Worldwide Trends in Fishing Vessel Design and Equipment

EDWARD A. SCHAEFERS
and
DAYTON L. ALVERSON
Bureau of Commercial Fisheries
Washington, D.C.

Abstract

For the past 10 years there has been a worldwide trend to develop large, highly-automated freezer-processing, single purpose type trawlers. More recently there has been a trend to incorporate all of the desirable features of these vessels into smaller combination type fishing vessels. There has been an increased awareness of the need for better working arrangements, accommodations, and safety features in vessels comprising fishing fleets throughout the world. Trends in the design of these fishing vessels on a worldwide basis are reviewed along with the various problems attendant with increased automation and more sophisticated equipment. The status of worldwide efforts regarding implementation of the various recommendations concerning fishing vessels resulting from the 1960 Safety of Life at Sea Conference is explained.

Various plans for overcoming the worldwide shortage of fishermen through changes in vessel design and equipment are analyzed. The trend in various countries to convert vessels rigged for fisheries that no longer yield a profitable return to profitable fishing endeavors is reviewed.

INTRODUCTION

IN RECENT years many countries have become aware that the sea is the most logical source for increasing the production of animal protein. Marine fisheries have had a phenomenal growth—increasing from about 46 billion pounds landed in 1948 to about 116 billion pounds in 1965. Such a growth would not have been possible had not the fishing industry, which is noted for its conservatism, contained more than a few farsighted individuals. These people realized that if the fishing industry was to thrive or even survive, it must undergo the sociological, economic, and technological changes that have been so successful for land-based industries. It is only in recent years, however, that throughout the world the fishing industry has begun to accept the fact that the "good old days" are a thing of the past. No longer can fish resources be profitably harvested by inexpensive vessels that are designed by rule of thumb and that utilize human power instead of mechanical power. Now, most fisheries people agree that if a nation is to assure itself of an adequate harvest of food from the oceans, it must devise or adopt more efficient and more effective fishing methods, equipment, and vessels.

Present progress in fishing has been achieved through combining the talents of naval architects, engineers, fishermen, economists, equipment manufacturers, and fishery scientists. Today's modern fishing vessel, whether it is a 50-foot Pacific Coast combination vessel or a 286-foot

factory stern trawler, would not exist had a unilateral course been pursued. Additional factors that helped bring about much of the progress in recent years are:

1. Technical meetings that resulted in the dissemination of technical information on all aspects of fishing. These included the three World Technical Meetings on Fishing Vessels and two on Fishing Gear and Methods that were sponsored by the Food and Agriculture Organization of the United Nations, the 1966 Canadian Atlantic Offshore Fishing Vessel Conference, the 1963 Whitefish Authority Meeting on Stern-trawling, and the annual meetings of the Gulf and Caribbean Fisheries Institute.
2. The financial assistance programs sponsored by the governments of many nations. The status and influence on vessel design and equipment of the U.S. Fishboat Subsidy Law has been discussed here, and the Federal Fishery Loan Fund and Mortgage Insurance Programs have been explained at previous Institute meetings.
3. The extension of fishing effort to new grounds and the harvest of new and under-utilized species on existing grounds.

In addition, various international organizations have played a rather subtle role in influencing fishing vessel design to date. We are quite certain, however, that their influence will be more pronounced in the future. These groups are:

1. The International Labor Organization whose conferences led to the 1966 Convention on Accommodations Aboard Fishing Vessels.
2. The Intergovernmental Maritime Consultative Organization, which supports the studies of the recommendations on fishing vessels adopted at the 1960 Safety of Life at Sea Conference.

OVERALL TRENDS

Let us now review general and specific trends in fishing vessel design and equipment.

Based on available information, the general trend can be summed up as MORE:

1. More automation.
2. More stern trawlers, both large and small.
3. More size.
4. More conversions and more combinations.
5. More horsepower.
6. More use of mechanical refrigeration.
7. More electronic aids.
8. More attention to accommodations, comfort, and safety.
9. More capital.

We will now consider these factors individually, beginning with automation.

