to accept technological packages as they are offered by these entrepreneurial entities. In response to this reality, PIN must continue to network with other developing nations. Through this activity they will best equip themselves for negotiations with transnational organizations. Through regional cooperation PIN could also establish relationships with larger developing nations that have the capability of unpackaging technologies. PIN have already proven their ability to work closely with each other as well as with other developing nations.

One of the most important tools for technology control is the creation of technology plans. Most PIN have established development goals and plans. These plans need to be complimented with a technology audit so that the goals can be implemented. The following guidelines clarify the issues that must be considered for both the development goals and the accompanying technology plan.

a) A broad consensus on the desired mix of appropriate technology and the pattern of national technological capabilities;
b) An assessment of the present status of technological capabilities and identification of gaps and shortcomings;
c) Strategy formulation in terms of policies, programmes and institutions, together with the financial and manpower resources needed for its implementation;
d) A re-assessment of the coherence of ends and means as well as arrangements for co-ordination and monitoring (UNIDO 1981: 24).

Technology plans establish a framework in which governments, private enterprises, institution, international and regional organization can effectively interact during the introduction of technology. These plans offer a blueprint for the development goals of the island nations and allow for the emergence of an endogenous technological intelligence. It will be imperative for PIN when fully exploring their ocean resources that a technology plan be developed. Without this blueprint, the development of PIN ocean industries will mimic the present pattern of inappropriate forms of dependence.

Technology will continue to enter the PIN markets with or without government oversight or planning. Government officials need to identify which of these introductions fall under the purview of government and which do not. Given the limited resources of these governments they should restrict their regulatory activities to technologies that specifically impact the economic development of these nations. By narrowing their regulatory scope PIN will find it easier to control in-coming technologies.

Technology transfer is a people oriented process. PIN are fortunate to have many long standing and historical relationships with individuals and institutions in the west where the majority of technology is being developed. These personal and professional relationships can be instrumental in not only acquiring technology but also being appraised of new and appropriate inventions. Expatriate workers can also advocate for PIN interests as well as broker transfers. It is important that these relationships remain long term since technology transfer typically occurs over many years not just when the switch is turned on.

Assets available to PIN governments will be instrumental in successful technology transfers. The continuing evolution of existing political and legal systems means that decision making has a context in which to function. PIN governments have established strong regional and international ties which give them access to many human resources. Financial institutions, industrial sectors, and educational systems exist in PIN countries although their level of sophistication is varied. All of these are critical factors in technology transfers. It is inevitable as well as imperative that technology continue to be introduced to these islands. It is as important as other development factors such as physical and natural resources, socio-cultural influences, demographics and economic conditions.

PIN must consider what economic paths they will choose and what courses they will take to accomplish these choices. As PIN governments look forward they must address the realities associated with their particular progress. PIN must understand that the analysis of issues related to technology transfer is critical to the development of skills as well as necessary in their attempts to solve their problems. Resolution of problems begins first at the identification of roadblocks so they can be addressed and overcome. Without this process PIN will be left with wish lists called development goals and no local capability to overcome challenges.

PIN vary greatly in terms of available infrastructures and this is recognized in the discussion. While some states have made great progress in establishing infrastructures such as energy, educational, legal and medical industries others are still at the most rudimentary of levels in this regard and for most these systems are not pervasive. However, whatever technology is being considered basic services such as energy, legal and political systems must be available. It is an important point that all PIN have in place the beginning systems of these critical infrastructures. Whether OTEC or agriculture are being considered the reality is PIN need to address the shortcomings in their infrastructures.

PIN are at the beginning stages of their development and all of them have a vision of where they are headed. They continue to acquire the necessary technologies to accomplish these goals. As PIN governments look forward they must address the realities associated with their particular progress. No country on the planet is exempt from the extraordinary complexity of modern technology and PIN must consider ways to access complex technologies given their limited resources. Through this process PIN will develop a technology intelligence amongst their populations and acquire technologies that are appropriate. These nations have moved in an upward progression since independence and will undoubtedly continue to do so regardless of their present situation. The reality is that these nations hold the trump card for now. With careful planning and timely initiatives they may be able to secure a place in the world economic order that allows them the autonomy they desire and the material wealth they yearn for. A race is on, although few know it and the question is: Will PIN be partners in this course to the sea and if so who will guide them there?

Bibliography

1 Actouka, Marcelino. Recommendations and Justifications for an Energy and Rural Development Research Planning Workshop for the Pacific Island Countries. Honolulu, Hawaii: East-West Resource Systems Institute, The East-West Center, 1979.

2 "Banking on Ideas Men." Islands Business October 1983.

