THE IMPACT OF CONTRACTS ON SHIP DESIGN PREPARATION [1]

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Abstract

The implementation of vessel designs is usually achieved through contracts for ship construction or conversion. Accordingly, the design process and the design organization's product have to anticipate and take into account the constraints and requirements of the contracts that control the use of the design, as well as the contract that initiates the design process. This paper addresses the most common contractual factors that have to be considered during preparation of ship designs.

Keywords: Design. Intellectual Property. Contracts.

[1] Introduction

When a design organization commences a project, they are usually doing so because there is a contract with the party that will be using that design to procure a vessel or complete some desired work on a vessel. That is, a contract of some form is the mechanism that is used to engage the services of a design organization; and later a different contract will be the mechanism that is used to obtain the product (ship or conversion) that is based on that design. Inasmuch as there has to be complete compatibility between the design and the two contracts, it is important that design organizations understand what objectives have to be achieved in order to be, not only technically appropriate, but contractually appropriate. This paper offers insights helpful to the achievement of compatibility between designs and contracts that design organizations should bear in mind when developing their product, i.e., the design.

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[2] Presence of Multiple Contracts and Design Objectives

The design organization commences a project because there is an assignment, usually expressed by a contract, from the party that will be using that design to procure a vessel or complete some desired work on a vessel. Later on, that design is expected to become part of another contract, namely a shipbuilding or ship conversion contract. In fact, often several other intermediate contracts, such as time charters or bare-boat charters, may include that design before it eventually becomes part of a shipbuilding contract. In order to obtain financing, or satisfy the needs or a particular charterer, the party that initially requested the design may arrange for another organization to alter that design before it goes to a shipbuilder. The matter of whether or not the design will be used with or without alteration then may become beyond the control of the initial developers of that design.

Moreover, the marine industry is burdened by the fact that, by the time the ship is constructed, there are usually two groups of design teams that will have contributed to the final design. One group is the team that works for the owner developing the target design. The other team works for the shipyard to develop the details that are not in the contract design while also adapting the design to the shipyard's construction processes. This creates a potential for conflict between the design that the shipowner wants and the design that the shipyard wants to build. This means there are at least two different contracts and two different sets of objectives involving that design. Thus, the design team that first produced the design will eventually lose control of design finalization. Changes to the design that occur in that process may have significant impact on vessel performance under certain conditions. For example, complex hull shapes that are preferred for minimization of ship resistance and powering may be converted to simple shapes that are less expensive to construct, thereby impacting the vessel's speed and power characteristics.

Thus, it becomes very important for the design team developing the initial design to understand how the design might be used, altered, modified or misused later on by other parties. Actions to prevent those abuses need to be taken from the outset. This starts with the observation that if the design team wants to ensure that their design objectives are achieved in the end, it is important that the rights and limitations pertaining to key aspects of the design are spelled out in a manner that is consistent with the contracts. This includes both the contract with the prospective ship owner who arranges for the design, and the one between the owner and the shipbuilder.

In order to place the entirety of the design process in proper perspective, three fundamentals should be appreciated:

1. The Contractual Answer
2. Quantitative Translations
3. Designer Responsibilities

[3] The Contractual Answer

The first fundamental is the contractual answer, which is always the same: *"Let's read the contract and see what it says."* You may think, *"But we don't yet know what the question is."* That's mostly irrelevant because a question would not arise if a contract didn't already exist, either the contract for design services or the contract for ship construction.

This may be true if the contract is between the owner and the design team who was contracted to design a vessel modification. It would also be true between the shipowner and a shipyard that will build or modify the vessel in accordance with the design. However, remember that it may not be the same design that the initial design team created because it may have been modified by a second design team along the way.

It is not uncommon for shipowners to take a design from one design agency and hand it off to another agency and say, *"I have a design for a new vessel, but since the design was finished our needs have changed. Will you please modify the design to accommodate our restated needs?"* This causes two design teams to have interest in the design and it is hard to know who owns the design. We also do not know who is responsible for any subsequently discovered problems with the design unless it's reflected in the contract.