AUTOMATION

The main purpose of automation aboard fishing vessels is to increase the productive capacity of the individual fisherman, so that catches

can be maintained or increased with fewer fishermen. In most nations the most serious problem in operating fishing vessels is the lack of trained fishermen. The pros and cons of automation have been discussed at great length with regard to its economic and social impacts in nations having highly developed fisheries, as well as in those with developing fisheries. It appears, however, that it is not a case of the vessel eliminating the crew, but rather the crew eliminating the vessel. Does this seem unreasonable when only recently in this country has there been a tendency to consider fishermen as being entitled to at least some of the comforts found at home. Why, it has been asked, should men spend from 4,800 to 7,200 hours per year on a vessel, away from their families and subject to all the hardships attendant with life at sea, when their counterparts ashore are spending about 2,000 hours per year on the job and often at higher pay? Many predict that if living accommodations and working conditions are not improved and pay increased, fishermen will seek jobs ashore.

One of the first actions to effect increases in productivity per fisherman on trawlers is to mechanize and automate the engineroom and trawl handling equipment. A good example of this concept is the 90-foot English stern trawler ROSS DARING, launched in 1963. After several years of operations it was found that this vessel could be handled by a skipper, a mate, three deckhands, and a cook, with bridge control of both the engine and the winch. The cost of the skipper and the crew is 27 percent of the total operating cost; on conventional trawlers such costs are 35 percent of the total. The automation of the engineroom, however, was too complex to be successful and furthermore, the owners state that they are unable to find an engine that is simple enough to run trouble free and without attendants. Consequently, the owners have trained skippers to look after the engine and have suggested that perhaps the success of such a fishing operation depends more on skippers' skills in maintaining an engine than on their fishing abilities.

The application of mechanical equipment has increased the efficiency of menhaden vessel operations so that the crew now averages 14 to 16 compared with 27 to 29 a few years ago. This remaining complement includes that member many individuals consider the most important man aboard, the cook.

At least one naval architect, however, does not agree. He has pointed out how strange it is that the fishing industry is quite advanced in the production of frozen foods but completely ignores the advantages of pre-cooked frozen meals on its own ships. He also made the point that a vessel is out to catch fish and not to feed the men—an observation that is sometimes not always readily apparent.

To our knowledge, no fishing vessel has been designed with a galley containing a micro-wave oven instead of cooking stove. We do know that the micro-wave system is being used on a trial basis on at least one Canadian and one German stern trawler, and, of course, thousands of pre-cooked meals are served each day aboard airlines. From a purely economical standpoint, this concept is in its infancy. For example, the food cost per man per day for Boston trawlers was $3.20 exclusive of the cook's salary. The average cost of three pre-cooked meals from airline caterers is about $7.25. Of course, more economical types are available from the supermarket. At the present time, serving pre-cooked meals

would help solve the problem of obtaining trained cooks. Some of the large tankers operated by international oil companies have adopted this method of feeding their crews, which may have mixed nationalities. The preferences of each, therefore, ranging from finnan haddie through arroz con pollo to meatless Irish stew can be easily satisfied. Please do not get the idea that we are recommending that the ship's cook should be replaced by a stewardess; that vessels should be built without a galley range or that we feel this concept of meal preparation will be adopted by the fishing industry overnight. We are merely trying to point out a possible trend.

STERN TRAWLERS

Let us now examine the trends in stern trawlers. One of the striking features is that some of the smaller ones (under 100 feet) are turning to drum trawling. This trend has extended from our Pacific coast to the east coast of Canada and to several European countries. This system, coupled with midwater trawl and accessory equipment developed at the Bureau's Gear Research Base, at Seattle, Washington, has enabled combination-type purse seiners only 53-feet long to effectively harvest Pacific hake in Puget Sound, Washington. For example, between January 16 and June 10, 1966, one such vessel, the ST. JANET made 126 drags, caught 1,750,000 pounds of hake, and averaged 19,000 pounds per hour. The similarly equipped 73-foot ST. MICHAEL landed 2,500,000 pounds between November 20, 1965, and April 6, 1966, and averaged 17,000 pounds per hour. The results of these two vessels are excellent examples of the trend to consider the entire fishing operation as a system. For example, the drum reel itself was not responsible for fishing success, but rather its combination with the midwater trawling system, which in turn is composed of various integral parts. Two conventional drum trawlers fishing the same area with high-opening bottom trawls caught only 4,000 to 5,000 pounds of hake in drags of 1 to 2 hours. Vessels with midwater gear caught about 10 times more in less than half the time than did vessels with the bottom gear—these results occurred while the four vessels were fishing close to each other.