3 Arthur Young & Company. "The Ocean: A Resource for Economic Development in Hawaii. A Report on a Survey of Ocean Science and Technology Companies' Attitudes Toward Relocation to Hawaii. " Prepared by Arthur Young & Company in Conjunction with the High Technology Development Corporation and The County Hawaii. 1987.

4 Baines, Graham. "Environment and Resources--Managing the South Pacific's Future." Ambio 13.5-6 (1984):355.

5 Ballendorf, Dirk Anthony. "American Social, Political and Economic Interests in Micronesia." Ambio 13.5-6 (1984): 294.

6 Beeby, C.D. "Extended Maritime Jurisdiction: A South Pacific Perspective." 21st Annual Law of the Sea Conference. Honolulu, Hawaii, August 3-6,1987

7 Belsky, Martin H. "The Marine Ecosystem Management Model and the Law of the Sea: Requirements for Assesment and Monitoring." 21st Annual Law of the Sea conference. Honolulu, Hawaii, August 3-6,1987

8 Boczek, Boleslaw. The Transfer of Marine Technology to Developing Naitons in International Law. The Law of the Sea Institute Occasional Paper. 32. Honolulu, Hawaii: Law of the Sea Institute, University of Hawaii, 1982.

9 Carew-Reid, Dr. Jeremy. "The South Pacific Regional Environment Program." Ambio 13.5-6 (1984).

10 Christopher, Luella S. "Pacific Island Naitons: Overview of Trends and Problems in the South and West Pacific." Wash. D.C., Congressional Research Service for congress, 1989.

11 Cole R.V. and Somsak Tambunlertchai, The Future of Asia-Pacific Economies: Pacific Islands at the Crossroads? , Pub. Asian and Pacific Development Centre, National Centre for Development Studies, Canberra, Australia, 1993.

12 Cole, R.V. and J.G. Parry eds. Selected Issues in Pacific Island Development. National Centre for Development Studies. The Australian National University. Canberra, Australia, 1986.

13 Connell, John. "Islands Under Pressure-Population Growth and Urbanization in the South Pacific." Ambio 13.5-6 (1984): 306.

14 Council on Ocean Law and the Law of the Sea Institute, "The Persian/Arabian Gulf Tanker War: International Law or International Chaos. Transcript of an Evening Panel Discussion sponsored by Council on Ocean Law and the Law of the Sea Institute" Wash., D.C., 1988.

15 Craven, John. "A National Ocean Resource Laboratory: A Concept Paper." Honolulu, Hawaii: Pacific International Center for High Technology and Research. 1989.

16 Craven, John. The Management of Pacific Marine Resources: Present Problems and Future Trends. Westview Special Studies in Ocean Science and Policy. Boulder: Westview Press, 1982.

17 Craven, J.P. "Technology and the Law of the Sea." Louisiana Law Review Vol 45 (1985): pg 1143-1159

18 Crocombe, Ronald G. Co-operation Involving Pacific Island Nations city: ESCAP, ca. 1980.

19 Dahl, Arthur Lyon. "Biogeographical Aspects of Islolation in the Pacific." Ambio 13.5-6(1984): 302.

20 Dahl, Arthur Lyon. "Oceania's Most Pressing Environmental Concerns." Ambio 13.5-6 (1984): 296

21 de Cubas, Jose. Technology Transfer and the Developing Nations. New York: Council of the Americas and Fund for Multinational Management Education, N.Y., 1974.

22 Fairbairn, Ian Te'o. "The South Pacific Least Develped Countries: Develpment Problems and Prospects. A Synthesis Paper. Intergovernmental Meeting on the ESCAP Least Developed Countries, in Preparation for the United Nations Conference onthe Least Developed Countries." Bankok, Thailand: Economic and Social Commission for Asia and the Pacific, 1990.

23 Fairbairn, Te'o I.J. "Pacific Island Economies: Development Issues and Growth Possibilities. Conference on ASEAN and the Pacific Islands." Honolulu, Hawaii: East-West Center, 1987.

24 Fisk, E.K. "Economic Classification of Pacific Developing Countries."

25 Fosberg, F.R. ed. Man's Place in the Ecosystem. Symposium held at the Tenth Pacific Science Congress of the Pacific Science Association, Honolulu, Hawaii: Univerity of Hawaii Press, 1963.

26 Global Community Forum "Background Document No. 1 Pacific Cooperation and Devleopment." Global Community Forum. Apia, Western Samoa, 1987.

