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Special Structural Shapes: Factors Affecting Usage in U.S. Shipbuilding

U.S. Department of Commerce
Maritime Administration
in cooperation with
Todd Pacific Shipyards Corporation

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FOREWORD

This is one of the many projects managed and cost shared by Todd Pacific Shipyards Corporation as part of the National Shipbuilding Research Program. The Program is a cooperative effort between the Maritime Administration's Office of Advanced Ship Development and the U.S. shipbuilding industry. The objective described by the Ship Production Committee of the Society of Naval Architects and Marine Engineers. emphasizes productivity.

The research effort was assigned to SRI International (Stanford Research Institute). The work was conducted by management consultants within SRI's Materials and Metalworking Group under the direction of Dr. Charles D. Turk. Others in SRI who actively contributed include Barry H. Minkin, senior management consultant, and Deborah L. Godat, research analyst.

In behalf of Todd Pacific Shipyards Corporation, Seattle Division, L.D. Chirillo served as the R&D Program Manager. He was assisted by J.F. Curtis.

Appreciation is expressed for the constructive comments, much of which is included in this text, submitted by: American Bureau of Shipping; Avondale Shipyards, Inc.: Bethlehem Steel Corporation; Connors Steel Company; General Dynamics, Quincy Shipbuilding Division; Maritime Administration, Office of Ship Construction; Naval Ship Engineering Center: Newport News Shipbuilding; Shipbuilders Council of America; SNAME Panel SP-2; United States Steel Corporation.

EXECUTIVE SUMMARY

Shipbuilders consider that the substitution of special structural steel shapes for standard shapes has potential for increasing productivity. The use of special shapes, e.g. long-leg angles and bulb flats, in ships is common throughout the rest of the world. In the United States, except where shipbuilders have resorted to fabricating shapes, standard angles, tees and channels that frequently need further processing are the norm. In response to shipbuilders' interest in the potential for increasing productivity, this report presents the results of an investigation of the major issues and problems affecting the adoption of special structural shapes by U.S. shipbuilders.

The purpose of the study was not to do a detailed engineering analysis of the use of special structural shapes, but to bring into focus the major issues concerning their potential usage. Therefore, analyses of the attitudes of both shipbuilding and steel mill people significantly contributed to the findings and recommendations reported herein.

A major recommendation stated in Chapter I is" . . . to initiate a study of MarAd policy (Buy American) to determine if that policy is working toward MarAd's ultimate goal." The author describes, in Appendix A, his understanding that MarAd is required" . . . to ensure that domestic steel supplies exist in case of a defense mobilization." Also, that with respect to structural shapes he" . . . could find no evidence that the current' Buy American' laws or policies are ensuring an adequate supply." He noted instead, that the". . . historical trend in the <u>reduction</u> of structural products offered to (U. S.) shipyards. . . is likely to continue. . ."

As the tonnages involved for building commercial ships are of no significance, less than one one-hundredth of a percent of the U.S. steel industry's total output, inhibiting more productive shipbuilding methods in the U.S. throughout all of peacetime is no longer believed to be in the national best interest. Shipbuilders, particularly now with computerized design, lofting, and material definition, can quickly develop or maintain on file everything needed to shift to conventional and less productive structural shapes should they ever be required for defense mobilization.

The Shipbuilders Council of America (SCA), in commenting on the initial draft of this report, urged that". . . first emphasis should be on building firmer demand." Thus, a study of how shipbuilders elsewhere have overcome the problems of welding certain special shapes has been recommended to the SNAME Ship Production Committee. And, in order to better identify the cost benefits, building selected ships with applications of special structural shapes will also be recommended. As noted by the SCA, these will require MarAd support.

Favorable MarAd consideration is more justified now than ever before because productivity gains are universally recognized as the most outstanding weapons to combat inflation. The SCA, in a letter incorporated herein as Appendix D, also suggested that the needed support could be similar to MarAd's recent promotion of slow speed diesel engines. An applicable rationale to justfy a pertinent policy change could note that the drafters of Section 505 of the Merchant Marine Act of 1936, as amended, likely intended that the requirement for "major components of the hull, superstructure, and any material used in the construction thereof must be of domestic origin" applies to large entities such as a midbody or forebody. By specifically stating "major components of the hull" rather than just "components of the hull" the existance of minor components, for which the same rigid exclusion does not apply, is established. Thus, structural shapes could be acknowledged as such minor components justifying MarAd allowing a free-market. This would permit U.S. shipbuilders to select structural shapes that are based only on productivity considerations.

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I SUMMARY

Conclusions

As a result of SRI International's analyses of the usage, issues, and related problems affecting the adoption of special structural steel shapes, the current and future market potential for U.S. shipbuilders was estimated. The following subsections present the major conclusions regarding current market size, factors affecting the adoption of special shapes, and potential for special steel shapes.*

Current Markets

The following list summarizes the findings with regard to the current markets for special structural steel shapes:

- Special steel structural shapes--bulb flats and long-leg angles--currently are unused by U.S. shipyards although they have been used intermittently in the past.
- It is estimated that about 100,000 tons of structural (excluding inland barges) were used in 1977 for shipyard activities. Naval vessels represented about 45% of this total.
- The estimated usage of structural shapes for all types of shipyard building, including the addition of structural steel for inland barges to this total tonnage, is divided as follows:

	Amount (tons)	Percentage of Total
Inland barges	65,000	39
Other merchant vessels	55,000	33
Naval vessels	45,000	27
	165,000	99+

- About 16,500 tons of structural are used in privately funded shipbuilding and barge construction, 27,500 tons for shipbuilding construction with subsidies, and 76,000 tons under mortgage-guaranteed only construction.

*The study was limited to shipbuilding in the U.S. People were interviewed at shipyards and steel mills and in the American Bureau of Shipping, American Iron and Steel Institute, Maritime Administration, Shipbuilders Council of America and Naval Ship Engineering Center. Additional information was obtained through questionnaires to shipyards and steel mills. It was outside the research scope to develop forecasts of shipbuilding. Consequently, those included are based on existing forecasts available throughout the industry.

+Does not add to 100% due to rounding.

Current Factors

U.S. shipbuilders do not use special structural shapes for many reasons. The principal reason, however, is that current law or policy either discourages or prohibits their use because they are unavailable domestically for all practical purposes. The following listing not only cites the major reasons why special shapes are not used, but also gives some of the factors that will affect their adoption. Although the reasons for not using special steel shapes vary from one shipbuilder to another, the following are most common to all shipbuilders:

- Current law and policies tend to perpetuate usage of standard shapes available domestically.
- Lack of domestic steel producers of special shapes.
- Many shipbuilders are apprehensive about possible welding problems with bulb flats.
- Shipbuilders generally agree that cleaning and painting productivity will increase with bulb flats; however, no economic analysis of the potential savings has been conducted.
- Laws or policies will not likely be changed to aid in the substitution of special shapes.
- A change in specifications will not likely allow shipbuilders to adopt special shapes used in other industries.

Other factors that were identified in the interviews include:

- U.S. steel mills will not likely act on their own to develop the market for special shapes.
- Imported special sections, in most cases, cost less than domestic standard shapes; however, if U.S.-produced, special shapes will likely cost more than domestically produced standard shapes.
- A weight savings, in the structural members, in general, of about 20% could be expected when bulb flats are substituted for standard angles on an equivalent section modulus basis.
- Inland barge builders represent a significant factor in the market, and their requirements will have to be considered.

Outlook

Significant usage of special structural shapes is not anticipated unless domestic steel sources are available or a change in MarAd policy occurs. In the interviews conducted during this study, the merits of MarAd policy on “Buy American” could not be evaluated. Thus, the following was based on the development of domestic sources as an alternative. Based on the assumption that the recommendations in this report

Could initiate the development of domestic sources, the following would be the expected outlook:

- Ž The demand for all types of structural shapes will decrease from the 1977 level of 165,000 tons to about 145,000 tons in 1985 as a result of an expected slowdown in shipyard activity as shown below:

	Demand (tons) 1977	1985
Inland barge	65,000	95,000
Other shipbuilding	100,000	50,000
Total (including Naval)	165,000	145,000

- The 1985 projection for special shapes assumes the following possible market distribution:

	Amount (tons)	Percentage of Total
Inland barges	25,000	45
Other shipyards	30,000	55
Total	55,000	100

Recommendations

The major goal of the study recommendations is the development of demand for special shapes. The development of domestic steel sources and the inclusion of barge builders in the market will generate this demand. The recommendations were based on practical requirements; however, it is believed that a change in law or MarAd policy would also stimulate the demand for special structual steel shapes. (See Author's Comments, Appendix A.) As a result, a major recommendation of this study must be to initiate a study of MarAd policy to determine if that policy with respect to special shapes is working toward MarAd's ultimate goal. The other major recommendations are as follows:

- Ž Conduct a technical study on the techniques and problems of welding bulb flats.
- Ž Develop domestic sources by funding initial tooling costs at selected domestic steel mills.
- Select standard sizes of bulb flats that meet the needs of inland barge and other shipbuilders for initial tooling funding.
- Ž Initiate a technical and economic case study of the impacts of change to special shapes in inland barge design.

Ž Establish a joint barge-shipbuilders committee to aid in size selection, case study selection, and the dissemination of information to the industry.

In summary, the assessment of all of the information collected during the study indicates two important aspects in the substitution of special structural steel shapes for standard shapes that must be considered. First is the requirement to develop domestic sources for the production of special shapes. The second is the importance of including the inland barge builders as a part of the market for special shapes. Existing law and policy, however, somewhat constrain a changeover to special shapes. In addition, the small size of the market provides little motivation for the steel mills to invest in the tooling and marketing costs needed to develop the market for special structural steel shapes.

II USAGE OF STRUCTURAL SHAPES

The first objective of this study was to determine the usage of special structural shapes in shipbuilding. Although some shipyards used these materials a few years ago, it was found that no bulb flats or long-leg angles are currently being used. Those cases in which special shapes were used were at the demand of the shipowner and on a temporary basis only. Thus, this current research focused on determining the potential for the use of special shapes rather than to identifying current levels of usage and the reasons shipbuilders selected special shapes.

Determining the potential for special shapes entails two main steps. The first step is to establish the maximum theoretical replacement potential; this maximum would represent the current usage of standard shapes less any estimated amount made unavailable because the switch to special shapes is prohibited. The second step is to estimate a realistic potential usage or substituted level of special shapes on the basis of attitudes of buyers and market requirements. The following discussion concerns the maximum replacement potential. Section IV discusses the factors that will determine the actual levels of substitution, and Section V estimates how much substitution is expected, given certain basic assumptions.

