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Economically Complementary, Ecologically Balanced, On-Shore/Off-Shore Industrial Clustering*

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ABSTRACT

The paper discusses the benefits of maximizing interindustry cooperation based on input-output analysis. Output is composed of product and waste. Assuming product is fully utilized by the market, maximization occurs when input use is maximized and waste is reduced. By matching industries that use each other's inputs and wastes, the industries reduce private economic and public ecologic costs. The matching reduces and shares input costs, creates products from wastes, and creates a more closed ecologic system with less external effect.

Some industries' ecologic costs are so high that they have investigated off-shore sites, but the economic cost for one industry is usually too great and the ecologic cost may still be too high. However, industrial clustering may reduce these costs enough to make off-shore sites practical.

Recycling Wastes

The next step in industrial planning is the economically complementary, ecologically balanced, on-shore/off-shore industrial complex. This approach to industrial clustering is based on recycling industrial wastes.

The latest concept to cope with externalities is the industrial park. While encouraging industrial ratables, it not only limits the effects of industrial externalities to the industrial site and more efficiently provides the infrastructure necessary to control the externalities, but also reduces the effects of the visible externalities within the site itself by introducing

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natural and leisure amenities—the opposite appointments of a factory—onto the site. This approach, although an important improvement in working conditions, is largely cosmetic. Industry is still producing the same amount of wastes which the public must dispose of.

Industrial output is presently dealt with in two ways. The usable outputs—*the products*—of the processes are sent to the market for sale. The unusable outputs—*the waste externalities*—are sent to the public domain for disposal. When industries cluster, they do so to maximize the benefits of their usable outputs. Similarly, cities encourage industrial clustering to minimize the costs of treating industry's unusable outputs (externalities) and to increase taxes. Both groups are saddled with the cost of externalities, whether through taxes, cost of infrastructure, or political opposition to industry and public utilities. But both groups can increase benefits and decrease costs by recycling wastes in ways that make a waste output of one process a usable input of another process. Wastes thereby become products worth considering when clustering industries. Assuming the cost of recycling is less than the combined costs of input and disposal, industries and cities can save money; and whichever handles the recycling process can at least reduce the cost of disposal, if not make money. In this way we can achieve a more economically-complementary and more ecologically-balanced industrial complex which can more satisfactorily prevent externality problems of even heavy industry.

Some industries are being squeezed between demand for their products and objections to their wastes. Examples of these industries are air transportation and electric power generation. Recently, separate proposals for solving airport congestion and electric power demand have suggested building an appropriate facility on an off-shore island. The principal reasons for this suggestion have been the inability to acquire sufficient land conveniently near serviced urban centers, and residents' objections to possible pollution. Airports and electric generating plants (nuclear-powered), however, are not the only urban facilities that stir the ire of their potential neighbors. With both on the same island, these build-it-somewhere-else operations, as well as operations that are advantageously located on or near an island—and that complement the island complex—can better support the development and maintenance of such an island, service the shore, and service each other. For example, several financial sources can better afford the cost of jointly developing an island than a single-function authority. Also, an island complex of complementary operations can use one operation's discharged waste as inputs for other operations and can thereby reduce costs and strive for a balanced ecology.

More specifically, capital costs can be reduced by the use of the waste heat from an electric generating plant (nuclear-powered) for heat-consuming operations that otherwise require their own heat-generating plants because of the difficulty in transporting this kind of energy in the required quantities. This reduced cost factor can help put the cost of some operations and their externalities into more competitive positions with existing operations and their externalities. For example, the total cost of desalinating sea water becomes more competitive with the total cost of extending the watershed.

Using the same example, conservationists have pointed out the harm to the local ecology of overheating a stream or river with the heat discharged by a nuclear-powered electric generating plant. The entire ecology of the area may lose its checks and balances and run amuck because of the rise in temperature of the water. Moreover, all of the expelled heat is lost. The heat is not only wasted, it can be destructive. But using the waste heat to help operate other facilities *reduces* the demand of heat required to run these facilities if powered by separate power plants, and thus reduces the ecological disruption and helps maintain an ecological balance in the area. If reuse of waste is a consideration in the combination of facilities that composes the island complex, and what little waste must be discharged is treated and controlled, the island can operate with minimal ecological disturbances.