27 Goodenough, Ward Hunt. Cooperation in Change. New York:Russell Sage Foundation, 1962.

28 Gopalakrishnan, Chennat, ed. The Emerging Marine Economy of the Pacific. Ann Arbor: Butterworth, 1984.

29 Gunasekera, Dr. Hitihamy M. "Fiji, Energy in the ESCAP Region: Policies, Issues and the Potential for Regional Co-operation." United Nations Development Papers 4. Bangkok, Thailand: Economic and Social Commission for Asia and the Pacific, 1984.

30 Hamnett, Michael. "Critical Issues in Pacific Island Development." Honolulu, Hawaii: Pacific Island Development Program, East-West Center, 1984.

31 Hau'ofa, Epeli. "Pacific Islands in the Year 2,000: The Future of our Past." Suva: University of the South Pacific, Department of Sociology

32 Heine, Adio. "Urbanization and Social Change in the Marshall Islands." Ambio 13.5-6 (1984): 313.

33 Inouye, Senator Daniel. "The American Blue Revolution: A Solution for the 21st Century." Sea Technology. September 1992

34 Institute of Pacific Studies. "The Pacific Islands in the Context of the Pacific Basin. Global Community Forum. '87" Suva, Fiji: University of the South Pacific, 1987.

35 Johnson, Peter. "Energy Use and Resources in the Pacific." Ambio 13.5-6 (1984): 322

36 Kakazu, Hiroshi. "Trade and Development of Small Island Economies with a Particular Emphasis on the South Pacific" Working Paper Centerwide Program. Honolulu: East-West Center, February 1984.

37 Kiste, Robert C. Dr. "Economic Security Issues in the South Pacific." Prepared for Symposium on Pacific Basin Security: Economic Dimension. Wash. D.C.: National Defense University, Feb. 14-15 1986.

38 Koh, Ambassador Tommy. "The International Implications of Extended Maritime Jurisdiction in the Pacific." 21st Annual Law of the Sea Conference, Honolulu, Hawaii, The East-West Center, Aug. 3-6, 1987.

39 Kotobalavu, Jioji, "Extended Maritime Jurisdiction in the Pacific Maximising Benefits form Marine Resources." 21st Annual Law of the Sea Conference, Honolulu, Hawaii, The East-West Center, Aug 3-6, 1987.

40 Krock, Hans-Jurgen ed., "Ocean Energy Recovery. First International Conference ICOER '89." Honolulu, Hawaii: American Society of Civil Engineers, 1989.

41 Lal, Padma Narsey. "Environmental Implicaitons of Coastal Development in Fiji." Ambio 13.5-6 (1984): 316.

42 Lomont, Diana. "Keahole Point: Where Salty Profits are in the Works." Hawaii Investor May 1990:13.

43 Loupe, Diane. "The Food Factor." pg 22-27.

44 MacDonald, Craig D. and Howard Deese. "Hawaii's Ocean Industries: Relative Economic Status." Honolulu, Hawaii: State of Hawaii, Department of Business and Economic Development, Ocean Rsources Branch, 1988.

45 MacDonald, Craig D. and Howard Dees. "A Typology and Portfolio Model of Hawaii's Ocean Industries." 12th Annual Oceans Conference, Halifax, Nova Scotia, Canada. September 28-October 1, 1987. Department of Planning and Economic Development, Ocean Resources Branch.

46 MacDonald, Craig D., et al. "Strategic Market Planning for Hawaii Ocean R&D: Comparative Rating and Industry Potential." Honolulu, Hawaii. State of Hawaii, Department of Business and Economic Development, Ocean Resources Branch, 1991.

47 MacDonald, Craig D., and Andrea LaBarge. "Ocean R&D Spending Patterns in Hawaii: An Analysis and Outlook.", Honolulu, Hawaii. State of Hawaii, Department of Business and Economic Development, Ocean Resources Branch, 1990.

48 Mackensen, Gotz and Don Hinrichsen. "A New Pacific." Ambio 13.5-6 (1984):291.

49 Marjoram, Tony. "Technology Transfer in Pacific." Search, June 1990

50 Marjoram, Tony. "Small is Beautiful? Technology Future in the Small-Island Pacific." Futures, May 1991:373.

51 Marsh, James Barney, Mary Ann Barnard, et. al, "OTEC Implementation in the U.S. Pacific Islands." Honolulu, Hawaii:Marine Program, University of Hawaii, 1980.

52 Matsumoto, Walter. "Potential Impact of Ocean Thermal Energy Conversion (OTEC) Operation on Fisheries." Honolulu, Hawaii: S.W. Fisheries Center, National Maine Fisheries Service, National Oceanic and Atmospheric Administration, 1984.