Steel enters the shipyard through three main distribution channels: direct from a domestic steel mill; from a foreign steel mill; and from warehouses, service centers, or other distributors. Steel shipments from U.S. steel mills are reported annually by the American Iron and Steel Institute (AISI). Table 1 gives historical data on the steel shipments by end market. As indicated in the table, shipbuilding generally accounts for about 1.1% of the total steel consumed; the range has been from a low of 0.9% to a high of 1.3%. In 1977, shipments of steel to the shipbuilding industry were reported at 869,342 tons, or 0.95% of the total. The field interviews revealed that distributors are not a significant supply factor, but some shipyards do buy foreign steel, primarily plate. Based on steel industry 1977 statistics, the following gives an estimate of steel usage by all shipbuilders:

Table 1

DISTRIBUTION OF STEEL TO CONSUMING U.S. INDUSTRIES
(In Percent)

	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977p
Warehouses, service centers, etc.*	18.3	17.7	18.2	17.7	17.5	18.7	19.5	18.6	20.3	20.4	21.2	20.5	16.3†	16.8†
Construction	12.9	12.8	13.2	13.6	13.3	12.1	11.6	11.0	10.1	10.2	11.3	9.5	8.4	8.2
Contractors' products	5.5	5.4	5.5	5.5	5.4	5.1	4.9	5.6	5.5	5.8	5.6	5.3	5.0	5.0
Automotive	21.6	21.7	20.0	19.7	21.0	19.5	15.9	20.1	19.8	20.8	17.3	19.3	23.9	23.6
Rail transportation	4.1	4.1	4.8	3.8	3.3	3.6	3.5	3.4	2.9	2.9	3.1	4.2	3.4	3.6
Shipbuilding	0.9	1.1	1.1	1.1	1.1	1.0	0.9	1.3	1.0	0.9	1.2	1.2	1.1	1.0
Aircraft‡	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Oil and gas drilling	0.5	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.4	0.5	0.7	3.0*	4.0*
Mining, lumbering	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.7	0.6	0.5
Agriculture	1.6	1.6	1.9	1.7	1.5	1.2	1.2	1.3	1.6	1.6	1.7	1.9	2.0	1.8
Industrial equipment	6.3	6.3	6.4	6.0	6.0	6.1	5.6	5.6	5.9	5.7	5.9	5.9	5.8	6.1
Electrical equipment	3.1	3.2	3.4	3.3	3.2	3.0	3.0	3.0	3.1	3.0	3.0	2.7	3.0	2.9
Appliances, cutlery, etc.	2.6	2.4	2.6	2.5	2.5	2.4	2.4	2.5	2.6	2.5	2.2	2.3	2.2	2.3
Other home, commercial	2.4	2.4	2.5	2.5	2.2	2.0	2.0	2.0	2.0	1.8	1.8	1.9	2.0	2.0
Containers	7.7	7.9	7.3	8.6	8.6	7.6	8.5	8.3	7.2	7.0	7.5	9.2	7.7	7.4
Ordnance, etc.	0.3	0.3	0.8	1.9	2.2	1.9	1.3	1.0	0.9	0.8	0.6	0.4	0.2	0.2
Miscellaneous	8.5	9.9	9.7	9.5	8.9	9.5	12.2	12.6	13.4	12.8	12.8	12.4	13.2	13.3
Total domestic	96.8	97.7	98.3	98.3	97.7	94.7	93.4	97.2	97.2	97.2	96.4	98.2	97.9	98.8
Export	3.2	2.3	1.7	1.7	2.3	5.3	6.6	2.8	2.8	2.8	3.6	1.8	2.1	1.2
Total shipments	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0‡

* Includes oil and gas supply houses.

† No longer includes oil and gas supply houses.

‡ Percentages based on total steel shipments of 91,147,267 net tons.

Note: p = Preliminary

Source: Metal Statistics 1978, American Metal Market

	Net Tons
Direct from U.S. mills*	869,342
Imports estimated at 2% of imported plate and shape+	76,000
Shipments from warehouses, distributors, and service centers†	Minor
Total	945,342

Thus, including a rough estimate of the amount of steel imported, the U.S. shipbuilding industry used approximately 945,000 tons of steel in 1977. Some private estimates by steel mills place this figure at about 1 million tons.

The total direct shipments of 869,342 tons of steel from U.S. mills is further segmented by the AISI into product categories. Table 2 gives U.S. steel mill shipments, by product, to the shipbuilding industry. About 77% of the total shipped was in the form of plate, whereas structural shapes of all types accounted for about 11% of the total. It should be noted that the interviews with shipbuilders indicated that plate usage ranged from 70% to 90% of the total. If a shipyard purchased all of its structural, the plate purchases averaged 75% to 80% of the total; if they fabricated most of their structural shapes from plate, the plate purchases were about 90% of the total. Barge builders tended to use more structural, and their plate purchases typically ranged from 70% to 85%, depending on the barge design.

According to the industry statistics in Table 2, an estimated 100,OOO tons of steel are used in structural shapes in shipbuilding. However, this report's estimate differs from this value. The estimated steel usage for structural shapes was calculated by totaling the purchased tonnage as reported in the interviews in the shipbuilding industry. Steel usage compiled from those interviews for both plate and structural shapes amounted to over 400,000 tons, with an average of 12% going into structural. Based on this 400,000 ton figure, the estimated consumption of steel for all shipbuilding is 1,385,000 tons, and the total structural usage for all shipbuilding is 165,000 tons.

A separate survey of barge builders showed a total steel usage of about 400,000 tons for this market segment; only about 60% of the barge builders were included in this survey. Based on the barge survey and an average of 20% ratio of shapes to steel purchases for barge builders,

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*AISI

+SRI estimate.

Table 2

STEEL PRODUCTS FOR SHIPBUILDING
(Shipped Direct from Mills)
1977

Product	Net Tons	Percentage of Total
Plate	665,851	76.6
Structural	99,425	11.4
Hot rolled sheet	60,877	7.0
Hot rolled bar	26,761	3.1
Cold finished bar	4,258	0.5
Galvanized sheet	2,538	0.3
Other coated sheet	1,949	0.22
Piling	1,639	0.19
Standard pipe	1,524	0.18
Rails	955	0.11
Hot rolled strip	972	0.11
Other	2,593	0.3
Total	869,342	100.0

Source: AISI

it is estimated that 165,000 tons of structural steel would be required for this market segment alone. Combining this estimate with the interview data on structural usage (excluding inland barge builders interviewed) yields an estimated 265,000 tons of structural steel usage. Table 3 summarizes the various estimates and illustrates the basic discrepancies.

Table 3

SUMMARY OF ESTIMATES OF STRUCTURAL STEEL USAGE
(tons)

		SRI Data Source	
	Primarily AISI Data	Shipbuilders Interviews	Barge Survey Plus Interviews
Total steel shipbuilding	945,342	1,385,000	NA
Structurals			
Barge	NA	65,000	165,000
Other	NA	100,000	100,000
Total structurals	99,425	165,000	265,000

* AISI supplied only a total usage figure for structural

Some basic reasons for the differences in the estimates from the various sources are that not all steel companies report shipments, survey coverage was limited in size, and estimating the amount of foreign steel purchases was difficult. For the purpose of this report, the totals obtained from the interviews were selected as the basis for the estimates of the total 165,000 tons of structurals, inland barge building activity accounts for about 40%. This estimate can be considered either conservative or optimistic, depending on the source as shown in Table 3. It should be noted that structural shapes for shipbuilding represent about 0.2% of all steel shipments and are of relatively little importance to the steel industry as a whole.

The usage of structural can be further segmented into naval and merchant vessels. In 1977, about 38% of the vessels (in tons) under construction in shipyards, and not included in the barge category, were naval vessels. Naval architects primarily select Tees for the structural shapes in ship construction; therefore, the ratio of structurals, by weight, will be proportionally larger than the 38% and is estimated roughly at 45% of the nonbarge total. Thus, naval vessels account for 43% of the nonbarge weight; when barges are added to this nonbarge figure, the new resulting proportions are as follows:

	Tons	Percentage of Total
Inland barge	65,000	39
Other merchant vessels	55,000	33
Naval vessels	45,000	27
Total	165,000	99*

Merchant vessels can be built with or without a subsidy administered by MarAd. Virtually all merchant vessels built with a subsidy also have federal ship financing guarantees associated with them. Some vessels built without subsidy may have federal ship financing guarantees, whereas others may be built without any government aid (private). Vessels built under subsidy or ship financing guarantees fall under laws or regulations (policy) developed by MarAd concerning the source of steel supply; thus, it is important to identify the portions of usage that fall into these financing categories. In that naval vessels are excluded from the MarAd regulations and almost all barges are built privately, the following steel usage pattern is based on estimates of ratios for the three categories:

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*Does not add to 100% due to rounding.

Category	Steel Usage (tons)		
		Merchant	Total
Private	--	16,500	16,500
Subsidy (Title 2)	--	27,500	27,500
Mortgage guarantee (Title XI)	65,000	11,000	76,000
Total			120,000*

It is estimated that about 25% of the barges constructed use Title XI mortgage guarantees. To maintain eligibility for future Title XI applications, the remaining owners usually require certification that all hull materials are of U.S. origin. Therefore, the above tabulation shows all the barge activity as Title XI. Thus, of the total 120,000 tons of commercially used steel, about 14% is privately financed.

Current practices in designing military vessels make it unlikely that special bulb flats or long-leg angles will be adopted for combat or semi-combat vessels. The principal reason for this conclusion is that the structural parts of naval military vessels are designed to resist dynamic loading; thus, the buckling strength of a reinforcing member becomes critical. Given the spacing now being used between reinforcing members, the combination of mechanical properties and column buckling strength can be best met by a T-section. Although naval designers are aware that combat vessels from other nations do use special shapes--required properties are different because of different spacing between reinforcing elements--it is unlikely that a massive change in design philosophy will occur. As a first approximation, therefore, the 45,000 tons of structures used for naval vessels is excluded from the maximum theoretical potential market, yielding a maximum market of 120,000 tons.

The 120,000 tons represent the total theoretical market potential for special structural shapes. To obtain this total, special shapes would have to replace all usage of angles, channels, and Tees in non-military shipbuilding. Such an eventuality is not likely to occur; therefore, this total should be considered as the maximum theoretical limit for 1977. This maximum will vary annually in accordance with the amount of shipyard activity. In addition, this total does not reflect the effect of the current law and MarAd policy that prevents the usage of foreign steel in hull construction. Without domestic special steel sources, almost 25% of the market is currently prohibited from using special shapes because of "Buy American" requirements for subsidized ship construction. Another 63% of the market is not likely to use foreign

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*Excludes naval construction.

shapes because of economic disincentives under Title XI. Rarely will a barge builder consider foreign steel for structural shapes mainly because of delivery requirements of the barge builder. Therefore, for all practical purposes, only a maximum of about 16,500 tons of structural could be replaced by special shapes under current conditions.

The degree to which special structural shapes actually penetrate the market can be expressed as a percentage of the theoretical maximum. It was found that no special structural shapes are being used in U.S. shipyards although some were used in past years. The future percentage of market penetration will depend on a number of factors. These factors, as determined by the field interviews, are detailed in the subsequent sections.

III FACTORS AFFECTING ADOPTION OF SPECIAL STRUCTURAL SHAPES

The previous section developed the theoretical market potential for special structural steel shapes for 1977. The actual penetration or replacement will depend on a number of factors that will affect not only the shipbuilders but also their suppliers. This section identifies the key factors and describes the key issues that shipbuilders and their suppliers will have to deal with if shipbuilders are to consider switching to special steel shapes. The following discussion presents the viewpoints of both the shipbuilders and domestic steel producers and is intended to provide the background for the recommendations made in a later section.

It is often assumed that special steel shapes must be advantageous because of their general acceptance by foreign shipbuilders. However, unless U.S. shipbuilders are cognizant of explicit advantages, it is unlikely that much consideration will be given to substituting special shapes for standard shapes. It was found that this is indeed the case--the shipbuilders have evaluated few economic or quantitative technical studies. The major reasons for this apparent disinterest are:

- Law and/or government policy that prevent or discourage the use of foreign special shapes.

