Total Transportation and the Development of Evaporite Deposits

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ABSTRACT

Transportation is a major partner of yours in the evaporite industry. Whereas Federal income taxes merely take 50 percent of your firm's profits, transportation cost may take 50 percent of the gross realization—selling price plus transportation—on your product, f.o.b. customer's plant.

Too often corporate management accepts freight charges as an uncontrollable cost despite the fact that for most evaporites these costs equal or exceed the selling price. You need to know that transportation is influenced by many decisions at many levels in a company and progress in reducing these costs requires crossing corporate organization lines. Answers to profit improvement can be found the same way for both large and small shippers through detailed quantitative and qualitative analysis of the Total Transportation System.

Far too many producers believe there is nothing they can do about cutting the costs of moving their goods. This is false! The answers to lowering transportation costs are found the same way for small shippers of a few thousand tons as well as for shippers of millions of tons. The key is to study all the costs from the production point to the consuming point; this means total systems analysis from source to use.

Such analysis can be called Total Transportation because it examines and analyzes transportation cost per se and all the areas that influence transportation cost. These include:

SALES . . . policy and practice

PURCHASING . . . policy and practice

PRODUCTION . . . scheduling and operation

INVENTORY CONTROL

MATERIAL HANDLING

PACKAGING

STORAGE AND WAREHOUSING

TRANSPORTATION . . . inbound and outbound

PLANT LOCATION

The systems concept requires monitoring the Total Transportation picture continuously with a "wide angle lense" even while narrowing the focus with a "zoom lense" to look separately at particular detail. Our view of Total Transportation conforms closely to one definition of the newly emerged field of corporate specialization. "Physical Distribution," except that we include inbound as well as outbound movements.

Physical Distribution has been defined as "the key link between manufacture and demand creation, activities, whereby the proper amount of the right kind of product is put at the place where demand for it exists at the time it exists." As a linking process it is obvious that coordination between many functional and staff activities in a corporation is necessary if distribution costs are to be included to maximize profit.

Mineral industries managements have tended to be myopic in seeking to improve their profits by concentrating the vast bulk of management resources on reducing production cost. The operations researcher would explain that they are attempting to optimize a sub-system. He would also point out that it is extremely unlikely that optimization of a sub-system will result in the simultaneous optimization of the total system. Stripped of

'on, he is saying you can make more money if : integrate transportation planning with all management planning in your company.

t of delivered cost.

Aanagement ignores at its peril transportation t. A.E. Cascino, vice president of International ierals and Chemical Corporation, recently gave example of why top management in his firm is icerned with distribution: "The price of a ton rock, f.o.b. mine, is about $7. The cost of wareising, freight, and handling frequently totals an litional $11... If one of our competitors ... :overs a way in which he can cut his distribu- costs by $3, we're dead! Even if we wanted to set our competitor's more efficient means of pping with reduced f.o.b. price for our prod- —we don't have that much profit margin. ... "

Transportation costs are influenced by many de- ons, at many levels of a company, and progress :educing these costs requires crossing corporate anization lines. Transportation myopia afflicts ny managers, planners, analysts, and other staff sultants including geologists. Too often this big- t cost of getting a mineral to a customer is rele- ed to a few brief telephone calls to solicit rate ormation from a railroad, a ship broker, or a ;e lime operator. No thought is given to plan- g the Total Transportation System that is in- ved.

The absence of attention to transportation costs lains why corporate-wide cost reduction drives profit improvement programs are seldom suc- sful in reducing transportation costs. What is cing is not the opportunity to improve profits, the imagination and the audacity to find and lement profit-producing ideas in the transporta- area. The same aggressive top management t finds profit improvement in the production will increase profits again when they pursue concept of Total Transportation with the ob- ivity and attention that is now lavished on pro- tion and marketing.

As an example, potash formerly was delivered d in both ends of an ordinary box car. It takes , mobile equipment, time and spillage before customer has potash ready to put into a vat to ce a fertilizer slurry, the first step in his produc- process.

