Technical Economics . .

Department of Naval Architecture
and Marine Engineering
University of Michigan
450 West Engineering Building
Ann Arbor, Michigan

TECHNICAL ECONOMICS AND THE GREAT LAKES TRADE

by

Harry Benford

Professor of Naval Architecture and Marine Engineering

The University of Michigan

for presentation before the

Lake Carriers' Association

Cleveland, Ohio

January 31, 1963

TECHNICAL ECONOMICS AND THE GREAT LAKES TRADE

Since there's much to say on the subject, and time is limited, I'll assume two things. One is that most of you know more than I about world-wide shipping needs for iron ore, and why the U. S. Great Lakes ship operator is at least temporarily in trouble. The other is that most of you are familiar with the studies and proposals that are incorporated in the paper E. B. Williams, Kent Thornton, and I read before the last Spring Meeting of the Society of Naval Architects and Engineers.

If you've been too busy to look at the above mentioned paper, you might want to borrow a copy from one of your friends. It shows an engineering economy study of Great Lakes ore carriers and investigates the economic benefits of larger ships, automated operation, and extended operating season. Let me repeat part of the final conclusions:

> The inescapable over-all conclusion is that the Great Lakes maritime industry must either make radical departures from traditional design concepts and operating procedures or face a losing battle with foreign competition. Minor refinements and gradual evolution will not be enough.

I'll discuss some of the other conclusions shortly but first it's important to recognize that the new ships we have in mind are things of the future. They are of doubtful merit for immediate needs simply because of the world-wide surplus of bulk cargo ships, a condition that extends right up into the Great Lakes. So it's important that we bend every effort to gain maximum returns from our older ships while making plans for beating the competition with new and more profitable ships in the future.

What are some steps we can take to exploit to the maximum our older vessels? One of the better answers is the tug and converted barge concept, which Wilson Transit is introducing. Basically, a tug and barge is not as good as a conventional ship but it is, indeed, a successful rule-beater. Now I generally take a dim view of rule-beaters, but in this case I applaud it -- not so much because it's clever, but because it points the way to crew size reductions without the need of major investments in automation. Let's put the tug's wheel house and accommodations on the barge and its engine inside the barge and what do we have but a ship with a 12-man crew. No automation whatsoever.

There must be many other ways to make use of our older ships. W. E. Zimmie has proposed increasing the deadweight capacity through the addition of sponsons along the vessel's side. This thought gains added impetus with the new wider lock at the Soo. My colleague George West has made studies that indicate the economic advantage of diesel engines in repowering jobs where horsepowers do not exceed 4000 to 5000. The way we can butcher up old ships and weld them back together in new combinations suggests several alternative schemes, one of which is already underway up at Manitowoc.

But let's go on to the Great Lakes ore carrier of the future. How can these ships be built and operated so as best to meet foreign competition? I think perhaps the single most important technical development will be in more ship for the shipbuilding dollar. You have already heard Richard Lowery say we are building Cadillacs instead of Mack Trucks and that we could slice half a million dollars off the cost of a ship such as the RYERSON. Can anyone dispute this? One important conclusion, then, is that austerity must be stressed in ship design. There are other important ways to lower cost, and multiple orders is one of the best. We've found in saltwater cargo ships that you save about seven percent in the average cost everytime you double the number of ships in a contract; I presume the same values would apply here on the lakes. Thus, if several Great Lakes operators would accept a standard design and place orders for a dozen ships to be delivered in as many years, they would save perhaps 22 percent in invested costs.

Let me conclude this discussion of shipbuilding costs with some dollar signs preceded by a bit of economic philosophy. I am convinced that few of us actually realize how expensive an invested dollar is when it's converted to an average annual cost for purposes of transportation economic analysis. We usually find that cost studies include an item for depreciation plus a nominal charge for interest; the sum of the two (or capital recovery factor) for a Great Lakes ship may show up as only five percent of the invested cost, per year. My bone of contention is that it ought to be closer to 19 percent. This is the capital recovery factor needed to repay the investment over the life of the ship, plus an annual after-tax profit equivalent to ten percent interest. If ten percent sounds a little opulent, it's well to remember that few operations turn out to be more than two-thirds as lucrative as painted in these idealized cost studies. Strikes and other factors always take their toll, and compensating pleasant surprises are as rare as balanced budgets on the Potomac. If you'll accept my 19 percent capital recovery factor, even for the moment, let's look at the average annual cost of running a ship like the RYERSON. I expect such a ship would cost about $9,500,000 including architects' fee and other owner's expenses. The direct operating costs would total about $755,000 per year. The capital costs, figured at 19 percent of investment, would come to $1,800,000 per year. The bar graph below illustrates the contrast.

TOTAL ANNUAL COSTS: $2,555,000

Let's refigure annual costs assuming we have saved $500,000 through austerity and 22 percent through multiple orders. Our ship will now cost ($9,500,000 - $500,000) 0.78 ≈ $7,000,000 and the average annual capital cost will be $1,330,000. This is $470,000 less than before, a saving that exceeds 60 percent of the total annual direct operating costs. In terms of transportation economics, we could trim 45 cents off the required freight rate per ton!