- Lack of domestic sources for special shapes.

The impact of these factors will be examined in the following discussion.

Even though few quantitative evaluations have been conducted or are available, many opinions were expressed on the pros and cons of the use of special structural shapes. The following discussion summarizes the opinions of shipbuilders. Some quantitative data that were available from shipbuilders are presented to substantiate some of the opinions.

Factors Cited by Shipbuilders

Shipbuilders provided both positive and negative viewpoints not only in the direct field interviews, but also in the written questionnaires. In some cases, the positive and negative opinions of different shipyards contradicted each other. All of the opinions are summarized, however, without expressing a judgment on the apparent contradictions.

Positive Factors

Without considering the economic advantages that may be obtained in the shipbuilding process itself, some shipbuilders report a potential direct dollar savings by converting to the use of bulb flats. One shipyard, for example, had a recent quote from a foreign source for bulb flats at 11% under the current price for equivalent U.S. standard angles. Table 4 shows some calculations on comparative costs that could be anticipated if bulb flats replace standard angles. This table originally contained the costs of the bulb flats, angles, and channels, but was changed into indexes to protect the confidentiality of the shipyard. This table and the results would vary for each shipyard because the data in the table would depend on the relative costs being paid by the shipyard. In addition, it should be stressed that the cost indexes do not take into account any costs or savings that may occur in the shipbuilding process itself.

Table 4 clearly demonstrates that for the prices being paid by this shipbuilder, bulb plates are more economical than ordinary angles at 7 x 4 x 3/8 inches and channels of 10 x 2-5/8 inches if equivalent section modulus is used as the criterion. As the size of the standard shape increases, the economic advantage of the bulb plate is more evident as is shown by comparing the following:

Section Modulus ($in.^3$)	Shape	Index (dollars/ft)*
40	9 in. x 4 in. x 7/8 in. angle	7.25
40	300mm x llmm bulb plate	4.53
40	15 in. x 3-3/8 in. channel	5.29

Even though this tabulation represents the expected savings for only one shipyard with specific costs, the major point is that it demonstrates the potential for a direct savings if foreign bulb flats replace some standard shapes.

Another advantage that special structural shapes may offer is weight savings. This could be of particular importance in inland barge building where weight is critical. Table 5 compares bulb flats and some standard angles on the basis of equivalent section moduli. For the particular

* The dollar per foot for angle with section modulus of 5 $in.^3$ and size of 5 in. x 3 in. x 1/4 in. is equal to $1.

Table 4

COMPARATIVE COSTS: ANGLE BARS, BULB PLATES, CHANNELS

Section Modulas (in.^{3})	Additional Plate Thickness (in.)	Ordinary Angle Bars				Bulb Plates				Standard Channels			
		Size (in.)	Index ($/100 lb)*	lb/ft	Index ($/ft) +	Size (mm)	Index ($/100 lb)*	lb/ft	Index ($/ft)†	Size (in.)	Index ($/100 lb)*	lb/ft	Index ($/ft) +
5	0.20	5 x 3 x 1/4	1.00	6.6	1.0	140 x 8	1.21	7.27	1.337	6 x 2	1.03	8.2	1.280
10	0.26	6 x 4 x 5/16	0.99	10.3	1.551	180 x 10	1.21	11.85	2.179	8 x 2 1/4	1.08	11.5	1.887
15	0.31	7 x 4 x 3/8	1.05	13.6	2.170	220 x 9	1.21	14.13	2.600	10 x 2 5/8	1.07	15.3	2.483
20	0.37	8 x 4 x 7/16	1.31	17.2	3.410	220 x 9	1.21	14.13	2.600	10 x 2 5/8	1.07	20.0	3.246
25	0.43	9 x 4 x 1/2	1.30	21.3	4.202	260 x 10	1.21	19.02	3.499	12 x 3	1.06	20.7	3.332
30	0.49	9x4x9/16	1.32	23.8	4.779	280 x 10	1.21	20.97	3.858	12 x 3	1.03	25.0	3.889
35	0.54	9 x 4 x 3/4	1.32	31.3	6.286	280 x 12	1.21	23.98	4.411	12 x 3	1.03	30.0	4.666
40	0.60	9 x 4 x 7/8	1.32	36.1	7.249	300 x 11	1.21	24.61	4.527	15 x 3 3/8	1.03	33.9	5.289

Notes: Each shape chosen on basis of lightest weight for given section modulus.
Bulbs are British.
Channels are Canadian.

* Base value for these indices is the value for "Ordinary Angle Bars" with 5-in.^{3} section modulus [Angles ($/100//) = l].

\+ Dollars/ft. of 5-in.^{3} angles = 1.

Source: Shipyard (name confidential)

Table 5

COMPARISON OF PROPERTIES OF BULB FLATS WITH UNEQUAL LEGS ANGLE

Bulb Plates				Angle			
mm	In.	Weight (lb/ft)	Section Modulus (in.^{3})	Dimension (in.)	Weight (lb/ft)	Section Modulus (in.^{3})	Steel Weight Increase (percent)
60 x 4	2.36 x 0.16	1.89	0.195	2 x 1 1/2 x 3/16	2.12	0.182	12.17
60 x 5	2.36 x 0.20	2.20	0.237	2 x 1 1/2 x 1/4	2.77	0.236	25.91
60 x 6	2.36 x 0.24	2.52	0.278	2 1/2 x 1 1/2 x 3/16	2.44	0.279	-3.18
100 x 6	3.94 x 0.24	4.09	0.778	3 x 2 x 3/8	5.90	0.781	44.25
100 x 7	3.94 x 0.28	4.61	0.885	3 x 2 x 7/16	6.80	0.894	47.51
100 x 8	3.94 x 0.32	5.14	0.995	4 x 3 x 1/4	5.80	1.000	12.84
140 x 7	5.51 x 0.28	6.55	1.770	4 x 3 1/2 x 7/16	10.6	1.720	61.83
140 x 8	5.51 x 0.32	7.26	1.983	4 x 3 1/2 x 1/2	11.9	1.94	63.91
140 x 9	5.51 x 0.35	8.00	2.197	6 x 3 1/2 x 1/4	7.9	2.21	-1.25
180 x 8	7.09 x 0.32	9.95	3.41	6 x 4 x 3/8	12.3	3.32	23.62
180 x 9	7.09 x 0.35	10.89	3.77	6 x 4 x 7/16	14.3	3.83	31.31
180 x 10	7.09 x 0.39	11.83	4.14	7 x 4 x 3/8	13.6	4.44	14.96
180 x 11	7.09 x 0.43	12.77	4.49	7 x 4 x 3/8	13.6	4.44	6.50
220 x 10	8.66 x 0.39	14.78	6.41	7 x 4 x 9/16	20.0	6.48	35.32
220 x 11	8.66 x 0.43	16.46	6.90	7 x 4 x 5/8	22.1	7.14	34.27
220 x 12	8.66 x 0.47	17.61	7.45	8 x 4 x 1/2	19.6	7.49	11.30
							421.27
							16 = 26.33%*

* Average steel weight increase by using angles over bulb flat which is equal to 20.84% steel savings by using bulb flat.

Source: Courtesy of shipyard (name confidential) sizes being compared, an expected weight savings of about 20% would be anticipated. In addition, Appendix B gives some calculations for 24-in. sections to enable shipbuilders to compare some of their own data to estimate weight savings. The concept that special structural shapes will reduce weight is generally accepted by most shipbuilders. An example of the acceptance of this concept is given in the following quote from a shipbuilder concerning the repair of ships:

> "A substantial weight penalty is encountered along with difficulty in making a longitudinal connection between a bulb plate and our substitution [when available steel is substituted for a bulb flat in repair]."

The most generally accepted advantage of special structural shapes concerns cleaning and painting of the sections. Virtually everyone agreed that sections using bulb flats would be considerably easier to clean and paint. However, it is interesting to note that not one shipbuilder interviewed could place an economic value on the potential savings that could result from improved ease in cleaning and painting. Thus, although this advantage is widely recognized, the lack of data to validate its value leads to the conclusion that it is not a significant motivating factor to cause a change to the special shapes.

Special structural steel shapes, bulb flats in particular, give easier accessibility for welding. An investigation conducted by one shipyard pointed toward this advantage; however, no economic analysis was conducted to place a value on this advantage.

All of the above advantages refer to the shipbuilding process itself. However, some shipowners would also benefit from special structural shapes. For example, in many cases, cleaning so as to switch cargos is a problem. To what degree owners will pay for this advantage is not known. Many inland barge owners, for example, would certainly benefit from improvements in cleaning.

<u>Negative Factors</u>

Many shipyards were able to cite negative factors. Some of these expressions of concern are attributable to a lack of familiarity with special shapes. Some of these negative opinions are the result of attempts to use bulb flats in the past.

The most often cited reason for not using special shapes is the lack of domestic sources. For all practical purposes, special steel shapes are not available through domestic steel mills, although U.S. Steel does offer one size of bulb flat (see Figure 1). The impact of the absence of a domestic source is twofold. First, some shipbuilders prefer to buy domestic and will not consider foreign steel. Second,

I_y = 44.7 in.^{4}
S_y = 7.68 in.^{3}
r_y = 2.98 in.
I_x = 0.761 in.^{4}
S_x = 0.572 in.^{3}
r_x = 0.389 in.
Area = 5.02 in.^{2}
Weight = 17.1 Lbs/Ft

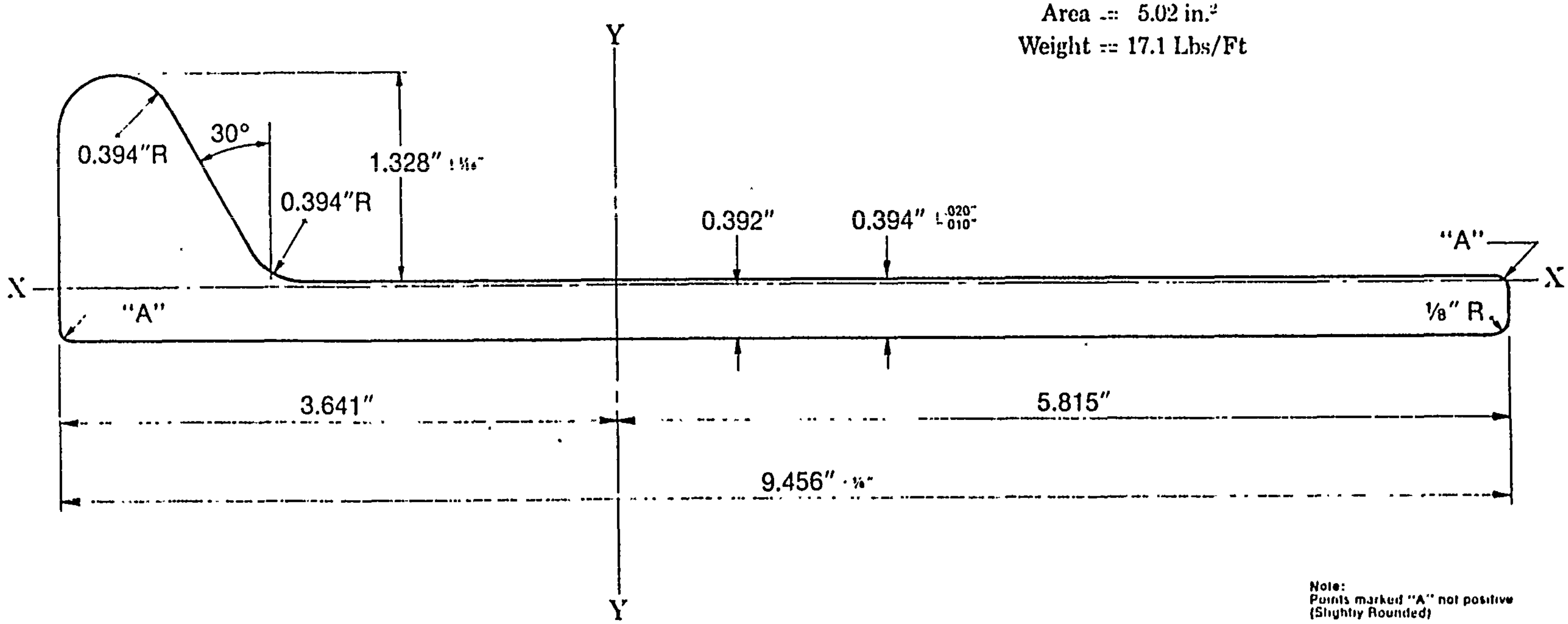


FIGURE 1 BULB FLAT PRODUCED FOR BATH IRON WORKS

ships built under Title V subsidy, Title XI mortgage guarantees, or subject to the Jones Act are also subject to regulations or policy concerning source of steel used. In actuality, therefore, shipbuilders are limited in their purchases of steel from foreign sources. Thus, most shipbuilders will not consider bulb flats or long-leg angles because there is no viable domestic market.