Several firms took a long look at the common car and came up with the "sparger" car. It ies twice as much dry potash as a standard box It is unloaded by connecting a saturated brine e and the lading comes out of the unattended car as a slurry ready for use. But that's not all. IMC owns the cars and can deliver potash to the customer at a lower transportation cost than if box cars were used.

Plant location.

Development of new reserves of evaporites and location of new plants for processing have minimized distribution costs as a prime consideration. Some industries such as salt will tend to minimize this category of cost by locating all processing at the mine. Others such as gypsum producers will often locate processing plants near markets because it is preferable to ship raw material rather than finished gypsum board. Other minerals may be assembled at some intermediate point and shipped from there.

The geological conditions required for the creation of evaporite deposits were such that there are relatively few locations where these materials can be produced competitively. Salt is more ubiquitous than other evaporites due to the large areas of industrialized nations underlain by salt beds and the fact that solar salt can be produced in many of the developing countries. Because salt from certain locations can be produced at extremely favorable prices, transportation costs provide a competitive weapon in this sector of the evaporite industry. If the Total Transportation System can be worked out satisfactorily, the remote location may in the future be developed in preference to a nearer source.

Low cost, well planned transfer terminals.

National Bulk Carrier's transfer station on Cedros Island is an example of an installation that is part of a Total Transportation System. In this system that moves solar salt from Mexico to markets in Japan, low cost transportation is the essential ingredient that makes this project an economic success. The salt is moved about 60 miles from Black Warrior to the Cedros Island transfer station by barge, then by large ocean vessel to a second transfer station in Japan, and then to the user in Japan by small vessel or barge. A back haul of oil from the Persian Gulf to California was a significant part of the original concept.

The transfer station equipment is semi-automated, requires only a minimum of manpower yet handles fairly sizable tonnages with a relatively modest capital investment. As you know, this low cost operation has altered the economics of salt supply as a raw material for the chemical industry in the Washington, Oregon and British Columbia area.

A similar transportation plan has supplied gypsum rock to the East Coast wall board plants for almost 15 years. Skaarup Shipping Corporation has had the *Melvin Baker* on time charter to the National Gypsum Company for that period. The ship shuttles between a Nova Scotia bulk loading facility and the company's several plants along the East Coast of the U.S. Both sets of installations are designed to achieve the lowest cost capital investment and still achieve high productivity.

Range and comparison of costs.

In a paper "The Cost of Transporting Ores and Raw Materials in World Markets," Phil Maddex presented some information on the relative cost of the several modes of transportation. The lowest cost transportation plan will very likely use a combination of several transportation methods. The costs shown in Figure 1 will provide a "feel" for the cost of each mode. It also shows that there is a wide range of cost that may be paid for each mode. For example, Figure 1 shows two interesting things about ocean transportation . . . (1) it provides the cheapest type of transportation, and (2) it has a range from 0.3 to 10 mills per ton-mile. In other words, you might pay 30 times more than necessary by doing it the wrong way. Again, it shows how important the consideration of transportation costs may be to the development of evaporite deposits.

Mode	Mills/Ton Mile
Ocean Shipping	.3 - 10
Pipeline	1.5 - 10
River Barge	2 - 4
Rail	4 - 15
Truck	55 - 70
Air Freight	120 - 200

Figure 1.

Lowest costs are usually achieved when a back haul can be provided, such as the movement of bulk borax from California to Northern Europe in vessels chartered to Wolkswagen Werk that carry automobiles from Northern Europe to California.

Capital utilization.

Historically, freight rates have been based on the concept, "charge what the traffic will bear." This principle was applied to all forms of transportation, both water or land, and to regulated and non-regulated freight. This philosophy is not unique to transportation, but the dependency of the shipper on the transportation service did not encourage the application of industrial engineering principles to reduce charges to shippers.

The early U.S. laws were drawn to protect the small shipper. For the railroads, volume shipments were carload lots and the first volume rates in 1893 were on car-load quantities. Multiple car rates were first used 66 years later in 1939. The Transportation Act of 1958 made volume rates possible and enabled the railroads to reflect their costs in their rate structure. Today the railroads *can* apply cost analysis and cost control to produce low costs and rates for their volume customers.