Although lowered first cost is a most important potential development, its probable benefits are certainly no greater than those offered by a greatly extended operating season. Admiral Thiele has repeatedly expressed confidence in the practicality of almost year-around operation, and our cost studies have shown the economic importance of it. For example, extending the persent seven-month season by about 50 percent would lower required carrying charges by about 25 percent. Like Admiral Thiele, I want to see the idea tried first in the Escanaba-Chicago area trade, because keeping the Lake Michigan routes open should be duck soup compared with the task on Lake Superior. I believe the ship of the future will be designed for winter operation, with reinforced hull and, possibly, a spoon bow.

Ship size will of course continue to grow, for large size is as good as automation when it comes to increasing labor productivity. The new

Soo lock will stimulate this development and I feel safe in predicting that one or more shipyards will soon be able to turn out ships of the maximum allowable size. And we may see ships of even greater size, for I visualize the all-Lake Michigan trade as an open invitation to bulk carriers of a capacity comparable to those in ocean service. These ships could load and discharge pelletized ore at offshore facilities and would thereby be freed of harbor or canal restrictions. Whether such giants will ever come into being, and if so, how large they will be depends upon the extent of the ore traffic. If these ships can promise great reductions in transportation cost, they may generate considerable demand for their services. If this demand is great enough, the cost of new shipways and drydocks would be spread over many contracts and the building cost of ships would thereby be lowered. Thus, cause and effect are all snarled up, and the final answer is beyond my ken. Nevertheless, I have induced one of our seniors (Lt. William Sheppard, USCG) to block out the preliminary design of such a ship, and this is shown in outline form in Figure 1. Table I lists its estimated technical characteristics. Next semester Lt. Sheppard will make an operational analysis of his proposed design and I hope he'll find time to write a paper on it. He'll have a mighty sore arm if he doesn't.

Channel depth is another potent factor in Great Lakes transportation economics. Our limitation of 25-26 feet looks pretty puny alongside our oceangoing competitors, where drafts frequently range from 35 to 40 feet, And you may want to note that the new 130,000 DWT ton Japanese tanker has a design draft of 54 feet! Recently I made a little study for the State of Michigan Attorney General's Office in connection with the Chicago water diversion hassle. I concluded that a ship of the RYERSON type, but