The economics of special structural shapes was of great concern to almost all of those interviewed. Many shipbuilders believe that these special shapes are not currently competitive on an economic basis with standard shapes. As one would expect, the prices quoted to shipyards varied considerably with quality, size, and source. The following tabulation gives some of the typical price ranges quoted to shipyards:

Source	Product	Price Range (dollars per ton)
Foreign	Bulb flat	345-620
Domestic	Bulb flat	440
Domestic	Mill angles	325-450

The $620/ton figure from a foreign source was for quantities of 50 tons; for volumes of a few hundred tons, the price was reduced to about $355/ton. In addition, the U.S. mills also include a tooling charge that varies with the size of the bulb plate. This charge ranges between $40,000 and $90,000, depending on the bulb flat specification. The steel mills will rebate to the shipyard about $5/ton of special shape produced as a credit against the tooling charge. The best example that summarizes the feelings of many of the shipbuilders with respect to domestic sourcing of special shapes is contained in the following quote:

> "We have looked into using bulb plates for new construction, but the expense of these shapes produced in this country has always brought things to a halt."

Another negative factor applies primarily to the larger shipbuilding companies. Some of the major shipbuilders currently fabricate angles and Tees from plate. Facilities that fabricate angles require large capital investments in welding equipment. The capability to fabricate shapes eliminates the need to inventory many small amounts of shapes. Instead, the plate inventory can be used as the starting material in the production of shapes. As a result, they have less of an incentive to investigate the advantages of using bulb flats. It would take an explicit economic advantage for them to purchase bulb flats.

One of the foremost concerns of shipbuilders is the need for capability to weld the large mass of the bulb flat. Some of those interviewed expressed this concern because they had no experience to date with bulb flats. However, two sources who had used bulb flats acknowledge problems in this area. One felt the problem would be minimal with more experience; the second felt that the problems (distortions when welding) were severe, and they would not want to consider bulb flats again. One shipbuilder, who had used long-leg angles in the past, reported no problems in welding these shapes.

One shipyard pointed to a technical problem with bulb sections. It was stated that the stress at which lateral instability or tipping will occur is 20% to 25% lower for bulb sections than in equivalent angle or L-profile shapes. If bulb sections are to be used as longitudinals in longitudinally framed vessels, many high-quality butt welds will be required. The ability to perform such welds easily and inexpensively needs further investigation and study.

There still is disagreement among shipbuilders as to the applicability of bulb sections. One shipbuilder reported the following:

> "European shipbuilders, especially the Soviets, use bulb flats successfully and with relish because their designs space web frames close together--typically 7 feet apart. At that short span, the bulb flat section has sufficient lateral stability to take advantage of its easier cleaning and coating. But ASI practice is to space web frames at 14 to 16 feet--double that of the Europeans. Used in our wider spacing, the bulb flats do not have adequate stability. Our labor costs could increase prohibitively if closer, European size, web frame spacing were selected."

The configuration of bulb flats might have to be modified to reflect U.S. ship design and modern labor-saving design practices. Shapes having greater resistance to lateral bucking from impact in conjunction with widely spaced trasverse webs are needed for a more economically structured system.

Some additional technical work is therefore required on the stability of bulb sections. However, MarAd recently predicted that the shipbuilding market for the remainder of this century will be characterized by more smaller ships, e.g., 30,000 DWT bulk carriers. This should stimulate consideration of bulb flats.

Other considerations

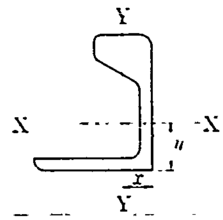
A number of other factors were reviewed that could affect the usage of special structural shapes. Among these factors were the procurement practices of shipyards, usage of similar shapes by other industries, and engineering specifications. The following discussion summarizes some of the interviewees' observations in relation to these factors.

The procurement practices of those interviewed were examined to evaluate the impact of those practices on the adoption of special structural shapes. Generally speaking, there do not appear to be any major procurement problems except potentially for inland barge builders. Inland barge production tends to be more volume-oriented; these barge builders consider steel delivery times to be critical, and they work with relatively short lead times--4 to 6 weeks at the most. Long lead times for special shapes would not be acceptable. In addition, lead time is a critical factor for repair of these barges.

Similar special shapes used by other industries that might find applications in shipbuilding could not be found. Only one special shape, a 5 x 3.5-in. bulb angle as shown in Figure 2, was identified as being used in another industry for railroad car building. This shape would not likely be of use to shipbuilders. If they become readily available, some bulb flats may be used in railcar building; however, this application cannot be counted in determining potential market. Conversely, the chances of adoption of shipbuilding shapes to other industries are small.

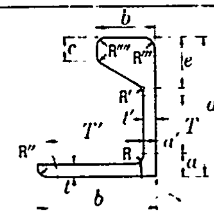
Domestic shipbuilders specify standard angles and channels that are found in the inventory catalogues of the steel mills. In many cases, the dimensions are not the most efficient ones that could be used in shipbuilding. Steel mills continue to reduce the number of available shapes; consequently, shipbuilders select the sizes that come closest to their needs. Shipbuilders will be faced with a similar problem for special shapes. Table 6 shows typical values for bulb flats. The sizes are grouped into "families" of sizes that could be produced on one set of tools. In Table 6, families of sizes each require individual tools averaging between $40,000 to $90,000 per set of tools. This initial tooling cost will require that priorities be put on the sizes and that shipbuilders try to design with specific sizes in mind.

Table 7 provides a summary of most common sizes of angles used. Using the section moduli as the main criterion, the expected sizes of bulb flats are estimated and Table 7 lists the sizes in order of priority. The ones listed at the top of the table represent the sizes in which the greatest volume is expected. To keep the cooling costs to a reasonable level, shipbuilders will have to design to these standards or perhaps to some other agreed upon standards.



Properties for Designing

Designation and Nominal Size	Weight per Foot	Area	Depth	Flange Width	Flange Thickness	Bulb Width	Web Thickness	Axis X-X I	Axis X-X S	Axis X-X r	Axis X-X y	Axis Y-Y I	Axis Y-Y S	Axis Y-Y r	Axis Y-Y x	Producing Mill Location
In.	Lbs.	In.²	In	In	In	In.	In.	In⁴	In³	In	In.	In⁴	In³	In.	In	
BL5x4½	19.1	5.62	5.00	4.504	440	2.254	442	20 4	7.70	1.90	2.36	7 57	2.30	1.16	1.22	CF
BL5x3½	13.0	3.82	5 00	3.505	.377	1.505	380	13.3	4.73	1.86	2 19	3.14	1.18	.906	851	GaF

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Dimensions for Detailing

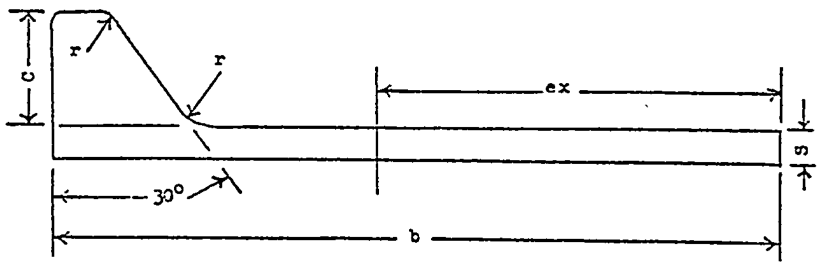
Designation and Nominal Size	Weight per Foot	Depth d	Flange Width b'	Flange Thickness t	Bulb Width b	Bulb Edge Depth c	Bulb Inner Depth e	Web Thickness t'	Distances a	Distances T	Distances a'	Distances T'	Radii R	Radii R'	Radii R''	Radii R'''	Radii R''''
In.	Lbs.	In.	In.	In.	In.	In.	In.	In	In	In	In	In.	In	In.	In	In.	In.
BL5x4½	19.1	5	4½	7/16	2¼	9/16	1 5/16	7/16	7/8	2½	7/8	3¼	3/8	½	3/8	½	1/8
BL5x3½	13.0	5	3½	3/8	1½	7/16	15/16	3/8	¾	2 7/8	¾	2 3/8	3/8	½	5/16	3/8	1/8

Source: U.S. Steel

FIGURE 2 BULB ANGLE SPECIFICATIONS

Table 6

PROPERTIES FOR DESIGNING BULB PLATES



METRIC

b mm	s mm	c mm	Area cm^2	Weight kg/m	r mm	I x-x cm^4	ex cm	Section Modulus cm^3
200	9	28	23.6	18.5	8	941	12.1	77.7
200	10	28	25.6	20.1	8	1020	11.9	85.0
200	11	28	27.6	21.7	8	1090	11.8	92.3
200	12	28	29.6	23.2	8	1160	11.7	99.6
220	10	31	29.0	22.8	9	1400	13.4	105
220	11	31	31.2	24.5	9	1500	13.2	113
220	12	31	33.4	26.2	9	1590	13.0	122
240	10	34	32.4	25.4	10	1860	14.7	126
240	11	34	34.9	27.4	10	2000	14.6	137
240	12	34	37.3	29.3	10	2130	14.4	148
260	11	37	38.7	30.3	11	2610	16.0	162
260	12	37	41.3	32.4	11	2770	15.8	175
260	13	37	43.9	34.5	11	2940	15.6	188
280	11	40	42.6	33.5	12	3330	17.4	191
280	12	40	45.5	35.7	12	3550	17.2	206
280	13	40	48.3	37.9	12	3760	17.0	221
300	11	43	46.7	36.7	13	4190	18.9	222
300	12	43	49.7	39.0	13	4460	18.7	239
300	13	43	52.8	41.5	13	4720	18.5	256
300	14	43	55.8	43.8	13	4980	18.3	273
320	12	46	54.2	42.5	14	5530	20.1	274
320	13	46	57.4	45.0	14	5850	19.9	294
320	14	46	60.7	47.6	14	6170	19.7	313
320	15	46	63.9	50.1	14	6480	19.5	332
340	12	49	58.8	46.1	15	6760	21.5	313
340	13	49	62.2	48.8	15	7160	21.3	335
340	14	49	65.5	51.5	15	7540	21.1	357
340	15	49	68.9	54.0	15	7920	20.9	379
370	13	53.5	69.6	54.6	16.5	9470	23.5	402
370	14	53.5	73.3	57.5	16.5	9980	23.2	428
370	15	53.5	77.0	60.5	16.5	10490	23.0	455
370	16	53.5	80.7	63.4	16.5	10980	22.8	478
400	14	58	81.4	63.9	18	12930	25.5	507
400	15	58	85.4	67.0	18	13580	25.2	537
400	16	58	89.4	70.2	18	14220	25.0	568
400	17	58	93.4	73.3	18	14850	24.7	598
430	15	62.5	94.1	73.9	19.5	17260	27.4	628
430	17	62.5	103.0	80.6	19.5	18860	26.9	700
430	19	62.5	111.0	87.4	19.5	20420	26.5	770
430	21	62.5	120.0	94.1	19.5	21950	26.1	839