With these concerns in mind, when questions arise, we want to be able to read a contract and say, *"There it is. There's the answer - it's already in the contract."*

[4] Elements of a Contract

Before continuing, consider what the word 'contract' means (Fisher 2003). Suppose that a tugboat is to be constructed. There would have to be an entire bookshelf to contain the shipbuilding contract. For larger vessels, larger bookshelves are needed. Contrary to popular belief, the contract is not just what the lawyers drew up – that document is the Contract Agreement, which is just one element of the contract. In addition to the Contract Agreement there are a number of other documents that will make up the contract, as follows:

1. The Contract Agreement
2. Terms and Conditions
3. Contract Technical Specifications
4. Contract Plans or Drawings (possibly including Guidance Plans and/or Information Plans)
5. Domestic Regulatory Requirements
6. International Regulatory Requirements
7. Classification Requirements
8. Standards for Construction (referenced by the Specifications)
9. Standards for Testing and Trials (referenced by the Specifications)
10. Secondary standards (referenced by any of the elements listed above)

These are the components or elements of the contract and each (in hard copy) will occupy a portion of the bookshelf. The first four elements are essentially unique to the project, occupying only a small section of the bookshelves. The other elements of the contract are common to many projects. However, the entire

remainder of the bookshelf is needed for those contract elements. This includes all of the documents that those first four documents refer to, as well as the ones the referenced documents refer to in turn.

For example, if the Contract Agreement or the Contract Specifications require that the ship be classed, then a set of the applicable classification rules is needed on the bookshelf since they are also part of the contract. If the vessel is to be flagged under a particular set of regulations, those regulations need to be on the bookshelf. If the contract specifications state that all electrical installations shall be done in accordance with Institute of Electrical and Electronics Engineers 45, then we need a copy of Institute of Electrical and Electronics Engineers 45 on the bookshelf. If the contract specifications state that all coatings shall be applied in accordance with the coating manufacturer's recommended surface preparation and application procedures, then we need a copy of those procedures for each different coating on the bookshelf also. All of these identified documents are part of the contract. Thus, when a question arises, first read the contract - but not just the Contract Agreement and the Contract Specifications. The question may pertain to a standard, regulatory requirement, or classification requirement that is also part of the contract.

Sometimes when you read the contract to find answer to a pending question, you may not be happy with the answer you find therein. You will read the contract and ask, *"Who wrote that? Who put this in the contract? We can't live with that. We cannot abide by that."* Nevertheless you must abide by it because it is the contract that controls the relationship. Accordingly, it is essential that the design team understand that the drawings and specifications it is developing will become the basis for answers; that design information will end up being in a subsequent shipbuilding or conversion contract that controls the use of the design. The appropriate phrasing of the design information is essential to ensure that the goals for the design are achieved in the end. The design services contract is going to control the output and control what becomes of the design. If this is not recognized during formation of that design services contract, the loss of control of the design is more likely to develop.

The burden is on the design team to understand they cannot use general words in the design specifications (Fisher 2004). Nor can they use things that 'sound nice,' since they probably are also not well defined. For example, typically the general section of the specifications includes a requirement that all materials and equipment being put into the ship shall be new. Sounds good, but a question arises: *"What do we mean by 'new'?"* An actual illustration of this applies to a shipyard that was building several patrol boats. The contract called for the shipyard to supply and install a certain gun on the foredeck of each of these patrol boats. All the materials had to be new. The shipyard acquired and installed these guns, however the owner's representative complained that the guns were not new. The shipyard responded, *"What do you mean*

'not new'? They are new. Let's look at the dictionary."

The Contract Agreement stated that the law of the contract was a certain country, and the language of the contract was English. But it did not say anything about 'new'. In fact, nowhere in the agreement, specifications or elsewhere was the word 'new' defined. The problem that the owner saw was that these guns weren't really 'new' according to the owner's expectations, since these guns had been manufactured in eastern Europe more than 10 years earlier (although they had been put into storage, and then taken out of storage and put on the ships never having been fired except for the test firing).

Were these guns new or not? How would you know? Remember the first fundamental: read the contract. In this case, the contract didn't define the word new. Thus the parties had to resort to looking at the English dictionary from the country where the ship was being built. Of course, although far from the owner's intent, according to that dictionary the guns were in fact 'new' -- not previously used. Perhaps the owner's design team should have thought more about what they were requiring and defined what was intended to be 'new'. How long before installation should they have been manufactured to qualify as 'new'? Two years? Five years? Ten years? For example, perhaps they should have defined 'new' to mean that the component be manufactured less than 'x' years prior to installation. This example illustrates that a design team must understand how other parties are going to read the design package information and use it or abuse it.

[5] Quantitative Translations

The next fundamental is the topic of translations. This does not mean a linguistic translation between English, French, Japanese, Mandarin, German, etc. Rather, this focuses on quantitative translations, as described in detail below. Design teams have to understand that the design package they create is going to be subjected to such a quantitative translation. This arises when the shipowner, who originally contracted with the design agency, takes that design package to shipyards and requests a bid with fixed prices and schedules to produce the product – the ship – described by the design package.

