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U.S. DEPARTMENT OF THE NAVY CARDEROCK DIVISION, NAVAL SURFACE WARFARE CENTER

**ABSTRACT**

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THE NATIONAL SHIPBUILDING RESEARCH PROGRAM'S

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Preparing for the 21st Century: Focusing on Productivity and Quality Management

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Political Changes in Eastern Europe and the World Shipbuilding Market

Dr. Boris S. Butman, U.S. Merchant Marine Academy

Abstract

The recent political and economic events unfolding in Eastern Europe have brought about changes that are of vital importance to the world shipbuilding community. Following in the footsteps of Yugoslavia, already the No 3 shipbuilding power in the world, these countries view shipbuilding as a source of very needed hard currency, and also as a way of generating employment. The relatively low cost of ship construction together with an adequately developed level of technology, and comprehensive engineering support, make these communist countries serious competitors. Moreover, the announced reduction of the Soviet military budget might free up substantial capacities for export ship construction, and sharply reduce Soviet orders in their former satellite countries, thus making them available for foreign orders. The following paper addresses shipbuilding organization and capacities in the communist countries, advantages, problems and possible forms of business relations with their shipyards.

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During the 1980's decade of bargain prices resulting from a sharp decline in new ship orders, the combined shipbuilding workforce of Japan, South Korea and Western Europe shrank by over 303,000 workers. By the beginning of 1989 the world shipbuilding capacities have been reduced from 37.5 million gross registered tons (GT) to about 18.0 million [1]. Over 75 shipbuilding and ship repair facilities closed in the U.S. alone. By 1990 the world-wide shipbuilding capacity had been reduced sufficiently to give the world shipbuilding community a potentially manageable control over the market.

According to the published estimates [1], the projected annual demand for new construction in 1990-94 is in the range of about 14-16 million GT or 12-25% below the estimated shipbuilding capacity, which promises a substantial improvement of the current order book and increased prices. The level of new ship construction for 1995-99 is projected to be 21-24 million GT likely resulting in even larger demand and higher prices. Actually, the orders and prices are already climbing up, but whether this trend will continue into the 1990's depends to a large degree upon the developments in the economic and international marketing postures which arise from the dramatic political changes being experienced in the communist, or for some of them, the former communist countries.

The share of these countries in world shipbuilding is already quite
substantial. Four out of the eleven largest shipbuilding countries in 1989 were Yugoslavia (No 3), China (No 9), Poland (No 10), and Romania (No 11), and their combined tonnage of ships on order reached 13.5% to the total world order book [3]. Since 1978 these four socialist countries together have more than tripled their share of the world tonnage on order. Yugoslavia and Romania began building ships for foreign "non Soviet", owners more than 20 years ago, almost immediately after they split with the U.S.S.R. They have managed to maintain, ever since that separation, practically the same number of ships on order, while the average ship's tonnage is gradually increasing.

The People's Republic of China has embarked on the export shipbuilding path only recently, and in a few years has grown to become a substantial shipbuilding power with a share in the world market, reaching over 5% of total number of ships on order.

As per table 1, the other East European countries, currently in the process of severing their traditional ties with the Soviet Union, also possess considerable shipbuilding capacities. As of June 1989, East Germany and Bulgaria had on order all together 71 ships with total tonnage of about one million DWT. At the same time, total tonnage on order in the Communist countries was 7,130 thousand DWT which accounts for over 17% to the world level.

### Table 1 Ships on Order in the Communist Countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of ships (000)</th>
<th>DWT (000)</th>
<th>Number of ships (000)</th>
<th>DWT (000)</th>
</tr>
</thead>
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<tr>
<td></td>
<td>Ref. 2</td>
<td>1987</td>
<td>Ref. 3</td>
<td>1989</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>53</td>
<td>39</td>
<td>505</td>
<td></td>
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<tr>
<td>Czechoslov.</td>
<td>6</td>
<td>18</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>China</td>
<td>37</td>
<td>834</td>
<td>56</td>
<td>1,165</td>
</tr>
<tr>
<td>E. Germany</td>
<td>15</td>
<td>133</td>
<td>32</td>
<td>450</td>
</tr>
<tr>
<td>Poland</td>
<td>94</td>
<td>945</td>
<td>49</td>
<td>1,139</td>
</tr>
<tr>
<td>Romania</td>
<td>19</td>
<td>339</td>
<td>38</td>
<td>1,111</td>
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<tr>
<td>USSR</td>
<td>14</td>
<td>285</td>
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<td>Yugoslavia</td>
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<td>51</td>
<td>2,230</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>5,085</strong></td>
<td></td>
<td><strong>7,129</strong></td>
<td></td>
</tr>
</tbody>
</table>