Shuttle train rates were introduced soon after the 1958 Act. The "shuttle train" principle introduces the opportunity for the railroad and the shipper to cooperate and develop an operating plan that makes the maximum use of a total transportation system. When this is done, both the shipper and the railroad can benefit. In a talk at the "University of Illinois Marketing Forum," John Ingram, V.P., Illinois Central Railroad, outlined the difference in railroad costs for single car and "shuttle" operation, which he calls "Full Capacity Utilization Trainload" and is shown in Figure 2.

In Ingram's illustration, the total costs, 100% of the railroad costs for single cars, can be broken down as follows:

(1) Yard costs typically account for 30%.

(2) Freight cars account for about 25% . . . depreciation, maintenance and repairs.

(3) Bookkeeping costs about 5% . . . accounting, preparing freight bills and the people to keep track of the train.

(4) The cost of operating the train . . . 40% as follows

(a) providing the capacity to move freight (20%)

(b) using the capacity (20%).

A cost reduction shown of 71% for the shuttle train is a pretty impressive number. It forcefully illustrates the benefit that is possible by the productive use of capital. This principle has long been a fundamental for planning a production line, but it hasn't been very widely applied to transporta-

APPROXIMATE MAIN LINE RAIL COSTS

Broad Cost Item	Single Car	5 Cars	25 Cars	Occasional Trainload	Full Capacity Util. Trainload
Yard	30%	20%	15%	0%	0%
Cars	25%	20%	25%	25%	5%
Bookkeeping	5%	2-1/2%	1-1/4%	-	-
Train Running					
Providing Capacity	20%	20%	20%	20%	4%
Use Capacity	20%	20%	20%	20%	20%
SAVINGS		17-1/2%	18-3/4%	35%	71%
TOTAL	100%	100%	100%	100%	100%

Excerpt from Speech by John W. Ingram (Vice-President) Illinois Central Railroad (January 31, 1968)

Figure 2.

ın. The average covered hopper car on the rail- ad today travels about 18,000 miles a year. The huttle train" provides full utilization and makes 0,000 to 180,000 miles per year realistic. The luced charges now available for such movements lect the greater tonnage moved.

What happened to the yard cost? They are elimi- ted; if you don't go in the yard, you can't have y yard cost.

What happens to car cost? The cars still cost the ne on an annual basis, *but*, since the tonnage ›ved in the year is so much greater, then cost per 1 is very much lower.

What happened to bookkeeping cost? On a per 1 basis it is so small it can't be found.

What happens to capacity? The "shuttle train" roduces a chance to make a major improvement. ce the cost of cars, the annual cost is the same t the utilization of the track and locomotive in- ase greatly.

What happens to the cost of using the train or : cost of running the train? Nothing; it still costs : same per mile.

proved methods.

There are several other important improvements methods of inland transportation of which it is ful to be aware despite the fact that space will it discussion to special characteristics of each.

Trucking: Trucking of bulk solids has made rapid gains during the last decade because of the triple advantages of trucking: ease of adding additional haulage units; unlimited flexibility of location and scheduling; and efficient operation of relatively small haulage units. These advantages of trucks so overwhelmed the classical methods of rail traffic that major shifts occurred in the location of some types of mineral producers. For example, there has been a significant shift in location of Eastern cement producers from the Lehigh Valley of Pennsylvania to the Hudson River region.

New methods have been found to handle bulk materials in trucks. Cleaning of tanks has been advanced to the stage where food and chemicals can be carried in the same unit after only a short stop for flushing and drying. Air-slide trailers have made bulk shipments of fine-grained material possible to small consumers because they no longer find it necessary to limit their processing plants to sites with rail access.

An example of using trucks in an intermodal system is International Minerals and Chemicals motor shuttle operation in which thirty 25-ton aluminum trailers are used to haul potash from Esterhazy, Saskatchewan to Northgate, N.D., where unit trains are made up for weekly runs to storage centers in Minnesota and Illinois. Each trailer makes three 250-mile round-trips daily from the mine to Northgate where the rail cars are loaded, inspected and automatically weighed. Round-the-clock, systematized bulk trucking operations such as this can be accomplished for about 20 mills per ton mile compared to the average cost of 50 mills per ton mile for long distance trucking of bulk solids where the consuming point varies from trip to trip.