INCHES

b in.	s in.	c in.	Area in.^{2}	Weight lb/ft	r in.	I x-x in.^{4}	ex in.	Section Modulus in.^{3}
7.87	0.354	1.10	3.66	12.43	0.315	22.58	4.76	4.74
7.87	0.394	1.10	3.97	13.50	0.315	24.48	4.68	5.18
7.87	0.433	1.10	4.28	14.58	0.315	26.16	4.64	5.63
7.87	0.472	1.10	4.59	15.59	0.315	27.84	4.61	6.08
8.66	0.394	1.22	4.49	15.32	0.354	33.60	5.27	6.40
8.66	0.433	1.22	4.84	16.46	0.354	36.0	5.20	6.89
8.66	0.472	1.22	5.18	17.60	0.354	38.16	5.12	7.44
9.45	0.394	1.34	5.02	17.07	0.394	44.64	5.79	7.69
9.45	0.433	1.34	5.41	18.41	0.394	48.0	5.75	8.36
9.45	0.472	1.34	5.78	19.69	0.394	51.12	5.67	9.03
10.24	0.433	1.46	5.99	20.36	0.433	62.64	6.30	9.88
10.24	0.472	1.46	6.40	21.77	0.433	66.48	6.22	10.67
10.24	0.512	1.46	6.80	23.18	0.433	70.56	6.14	11.47
11.02	0.433	1.57	6.60	22.51	0.472	79.92	6.85	11.65
11.02	0.472	1.57	7.05	23.99	0.472	85.20	6.77	12.57
11.02	0.512	1.57	7.48	25.46	0.472	90.24	6.69	13.48
11.81	0.433	1.69	7.24	24.66	0.512	100.56	7.44	13.54
11.81	0.472	1.69	7.70	26.20	0.512	107.04	7.36	14.58
11.81	0.512	1.69	8.18	27.88	0.512	113.28	7.28	15.62
11.81	0.551	1.69	8.65	29.43	0.512	119.52	7.20	16.65
12.6	0.472	1.81	8.40	28.56	0.551	132.72	7.91	16.71
12.6	0.512	1.81	8.89	30.23	0.551	140.40	7.83	17.93
12.6	0.551	1.81	9.41	31.98	0.551	148.08	7.76	19.09
12.6	0.590	1.81	9.90	33.66	0.551	155.52	7.68	20.25
13.4	0.472	1.93	9.11	30.97	0.590	162.24	8.46	19.09
13.4	0.512	1.93	9.64	32.79	0.590	171.84	8.39	20.43
13.4	0.551	1.93	10.17	34.60	0.590	180.96	8.31	21.78
13.4	0.590	1.93	10.68	36.28	0.590	190.08	8.23	23.12
14.6	0.512	2.11	10.79	36.68	0.650	227.28	9.25	24.52
14.6	0.551	2.11	13.36	38.63	0.650	239.52	9.13	26.11
14.6	0.590	2.11	11.93	40.65	0.650	251.76	9.06	27.75
14.6	0.630	2.11	12.51	42.60	0.650	263.52	8.98	29.16
15.7	0.551	2.28	12.62	42.93	0.709	262.32	10.04	30.93
15.7	0.590	2.28	13.24	45.02	0.709	325.92	9.92	32.76
15.7	0.630	2.28	13.86	47.17	0.709	341.28	9.84	34.65
15.7	0.669	2.28	14.48	49.25	0.709	356.40	9.72	36.48
16.9	0.590	2.46	14.58	49.65	0.768	414.24	10.79	38.31
16.9	0.669	2.46	15.96	54.15	0.768	452.64	10.59	42.70
16.9	0.748	2.46	17.20	58.72	0.768	490.08	10.43	46.97
16.9	0.827	2.46	18.60	63.23	0.768	526.80	10.20	51.18

TOLERANCES

Straightness: 1/4 inch in 5 ft. camber
Width: Plus 3/16 inch, minus 3/32 inch
Thickness: Plus 1/16 inch, minus 0.010 inch

Source: CF & L Steel Corporation

Table 7

MOST COMMON BULB PLATE FAMILY

Bulb Plate Size Ranking mm	Inches
200	7.87
220	8.66
260	10.24
240	9.45
430	16.90
370	14.60

Viewpoint of Steel Producers

To understand why U.S. steel mills do not offer special shapes, a number of steel producers were interviewed. It is informative for shipbuilders to understand the viewpoints of these producers; moreover, it is important to take into consideration the steel producers' requirements if practical, useful recommendations are to be developed.

Some steel producers have evaluated the special structural shape market and concluded that the market in special shapes for shipbuilding is insufficient to warrant any major investment. If SRI were advising the steel mills on the potential demand under current conditions, SRI probably would reach the same conclusion. Many factors led to this conclusion; the following summarizes the most important of these factors.

- Most market studies exclude inland barge builders. The magnitude of the market without this sector is small.
- Some of the largest shipbuilders fabricate their own angles. Their interest in special shapes is limited; these same shipbuilders are the ones most likely to be interviewed in a market survey.
- A certain percentage of the shipyards cannot use foreign steel because of laws or regulations. They have not evaluated special shapes because of the lack of a domestic source.
- Shipyards--under current conditions--are unwilling to commit to these special shapes and in most cases are unwilling to invest in any tooling.
- Shipyards use so many different sizes that the volume in any one size is considered to be small.

The steel mills concluded that if there is a market for special shapes, it is small. Therefore, the burden of tooling should be on the user. With a relatively small expected market, what would be the advantage in offering a special shape? Currently, shipyards are buying standard shapes that are also ordered by other markets. Although shipyard demand is relatively small, it does add to the volume of these other markets. In addition, the existing law and MarAd policy protect shipyard demand from penetration from foreign sources. Offering of special steel shapes would reduce the volume of standard shapes, require more short runs, and increase the inefficiency of the mill. Would not the efficiency gained by the shipyard be at the expense of the steel mill? Unless there were some significant economic advantage, why encourage the use of these special shapes? In addition, the price of the special shape would most likely be greater than that of the standard shape it would replace; this might decrease the probability of shipyard conversions. A very small market would result at these higher prices.

Facilities, tooling market size requirements, and other factors applicable to steel mills were reviewed in the interviews and questionnaires. Tables 8 and 9 summarize the results of the interviews and questionnaires. Most steel mills will require 200- to 300-ton minimum orders per size; in addition, significant tooling and capital are often required. None of the steel mills anticipate being able to stock special shapes; consequently, average lead times range from 6 weeks to as much as 12 weeks, depending on the steel production schedule. Table 9 represents typical values; naturally, the minimum quantities, lead times, and costs vary with market conditions.

Summary

The one predominating factor in the discussion of special steel shapes is the lack of a domestic source. Without such a source, shipbuilders, for all practical purposes, are limited to standard angles. Steel mills are not likely to invest in the tooling and marketing costs to develop this special market and this situation is not likely to change under current conditions.

Table 8

SUMMARY OF STEEL MILL INTEREST IN SPECIAL SHAPE PRODUCTION

Possible Interest	No Interest
U.S. Steel	Inland Steel
Bethlehem Steel	North Star
North Western Steel	Phoenix
Connors	Oregon Steel
CF&I	Al-Tech Specialty Steel
Armco Steel	Timken Company, Steel Division
	Republic Steel
	Kentucky Electric Steel

Table 9

TYPICAL REQUIREMENTS OF INTERESTED STEEL MILLS

Steel Mill	Minimum Order (tons)	Lead Times (weeks)	Capital (dollars)	Other Considerations
U.S. Steel Pittsburgh, PA	300/order; 1,000/yr	8-10	40,000 avg. tooling cost	Sections all cover present straightness problems
Bethlehem Steel Johnstown, PA	Will quote	6-8	20,000 to 40,000 per roll	
Northwestern Stee1 and Wire Co. Sterling, IL	300/size; 20,000/yr	up to 12	270,000	
Connors Steel Co. Huntington, WV	500 to 1,000/size	8-13		Sizes & straightness could be problem
CF&I Pueblo, CO	500 to 600/size	4-8	40,000 to 90,000 per size for tooling	Want guaranteed tonnage` of each section each year
Armco Houston, TX			Major	Would split Ts for long-leg angles

IV OUTLOOK

The discussions in the previous sections concerned theoretical potentials and factors that will determine the actual usage of special shapes. This section presents the estimates of the likely demand, with consideration given to all the factors in the previous discussion. Unless some domestic sources are available, special structural shapes will never penetrate the standard market to any significant degree under current regulations and policy. Thus, any discussion of the outlook for the market penetration is predicated on the assumption that domestic sources will exist.

The outlook for special structural shapes will be dependent on three main factors as follows:

- Future shipbuilding activity
- Demands for inland barges
- Rate of change from standard shapes to special shapes.

It was outside the scope of this project to conduct a detailed study to project new shipbuilding activity or inland barge demand. Therefore, these projections are based on available sources of information. Although individual sources varied in the absolute values projected, the trends of these projections are similar, and the conclusions concerning special shapes are the same regardless of the individual forecast used. However, a reasonable estimate for the rate of change from standards to special shapes was developed under the assumption that a domestic source or sources could supply the demand. It is believed that trying to project the demand, given the current supply situation--that is, no domestic sources--would be an academic exercise, and it will not be given further consideration.