Based on the data in Table 1 the Soviet Union does not appear to be a real shipbuilding power, with only 18 ships of 529,000 DWT on order in 1989. The explanation to this misleading data lies partially in the limitations of the statistical analysis, which apparently does not consider the many large river ships over 2000 DWT and tug/barge trains of 5000-10,000 DWT, which are very popular in the Soviet Union. However, the main reason is in the vast naval orders, overloading the Soviet shipbuilding capacities. A recent attempt to create a 600-ship Wavy in the U.S. has provided our major yards with a substantial backlog. Eased on various counts, the Soviet Navy is 2.5 to 3 times larger. Considering a corresponding doubled and tripled number of naval auxiliaries, and also the correspondingly large volume of overhauls and modernizations, it can be appreciated that required shipbuilding capacities in the Soviet Union exceed those available for the American Navy by at least three times.

The driving forces behind the success of Yugoslav shipbuilding are similar to those found in all other communist countries, especially, now when they are struggling to convert into market economies. First of all; there is the ever present shortage of hard currency needed to repay previous debts to Western banks, to finance future industrial projects, and to pay for grain and other food related imports in the case of the USSR and China.

Unable to compete with Western democracies due to the low quality of most of their industrial products, the communist countries are realizing that construction of simple ships like tankers and general cargo carriers is the easiest way to enter the highly competitive world market of industrial products. They also view shipbuilding as a way of maintaining labor employment during the transition period while switching over to the market system.

The recent political events in the East European countries have brought to life various actions affecting world shipbuilding:

1. open-door policies adopted by these countries when giant deals like the recent Pepsico agreement become feasible;
2. incredible drive to earn hard currency resulting sometimes in accepting newbuilding sale prices which are far below the actual cost;
3. gradual secession of their economies from the Soviet economy and an end to the barter trade relations.

A reduction by 14.2% of the Soviet military budget and by 19.5% of the

annual production of weapons and military equipment during 1989-90 announced -- michael Gorbachev might have a "snow ball" effect on world shipbuilding. It would:

1. free up substantial Soviet shipbuilding capacities for commercial ship construction for both domestic and foreign owners;
2. sharply decrease Soviet orders placed in their former satellite countries thus making them available for foreign owners; and
3. further reduce the already limited Soviet orders to West European and Far Eastern shipbuilders, making that share of shipbuilding capacity available for other sales.

The gradual increase in the share of naval shipbuilding at Soviet yards in the 1950-60s was accompanied by the steady diversion of non-military orders placed with foreign yards. Actually, many foreign yards, especially those in the Warsaw Pact countries (East Germany, Poland, Czechoslovakia, Hungary, Bulgaria, and Rumania) have completely replaced the portion of Soviet yard capacities occupied by naval construction.

3. THE YUGOSLAV PHENOMENON

It was the first communist country that broke with the Soviets and decided to explore an independent course of development. Over 30 years ago the country started a program of export oriented shipbuilding. The main driving force was and still is the need for hard currency, In order to win the market, shipyards were forced to match South Korean prices. As a result, prices dropped as far down as $25 million for a 140,000 DWT crude carrier of 1985-90 delivery [4].

In Yugoslav shipbuilding we see a remarkable example of the competitive capabilities of a communist country. Recent issues of marine related periodicals have devoted a considerable amount of time and attention to the subject [5, 6 and 7]. Yugoslavia has maintained the number 3 spot in the world shipbuilding order book for four consecutive years. Moreover, their market share in terms of ship tonnage has doubled, and while it was achieved, the composition of the shipbuilding output changed from being primarily tankers and bulk carriers to more diverse and advanced designs. In 1989 the five major yards delivered 23 ships totaling over 900,000 DWT.