53 McKinley, Dr. Kelton, "U.S. Ocean Resources 2000: A National Plan for Growth, Revitalized Effort Calls for Sustainable Development to Stimulate Economy, Create Jobs, Realize Ocean Potential." Sea Technology. September 1992: pg. 10-23

54 Mitsue, Tsuneo, et al. "Outline of the 100kw OTEC Pilot Plant in the Republic of Nauru." NY.NY, IEEE Vol PAS-102, No.9, September 1983.

55 Moala, Jale. "The Sun's the Way to LIght Island." Island Business February 1989:56.

56 Narakobi,Camillus S.N. "The Law of the Sea and the South Pacific." Ambio 13.5-6 (1984):372.

57 National Oceanic and Atmospheric Administration,"OTEC Final Environmental Impact Statement." U.S. Department of Commerce, NOAA, Office of Ocean Minerals and Energy, 1981.

58 Naya, Siji. "The Asia-Pacific Region: Opportunities for Trade and Investment." Background Paper for Governor's Congress on Hawaii's International Role. Honolulu, Hawaii. December 6-7, 1988.

59 Neudecker, Steve. "Effects of Thermal Effluent on the Coral Reef Community at Tanguisson." Technical Report 35: University of Guam, Marine Lab, 1974.

60 Noda, Edward, Paul Bienfang and David Ziemann. "OTEC Environmental Benchmark Survey of Keahole Point, Hawaii." Honolulu, Hawaii. University of Hawaii, Hawaii Natural Energy Institute, 1980.

61 Nordquist, Myron and Choon-ho Park, Reports of the United States Delegation to the Third United Nations Council Conference. Law of the Sea Institute Occasional Paper 33, University of Hawaii: Honolulu, Hawaii, 1983.

62 Olsen, Stephen "Recent Developments in Ocean and Coastal Management." Elsevier Applied Science Publications Ltd., England. Vol. 11, No. 1, 1988: pg. 91-99

63 Pacific International Center for High Technology Research, "A Preliminary Assessment of the Feasibility of Employing Ocean Thermal Energy Conversion Technology on Kiritmati (Christmas) Island in the Republic of Kiribati." Honolulu, Hawaii: PICHTR, 1990

64 Panchal, C.B. and K.J. Bell. "Simultaneous Production of Desalinated Water and Power Using a Hybrid-Cycle OTEC Plant." Transactions of the ASME, May 1987:156.

65 Penney, Terry and Desikan Barathan

66 Pernetta, John C. and Lance Hill. "Traditional Use and Conservation of Resources in the Pacific Basin." Ambio 13.5-6 (1984):359.

67 Pulea, Mere. "Environmental Legislation in the Pacific Region." Ambio 13.5-6 (1984):369.

68 Rizer, James. "Factors Affecting Technology Choice Decision-Making in the South Pacific." Suva, Centre for Applied Science Studies in Development, University of the South Pacific, November, 1981.

69 Roughan, Dr. John. "Industrialization? In a Nation of Villages!" Conference on Industrialization and Economic Development of South Pacific Island States: Problems and Prospects. Dept. of Economics of the University of the South Pacific . Suva, Fiji. 1988.

70 Ryzin, Dr. Joseph Van and Tore Leraand. "Air Conditioning with Deep Seawater: A Cost-Effective Alternative." Sea Technology. September 1992.

71 Shand, R.T. and Brookfield. The Island States of the Pacific and Indian Oceans: Anatomy of Development. Australian National University Monograph. Canberra: Australia. No. 23. 1979.

72 Shand, R.T. "Island Smallness: Some Definitions and Implications." Paper presented for the 1979 Development Studies Centre Conference of the Australian National University, Canberra, Australia. May 1979.

73 Shelp, Ronald Kent, et al. Service Industries and Economic Development: Case Studies in Technology Transfer. New York: Praeger Publications, 1984.

74 Siwatibau, Suliana. "Traditional Enviromental Practices in the South Pacific: A Case Study of Fiji." Ambio13.5-6 (1984): 365.

75 SERI: Solar Energy Research Institute. "The Potential of Renewable Energy: An Interlaboratory White Paper. Prepared for the Office of Policy, Planning and Analysis, U.S. Department of Energy, in support of the National Energy Stratecy." Golden, Colorado: Solar Energy Research Institute, 1990.

76 Tagupa, William. "Oceania and the Law of the Sea: Prospects, Proposals and Problems for the Pacific Islands." 21st Annual Law of the Sea Conference, Honolulu, Hawaii, The East-West Center, August 3-6, 1987.