In order to provide a fix-price, fixed-schedule bid, the shipyards have to develop a quantitative translation of the design. Specifically, they must translate the design into the following estimates:

- Estimated Engineering Hours
- Estimated Production Hours
- Estimated Material Costs
- Estimated Subcontract Costs
- Estimated Schedule Duration

It is important to note that the design team's product – the design package -- must be appropriate for this quantitative translation. If it is not, then the shipyard or the bidders cannot give an appropriate bid. Later on, there will be a lot of unanswered questions and potential disputes as to what was included in the ship construction contract price and what was not.

An example of inappropriate design/quantity information comes from a recent vessel conversion contract that included replacement of both main diesel engines. The Technical Specifications included the following. *"Engine starting panel: Installation shall allow starting from either the engine room or navigating bridge."*

The intent was to have flexibility of operation by having a starting panel at both the navigating bridge and the engine room. However, the design team's specification writer did not convey that requirement in this language that became part of the shipbuilding contract. The shipyard interpreted this to mean that a choice could be made as to where only one starting panel would be located; the shipyard chose the engine room in order to minimize costs. The error was that the quantity of starting panels was not clearly defined.

Another example is as follows: The shipowner's design team specified a certain new 10 kW electric motor to be furnished and installed to operate an item of equipment as part of a ship conversion project. The shipyard went out to get prices for the motor from several potential vendors. During the discussions between the shipyard and the vendors, each vendor asks, "*What controller are you going to be using for this motor?"* The shipyard replied, *"We don't know because it's not specified. Doesn't it have an integrated controller?"* The vendors respond by informing the shipyard that *"This motor requires a separate controller."*

The shipyard then had to obtain a controller for the motor, which was considered an extra cost. However, this was not the total extent of the extra cost borne by the shipyard since they also had to build a foundation for this controller as well as install extra cable terminations rather than just going directly between panel and motor. When the shipyard later presented this work as an extra to the shipowner, the reply was, *"No, it's not an extra because you promised a complete job - besides which, everybody knows that large electric motors need separate controllers."* The shipyard's contractually correct reply was, *"If everybody knows, your design team should have mentioned the word 'controllers' in the specifications since you should have also known about that. We'll put the controller in but it's an extra."* This example illustrates that the architects and engineers who create the design package that will be used for a bid have to understand that it has to be subject to this quantitative translation. If the design specifications don't mention a controller, it won't be in the bid. However, note that if the contract is a "design-build" one utilizing a performance specification instead of a design specification, this would not be a concern.

[6] Designer Responsibilities

It is noted that the quantitative translation issue discussed above comes about before the contract is signed. But an equally important issue – Designer Responsibilities -- comes to the forefront of a design team's efforts even earlier. Generally speaking, whenever a design team member is generating or compiling

information, which information is later going to be in an element of the shipbuilding contract, that person has a professional responsibility to ensure that the information is consistent with everything else that is going to be in the contract. This is true even in instances when the rest of the contract may not yet be defined.

Of course, the design team has to ensure that the Contract Specifications, the Contract Plans and the other secondary elements of the contract are all consistent with the Contract Agreement. For example, if the Contract Agreement says the shipyard does not have engineering responsibilities, but the contract specifications and drawings assume the shipyard will be executing engineering, there's an inconsistency. This inconsistency will cause problems later on, if not sooner.

The burden on the shipyard is that it has to achieve compliance with all of those contractually-defined requirements at the same time. They can't pick and choose between them and say, *"Well, we will comply with this standard and not that standard."* They must comply with all of them. However, this means that there is a burden on the design team to ensure that there are no conflicting requirements between the various parts of the design package. If there are conflicting requirements, there will be conflicting interpretations between the shipyard and the owner's inspectors.

Whenever a member of the design team is putting pencil to paper, it is important that the information be consistent with all the rest of the contract - which likely is far from being completely defined at the time the design information is being developed. A relevant example pertains to a large fish factory vessel that was being designed to be classified by the American Bureau of Shipping ("ABS"); at least that was the original intent of the design team and the owner. When the owner went out to get construction financing with a Norwegian bank, the bank said it would only finance projects that are classified by Det Norske Veritas (DNV). Subsequently, the owner's attorneys went to the Contract Agreement and Contract Specifications and replaced 'ABS' with 'DNV'. Of course, the design team was never told about this, so all the drawings were consistent with ABS requirements, even though DNV remained in the contract.