The present order book includes a number of modern designs ranging from 140,000 DWT tankers, 40,000 DWT product carriers to 100- and 40-ton cranes and 2,000 HP harbor tug boats. Among the deliveries of the last three years are two 3,500-car carriers with a high degree level of automation, providing a potential manning level of eight crew, series of eight rail ferries for the Caspian Sea, large multi-purpose reefer, and Baltic cruise ferries.

Twenty years ago, the JADRANBROD Shipbuilding Association was founded to represent and coordinate the efforts of the major shipyards on the Adriatic Coast. Although a government-controlled entity, similar to the Soviet Ministry of Shipbuilding, the JADRANBROD, as well as the shipyards themselves, enjoy substantial independence. The four major shipyards are the ULJANIK in Pula, the country's largest shipbuilder, the 3 MAJ yard in Rieka, the Brodsplit yard in Split, and the JLM yard in Trogir (See Fig. 1).

The Uljanik yard, with a workforce Of 8,000, with two 173 meter and 135 meter long shipbuilding berths is capable of constructing ships up to 160,000 DWT on the larger berth. It also has a diesel plant to build MAN B&W and Pielstic engines, and an electrical factory with licenses from Siemens and ESAB.

The 3 Maj yard is a combination of a three-berth shipbuilding facility with capacities of up to 80,000 DWT, and a modern diesel plant, building the newest Sulzer design engines under the license agreement. The Split Yard with four building berths and 5,000 employees has a most diverse portfolio and delivery history, including very large crude and bulk carriers, 2,200 passenger/car ferry, reefer, and product carriers.

The forth major shipbuilding yard, the JLM at Trogir, specializes in floating docks, mid-size product carriers, and harbor tugs.

Another large shipyard, the Victor Lenac in Rieka, is the major repair and conversion facility which has floating docks with up to 24,000 tons lifting capacity.

With all its shipbuilding successes, Yugoslavia remains a state run economy, plagued with all of the familiar drawbacks and shortcomings: planning flows and material shortages, lack of incentive on the part of the workforce towards the improvement of productivity, political instability and labor unrest, and high inflation. However, the main lesson to be learnt is
that all of the inherited problems have
not prevented the government-controlled
 economy from gaining 'a substantial share
 of the world shipbuilding market. It
 should not be forgotten, however, that
 state run economies do have one
 advantage, namely, the ability to keep
 labor cost low. But with the current
 changes taking place in the world today,
 it is doubtful how long this will
 continue.

4 SHIPBUILDING IN EASTERN EUROPE
AND CHINA

There exists a substantial body of
literature dealing with shipbuilding
capacity in the former East European
Communist Countries and China. The
following is a brief summary of the
available information.

China

Although only a decade ago it was
practically unknown as a shipbuilding
country, China today competes today for
the No 3 spot in the world order book:
From the creation of the People's
Republic of China in 1949 up until 1979;
the Chinese shipyards built 4.61 million
DWT of total tonnage for their own
merchant fleet, or about 150,000 DWT per
year. They built 3.5 million DWT in the
next 7 years, including over one million
DWT for foreign shipowners [8, 9].

For many years, China, like the
USSR, has set aside a substantial
portion of its shipbuilding capacities
for naval construction. The naval build-
up slowed down a few years ago when
China launched its dramatic economic
reforms. After adoption of the open-door
policy in the mid-eighties, the growth
of industry accelerated, especially with
regard to the export portion of
industrial output. Thus, the
shipbuilding industry enjoys a steady
annual increase in the order book of
over 10%.

The details of the organizational
structure of China's shipbuilding
industry are very similar to that of the
USSR. The industry is managed by the
China State Shipbuilding Corporation
(CSSC), a Government entity, embracing
26 shipyards, 60 machinery plants and
over 70 institutions, factories and
shops with a total of almost 300,000
employees. Among the institutions under
the CSSC umbrella there are about 35
design and research centers employing
over 40,000 personnel [10].