But reuse of waste products does not always reduce the amount of waste we must dispose of. For example, waste heat from one process may be used in another process without being consumed or converted to a more disposable form. The reuse, however, can create enough benefits to afford the cost of proper disposal.

There are five ways in which the problem of disposing of waste matter and energy can be reduced:

1. Find a process for which waste is an input. This is the idea of complementary facilities in which waste becomes useful; e.g., use the heat from an electric generating plant to desalinate sea water.
2. Change the physical state or physical composition of waste matter into useful or more easily disposable states or composition; e.g., compress solid waste into bricks.
3. Change the chemical composition of waste matter into useful or more easily disposable material; e.g., extract useful minerals from waste.
4. Change the form of waste energy into useful or more easily disposable form; e.g., convert heat to electricity.
5. Change waste matter to useful or more easily disposable energy, and vice-versa; e.g., use solid waste for fuel, the waste products of which can be controlled.

The coordination of processes that perform the above functions is the basis of a multiple-facility complex. The removal of such a complex to an off-shore island is an additional precaution against the imperfect absorption of waste output as useful input (e.g., reused heat remaining after desalinization), and the imperfect control of anti-social effects of production (e.g., pollution and safety hazards). These imperfect capabilities sometimes are expressed as local opposition to any one of such facilities. (Removal to an off-shore island may not be necessary if these capabilities are not greatly deficient and the public can be so convinced.) The character of the facilities included in the complex (e.g., input-output interdependency and safety requirements) and the location of the complex on-shore or off-shore are interdependent, one helping to determine the other, particularly with regard to the facilities included because of the location (e.g., seaport).

The island ecology may be somewhat unique, but it can be balanced internally and can be relatively harmless, even beneficial, externally. The meaning of complementary facilities, then, is the joint use or reuse of inputs, products, and wastes. The advantages of complementary facilities are economic and ecological.

OFF-SHORE ISLAND

A multiple-use, off-shore island can include some or all of the following facilities:

1. Airport
2. Nuclear-powered electric generating plant
3. Desalinization and mineral-recovery plants
4. Large-vessel seaport and storage facility
5. Sanitation facility: sewage treatment plant, land-fill operation, and oil clean up facility
6. Sea farms
7. Ecological and marine research laboratory
8. Transportation structure: shore-to-island tunnel for high-speed mass and freight transit, pipelines, and electrical lines

Airport

On the surface of the island would be an airport. Served exclusively by mass transportation between the island and centrally-located terminals on the shore, terminal facilities on the island may be kept to a minimum via direct plane-train access.

Nuclear-Powered Electric Generating Plant

Beneath the surface of the island would be a nuclear-powered electric generating plant. This facility supplies electricity to the other island facilities and to the shore. The heat generated by the conversion process would be used to heat the island facilities: to provide the airport (and perhaps the rest of the island) with year-round dry and ice-free runways, service roads, and pedestrian paths; to control ice formation at the harbor entrance and the island port; to evaporate ocean water from brine; to separate minerals in the brine residue; and, possibly, to extract minerals from the sanitation waste.

Desalinization and Mineral Recovery Plants

A desalinization plant on the island would supply pure water for the island and the shore, and cooling water to control the indoor climate of the facilities and to cool the nuclear-powered electric generator on the island. In addition, a mineral recovery plant would extract minerals from the brine residue of the desalinization process and, perhaps, from the sanitation waste. Heat and electricity for these operations, as for all operations on the island, would be obtained from the nuclear-powered electric generator. The sanitation facility would also maintain the capability of containing and cleaning up oil and other liquid leakages of the large ocean vessels and the underwater storage tanks of the seaport complex.