SIZE

Another trend, which has been documented in previous papers, has been the increase in the size of vessels. Until recently, increases in size were usually associated with increases in length. The trend towards raised forecastle head type vessels with the shelter roof extending aft, such as in certain West Coast combination style vessels, has given some 80-foot vessels the spaciousness of former 100-foot types.

CONVERSIONS

Changes in vessel design are not related specifically to new construction. A combination of factors, including the increased use of hydraulic systems that operate whole arrays of deck machinery and gear handling apparatuses along with the adaptation of existing gear to both traditional and new fisheries, has brought about conversions that are startling. For example, who would have thought that the whale catching vessels of the Norwegian fleet would be suitable for other fisheries? How-

ever, during the first 9 months of 1966, eight of these vessels, from 127 to 168 feet long, have been converted to herring purse seining. Far less striking, but probably more numerous, has been the conversion of former purse seiners, draggers, and other types of vessels for king crab fishing. Existing California pilchard type seiners were converted to king crab fishing with modifications varying from the installation of circulating sea-water tank to a complete redesign of the deckhouse and upper pilothouse structure. Equipment for these vessels consists of a hydraulic pot-hauling device and cargo gear to swing the pots aboard and stack them on deck. Ten years ago, this fishery had only a few vessels; now it has about 220. Last year, however, saw the first launching of a new vessel designed specifically for the king crab fishery.

This prototype king crab vessel has the enclosed forecastle deck which provides more enclosed space and has a shelter deck aft. Such a design is also typical of the newer trawl vessels being constructed in Canada. One might think that modern high-seas stern trawlers were the first to recognize the concept of more enclosed space. The standard Great Lakes gill net tug developed many years ago, however, is an earlier example of the use of an enclosed deck aboard fishing vessels. Some of these vessels have been converted to trawlers to harvest the tremendous stocks of alewives that now inhabit Lake Michigan. This type of vessel, along with a few former Gulf shrimp boats, has taken considerable quantities of alewives. This fishery has grown from only 400 pounds in 1956 to about 30 million pounds in 1966.

While it is rather difficult to consider conversions and combination vessels as separate topics, in general, conversion entails major alterations and structural changes. A combination-type vessel, however, requires little major alteration to shift to multipurpose fishing. These are exemplified by the Aluminum Association's design and the various types of combination type hulls described at this meeting. An example of a combination-type vessel that has fished successfully for almost a decade is the 63-foot combination purse seiner, bottomfish trawler SILVER MINK which, although originally built for shrimp trawling, has engaged in these fisheries off New England without significant structural changes.

An example of a larger combination vessel now under construction is the Bureau of Commercial Fisheries exploratory fishing and gear research vessel DELAWARE II. This 155-foot vessel is designed for efficient handling of a variety of different types of standard and experimental fishing gear in the North Atlantic. Special effort was devoted to designing and developing a system of stern trawling to achieve a simple, rapid, and efficient trawl and catch handling procedure. To achieve this, the designers provided a long trawl ramp extending from the vessel's stern through the deckhouse to the trawl winch in the bow. This ramp permits the entire trawl, including the cod end and its catch, to be hauled aboard with one continuous pull. The trawl and cod end are not hitched and hoisted successively as they are aboard conventional side trawlers and most stern trawlers.

The vessel was designed to be able to operate side trawls, drag heavy scallop and sea-clam dredges, and handle purse seiners. By removal of the portable (bolt-on) trawl gallows at the stern of the DELAWARE

II and attachment of a power block to the central hydraulic system, the vessel is easily convertible to purse seining operations. Purse seines for herring, mackerel, tuna or other pelagic schooling fish can be readily set from the broad open stern of the vessel.

A fore-deck space is available for hauling long-line gear and gill nets; these units can be set out smoothly through the trawl ramp at the stern.

Power is available from a central hydraulic system and from two 150 kw electric generators for powering various gear hauling units. The main winch is powered by a 225-hp diesel engine driving winch drums through a variable speed, high-pressure hydraulic system.