Consequently, there were many small problems, and a few large ones, associated with the process of obtaining class approvals. Although ABS and DNV both produce satisfactory solutions of the various design questions that arise; they are not the same solutions. In the case of the fish factory vessel, the shipyard had drawings representing ABS solutions even though the contract required that they build the vessel to be consistent with DNV solutions. The result was DNV's rejection of a lot of the shipyard's detail design. The root cause of this misunderstanding was that the Contract Plans were not consistent with the selection of DNV as the classification organization

[7] Reciprocal Information Responsibilities

During the shipbuilding process, a lot of information flows between a shipyard and the owner's project team. For this discussion, assume that the owner's project team (Fisher 2006) includes representatives of the firm that designed the ship or conversion.

Each time a shipyard accomplishes one of its requirements, there will be a communication across the contract boundary to the owner. The communication may be in the form of a drawing for the owner's review (Fisher 1991), or a test notification, a revised tank table, or the megger readings for the newly installed electrical cable. Whatever it may be, there is a communication transmitting information from the shipyard to the owner.

Whenever the shipyard communicates to the owner, the owner's team has a reciprocal responsibility, although it may be of an altogether different form (Fisher 1995). For example, the owner's team needs to show up to witness the test, review and comment on the drawing, or accept the equipment selection. In any event, communication has crossed the contract boundary; there has to be a response.

The next example is a subtle-but-interesting one: Most contracts require that the shipyard develop a detailed schedule, regularly update that schedule, and communicate the schedule to the owner. In these cases, what is the owner's reciprocal responsibility when the team receives the shipyard's detailed schedule? Is it their responsibility to admire the schedule; marvel that it has four colors, hundreds of activities; or put it up on the wall in four big sheets of paper? Certainly none of the above.

The owner's actual reciprocal responsibility is to examine the schedule and identify what owner-related obligations are being nominated for what dates. Bear in mind that, through the mechanism of the contract, the owner has given the shipyard the right to nominate the dates when certain owner-related obligations will take place. If the owner's team doesn't review those nominated dates and provide corrective feedback, after some time has passed, the shipyard will assume those dates will be achieved by the owner's team. With this in mind, it is appreciated that the owner's team has an obligation to look at those nominated dates. In the event that the owner's team cannot comply with certain nominated milestones, the owner must promptly inform the shipyard so that changes to the schedule can be made with the smallest impact. The owner's team always has a reciprocal obligation to respond to information received from the shipyard.

[8] Information Content

When discussing information flow, there are four components to consider, each of which is discussed in more depth in the following sections:

- Content
- Form & Format
- Timing
- Intended Use

Information content is a fairly easy concept to define. The basic question that covers content is *"What information is going to be transmitted to the other party."* However, deciding on content is not without its pitfalls. For example, be wary of content conveying information exclusively by the use of colors. Many junior designers and engineers are proud of their ability to convey information using color. With the wide availability of color printers and monitors throughout the industry, it is easy to give in to the temptation. However, one must be sure that the information being conveyed will survive black-and-white copying.

Consider the following example that illustrates this point: A ship was being converted and reflagged. Part of the work required installation of several new bulkheads of differing fire ratings. The designers indicated the fire rating of each bulkhead through color coding-- blue, red and green. When the shipyard received this information, it made black-and-white copies and handed them to the production department so they could begin installing the bulkheads. On the copies, all of the bulkheads appeared to be rated 'A15' since they were all gray. The error was not noticed until the Coast Guard's inspection of the vessel toward the conclusion of the project. In the end, the shipyard had to complete a number of last minute modifications at significant cost and also deal with the associated project delay.

[9] Information Form & Format

When considering form and format, modern information flow centers on questions such as *"In what form will the information flow?"* and *"Should the information be transmitted by hard copy or electronically?"* In the present age, keep in mind that simply specifying 'electronic' is also no longer sufficient. For example, after contract award one shipyard requested electronic copies of the contract drawings. The owner's design team obliged by sending the drawings electronically in portable document format (PDF). Of course, the shipyard anticipated receiving the drawings in a form which would be amenable to using them in computer-aided design format (CAD) so they could use them as jumping off points for their detailed design development. However, format had not been addressed in the contract. When the shipyard later requested CAD files, the owner's design team refused to turn over the documents in that format over fear that they would lose control of changes to the design.

Also worth bearing in mind during this discussion is the fact that there will likely be a least two contracts involved in a given ship construction project. There will be the contract between the shipowner and the design firm, as well as the contract between the shipowner and the shipyard. As one can see, consistency in the form of information between contracts is essential to avoid issues downstream. For electronic information, the defined format should also specify the particular application and version with which the information should be compatible.