Inland Barges

Barge production has grown at an average annual rate of 3.3% over the past 20 years as shown in Figure 3. Also shown in this figure is an industry projection through 1981. As shown in Figure 4, this industry historically has had a cyclical growth pattern that also includes the least-squares trend line based on the 1956 to 1976 data. The industry forecast through 1981—especially for the 1974–1980 period--appears to be optimistic in terms of historical performance. The industry probably will be above the historical trend because it should be in the positive cycle; however, the industry forecast would have a level of production almost 110% over the historical trend. Thus, the industry projection most likely

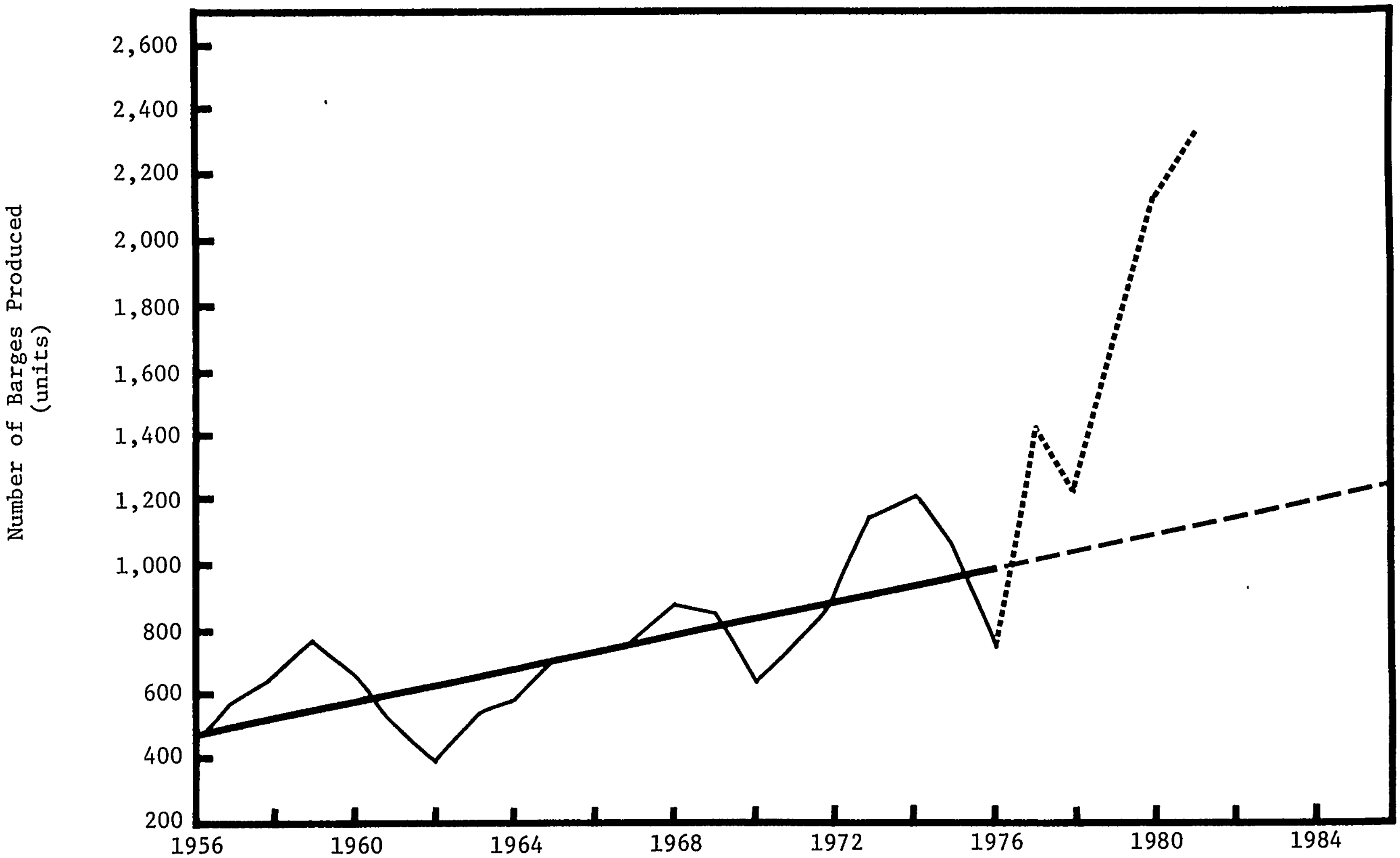


FIGURE 3 HISTORICAL TREND AND FORECASTS OF DOMESTIC BARGE PRODUCTION

FIGURE 4 ANALYSIS OF CYCLICALITY IN DOMESTIC BARGE PRODUCTION

reflects a change from historical performance to an accelerated level of production. For the purpose of this report, a value between the maximum positive deviation and the industry estimate for the 5-year demand was chosen; this gives a slightly more conservative estimate--but still very positive-- than that of the industry.

Other Shipbuilding

In contrast to the optimistic projection for barge production, those forecasting other shipbuilding activity are pessimistic about production during the next 5 years. Figure 5 compares three forecasts of shipyard activity. The data are expressed in indices to emphasize the trend in each forecast. Although the original forecasts for Figure 5 were made in terms of expected manpower, they do reflect the view of many of those interviewed that shipbuilding activity would decrease over the next 5 years.

The trends shown in Figure 5 were accepted, and it was assumed that these declines in manpower will correlate to a decline in steel usage. It should be noted, however, that some private steel mill forecasts do show a gradual turnaround in shipyard steel demand for the long term. A value in the middle of the three estimates of Figure 5 was used to estimate the expected decline in steel usage over the next 5 years. These values are as follows:

Year	Estimated Decline
1978	1
1980	0.78
1983	0.65
1985	0.50

Special Structural Shapes

The first step in estimating the potential for special structural shapes is to evaluate the theoretical potential based on the forecasts for barge demand and for shipbuilding activity. Hence, on the basis of these individual forecasts, Table 10 gives the maximum theoretical potential.

Table 10

HISTORICAL AND FORECAST ESTIMATED THEORETICAL POTENTIAL FOR SPECIAL SHAPES (tons)

	1977	1983	1985
Inland barges	65,000	74,100	95,000
Other shipbuilding	100,000	65,000	50,000
Total (including Naval)	165,000	139,100	145,000

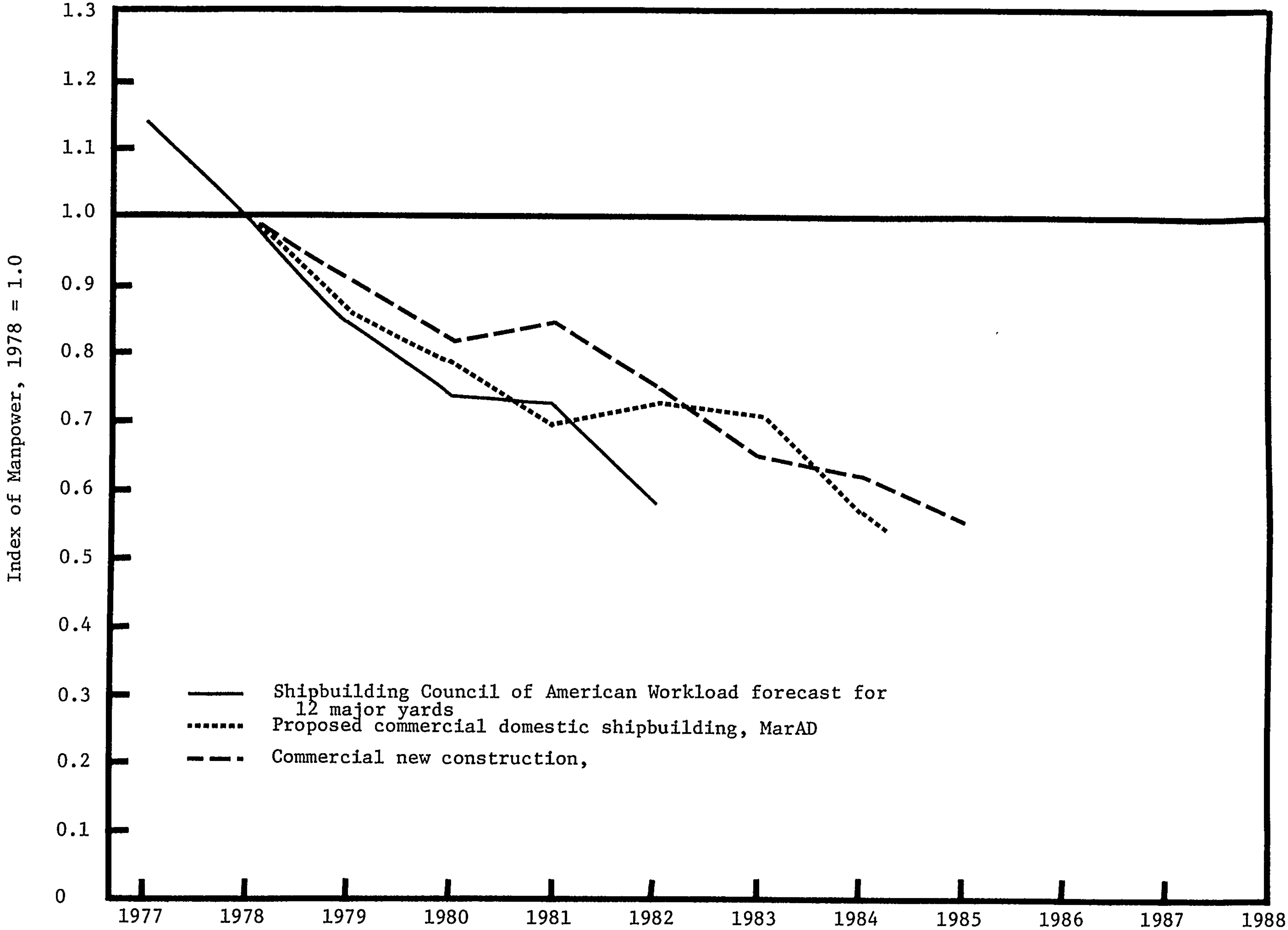


FIGURE 5 COMPARISON OF FORECASTS OF SHIPYARD PRODUCTION

In 1977, the inland barge market represented about 40% of the potential market; by 1985, the inland barge market will represent over 60% of the potential market as a result of the divergent forecasts for these sectors. Some private forecasts do not have the same degree of decline in the shipbuilding sector; as a result, these forecasts show a slight increase in structural shape (approximately 170,000 tons) in 1985. Thus, for a truly viable domestic market, some penetration of the barge market is a necessity.

Estimating actual levels of usage is more difficult. The forecasts are based on the following assumptions:

- Naval design will not likely change and will continue to use Tee shapes.
- Initial changeover will be slow and mostly by the intermediate-sized shipyards that do not fabricate their own angles.
- Penetration of the barge industry will be slow and will depend on the acceptance of a few major barge builders.
- Major shipyards that fabricate their own angles will continue to do so; they may adopt special shapes for those angles that they currently purchase.

Using these assumptions, it was estimated that a realistic potential for special shapes is about 55,000 tons by 1985. Table 11 shows the estimates and the penetration of each market assuming available domestic sources.

Table 11

FORECAST OF ADOPTION OF SPECIAL SHAPES
(tons)

	1983	1985
Inland barge	10,000	25,000
Other shipbuilding	25,000	30,000
Total	35,000	55,000

Expressed in percentage of the theoretical potential, a 25% penetration is expected by 1983; by 1985 a 41% penetration will be achieved. It must be reemphasized, however, that these levels are feasible only if domestic supply sources are developed. In addition, if a gradual turnaround in shipyard demand does occur, these estimates would be low by perhaps 10,000 to 30,000 tons. Additionally, if a change in law and MarAd policy occurred, these levels could be attained.

V GENERAL DISCUSSION AND RECOMMENDATIONS

The purpose of the National Shipbuilding Research Program is to identify areas in which the productivity of domestic shipbuilders can be increased. Increased productivity should lower the overall costs of shipbuilding and make the domestic shipbuilders more competitive internationally. Shipbuilders generally agree that the use of special structural shapes--bulb flats and long-leg angles--could increase productivity. These shapes are more efficient in terms of weight required to obtain a needed section modulus and in cleaning and painting of the sections. Nevertheless, the problems of obtaining special structural shapes from domestic sources have practically precluded their use in domestic shipbuilding. In fact, many shipyards have not conducted the necessary technical and economic evaluations of special shapes because these evaluations would be meaningless without available domestic sources or significant changes in the current law and MarAd policy.