77 Takahashi, Patrick, and Richard Matsuura, "Blue Revolution, Keynote Address." Proceedings of the First International Workshop on Very Large Floating Structures, (VLFS) '91. Honolulu, Hawaii. April 24-26, 1991.

78 Takahashi, Patrick K., and Andrew Trenka. "Ocean Thermal Energy Conversion: Its Promise as a Total Resource System." Energy , 17.7:657. 1991.

79 Thatcher, Peter. "The South Pacific, Wave of the Future." Ambio 13.5-6 (1984):384.

80 The East-West Center, "Concluding Remarks and Background Papers. Summit of the United States and the Pacific Island Nations." Honolulu, Hawaii, The East-West Center Pub., 1990

81 The East-West Center," Pacific Islands Conference: Development the Pacific Way, Proceedings." Honolulu, Hawaii: East-West Center, Pacific Islands Development Program, March 26-29, 1980.

82 Thomas, Anthony and David Hillis. "Hybrid Cycle Adds Potable Water to OTEC Areas in Short Supply: Design-Study Phase Concept Combines Open and Closed Cycles of Ocean Thermal Energy Conversion." Sea Technology October 1989:

83 Thomas, Anthony and David Hillis. "Ocean Thermal Energy Conversion: An Update." Sea Technology October 1991:19.

84 Tsamenyi, B. Martin. "The Exercise of Coastal State Jurisdiction Over EEZ Fisheries Resources: The South Pacific Practice." Amib 17.4 (1988):255.

85 Udui, Elizabeth S. "Socio-Economic Study of the Kingdom ofTonga." Second Year Report for the Pacific Islands Multiple-Product OC-OTEC. Honolulu, Hawaii. Pacific International Center for High Technology and Research, 1989.

86 United Nations Conference on Trade and Development. "Major Issues Arising from the Transfer of Technology to Developing Countries." Geneva: UNCTAD, 1975.

87 United Nations Conference on Trade and Development Secretariat. "Planning the Technological Transformation of Developing Countries." Geneva: UNCTAD, 1981.

88 United Nations Conference on Trade and Development,"Renewable Energy Technology: Issues in the Transfer and Development of Biomass-Ethanol Technology." UNCTAD, 1985.

89 United Nations Industrial Development Organization. "Technological Self-Reliance of the Developing Countries: Towards Operational Strategies. Development and Transfer of Technology," 12. Vienna, Austria: UNIDO, 1982.

90 United Nations Industrial Development Organization. Selection of Technology: Guidelines for Evaluation of Transfer of Technology Agreements. Development and Transfer of Technology, 12. New York: United Nations UNIDO. 1979.

91 United Nations Economic and Social Council. "Technology for Development." Tokyo: United Nations ESCAP. April 17-27, 1984.

92 United Nations Economic and Social Council. "Escap Co-operation Involving Pacific Island Nations."

93 Uwate, K. Roger. "Market, Technical, Financial, Economic and Organizational Considerations for Preparing Aquaculture Feasibility Studies in the Pacific Islands Region." Honolulu, Hawaii. Pacific International Center for High Technology and Research. 1990.

94 Uwate, K. Roger and Peniasi Kunatuba. "Aquaculture Development: The Pacific Way." Fifteenth Regional Technical Meeting on Fisheries. Noumea, New Caledonia. Honolulu, Hawaii. The East-West Center, Pacific Islands Development Program, 1983.

95 Uwate, K. Roger, et al. "A Review of Aquaculture Activities in the Pacific Islands Region: General Overview by Political Entity." Honolulu, Hawaii: THe East-West Center, Pacific Islands Development Program, May 1984.

96 Vega, Luis A., Ph.D. "Eonomics of Ocean Thermal Energy Conversion (OTEC)." Pacific International Center for High Technology and Research. 1992.

97 Williams, Federick and David Gibson, eds. Technology Transfer: A Communication Perspective. Newbury Park, California: Sage Publications, 1990.

98 Wilson, T., A. Bhargava and S. Hoffman. "Optimization Model for a Mariculture System Utilizing OTEC Cold Seawater." Honolulu, Hawaii: Pacific International Center for High Technology and Research. 1989.

99 Yamashita, Yoshiko. "Numerical Solutions for the Dispersion of Cold-Effluent into the Thermally Stratifies Ocean Environment." Dissertation. University of Hawaii, 1980.

100 Yuen, Paul. "Ocean Thermal Energy Conversion: A Review." University of Hawaii, Hawaii Natural Energy Institute, 1981.

101 Wace, Nigel. "Exploitation of Some of the Advantages of Remoteness and Isolation in the Economic Development of Pacific Islands." See Shand.