HORSEPOWER

An example of the trend to more horsepower is indicated in the Gulf of Mexico shrimp fleet. In 1964, the typical double-rig 55-foot shrimp vessel fished two 45-foot nets and had 197 hp. The relation between vessel size and main engine horsepower varied considerably from the typical. The reason for this variation may stem from the popularity and preference for certain engine models, available only in specific horsepower. It may also indicate, however, that data needed to determine specific horsepower requirements are not available. The present trend is toward larger vessels in the 65-to 80-foot class and 275- to 330-hp main engines. Accordingly, the use of larger shrimp trawls follows. What is the optimum combination of vessel size-trawl gear and engine horsepower requirements? This can be answered only by conducting studies that will result in guidelines for determining:

1. Optimum horsepower requirements for specific hull designs.
2. The relation existing between horsepower and net size, including trawl doors.

At present only rough estimates can be made.

MECHANICAL REFRIGERATION

The trend towards replacing ice with various systems of mechanical refrigeration has been well documented and is certainly worldwide. Let us consider for a moment, however, a preservation system that will enable sea-fresh finfish and shellfish to be sold in cities not only at seacoast ports but throughout the entire Midwest. We refer to the experimental shipboard irradiator aboard our exploratory fishing vessels DELAWARE and OREGON.

A "portable" 17-ton shipboard irradiator was installed aboard the DELAWARE in January 1966. The purpose of this irradiation program is to determine the effect and value of irradiating fishes immediately after they are taken from the sea. Shore based irradiation experiments on fish products have shown that over 99 percent of the bacteria responsible for spoilage can be killed without adversely affecting the quality of the fish flesh. Reduction of spoilage bacteria to a very low level immediately after catching the fish will make possible a greatly extended storage or shelf life of fresh fish. Sea-clam meats and haddock have been irradiated aboard the DELAWARE, and preliminary reports indicate excellent results in quality

improvement and extension of the "fresh life" of these products. Experiments with shrimp are underway with a similar irradiator aboard the OREGON.

ELECTRONIC AIDS

Naval architects and boat owners are becoming increasingly aware of the need to design vessels with enough pilothouse space and generating capacity to accommodate the wonderful array of electronic devices now in common use aboard vessels, as well as provide room for devices not yet adopted by the fleet. One such device, called a portable radiofacsimile recorder, which receives synoptic sea surface temperature data, is now used aboard the DELAWARE. The recorder is used aboard the vessel during tuna work in the western North Atlantic and ashore between tuna trips to assemble data for planning future explorations. The unit is about 5½ feet high, 2 feet wide, and 15 inches deep. Other than a good whip or wire antenna, and a 110-volt power supply, no special installation is needed, provided space is available. Charted information is recorded on an 11- by 19-inch display. Synoptic environmental data for our area of interest are transmitted from U.S. Government facilities several times daily. Information on these daily charts of potential use to fishermen are:

1. Sea surface temperature analyses and forecasts.
2. Sonic layer depth analyses and forecasts.
3. Selected bathythermograms.
4. Surface weather analyses and forecasts.
5. Sea wave analyses and forecasts.

Temperature data are collected, digested, plotted, and broadcast by the Navy. Sea surface temperature charts are made up from data radioed in daily to the Naval Oceanographic Office. Five hundred participating merchant and naval vessels report four times daily from the North Atlantic area—a total of 2,000 daily temperature observations. Charts are made up from 5 days of observations and are updated with new information every 3 days.

Sea condition and weather information pertain primarily to vessel operations; sea surface temperatures (SST), layer depth (LD), and selected bathythermograms (BT) can be useful in selecting areas that have environments favorable for fish. Such an environment, for example, is the warm convergence that shows as a characteristic gradient pattern on the synoptic SST chart, and a characteristic thermocline structure on the LD and BT charts. This information is the basis for advance selection of the fishing area. Succeeding verification of the structure by vessel transect across the area is followed by test or commercial fishing.