The review of the available information on special structural shapes led to the conclusion that any recommendations directed to the adoption of special structural shapes will have to deal with the issue of the development of domestic steel sources. A second key issue that also must be considered is the inclusion of barge builders as part of the market. If any set of recommendations is to make any practical impact on the problem of using special structural shapes in domestic shipbuilding, it must account for both of these issues. Accordingly, the following general discussion considers both the domestic source problem and the inland barge market as required background for the subsequent discussion of specific recommendations.

Domestic Sources

Special structural steel shapes are available in the United States primarily through European or Japanese suppliers; however, U.S. Steel offers one size of bulb flat as described previously. From field interviews with shipbuilders, a list of possible sources for special structural shapes was compiled and is given in Table 12.

Table 12

LIST OF SOURCES FOR SPECIAL SHAPES

COMPANY	LOCATION
Norrbottens Jarnverk Aktiebolag	Stockholm, Sweden
British Steel Company	London, England
Kansai Steel Corporation	Osaka, Japan
Thyssen Stahlunion Subsidiary August Thyssen Huntte AG	Duisenberg-Hamborn, W. Germany
United States Steel	Pittsburgh, Pennsylvania

everal factors have constrained domestic shipbuilders from using special structural shapes from foreign sources. As noted in the previous discussion, either the law or MarAd policy precludes or discourages many shipyards from using the foreign steel, and they use domestic steel by their own choice. In any event, the lack of domestic sources limits the usage of these special shapes. In addition, domestic shipbuilders refrain from using foreign sources because of perceived problems with delivery and with welding the special structural shapes.

Foreign suppliers apparently can deliver in the United States special structural shapes at prices below those for equivalent domestic standard shapes. Even without considering the possible weight savings, one concludes that the usage of domestic standard shapes does increase the overall cost of shipbuilding. Despite the potential cost advantages, however, it should be noted that, in most cases, private shipbuilders still do not use foreign special shapes. To a degree, the current law and MarAd policy ensure this increase in cost. However, the goals of the law and of MarAd policy must be understood before one comments on their effect. A major objective of MarAd and of the existing laws is to ensure that adequate domestic steel sources will be able to support shipbuilders if national mobilization is required during a wartime threat. MarAd's support of the shipbuilding industry--by subsidy or financing guarantee-works to achieve this goal. For example, a subsidy pays the difference between the cost of U.S. production and foreign production, thereby allowing the U.S. shipbuilder to use domestic steel and other components even though the cost may be higher. MarAd is willing to subsidize the higher cost of using the standard shapes because it ensures the continuing availability of domestic sources.

Under current MarAd policy, the usage of standard shapes will continue. It is expected that the subsidy MarAd pays to perpetuate these domestic steel sources will continually increase. The domestic steel mills have been reducing the size range of standard shapes available to shipyards primarily to increase the efficiency of the mills by eliminating short runs. Domestic steel mills are being hurt by imported standard shapes; limiting the available sizes offsets some of the production run losses to imports. The reduction in available sizes should continue, and shipbuilders will continuously be faced with using less efficient standard angles. Thus, MarAd will be forced to continuously increase its subsidy of these standard shapes as they become increasingly less efficient and more costly to use.

If domestic steel mills do offer special shapes, the productivity of shipbuilders should increase. Conversely, efficiency at the steel mill will decrease because special shapes mean shorter production runs. The prices for domestic special shapes are expected to be higher than those for the current domestic standard shapes. Even with a 15% to 20% potential weight savings, the total cost of special shapes could possibly be higher than the savings gained from the reduction in weight. MarAd will therefore be subsidizing the difference between the cost of domestic special shapes and foreign special shapes. The objective of this subsidy--development of domestic sources for mobilization--will still be met. In fact, subsidizing special shapes makes the U.S. shipbuilding more international in scope and not only develops domestic steel sources but also allows for worldwide secondary sources in case of emergencies.

Although no direct economic benefit may result from using higher-cost domestic special shapes, two indirect benefits may occur that could lead to an economic gain. First, cargo owners may be willing to pay more for vessels with lower weight. If a vessel is 12% by weight structural shapes and a 20% weight reduction in structural shapes could be accomplished, only about a 2.5% reduction in total steel weight could be expected. This raises two questions. Will this amount of weight reduction be an incentive for cargo owners to pay more? In addition, will these owners pay more for the ease of cleaning that these special shapes offer? The answers to these questions are uncertain.

The use of special shapes would make U.S. designs more international in scope. Currently, the Livingston Shipyards has a contract to build bulk carriers from a Japanese IHI design. Under MarAd sponsorship, Japanese technology will be transferred to the United States. Where special shapes are used, IHI will have to change all of its designs to accommodate equivalent standard shapes produced in the United States. If special shapes could be used, the technology transfer cost would certainly be less.

Inland Barge Builders

One outcome of this study is the demonstration of the importance of the inland barge builders in creating the demand for special shapes. The major shipyards considered as a single market are probably not enough of a significant force to create a competitive special shape market. This is especially true in view of the projections for a decline in shipbuilding activity over the next 5 years. It is therefore apparent that shipbuilders will have to work closely with the inland barge builders if a competitive market is to be developed.

Although the scope of this study did not include a detailed study of inland barge requirements, the preliminary analysis certainly shows some significant potential advantages from the use of special shapes by these barge builders. Reduction of weight is a critical factor along with the ease of cleaning. However, delivery lead times, availability, price, and the need for redesign will act as barriers to the adoption of special shapes. In any case, the recommendations made in the next section are premised on integrating barge builders into any program.

Recommendations

The recommendations developed can be categorized into the following essential requirements for developing a market for special shapes.

- Development of domestic sources
- Work with inland barge builders
- Technical understanding.

A discussion of these requirements follows, along with some specific recommendations for each of them.

Development of Domestic Sources

It is not likely that the U.S. steel mills will act on their own to develop the special shape market. The initial barrier to the establishment of a domestic source is the high investments required for tooling. It is recommended, therefore, that the initial tooling cost be underwritten, presumably by MarAd. Some specific steps for accomplishing this task are as follows:

- Solicit bids from interested steel mills for tooling costs
- Select at least two sources--a minimum of one serving each coast--to develop tooling
- Limit the initial number of sizes of tooling by requiring barge builders and shipbuilders to set up size priorities.

About five sizes would be selected for each steel mill. At an average of about $50,000 per tooling set, a minimum of $500,000 would be required as an initial investment to offer about ten families of sizes.

In line with current practice with regard to tooling, the steel mills would rebate about $5 to $10 per ton to offset tooling costs to MarAd. This rebate fund could be used to repay the initial investment, or to be reinvested in establishing tooling for other sizes, or to develop additional sources. The more sources developed, the more likely the prices will remain competitive. Finished quoted shape prices would be a consideration in placing the tooling orders.

Work with Inland Barge Builders

It is imperative that shipbuilders and inland barge builders cooperate in an effort to develop the market for special shapes. Some additional work regarding barges and the impact of special shapes on weight savings is required. It is recommended that technical and economic analyses of a specific case be conducted to illustrate the potentials for barge builders. One source estimated that a 3 to 6 person-month effort would be required to fully evaluate the potentials for special shapes in barge building. This case study will probably have to be funded because it is unlikely that any individual barge builder will initiate such analyses.

The establishment of a joint barge/shipbuilder committee is recommended. The main purpose of this committee will be to integrate the results of the technical/economic study into specific recommendations. The joint committee will also be responsible for selecting the initial sizes of special shapes for which tooling will be developed. The joint committee will ensure that information regarding advantages, problems, technical solutions, and economics is disseminated to both the barge building and shipbuilding market sectors.

Technical Understanding

The main technical problem that could affect the adoption of special shapes concerns distortion during welding. Most of the welding problems stem from the lack of familiarity of welders with bulb flats. Therefore, it is recommended that a technical survey of welding techniques be conducted to familiarize shipbuilders with welding bulb-flat technology and practice. It should be noted that this welding study is independent of the other recommendations in that it could be started immediately and would contribute to increased usage of special shapes.

Appendix A

AUTHOR'S COMMENTS

One purpose of this study is to raise related issues that could impact on productivity in shipyards. As a result of the interviews and the comments on the draft report, the author believes one of these issues should at least be mentioned in this report. This appendix was chosen as the place to comment on the issue because the comments reflect more personal opinion rather than any in-depth research. Therefore, this appendix is to be distinguished from the main body of the report that reflects the research conducted by SRI. The following, therefore, gives the author's comments on a related issue:

Would a change in the law or policy--with regard to special shapes--be recommended?

The main reason given to the author for the current "Buy American" laws and policy is that it is the requirement of MarAd to ensure that domestic steel supplies exist in case of a defense mobilization. With respects to structural shapes in shipbuilding, the author could find no evidence that the current "Buy American" laws or policies are ensuring an adequate supply. The author's reasons for this very prelimianry conclusion are as follows:

- The structural shape market is primarily a construction market; shipbuilding is a minor consideration in the market.
- The structural shape market is subject to foreign competition; steel mills are reducing the structural shape products in an effort to remain competitive.
- The outlook for this market and U.S. production capacity will be determined by international economic forces--it is not likely that U.S. shipyard demand will have much influence on the decisions to reduce structural products or capacity to produce these products.
- The historical trend in the reduction of structural products offered to shipyards as a result of the competitive environment is likely to continue and has not been deterred by the "Buy American" policy.
- Structural shapes for construction for a defense mobilization would seem to be a low priority item. Most steel companics would probably have to change to other steel products.

- Usage of an "international shape" would still allow for imports from allies even if the domestic structural steel mills changed products.
- Could shipyards not revert to standard shapes during a crisis period?

It was well beyond the scope of this study to evaluate the impact of a change in the law on U.S. mobilization capacity. Certainly, a change in the law or policy would have at least two effects on the demand for special shapes, as follows:

- Demand would increase at a more rapid rate as some shipbuilders would consider using special shapes because of the apparent economic advantages.
- Assuming domestic sources were still encouraged to enter the market as outlined in this report, the foreign sources would tend to put a check on prices as a more competitive situation would likely result.

The author believes that demand must be created to have a viable market. However, based on the interviews, demand would still lag because of the shipbuilders' reluctance to use foreign sources if this were the only available source. The author believes that this reluctance is, however, probably overstated. If, in fact, shipbuilders could easily buy foreign special shapes at prices economically attractive, the author believes that some of this reluctance would disappear.