[10] Information Flow Timing

Consideration of information flow timing is best addressed by asking the question, *"If there's going to be information flow, when should it occur?"* For example, specifications will often state that the shipyard must provide megger readings for all the newly installed electrical cables. While this may be desirable information for the owner, in a recent contract, there was no statement as to when it should be transmitted. Later on, the shipyard began installing the cables and taking the required megger readings for this first batch of cables. However, the owner did not promptly collect the readings. As the project progressed, the shipyard stopped taking megger readings as a cost saving measure. Subsequently, as the ship was getting ready for trials, the owner's project team noticed that they had only few megger readings on file. When the owner requested the readings from the shipyard, the shipyard replied that *"We have some here. As for the rest of the megger readings, don't worry about it - energizing the circuits is equivalent to taking megger readings."* This all comes about because the owner had not specified when the megger readings should be delivered, nor did they track the receipt of readings on their deliverables checklist.

[11] Intended Use of Information

The impact of a transferred element of information's intended use is best described by the question, *"What is the intended use of the information that is going to be transmitted to the other party?"* Often times during our firm's quality assurance review of design packages, we find that the lines plans have been developed by the owner's design team, as well as the powering plans and speed. Subsequently, each of these three items is incorporated into the draft contract or specifications. However, imagine for a particular example that the contract documents state that the shipyard shall install a 12,000 horsepower (HP) power plant for a particular lines plan for a 22-knot service speed. In this example, who is guaranteeing that 12,000 HP will produce the requisite speed for this particular lines plan? The owner has to decide whether the shipyard should be responsible for speed or for the 12,000 HP because the two may not be exactly consistent. In terms of intended use, consider why the shipyard should be given the speed information. Will speed be a contractual requirement, or an assumption for planning and testing purposes?

Alternatively, the owner may say that for bidding purposes, the shipyard should assume a 12,000 HP power plant. However, before the shipyard builds the ship, the owner will require the shipyard to do model tests to ensure that the design will achieve the desired speed. Should the tests find that more than 12,000 HP will be needed; a change order will then be negotiated to make sure that the ship achieves this speed.

Another example of entities failing to consider information's intended use centers around a shipyard that was building an Antarctic supply ship. The owners knew that the draft of the ship couldn't be more than a certain amount. However, they also

wanted to carry a full load of supplies to some ports in the Antarctic at a certain time of year. When all was said and done, the ship exceeded the draft, which meant that from time to time another vessel would have to be chartered to make an extra voyage to the Antarctic – a very expensive proposition.

The owners later assigned this author's firm to determine if the shipyard was responsible for the excessive draft of the vessel. However, when the contract history was examined, it was found that the shipyard was only required to report the light ship weight as they developed the ship. The responsibility for reporting the draft actually rested with the owner's naval architect. Compounding matters, the increased draft came about because of change orders during vessel construction from many of the project's stakeholders. These changes increased the light ship weight and, consequently, the draft. The shipyard's responsibility was not to report the draft, only the light ship weight. However, the owner's team did not follow through with its own analysis of draft based on the available hydrostatic curves. The problem was that the technical specifications did not assign the shipyard to use the combination of weights and hydrostatic curves to determine the draft.

[12] Intellectual Property Rights

A discussion of intellectual property rights invariably centers around the question of *"Who owns the design?"* Although the ideal answer is to read the contract between the design agency and the shipowner and the contract between the shipowner and the shipyard, we are beset by a fundamental problem in our industry. This problem is that, except when a shipyard is selling vessels of its own design, there are two sets of design teams: (a) the owner's design team, who prepared the contract design, and (b) the shipyard's design team, who developed the details. Since two different design teams have contributed to the final design, the question still stands - *"Who owns the final design?"*

A common problem is that the majority of contracts don't discuss intellectual property rights, or that the contracts do not ensure that these rights flow down from one party to the next. This is primarily because the shipowner has agreed, for example, that the design shall be owned by the firm who designed it for them. However, this agreement fails to flow down to the shipowner-shipyard contract. Later on, the shipyard claims that they own the design since there are less than 100 contract plans created by the initial design firm, compared to the thousands of detail plans created by the shipyard. The shipyard's stance is that since they did most of the work, they own the design. Their motivation for this claim is the potential to use the same design to build ships for other customers. However, the initial design team also wants its royalties. This problem occurs when there was no contractual requirement that the intellectual property rights flow down to all subordinate contractors.

When discussing design ownership, keep in mind that although the obvious application would be the design of the entire

ship, it may also apply to the design of a system or even a single component. Whenever naval architects and engineers start designing something, they must keep in mind that before they even give a sketch to the client, they should discuss intellectual property. Suppose a prospective vessel owner comes to your organization and states that they want to acquire a particular type of ship. Your firm sketches a concept of a potential solution, to which the owner inquires what would it take to develop the design to a point where it could be sent out for bid. When your firm asks for a few days to create a proposal, the owner walks away with the sketch, waiting for the detailed proposal and costs. However, a few days later the owner instead takes your firm's sketch to another design firm, who then produces a design that builds on that sketch. Who owns the design? The correct answer likely would not be discovered until after a number of years and large amounts of legal fees.