Large-Vessel Seaport and Storage Facility

The new island offers the opportunity to build a large-vessel seaport to accommodate the new, giant fuel tankers. Storage tanks may be underground or underwater, at the island or on the shore at existing facilities. Pipelines between island and shore would serve to transport the fuel to processing plants.

With tanker port and storage tanks at the island, docks and storage facilities would not compete on shore with other uses of the shoreline, tank farms would not rise on the horizon, and possible oil leakage would be buffered from the shore by distance, provisions at the island waste water treatment plant, and a runway extension.

Another possibility is provision of a staging area for the recently developed "piggy-back" system. In this system, truck trailers or other container units delivered by the mass transit system or by small river barges are placed aboard larger ships for oceanic transport or removed for dispersed delivery via rail or shoreline and inland waterways. The barge system perceives a barge as a containerized unit.

Sanitation Facility: Sewage Treatment Plant, Land-Fill Operation, and Oil Cleanup Facility

Many regions are faced with a lack of land-fill areas. In this proposal, the island and its extensions could be built of land-fill. Treated sewage, or extracted solids in containers, if necessary, could be buried in the land-fill of the island or dropped farther out at sea. Once completed, a treatment plant on the island could process sewage that was brought there by barge, pipelines, or train. A floating island loses the advantage of creating a disposal area for sanitary land-fill. However, it still can serve as a treatment and shipping center for waste disposal at sea.

Many cities are quickly running out of land-fill sites. An off-shore island could provide coastal cities with a large, new site for several years. In addition, the new sanitation facility would continue to solve part of the waste disposal problem after the island was completed. Undertreated wastes, including raw sewage, are now dumped at sea, creating biologically "dead seas" off-shore. These wastes could be processed by the sewage treatment plant and/or shipped in containers to guarantee ecological harmony of ocean disposal. Moreover, waste disposal could utilize the transportation facilities of the island.

If the waste is brought to the island sanitation facility by train, the train would travel to the island in the same tunnel as the airport high-speed mass transit, leaving the route at or before each end of the trip for the sanitation facilities. The heaviest schedule would probably be at night to complement air travel schedules and to make maximum use of the tunnel.

The sanitation facility could also handle any extensive oil or other liquid leaks from the large tankers and from the storage sea tanks. Any spillover from normal port operations would be handled by the port. Because of this mop-up capability to protect the ecology, the sanitation facility and the seaport would be located next to each other.

Sea Farms

The various temperatures possible near the island—the natural range of the sea from its surface to the bottom and the local warmth caused by excess heat discharge of the nuclear-powered electric generator—create the possibility of farming a variety of sea foods, both animal and vegetable, if radiation in the water can be controlled. Perhaps even native southern seafoods could be grown in a northern climate in the warm water around the island, and sold regionally. Here would be a source of fresh seafood—seafood that otherwise could only be obtained frozen for a comparable price. Another possibility is the cultivation of foreign seafood staples that are or will be finding their way into the American diet, for example, algae and ground fish flours.

Ecological and Marine Research Laboratory

Continuous inspection and research of the ecology of the island and the surrounding area should be a part of the operation of the island complex to insure safety to man and nature. Moreover, some islands may be locations of such interesting natural and human activity in relation to the marine environment that a marine and underwater laboratory may be included in the island complex. To facilitate its work the laboratory might include port facilities for floating and crawling underwater research vehicles.

Transportation Structure

The kinds of transportation between the shore and the island are dependent on the transport requirements of the facilities included in the complex. For the full complex of facilities described the island will probably have to be connected by one or more tunnels for high-speed mass transit, pipelines, and electrical lines. Other pipelines and electrical lines may be laid outside the tunnels for other purposes and destinations. For other groupings of facilities, less sophisticated transportation may do. If, for example, the airport is excluded from the complex, a personnel ferry may substitute for high-speed mass transit. Tunnels, then, may not be justified for freight alone and freight may also move only over water.

Authority

Some or all of these facilities may be included in planning the island. The complex, however, should be developed and operated by a single authority. Whether the developer and operator is the same authority should be worked out within the regional political structure.