The seven major shipyards capable
of building ships of 30,000 DWT and
above are located along the East China
Sea and Yellow Sea Coasts in Dalian,
Shanghai (3 yards), Guangzou, and
Chunhua. All of those shipyards are
heavily involved in export activities.
Among the recent deliveries from these
shipyards are two car carriers for 3,700
vehicles each, a 2,700 TEU containership
with reefer capacity, two 81,350 DWT
Superflex 3 Class multi-purpose ships,
and two 118,000 DWT shuttle tankers,

The prevailing types of
Shipbuilding installations are the
traditional inclined end-launching berth
and a side-launching berth. Only the
Dalian shipyard, the largest in the
country with 15,000 employees, has a
gravel dock to build ships up to 150,000
DWT. In addition, this yard has three
smaller berths - 290, 255 and 185 meters
long. A 350 meter long building dock for:
ships up to 300,000 DWT is scheduled to
be completed in 1991. Dalian shipyard,
as well as the Hudong and Shanghai:
yards, operate full-scale diesel plants
building Sulzer, B&W MAN and Pielstic
designs under license agreements.

CSSC also offers 24 drydocks at 17
shipyards around the country, capable of
lifting ships up to 60,000 DWT.

Last year's political turmoil in
China adversely affected the
Shipbuilding industry: number of new
orders dropped immediately and delays
with new deliveries were reported. Howev-
er, recent new orders have
significantly improved the situation,
securing a bright future for the Chinese
shipyards.

Poland

The four major Polish shipyards in
Gdansk (two yards), Gdynia and Szczecin
(fig.1) have been enjoying a very
steady market of new building for the
USSR for over 40 years. Since 1949,
Polish shipyards have finished about
1,000 ships, and most of them were
sold to the USSR. The Warsky shipyard in
Szczecin alone has built over 200 ships
on Soviet orders.

However, the advantage of this
steady and reliable demand has to be
weighed against the fact that the
transactions are carried out entirely on
the barter basis. The Soviet Union pays
for ships with raw materials, and the
prices for these supplies do not reflect
current world level. Moreover, many
components for the ships are purchased
by Poland from the West for dollars, and
are not reimbursed upon ship delivery.
At the same time it should be remembered
that significant modernization plans
also require hard currency. As a result,
in spite of the many advantages of
dealing with the USSR, including steady
demand and long ship series, Polish shipyards are turning towards western shipowners in search of hard currency.

The recent political and economic changes in Poland support the western orientation of the shipbuilding industry. Shipyards now operate under the umbrella of CENTROMOR, a combined venture of the Government, shipyards and marine equipment plants, which covers all aspects of the export and import of ships and marine equipment [13].

Among the ships built recently by the CENTRONOR group are floating docks, large passenger/car ferries, 85,000 DWT tankers, 150,000 DWT bulk carriers from Gdynia, 29,000 DWT bulk lumber carriers, and fish factory trawlers from Gdansk, car/passenger ferries, 32,000 DWT bulk carriers, and 30,000 DWT product carriers from Szczecin.

There have been, however, a few cases of substantial delays and late deliveries which led to the cancellation of contracts or reduction of the number of ships ordered. The main reason for these failures have been labor shortages and pure personnel discipline. Although the total shipbuilding workforce exceeds 50,000 people, many experienced workers left shipyards during and after the labor unrest of 1980-81, and a significant proportion of the remaining workers are still heavily involved in political activities. The problem is so serious that at one time the very existence of the Polish shipbuilding industry was in doubt.

As of January, 1990 all three major shipyards had the order books filled until 1992-93. The future will show if the industry is able to restructure and operate successfully without Government subsidies [14].

East Germany

The four major East German, shipyards in Wismar, Rostock, Stralsund, and Warnemunde have full order books until 1991-92, largely due to a steady demand from the USSR. Only 15% of the annual output is intended for the western countries. East Germany faces the same problems as Poland when dealing with Soviet orders. Not surprisingly, the yards are actively looking for Western business, and their marketing strategy is changing towards a more aggressive promotion of their products and services.

One of the main selling points for East Germany has been to emphasize their notable domestic designs: various fishing and fish-factory ships, a 18,000 DWT multipurpose container ship with a Sulzer engine manufactured in East Germany, a 1,200 TEU container ship with a MAN engine also built domestically, and a two-deck rail ferries for Baltic Sea. Recent deliveries include many high technology ships like icebreaking ro/ro's, sea-going and river -sea passenger liners [15].