Completion of the interstate highway system over the next several years will mean sharp reductions in trucking costs as the big rigs break free of tangled inner city traffic. It is probable that bigger and heavier loads will be allowed which also will reduce unit costs. Use of the double-bottom rig in which an additional trailer is pulled behind the semi-trailer, is a second factor that will increase tons delivered per tractor per year and further lower unit costs. Distribution managers should be negotiating now so as to reap such savings as soon as they are available.

Railroads: A few specific railroads have added new dimensions to the traditional method of moving bulk solids long distances. Other roads have then gradually begun to use these ideas. Unit trains, modern manna of the coal industry, were first seen on the Southern in 1959; piggyback is a little older, starting on the Pennsylvania R.R. in 1954; and in 1964, the New York Central originated Flexi-Flo, its trademarked, intermodal, yard transshipment service.

Many of the newly-popular rail services are examples of a systems analysis approach to transportation and distribution management. In systems management, redundant, circuitous, or resource-wasting operations are eliminated to provide smooth and rapid flow from initiation of a functional task through to its consummation.

Cars designed to be part of a complete distribution system and tailored to fit the special characteristics of each commodity group are an important benefit of systems analysis of rail transportation. The P-D car (pressure differential), the rack car for carrying automobiles, the coil car, the roll-top car, the high-cube car are but a few examples of the dozens of specialized cars now operating on American railroads. These cars are designed to be loaded and unloaded quickly and also reduce risk of damage to cargo.

Ownership or leasing of cars by the mineral producer or consumer has been gaining favor in recent years because it offers firm availability, specialized equipment and lower over-all transportation cost. IMC has over 1500 leased cars. Consol Coal owns several hundred cars operated in shuttle trains carrying its product, and cement companies have leased P-D cars.

Solids pipelining: Colorado and Tasmania share the distinction of being the only free-world locations of long distance solids pipelining today, though the first successful line was operated in Ohio by Consolidated Coal, and a 270-mile coal slurry line is planned by a Southern Pacific Railroad subsidiary for Arizona.

Canada may well lead in the pipelining of evaporites if one of the two presently proposed potash slurry pipelines is finally adopted. In June of 1968, the Canadian Pacific Railway acquired all the engineering and research data developed by IPSCO during a three-year research and development project, to analyze the feasibility of transporting potash in slurry form. This research has established that a 14-inch diameter pipeline capable of moving six million tons of potash per year from Saskatchewan to Vancouver should be profitable.

Belt conveyors: It seems clear that these will not soon compete with well-established rail and highway transport networks which exist in most regions of industrialized nations. In areas not serviced by railroads, however, long-distance belt conveyors are being considered.

In the Spanish Sahara, a belt was proposed to carry phosphate at 3000 tph for 60 miles. In India, a belt system was designed for service that would require it to carry iron ore (minus 6″ 160#/cr ft) at 3000 tph about 150 miles. About 100 miles are relatively flat, and 50 miles are hilly. A competing railroad route would be about 260 miles long with tunnels and bridges in hilly terrain.

Cable-riding belt conveyors are a recent addition that will promote long-distance belt movement. Because the belt carcass isn't under tension, a life of 15 years is guaranteed by the manufacturer. In this system, mechanical power is transferred only to two loops of steel cable on which the belting lies for both conveying and empty return.

Belt manufacturers indicate that a complete installation for a high capacity long-distance line costs about the same as a railroad for the same distance. Therefore, there is not much chance for a belt being built where capital is already sunk in an adequate rail line.

Intermodal Transfer Terminals: In discussions of transportation, the focus tends to be on each separate mode, such as truck, automobile, train, plane or vessel. This type of modal myopia has produced an extremely favorable opportunity for innovations in *Total Transportation Systems*.