COMFORT, ACCOMMODATIONS, SAFETY

As indicated by the vessels described in various publications, there has been an increasing trend to design greater comfort and safety into new and converted vessels. Greater crew comfort is accomplished by designing more enclosed space and shelter decks in all size ranges and types of vessels from the smallest combination vessels to the large stern ramp factory trawlers. Even so there are some complaints. For example, en-

closed working spaces are fine during winter, but some complaints have been voiced that complete enclosures on factory-type trawlers during summer may be likened to a jail where the August sunlight and refreshing breezes above deck are considered the outside. In addition to improved firefighting and lifesaving equipment more attention is being given to designing deck layouts to ensure as much built-in safety as possible. Considerable attention has been devoted to developing anti-rolling devices. While the so-called "flopper stopper" or paravane type stabilizer, suspended from outrigger poles, works quite well in vessels of the 30- to 75-foot range no practicable system has yet been devised for fishing vessels in the 75- to 150-foot range. Most attention is being centered on development of a passive system involving anti-roll or surge tanks. Some authorities feel that vessels without efficient anti-rolling systems will soon have difficulties in getting crews. Various naval architects agree there is little chance of reducing the present crews aboard 90- to 150-foot trawlers, on which the fish are dressed aboard, unless a practicable anti-rolling device is developed so that automatic processing equipment, which requires a fairly quiet ship, can be used. A reduction from 17 to 8 crewmen could be achieved aboard 100-foot English trawlers if automatic processing equipment were used.

CAPITAL

Some of the cost figures for recently constructed vessels indicate a considerable increase in the amount of capital investment required due largely to the 'mores' we have mentioned as well as present overall economic conditions. In general, the trend towards automation has resulted in a significant increase in the ratio of capital to labor. Studies of industries that have been characterized by increasing productivity and efficiency show one common factor—an increasing capital to labor ratio.

INTERNATIONAL ORGANIZATIONS

Without going into a long history of the factors that led to the International Convention on Accommodations Aboard Fishing Vessels resulting from the 1966 International Labor Organization Conference in Geneva, it is apparent that the provisions contained therein will influence vessel design in many of the nations in which it is ratified. This document applies to all fishing vessels 75 gross tons or larger (except sport fishing vessels, whaling vessels, and vessels operating in fresh water). The convention was approved by the International Labor Conference in June 1966, and will come into force for signatory notices relatively soon.

The convention applies to all new vessels and any major reconstruction of existing vessels. It requires sleeping, mess, and sanitary facilities of a certain minimum standard. Should the United States ever become a party to this document, undoubtedly design of commercial fishing vessels would be affected.

A recent Bureau of Commercial Fisheries study of accommodations on U.S. fishing vessels shows that present vessels of 200 gross tons or larger would have no difficulty meeting the standards; however,

many vessels in the 75- to 199 gross ton category would be affected. For example, the convention requires that vessels less than 250 gross tons or under 115 feet long should have no more than 6 crewmen in a sleeping room. Each crewman must have an individual berth, and no berths shall be placed side by side in such a way that access to one berth can be had only over another. Further, all vessels carrying a crew of more than 10 persons are required to have messroom accommodations separate from sleeping quarters. With regard to sanitary facilities the convention specifies that for each department of the crew wherever practicable the following shall be provided:

a. One tub and/or shower for every eight persons or less
b. One water closet for every eight persons or less
c. One wash basin for every six persons or less.

The Intergovernmental Maritime Consultative Organization (IMCO) is a United Nations specialized agency, which has a membership of 60 nations. The main objectives of IMCO are to facilitate cooperation among governments in technical matters of all kinds affecting shipping and to encourage the general adoption of highest practicable standards of maritime safety and efficiency of navigation. IMCO organized the 1960 Safety of Life at Sea Conference and administers the resulting Convention. Although fishing vessels are not included in the Convention, a recommendation was made to study the problems of stability of fishing vessels. IMCO subsequently established a panel on the stability of fishing vessels in July 1964, and formulated a work program in which 17 countries are involved. The program has numerous studies, all aimed at the ultimate objective of establishing criteria for judgment of stability and ensuring that the skipper is guided by adequate and understandable information. In its work to date, the Stability of Fishing Vessels Panel has compared national criteria for stability, issued recommendations concerning freeing ports and the closure of deck and superstructure openings, dealt with the construction and arrangement of fish bin boards, considered heeling forces produced by fishing gear, and issued some suggestions to fishermen about construction and operating practices that affect stability.

The formulae concepts used for determining stability criteria, being from the Greek, are, as the old saying goes, Greek to us so we will not offer an explanation. The suggestions to fishermen, however, are something easily understandable, and we are getting all 16 of them issued in graphic form so that they will come to the attention of as many people as possible.

In summary, although it is apparent that tremendous progress has been made in developing more efficient vessels and equipment, it is hardly a start compared to the adaptation of available space age technology to shore based resource extracting and transportation industries.