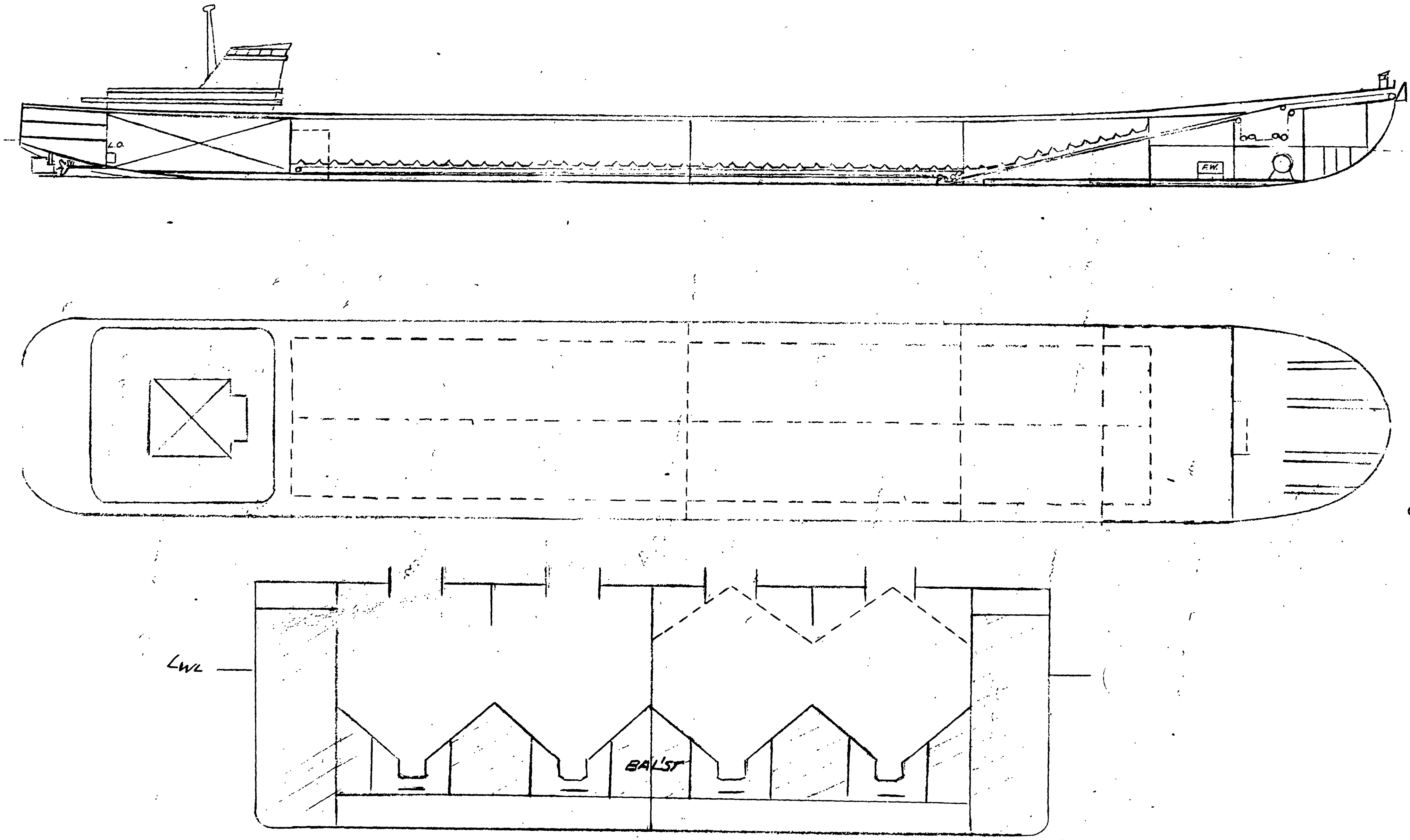

FIG. 1 : ARRANGEMENT OF PROPOSED 81,000 DWT
GREAT LAKES ORE CARRIER

TABLE 1

CHARACTERISTICS OF PROPOSED 81,000 DWT GREAT LAKES ORE CARRIER

DIMENSIONS		
Length (Between Perpendiculars)	1000	FT
Length (Overall)	1045	FT
Beam	150	FT
Draft	30	FT
Depth	46.5	FT
COEFFICIENTS		
Block Coefficient (C_B)	.88	
Maximum Section Coefficient (C_X)	.99	
WEIGHTS		
Displacement	110,300	LT
Machinery (Less Unloader)	2,050	LT
Outfit (Includes Hull Engineering)	2,580	LT
Steel Hull	23,320	LT
Unloading Equipment	750	LT
Light Ship	28,700	LT
Horsepower (Twin Screw)	49,600	SHP
Speed	20.2	MPH
CAPACITIES		
Cargo	77,690	LT
Fuel	3,170	LT
Feed Water	520	LT
Potable Water	150	LT
Lube Oil	10	LT
Passengers, Crew, & Effects	50	LT
Miscellaneous Supplies	10	LT
Deadweight	81,600	LT

redesigned for, and operated at, one-foot greater draft, could reduce fully-distributed costs by six cents per long ton. Multiply that for a five-foot increase and it looks pretty inviting: a 30-cent saving. In the case of ships that already have the technical capabilities of deeper loading, the gains are roughly double those mentioned above.

There is one great advantage of deeper draft that should be mentioned: from the marine industry's point of view it's always the cheapest way to get a bigger ship. This is particulary true at this time since further appreciable increases in length or beam will require new shipyard expansions; but this is not the case with increased depth and draft. The other side of the question involves the cost of dredging but, again, that phase is out of my province. While we're on the subject of ship dimensions, however, I want to mention that our cost studies in connection with the new Soo lock show that increases in beam are much more important than increases in length. We found that a 10-foot increase in beam was much more profitable than a 100-foot increase in length. I realize, of course, that the limitations of much of our shoreside ore-handling gear discourage this trend. Nonetheless, I'm sure that a modest investment in ingenuity and money can overcome these problems.

We must keep a watchful eye out for useful developments in new materials. High-strength steels, aluminum alloys, and various plastics all have potentially profitable application to our needs. Robert Miller of Manitowoc has published some convincing figures supporting the concept of an aluminum hulled ore carrier. He predicts after-tax returns would increase from 8.02 percent to 8.41 percent. This is not exactly overwhelming and I suppose no owner feels disposed to take the added risks of the new venture.

Perhaps this is a case where a little government support would be fruitful.

I'll not say much about propulsion manchinery. My admiration for marine engineers compels me to admit that they have gone about as far as anyone could possibly expect in the direction of fuel economy. Indeed, that category contributes only about 7 percent of the ship's fully-distributed operating costs. I believe future developments should be more in the line of simplification, ease of control, and -- wherever possible -- lowered first cost. In fact, I'm convinced that we could gain in overall profitability if we would place greater stress on lowered first cost, even at the expense of some increase in fuel bills. I'm also convinced that shipowners should consider diesels and gas turbines in their new ship plans. This is particularly germane to the introduction of automation, which is bound to be an important factor in ships of the future.

Well,there are many other ideas I could toss your way: some good, some bad, some merely irritating. If nothing else, I hope you've gained some food for thought. An outsider, such as myself,is apt to make impractical sounding suggestions. But if the economic potential of an idea is great enough, aggressive engineers and businesmen can usually find the way to make it practical. So let's <u>not</u> adopt the motto: IT CAN'T BE DONE AND WE'RE JUST THE GUYS WHO CAN'T DO IT. Let us, rather, make up our minds that the practical difficulties <u>can</u> be overcome. Then, let us collaborate with shipbuilders, ore miners, railroads, steel mills, -- and even college professors -- to find how Great Lakes ore carriers can best serve our nation's needs.