:amination of total systems offers great opportu-:ies for optimization, especially at terminal ints where there are intermodal transfers. Leland ızard, a leading philosopher on transportation d it well recently:

> "I conclude that we must make a virtue of the necessity of intermodality. I conclude that the wave of the transit future, whether for people or for goods, is the interchange, the facility, the provision for the interface between and among modes. We have enough technologies of movement by water, land, or air; but we are still in the stone age of accommodation for the meeting of those technologies. The next great break-through in transit will not move at all. It will be a structure, an organism, in which will be sorted out the people, goods, and communications, which are not to stop but to go on to endless varieties of desti-nations."

An example of the development of such an in-·modal exchange involves the transfer of bulk mmodities directly from rail car to truck, com-:tely eliminating permanent storage facilities :h as silos and warehouses. There are numerous :h integrated rail-truck delivery services based on .nsshipment in a rail yard. Depending on the mmodity and total services required, savings are)orted to run from 25 percent to as much as 50 rcent. Lower freight rates are earned with larger)acity rail cars. Shippers can also enter new mar-ts or service test-market areas more easily and ›nomically by using intermodal transfer termi-ls. Quantities for local delivery can be main-ined without requiring large inventories or economical small individual shipments.

The New York Central Railroad, now the Penn ntral, was first to widely promote this type of vice which they trade-named Flexi-Flo. Begin-ıg in 1964, the Central now operates 11 termi-ls. Cement and a wide variety of liquid and dry :micals, plastics, and food products are being nsferred from rail cars to trucks. All terminals · strategically located at major through-train-:ds adjacent to densely populated areas. Other lroads operate similar services. Most, however, not provide the single company responsibility · billing of both rail and truck charges and all patch operations that is part of the Flexi-Flo ıcept.

agination needed.

It is time for all shippers of bulk commodities to :ognize that new dimensions have been added to nsportation in America, and to use their imagi-:ions to take advantage of the altered character-:cs. For instance, there is no need for a local terminal or warehouse if the railroad can transship at its yard. Why ship in standard cars if your cus-tomer can save unloading costs by using a new type of car? Why accept present tariff schedules? These are the questions that the mineral industry should be asking itself. A Florida cement producer, for example, recently negotiated a multi-car rate of 15¢ per cwt for a 404-mile move.

A systems approach to physical distribution, of which yard transshipment is an example, tends to emphasize tailor-made transportation methods. Combining the advantages of both rail and truck conveyance, it illustrates just one direction in which future innovations in distribution may lead. Unit trains, specialized cars in siding-to-siding serv-ice, and containerized freight provide other promis-ing avenues of development.

While changes in the form in which minerals are transported have not been emphasized in this re-port to management, they are certainly important. Shipping molten sulfer has provided multiple bene-fits to that industry as has the shift from shipping bagged to bulk product by a borax producer. Prilled materials such as clay, and partially proc-essed minerals such as pre-reduced iron ore pellets will become more important in the future.

Managers need to view physical distribution of their product as a unified materials handling sys-tem. Residence time of finished goods in the sys-tem should be kept to the minimum that is consistent with low capital and operating costs. New dimensions in transportation promise to lower average distribution costs for firms selling bulk materials. Because of this, all marketing and plant constructing programs and proposals should be re-viewed with the developing transportation econ-omies in mind.

Use Outside Help: Many projects and many companies, large and small, feel there is nothing they can do to lower the cost of transporting their goods. Companies have accepted transportation and handling costs as fixed costs. Some manage-ments have a "Myopia" about transportation costs and overlook the fact that 20% to 90% of the landed cost of evaporite ores, minerals and prod-ucts may be the transport and handling costs. They feel there is but one way to do the job, "The Tradi-tional Way." It is the accepted practice for ac-counting, production, geology, engineering, marketing, advertising, public relations, and legal departments to obtain help from consultants out-side the company. *Yet*, very few managements have sought such help for their transportation and handling areas. The profitable development of evaporite deposits will be aided by adapting the same management philosophy to the transportation function that is used in other management areas.

A selected bibliography on recent developments in transportation may be obtained by writing to the author at the Department of Mineral Economics, The Pennsylvania State University, University Park, Pennsylvania 16802.