East German shipyards have full order books until 1992, but these came largely from the USSR, and there is a significant probability that most of them will not materialize. In the very near future, East German yards will be incorporated into the mighty West German shipbuilding system, and will become much less attractive for the USSR as they loose the opportunity for bartered payments, and for Western shipowners who will no longer be able to take advantage of low wage rates.

Other East European Countries

Recent political developments have created a confusing and unclear situation in Bulgaria and Romania, which both have their major shipbuilding facilities on the east coast of the Black Sea (Fig. 1). The three large Bulgarian yards in Varna and Burgas, and the five shipyards in Romania (Constanza, Galatz, Braila, Mangalia,
and Turnu Severin) enjoy a steady flow of orders from the USSR, China and the Comecon countries. The political changes will diminish the traditional ties with other Communist countries, and the need for hard currency will become a major factor. These countries can offer facilities and expertise to build primarily bulk carriers and tankers of all sizes, from small river-sea types up to 160,000 DWT (Constanza).

The two shipyards in Czechoslovakia (in Prague and Komarno), build mainly specialty river ships: self-propelled dredges, floating pump stations of passenger ships, and river-sea cargo carriers.

5. SOVIET SHIPBUILDING SYSTEM

The Soviet Union has not just imposed its own political system upon the East European countries; it also forced upon them the principles of Soviet style central planning and management. The Soviet Union brought these countries under the umbrella of Comecon (Council for Mutual Economic Assistance), where the Soviet management system is prevalent. The Soviet Union used its colleges and universities to educate and train the leading engineers and managers of these countries. Therefore, the organizational structure of shipbuilding in most of East Europe and even in China, closely resembles that of the Soviet Union. The following is a short description of the Soviet shipbuilding organization [see also 16].

Shipbuilding Production Associations - one of the latest inventions of the Soviet economy management think tank. It is aimed at a reduction in administrative personnel improvement of planning, and also represents an attempt to ease the excessively tight strings which are imposed by the central planning system. A shipbuilding association is normally formed by merging a major shipyard with one or several smaller yards and assigning additional manufacturing facilities to them, such as a foundry, a machine shop, an electrical factory, other factories and shops, and engineering institutions.

The eight major shipyards have already been typical full service enterprises capable of fabricating and building not only ship's hull, piping and foundations, but also various fittings, some auxiliary and even propulsion machinery, including steam boilers. The ship production association has substantially expanded capacities to produce more ship components, clearly an advantage under the Soviet material distribution system. Examples of ship-building associations include the one in Kherson, the Admiralty Association in Leningrad, and the Astrakhan Shipbuilding Association.

From the standpoint of assignment and production structure, there are three major types of shipyards in the Soviet Union: 1) naval, 2) commercial, and 3) mixed production. For a majority of shipyards, their assignments are generally unchanged for a long period of time. For example, the Admiralty Association is mainly a naval yard with occasional orders for special commercial vessels, like the first nuclear icebreaker, Lenin, while the Leninskaya Kuznya in Kiev is mainly a fishing vessel yard with limited involvement in naval construction. The largest mixed production yards, which appear to be the backbone of both naval and commercial shipbuilding in the Soviet Union, have been gradually moving toward deeper involvement into the naval area during the last two decades.

Based on the variety of shipyards available, and on the steady demand for new ships, narrow shipyard specialization has become an important feature of Soviet shipbuilding. Series construction creates the optimum condition for those yards. Among other advantages it allows them to reduce the negative impact of centralized planning on construction time, and reduces the cost of subcontracted works.

Western naval experts are familiar with most fixed assignments of the Leningrad and Nikolayev yards for the construction of large combatant vessels (cruisers, aircraft carriers, large destroyers), Severodvinsk and Komsomol for submarines, Tallinn for destroyers, and Liepava and Kaliningrad for smaller combatants. In the same way, commercial construction is assigned to various yards according to their capacities and experience (see Fig. 1):

- large tankers: Kerch' (after 1975), Admiralty and Baltic yards in Leningrad (before 1970);
- midsize tankers - Kherson;
- small sea-going, sea-river, and river tankers - Volgograd, Gorky, Astrakhan', Tumen' and some other inland yards;
- large dry cargo carriers - Vyborg, Baltic and Zhdanov (Leningrad), Ocean and Black Sea (Nikolayev), Kherson;
- midsize and small dry cargo carriers - Gorky, Navashino, Astrakhan', krasnoyarsk,
The eighties their growth was of a

whenever it is required to construct a

Leningrad and Nikolayev) are

usually receives the order.

building any type of ships, with very

naval vessels.

used for starting a new series of large

The second generation of nuclear-powered

icebreakers - at Baltic yard; and giant

whale factories - at the Black Sea

yard.

passenger vessels and ferries - Zhdanov (Leningrad), Gorky;

- drilling rigs - Vyborg.