Appendix B

SECTION MODULUS SPECIFICATIONS

SECTION MODULUS FOR 3/4 INCH PLATE WITH BULB FLATS

Size (mm)	Bulb-Flat Weight (lb/ft)	1/4-Inch Plate (in.^{3})	5/16-Inch Plate (in.^{3})	3/8-Inch Plate (in.^{3})	7/16-Inch Plate (in.^{3})	1/2-Inch Plate (in.^{3})
100 x 6	4.09	2.18	2.23	2.29	2.34	2.40
100 x 7	4.61	2.38	2.44	2.50	2.56	2.62
100 x 8	5.13	2.58	2.64	2.71	2.77	2.83
120 x 6	4.91	3.13	3.19	3.26	3.32	3.38
120 x 7	5.54	3.41	3.48	3.56	3.62	3.68
120 x 8	6.18	3.68	3.76	3.84	3.91	3.99
140 x 7	6.54	4.75	4.84	4.93	5.01	5.10
140 x 8	7.26	5.06	5.16	5.27	5.35	5.44
140 x 9	8.00	5.41	5.52	5.64	5.74	5.84
160 x 7	7.66	6.42	6.54	6.66	6.75	6.85
160 x 8	8.53	6.86	7.00	7.15	7.25	7.36
160 x 9	9.41	7.32	7.47	7.63	7.75	7.87
180 x 8	9.95	9.20	9.38	9.56	9.70	9.84
180 x 9	10.89	9.69	9.89	10.10	10.26	10.42
180 x 10	11.83	10.29	10.52	10.75	10.92	11.10
180 x 11	12.77	10.86	11.11	11.37	11.56	11.75
200 x 9	12.43	12.51	12.77	13.04	13.23	13.43
200 x 10	13.51	13.11	13.40	13.69	13.91	14.13
200 x 11	14.58	13.81	14.13	14.45	14.69	14.93
200 x 12	15.59	14.48	14.83	15.18	15.44	15.70
220 x 10	14.78	16.77	17.14	17.52	17.95	18.38
220 x 11	16.46	17.45	17.86	18.28	18.57	18.87
220 x 12	17.61	18.02	18.47	18.92	19.24	19.57
240 x 10	17.07	20.38	20.85	21.32	21.65	21.99
240 x 11	18.41	21.52	22.04	22.57	22.93	23.30
240 x 12	19.69	22.28	22.85	23.42	23.77	24.21

Appendix C

SELECTED INTERVIEWEE COMMENTS

The following comments or parts of comments were made by people whom SRI interviewed during the study. Although these comments were not incorporated directly into the main text, they are quoted in this appendix as relevant supplemental information.

> The subject report puts primary emphasis on its recommendation to develop domestic sources. In this respect it is our opinion that a more logical first emphasis should be on building a firmer demand. This suggestion in effect inverts the list of recommendations contained in the summary of the report, beginning with a study of the problems of welding bulb flats. The remaining studies and information dissemination should ultimately lead to some specific applications of special structural shapes in both barge and ship construction projects to visibly demonstrate the advantages to these industries. It would seem that such projects could be accomplished with foreign steel, if necessary with Maritime Administration support similar to their slow speed diesel engine promotion (see attached copy of their FEDERAL REGISTER notice). It would be at that point in time that it may be more appropriate to invoke the development of domestic sources in conjunction with the Maritime Administration and/or address the justification of modified government policy.

> The statement on page 4 relative to a 20% weight saving is, first of all, ambiguous; this could imply 20% total steel reduction. It is apparent, of course, that the 20% relates to shapes, or structural, only. Even so, the validity of that number is questionable. For any given plate and bulb section combination, it is possible to choose an angle, flanged plate or "tee" section which is as efficient, weightwise, as the bulb section. On Navy ships, for instance, where weight might be very critical, "tee" sections cut from light beams can be very efficient, even more so than bulb sections. Table 4 is a very narrow comparison. It is not fair to compare a 9 x 4 x 7/8 angle and a 300 mm x 11 mm (about 12inches x 7/16/ inch). A more meaningful comparison would be a 12 inch flanged plate or a 12 inch "tee". Another factor to consider is the inherent lack of lateral stability in bulb sections. A substantial amount of lateral stiffening would be expected

with their use. After a cursory examination, we have concluded that very little weight can be saved by use of bulb sections and in some cases they could even add weight.

We agree that there are potential production cost advantages associated with bulb sections primarily due to ease of cleaning and painting. On the other hand, butt welds are likely to be slightly more difficult to make, particularly for larger sizes. Also, allowing for additional lateral stability needs, production costs might be increased.

On page 12, the reason for not expecting military use of bulb sections is not really valid. Actually, commercial ships as well as Navy ships are subject to impact loadings. Navy ships are designed to withstand additional loading conditions, but that is generally a matter of degree rather than form. The principle reason for the use of "tee" sections of Navy ships (and they are being used more extensively on commercial ships) is that they are more efficient structurally and therefore reduce weight.

Typically, considering the many sizes and types of ships, barges, and inland boats, there is an extremely wide range of structural shapes used in this country. Also, considering the somewhat nebulous and less than certain advantages of using bulb shapes, as pointed out in the report and as noted above, it seems to us that it is not practical for MarAd to invest in the development of domestic sources.

There is a strong argument for the reluctance of the steel industry to make these shapes. However, there does not seem to be any real argument for MarAd involvement. The inference on page 37 is that using special shapes will increase the cost of ships for a small cargo increase. How this can increase competitiveness with the world is hard to see since we must subsidize ships at the current price. Some economic argument is needed to justify a MarAd underwrite. As a reader I would say there is not much of a justification given to proceed.

With respect to vessels constructed with Title V Construction-Differential Subside (CDS), "Buy American" policy is governed by Section 505 of the Merchant Marine Act of 1936, as amended, which states as follows:

> 'Sec. 505. All construction in respect of which a construction-differential subsidy is allowed under this title shall be performed in a shipyard of the United States as the result of competitive bidding, after due advertisement, with the right reserved in the Secretary of Commerce to disapprove, any or all bids. In all such construction the shipbuilders,

subcontractors, materialmen, or suppliers shall use, so far as practicable, only article, materials, and supplies of the growth, production, or manufacture of the United States as defined in paragraph K of Section 401 of the Tariff Act of 1930; provided, however, that with respect to other than major components of the hull, superstructure, and any material used in the construction thereof, (1) if the Secretary of Commerce determines that the requirements of this sentence will unreasonably delay completion of any vessel beyond its contract delivery date, and (2) if such determination includes or is accompanied by a concise explanation of the basis therefor, then the Secretary of Commerce may waive such requirements to the extent necessary to prevent such delay. . .

As to implementation of the above requirements, the Maritime Administration ensures that appropriate language is incorporated into each shipbuilding contract between the Purchaser and the Contractor for shipbuilding projects where CDS is paid. For example, a shipbuilding contract typically incorporates language virtually identical to the above with the following two exceptions:

- Financing guarantee purposes. If foreign components are used without an approved waiver or exception, the cost thereof will be excluded from actual cost if the Secretary determines that suitable American domestically produced components are available. This reduction in actual cost will increase the owner's share of the total cost of the vessel and reduce the amount of the guaranteed obligation.
- With respect to entitlement of a vessel to operate in the U.S. coastwise trade, the Merchant Marine Act of 1920, as amended, requires that such vessels, unless a waiver is granted, be built in and documented under the laws of the United States and owned by persons who are citizens of the United States. There appear to be no "Buy American" guidelines for use in assessing whether the "built in" requirement is met. However, it is my understanding that the Goast Guard does apply uniform requirements to determine qualifications of each vessel for coastwise trade documentation. Under these requirements, there are restrictions with respect to use of foreign fabrications and vessel components. It is recommended that you contact the Coast Guard if you need further information in this area.

SHIPBUILDERS COUNCIL OF AMERICA

600 NEW HAMPSHIRE AVE.. N,W WASHINGTON. O C 20037

December 22, 1978

Dear Lou:

We regret the delay in responding to your letter concerning the draft report, "Special Structural Shapes -- Factors Affecting Usage in U.S. Shipbuilding." We have, however, reviewed that report and generally concur in its summary and recommendations.

As requested, a resume of the "Buy American" laws which are currently in effect and apply to ship construction is enclosed. You will note that the Merchant Marine Act does indeed place a restriction on the use of foreign products for major components of a ship's hull, while requirements applicable to naval construction have no such restriction within the "50% rule." However, the issue as to whether a change in law or government policy is a proper pursuit to encourage industry's use of special shapes appears to be premature.

The subject report puts primary emphasis on its recommendation to develop domestic sources. In this respect it is our opinion that a more logical first emphasis should be on building a firmer demand. This suggestion in effect inverts the list of recommendations contained in the summary of the report, beginning with a study of the problems of welding bulb flats. The remaining studies and information dissemination should ultimately lead to some specific applications of special structural shapes in both barge and ship construction projects to visibly demonstrate the advantages to these industries. It would seem that such projects could be accomplished with foreign steel, if necessary with Maritime Administration support similar to their slow speed diesel engine promotion (see attached copy of their FEDERAL REGISTER notice). It would be at that point in time that it may be more appropriate to invoke the development of domestic sources in conjunction with the Maritime Administration and/or address the justification of modified government policy.

Hoping that these comments may be of some value to your research project, I am

Cordially,

Edwin M. Hood
President

Mr. L. D. Chirillo
R&D Program Manager
Todd Pacific Shipyards Corp.
P.O. Box 3806
Seattle, WA 98124

Maritime Administration

SLOW SPEED DIESEL ENGINES FOR SHIP PROPULSION

Domestic Manufacture

By notice published in the FEDERAL REGISTER on May 7, 1976, (41 FR 18896) the Maritime Administration ("MarAd") announced, as a matter of policy, "it, for a period of 'time reasonably required for the development or domestic sources for [slow speed diesel enginesl, will not withhold approval, for purposes of Title V Construction-Differential Subsidy, of vessel designs incorporating slow speed diesels solely on the basis of the Presence of foreign components therein." However, certain conditions were Placed upon the use of such components-the manufacturer will develop a slow speed diesel containing entirely domestic components within a reasonable period of time and submit its development plan for review and agreement to the MarAd office of ship Construction, the aggregate cost of foreign components will not exceed 50 percent of the zost of each unit, foreign items may not be used where domestically manufactured equivalent are available and subsequent units produced during the developmeat period should contain foreign components to a decreasing degree.

Comments and a memorandum of law in the nature of a Petition for Reconsideration questioning the authority of MarAd to waive the *"Buy* American" *provisions* of section 505 of the Merchant Marine Act, 1936, as amended, have been received from certain domestic propulsion equipment manufacturers.

MarAd has determined to afford all U.3. shipbullders, ship purchasers, propulsion equipment manufacturers and ether interested parties an opportunity to comment on the prior policy determination and the submittals received to date. All comments are to be fled with the Secretary, Maritime Admtiistration, Room 3099-B, Department of Commerce Building, Washington, D.C. 20230, by December 10, 1976. A copy of previous submittals may be reviewed in that office also. Upon review of all comments received, the MarAd staff will make a recommendation to the Maritime Subsidy Board ("Board"), a copy of such report being forwarded to all commenting parties. All interested parties may have 30 days thereafter to submit responses to the aicresaid recommendation. Within a reasonable period of time the Board will publish an Order setting forth the basis for its decision with respect to the request(s) for reconsideration and will publish in the Federal Resister the conclusions of its final determination.

For further information contact William G. *Bullock, Chief, Division of Engineering, Office of* Ship Construction. Room 4525. Department of Commerce Building, Washington D.C. 20230 (tel. (202) 377-3488) .

By Order of the Maritime subsidy Board, Maritime Administration.

Dated: November 3, 1978.

JAMES S. DAWSON,
Secretary.

[F`R DOc.76-32978 Filed ll-8-76:8.45 am]

AUTOKON '71 • SHIP

COMPUTER AIDS TO SHI

SHIP DESIGN IMPROV

WELDING PROGRAM

SURFACE PREPARATION

SHIP DESIGN

COMPUTER

MATERIALS