Alternatively, before your firm hands over information to a potential client, be sure to have agreements in place ensuring that the intellectual property rights of all information your firm gives to the client belong exclusively to your design firm. These agreements should also prohibit the transfer of information to any other party until written permission was received from your firm. For additional protection, remember to note on your sketches and documents that they contain copyrighted intellectual property that belongs to your design firm. Remember intellectual property control is lost the minute you give up a piece of information, unless you have addressed the intellectual property rights before you turn over the information. With regard to licensing and royalties, these issues can be addressed in the contract. Persons not familiar with these issues may be best served by consulting with an intellectual property lawyer the next time these issues have to be addressed. This will allow the firm to have a model to use for future contracts as well.

[13] First Class Marine Practice

Contracts typically state in the general section of the Contract Specifications that all workmanship accomplished and materials supplied by the shipyard shall be in accordance with 'first class marine practice' or a comparable phrase. While this may sound good, as discussed below, such a phrase falls far short of helping to achieve its intended goals from both a practical as well as contractual perspective.

Before examining what 'first class marine practice' means, consider the significance of this term being in the contract documents to begin with. Why is it necessary or considered reasonable to put this kind of language in the contract? First and foremost, it is recognition by the shipowner that the shipyard has been given the authority to make a lot of decisions and develop a lot of solutions as it expands the workscope into a large number of drawings beyond the Contract Plans and Contract Specifications. By putting this language in the contract, the shipowner is trying to influence the outcome of the shipyard's

decision making process by essentially saying that when the shipyard makes a decision it is preferable that it utilize this objective. However, it is also a recognition that the shipyard not only has the responsibility to make these decisions, but that it has the right to make these decisions any way it wants, as long as the decisions are consistent with the rest of the contract.

This concept is often illustrated during work associated with sister ships. These are a group of vessels that have been built under one contract. At first glance, they may look like identical vessels - same lines plan, same general arrangement, same general subdivision, same machinery components, etc. What about the details? Are they the same? Far from it.

For example, the shipowner can't expect that the cable trays are in exactly the same place, or that the take down joints for piping are in the same place. The shipowner has no right to expect any of these things because the shipyard has to comply only with the contract plans. More than likely, there's no contractual requirement that the details be identical between hulls. In reality, as the production department begins using the first set of shipyard-developed detail plans, they find conflicts between them often times in the form of interferences. These conflicts subsequently get resolved by the production department. One of the benefits of the production department's resolutions is that this information may go back to the shipyard's engineering department for use in subsequent hulls. By the time the shipyard begins work on the third hull, the number of changes due to conflicts has diminished, but now an altogether different production crew and construction sequence is being used. This not only results in a different set of conflicts, it also results in different solutions. These variances in the details are permitted because a shipyard has the right to figure out the details in the manner of their choosing, provided that it is still consistent with the rest of the contractual requirements.

[14] The Owner's Perspective

Returning to the subject of 'first class marine practice', those words go into the contract because the owner is trying to influence the outcome of the shipyard's decisions. Of course, the owner has some preconceptions as to what is meant by 'first class marine practice.' These preconceptions may be distilled into the following five expectations:

- Long Service Life;
- Low Maintenance Costs;
- Proven Reliability in Service;
- Ease of Operation by Shipboard Personnel; and
- Availability of Spare Parts and/or Technical Representatives.

These are the focused objectives that the owner expects the shipyard to utilize when the shipyard is making equipment selections and developing detail drawings.

[15] The Shipyard's Perspective

In contrast to the owner's conception of 'first class marine practice,' the shipyard's understanding of this concept may seem a bit cynical. Specifically, the shipyard's understanding of what constitutes

'first class marine practice' is that the following four points are concurrently accomplished:

- Meets a "plain vanilla" or simple reading of the specifications;
- Finishes within the amount of time believed to be appropriate;
- Implemented solutions outlast the warranty; and
- Uses a 'least-cost' solution at every opportunity.

As noted in the third bullet above, the requirement that the work outlasts the warranty seems cynical. However, this is part of 'first class marine practice' for the following reason. The shipyard's financial obligations extend through the warranty period. If they have given a warranty on some or all of the work and materials, then they may have to spend some money to deal with warranty issues. However, if the work and materials outlast the warranty, then they did not have to spend any of their warranty reserve fund. These funds in turn become profit, which is what the shipyard is in business for.