Actually, the eight largest yards (Kerch, Kherson, and three each in Leningrad and Nikolayev) are capable of building any type of ship, with very limited prior preparation. Therefore, whenever it is required to construct a unique or very complicated ship or to start a new series, one of these yards usually receives the order. For example, the unique fishing factory, Vostok, was built at the Admiralty yard; the largest surveillance vessel, Yury Gagarin, and the second generation of nuclear-powered icebreakers - at Baltic yard; and giant whale factories - at the Black Sea yard. Similarly, these same yards are usually used for starting a new series of large naval vessels.

6 SOVIET MARITIME EXPANSION

And SHIPBUILDING

The USSR came out of WWII with a very small fleet of two million DWT total tonnage consisting of very old, or second hand, lend-lease and reparation vessels. By the late fifties the overall tonnage had increased to about three million DWT. But during the next 10 years the fleet grew almost live-fold to the level of 15 Million DWT to occupy the 6th spot in the world ranking [17].

Growth has continued up to the present, although at a slower rate. While in the 60s they added primarily general cargo ships of simple design, in the eighties their growth was of a selective type: most of the new orders were either to replace older vessels, or to satisfy special needs. The latter were mainly ships capable of carrying out certain auxiliary naval functions (ro/ro, ferries, oil product carriers, research and hydrographic ships). Another special assignment of a new ship was, and still remains, the aggressive participation in the world ocean trade and competition with the traditional carriers on the major profitable lines. Most of these special ships were ordered from the European communist countries, while more sophisticated ships like icebreakers, reefer, and certain container carriers, were built for the USSR in Western Europe.

As of 1986, the number of Soviet ships on order exceeded 150. It grew to 189 in 1988, and to 210 as of January 1990. While number of Soviet ships on order constituted over 15% of the total world order book, their share by tonnage was only 3%. According to various Soviet publications and official interviews, there is no further substantial planned growth of their Merchant Marine for the near future.

The analysis shows that the Soviet fleet (currently holding the fifth spot in the World Maritime ranking with its almost 25 million DWT) is capable of meeting most of the water transportation needs of the Soviet economy. Therefore, the decision regarding a further increase of the fleet size depends on the evaluation of the three other functions of the Soviet merchant fleet: to earn hard currency; to support the Navy; to serve as the Navy's auxiliaries; and to provide transportation of cargoes to and from so-called "friendly nations".

The scope of the first function should be determined by a comparative economic analysis of profitability of shipbuilding for foreign owners versus ship acquisition from foreign and domestic yards for international trade. The odds appear to favor shipbuilding for the foreign owners. The Pepsico-Soviet deal supports this conclusion. As part of the agreement Soviet shipyards will build for Pepsico/ASA three new container ships, ranging in size from 28,600 DWT to 65,000 DWT, with the total value in excess of U.S. $ 300 million, that will later be sold or leased in the international markets [18].

The size of the merchant fleet required to support the Navy's operations can only be determined after the final points of the Soviet commitment regarding the military budget reduction are set. However, due to the severe economic conditions of the country, a decision to limit the Naval assignment of the merchant fleet might be taken independently and much earlier.

The urgent need for hard currency might accelerate this move. The latest political events as well as statements of the Soviet leaders suggest that their attitude to the "friendly nations" is gradually changing. There is much less
tonnage needed to support sharply reduced Soviet aid deliveries to Nicaragua, Angola and Vietnam. There are also indications of revaluation of the Soviet-Cuban economic relations which might free up many of the 163 ships that are used on the route to and from Cuba through a substantial period of the entire year [19].