The last point of the shipyard's perspective of 'first class marine practice' pertains to least-cost solutions. At every opportunity, the shipyard will be looking for a least-cost solution, and it is extremely likely that they will find it. Sometimes a ship owner's team is very unhappy about this. For example, during the course of negotiations the owner and shipyard look at one of the specification sections that states that certain piping shall be galvanized. When asked by the owner how they galvanize pipe, the shipyard responds that they use hot-dip galvanization, which is appropriate for the marine environment. However, when the ship is being produced, suddenly the shipowner sees that the piping is not being sent out for hot-dip galvanization. Instead, the galvanization is being painted on for the entire system. When the owner reminds the shipyard of what was said during the negotiations, the shipyard responds that production didn't have time to send it out for hot-dipping, although the point the shipyard is really making is that the specifications only say galvanized. Since the specifications did not say how the pipe should be galvanized, the shipyard was able to find a cost saving solution. The owner's design team should appreciate this perspective of shipyards, and add tighter language to the Contract Specifications as may be appropriate.

Although these points may seem cynical, designers should understand that the shipyard's definition of 'first class marine practice' is merely "first class business practice in the marine environment." Just as a land-based supplier is unlikely to go above and beyond the minimum requirements for a land-based buyer, the shipyard is not going to give anything extra, either.

The design team's understandings of these concepts are also essential. These firms must understand how their specifications are going to be read by the shipyard. For example, the firm knows that the shipyard will be looking for least-cost solutions, so the firm has to examine how the shipyard could interpret the specifications in such a cheap manner that

the client would not be happy. For those portions of the specifications where such an inexpensive solution can be used but would make the client unhappy, the firm should go back and write a tighter specification to preclude such a result. Don't trust the shipyard to know, respect or even understand *intent* - they will honor only what is unambiguously written down.

[16] Multiple Design Team Coordination

For the initial design team, the previous sections have provided some helpful insight into the communication of information to shipyards, as well as the team's rights and responsibilities, their role, and how their design is going to be used by the shipyard. The design team must also appreciate that its initial design work is likely to be subjected to design development by a series of additional contracts. The most immediate design relationship is defined by the contract between the shipowner and design agency. Later on, a contract will also exist between the shipowner and the shipyard, incorporating that design agency's work product. However, remember that there are other contracts involved as well. For example, the shipyard may be subcontracting classification, construction of certain components, engineering (possibly in different categories), and other tasks.

An illustration of this concept pertains to a particular US shipyard that did not have a substantial engineering department. When the shipyard signed a contract for a very complex vessel, they also subcontracted with structural and piping engineers in Bulgaria, electrical engineers in Canada, HVAC engineers in Australia, and mechanical and outfitting engineers in the US. In this arrangement, the shipyard had four different design teams, which were all competing with each other. Each subcontractor was of the mindset that the other subcontractors should design around their work. This resulted in significant cost and schedule overruns.

For such a multi-team arrangement to work, there has to be a unified team effort. Although this approach to the design is generally inadvisable, if it must be done because of economy, the primary design team should consider putting somebody on their team at the design subcontractors' facilities. This person should serve as a communicator, rather than a decision maker, to ensure that there are good communications between the primary design agency and the subcontractor design agency. The objective is have each group within the design team work to integrate its work product into the total design, and *not* to act individually as though the other members of the design team have to adapt their work product to that of another's.

Another issue the design team should be wary of pertains to the shipyard's detailed development of the design. Sometimes the team will prepare the contract plans and specifications for the owner. Later, when the shipyard has to develop the details, they ask the shipowner if they could use the same team – they already know the design, after all. While the design team would love this extra work, the

owner must be mindful of a potential conflict.

The obvious conflict is that the same design team that did the contract design for the owner would now be doing the detailed design for the shipyard. Somewhere along the line, there will come a point where a dispute arises whether a particular item was an improvement of the basic contract design (for the owner's account) or if it merely a straight-forward development of the detailed design (for the shipyard's account). The design team will never know which way it will work out when they work on both sides of the fence. If the team is tempted to take the bigger detailed design contract after doing the contract design, be sure to sit down and talk to all the parties about who is going to pay for the developments. Best practice appears to be for the owner to contractually prohibit its selected design team from concurrently working for the shipyard that constructs the ship.

[17] A 'Better' Design

Another issue centers around the designer's understanding of the word 'better.' We often see designers create 'better' solutions to a particular issue. Later on, we find that these 'better' solutions cause conflicts or extra costs. This begs the question of what criteria did the designer use to make the determination that solution 'A' is better than solution 'B'? We have seen many situations in the past where a designer decided that a particular solution was better, when in fact neither the shipyard nor the owner wanted it. However, the designer sold the solution to both parties by saying it was 'better.'