7. ADVANTAGES OF BUSINESS, Relations information WITH COMMUNIST COUNTRIES

The low price of newly built ships is the main attraction for the shipowner to enter a business relation with a communist country. These countries manage to underbid their Western or Japanese competition because their production cost is much lower. Moreover, the Government ownership of all shipyards and policy of subsidization, at times, even allows them to set prices below production cost, as long as the sale is for hard currency. However, it is extremely difficult to carry out a decent cost analysis of Soviet shipbuilding because they still censor all the vital data related to ships and shipyards in spite of all changes inspired by the "perestroika". Hence, the limited information presented below is a result of the author's analysis, evaluation and sorting of the data obtained from various Soviet official and unofficial sources and publications [20, 21 and 22].

The share of major components of production costs for the representatives of various types of ships built at Soviet shipyards is presented in the Table 2.

Table 2  Production Cost Structure

<table>
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<tr>
<th>Ship Types</th>
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</tr>
<tr>
<td>Barge Carrier</td>
<td>13</td>
<td>8</td>
<td>22</td>
<td>47</td>
<td>10</td>
</tr>
<tr>
<td>' (Nuclear)</td>
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Material costs are composed of steel, propulsion plant, auxiliaries, and other materials. The USSR is the largest producer of steel in the world, and their prices are the lowest by far. Fig. 2 shows list prices for steel plates in rubles per ton, which vary depending on steel quality and plate thickness.

The official Government exchange rate is one ruble for U.S.$1.5 which is artificial and not based on purchasing power parity. Moreover, the Soviet Government has recently announced a special business exchange rate of one U.S. dollar for six rubles, although, it is not clear if they intend to use it in all commercial transactions. Even based on the official rate, the average cost of U.S.$300/ton appears extremely low. A reasonable assumption would be an additional premium of at least 50% applied for special brands of high tensile steel. And it is also obvious that the price for steel, as well as for any other materials and components

Fig. 2 List Prices for Steel Plates

![Fig. 2 List Prices for Steel Plates](image-url)
intended for use on foreign orders, would substantially differ from those used on the internal market. It has been for years a practice of strict separation of the internal market from the export activities in pricing and financing area, as well as, in material supply system.

The general policy of the shipbuilding industry in Communist countries is to buy as little as possible from the foreign vendors in order to save hard currency to maintain lower production costs. The East European industry, if well capable of producing practically any component of a ship, including diesels, turbines, all auxiliaries and electronics, low labor rates and low costs of basic materials contribute to a very competitive cost of production.

Major diesel factories in Poland, East Germany, Czechoslovakia, and several plants in the USSR including those in Leningrad and Bryansk manufacture the entire range of marine engine types and sizes. In general, quality is the main problem of the industry, and of diesel manufacturing, in particular. The recent production and technology improvements combined with licensing the best designs from Sulzer and MAN/B&W might help them to become competitive in the world diesel market. The decisive advantage of Soviet and East European factories, if as well as other marine machinery, is the fact that their price is below world market level.

The main variable in construction expenses is labor cost, which in turn is dependent on labor rates and consumption. A rough estimate of total labor consumption for the construction of a cargo carrier, 160 m long and 12,000 ton of light weight, at a typical Soviet shipyard, is equal to about one million man-hours, or about U.S.$1.5 million for total direct labor cost. Another, interesting price parameter is production cost per one man-hour of labor consumed. The average value for this parameter is 13 rubles, however, it sets just an approximate value, because real cost depends on vessel class, yard particulars, etc.

Cost of production labor is a function of labor rates, fringe benefits, insurance and other related charges, and labor productivity. The Soviet labor rates are among the lowest in the world: one man-hour of average skilled labor costs in the range of .60 - 1.25 rubles. Using the official of exchange, it equals to approximately U.S.$1.50: with the more practical rate U.S.$1.00 for six rubles the average labor cost is estimated as U.S.$0.20 per one man-hour.

The cost of design and production engineering support comprises a substantial portion of the overall production cost. Communist countries, and especially the Soviet Union, are capable of providing quite adequate service for the lowest price. The Soviet Union, for instance, has created a huge multi-tiered educational system which contributes a great deal to the shipbuilding industry.

More than twenty schools - universities, colleges and academies - offer 5-6 year engineering programs in marine related fields including marine, electrical, radio and electronic engineering, as well as naval architecture. Several thousand engineers join the shipbuilding and repair enterprises every year. Therefore, it is not unusual to find that 5-10% of the overall workforce at a given yard are specialists with engineering, certificates or diplomas. Their salaries, however, are very close to those of the production workers in the area of 150-200 rubles or $225-300 per month [18].