When a dispute later arises, we often must examine what criterion was used to determine that the solution was, in fact, 'better.' To the shipyard, better is lower construction cost and ease of construction. To the shipowner, better is lower maintenance costs and ease of operation. However, the designer wants to use a 'gold plated' solution that causes access issues or uses very expensive spare parts. How is this better than the alternative? Is it 'better' today or 15 years from now? When designers are considering a 'better' solution, they should carefully identify the criterion or criteria being used for the determination that it is better, and ensure that their client concurs.

[18] A Ship Grows

This subject pertains to the concept of growth – specifically the future physical growth of a ship. Naval architects are trained to design for construction with margins being built in, such as a particular weight or stability margin that is included in the initial design. Typically this proves to be insufficient in the long term because that margin focuses only on the lack of accuracy of estimates of weights and centers. What the industry has seen occur is that these margins are consumed during the construction process by way of change orders or due to underestimates of weights. Thus when the vessel is delivered, there is little margin for future growth.

However, we must also consider where the ship is going to be in four or ten

years before we finalize the design with margins. Experience has shown that for non-standard designs, it is unrealistic to think there will be no change orders or no underestimates of weights. It is best practice for the designers to include ample margins in their initial design such that a reasonable age-based growth margin is still available after the shipyard and the change orders consume some of those initial margins.

Consider the design of a new oceanographic research vessel, which of course will have a lot of sampling, science and research equipment aboard. Looking ahead, what equipment will be on the ship ten years from now? Obviously it will be significantly different from what will be installed this year; but ship designers cannot predict what the new equipment will require in terms of space, weight, or electrical power. However, it is safe to say that the vessel will require more electronics and more cabling.

It is noted that when an item of equipment is replaced in a decade, no funding will be available to pull out the old cable. Thus, as the ship ages, more cable is being stuffed into it since shipyards are not contracted to take all the old cable out. Thus, whenever such a ship is being designed today, consider not only weight and stability growth, but also more cable tray space. With this in mind, designers must understand that this will happen to your design, not this year but 15 or 30 years down the road. Accordingly, another margin that should be included is cable tray volumes, as well as weight and stability.

[19] Summary

Normally ship designers are keen to learn how to improve their technical design procedures, and to identify concepts and ideas that can be incorporated into future designs for improvement in the vessel's capabilities. This paper has focused, instead, on non-technical aspects of a vessel designer's role as part of the process of going from conceptual design to delivery of the vessel and modification of the vessel many years into its lifetime. The concepts addressed are summarized by the following.

- Multiple contracts are needed to achieve implementation of a vessel design.
- Specifications and plans have to be complete and suitable for use in contracts.
- The specifications and plans will be the basis for binding answers to many questions during execution of the shipbuilding contract.
- The specifications and plans have to be suitable for quantitative translations during the shipbuilder's estimating and bidding process.
- The designers have to ensure that the specifications and plans are wholly compatible and consistent with all the other elements of the shipbuilding contract.
- The ship designers will have responsibility, along with others on the ship owner's team, to timely provide information responses to all communications received from the shipbuilder.

- All information flow between the owner's team and the shipyard has to be planned by addressing content, form, format, timing and intended use of the information.
- Intellectual property rights have to be addressed before the transmittal of any design information.
- First class marine practice is not interpreted the same way by owner and shipyards.
- There has to be tight coordination between design organizations when several different ones are concurrently working to develop the detail design.
- The recommendation to incorporate a 'better' design feature must be based on a clearly defined criterion of what makes it better.
- A designer's responsibility has to include anticipated growth of the ship in future years.

As a vessel designer, it is vital that you consider your obligations in addition to technical preparation of the design. Remember that your design is being undertaken because there's a contract. Later, your design will be implemented because of a different contract. There may also be other intervening contracts. In some cases, due to the contractual arrangements, you may start to lose control of the design. The shipbuilder will be interpreting the ship designer's contribution to the contract -- the plans and specifications -- in accordance with the shipyard's definition of first class marine practice. Since that definition includes the use of least-cost solutions, the designer will have lost control of the design through the contracting process unless the specifications and plans give the shipyard little choice in those areas that are important to the ship owner. Contracts are the mechanism to control the implementation and use of your design, so it's important for you to understand how your design is going to be compatible with the contracts. Work to ensure that the contracts are compatible with your design, and vice-versa. Finally, don't neglect questions of intellectual property rights.

Persons interested in developing a greater understanding of the connectivity between vessel design activities and multiple contractual requirements may wish to examine Fisher 1984 and Fisher Maritime Consulting Group 2008a and 2008b.

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