The development of an efficient shipbuilding organization is one of the principal areas of engineering and scientific studies in the Communist countries. The following essential factors have contributed significantly to the success of these studies: high level of standardization; extensive experience in employing various management methods based on detailed planning of all activities; constantly growing demand for products of shipbuilding; and strong support by a vast engineering and scientific community.

For instance, the modular system of ship construction is seen in the USSR as one of the most significant breakthroughs in the organization and management of ship construction. The modular system is based on standardization, group technology principles, zone outfitting, vast experience in the block/section method of vessel hull forming, and on the process lane concept. One of the first practical applications of modular principles appears to be the highly publicized construction of a series of KRYM-class super tankers of 150,000DWT in Kerch' and the subsequent POBEDA-class series.

3. PROBLEMS AND DEFICIENCIES

The product quality is an Achilles tendon of shipbuilding production in Communist countries, especially in the Soviet Union. It is reflected in poor
workmanship, inadequate appearance of compartments and accommodations, a high level of machinery and equipment wear, more frequent failures, and excessive warranty claims.

The quality of products is the major concern of their research and engineering institutions, and also of special quality service departments of the shipyards. For instance, to the individual Soviet shipyard a unique RITM Engineering and Production Association has been created in the USSR: a combination of the midsize Petrozavod shipyard in Leningrad with a government financed association employing hundreds of engineers and production workers has been given the task of developing and manufacturing new ship production equipment and tooling for use in Soviet shipyards. The goal of this effort is productivity and quality increases.

To the advantage of the Soviet, East European and Chinese shipbuilders, many shipowners are still maintaining a "built cheaper" approach without proper regard for future operational and maintenance expenses. While crew reduction and fuel saving considerations are normally a part of an evaluation of a proposed shipbuilding project, the maintenance and repair costs and the corresponding losses of operational time are not yet taken properly into account.

The absence of thorough studies on the subject is the main reason that whole life cycle evaluations are not done on a regular basis. It would have been very interesting to carry out a comparative study on maintenance and repair costs for comparable ships built in different countries, as was done in a very informative study conducted by Prof. H. Bunch regarding ship construction costs in the U.S., Japan and China [12].

The time needed to construct the ship affects general production expenses, expected profits of the shipowner, and also the amount of interest payments to the mortgage holder. The Soviet and East European yards are at obvious disadvantage compared with their Western or Japanese counterparts. Due in large part to inefficiencies of central planning in the USSR, and its legacy in Poland, Bulgaria, Romania and Yugoslavia, the construction time significantly exceeds that of, for instance, Japan.

9. Conclusion

Low cost of shipbuilding, a decent technology level, and comprehensive engineering support suggest that some kind of a business involvement with a shipyard in a communist country might prove profitable for an American Shipowner. The question for this audience is whether American shipbuilder can benefit from business relations with Communist countries. In the opinion of this author, there are a few avenues to follow:

1. A management agreement might be welcomed by a certain Soviet, East European or Chinese shipyard that is struggling to gain needed experience in how to operate in a free market world, how to incorporate the modern computer based management methods, and how to deal with quality problems.

2. Subcontracting a shipyard in a communist country to fabricate hull structural modules (cheap steel and high expertise in welding at Soviet shipyards), various auxiliary machinery units and installations.

3. Subcontracting a shipyard for a partial or even complete construction of a ship under the condition that all managerial (ship management, project management, scheduling, etc.), certain material and equipment procurement, quality control and some engineering functions are carried out by an on-site team of the general contractor.

4. Hiring or subcontracting an engineering institute in a communist country, for instance, in the Soviet Union, to carry out certain studies (naval architectural, marine and electrical engineering, etc.), prepare a proposal, conceptual or and detailed design. Incidentally, the Krylov Scientific Research Institute, a Soviet counterpart of the David Taylor R&D Center, offers foreign shipbuilding companies the opportunity to study the hydrodynamic properties of new designs in their 625 and 218 meters long towing basins.

5. Various types of joint ventures including a partial ownership of shipyards and machinery shops in the Communist countries.
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