NOTES ON SHIP REPAIR AND CONVERSION MANAGEMENT

BY ROBERT R. HART

EDITED BY DR. KENNETH W. FISHER

Fisher Maritime Consulting Group

Florham Park, New Jersey

Presented at

Fundamentals of Contract and Change Management for Ship Construction, Repair, and Design

«««««««««««««««««««««««««««««

---- CONTENTS ----

«««««««««««««««««««««««««««««

Foreword ••••••

One of Bob Hart's last employments was on the teaching staff at the California Maritime Academy. Prior to that he was associated with commercial and naval shipyards, as you will discover below. This two-part paper was originally an oral presentation at a two-day seminar in 1979 on contract management for ship construction and repair. Bob Hart has since passed away, but has left the maritime industry this legacy of his appreciation and learning process. In reviewing it again, more than a decade later, its timelessness becomes evident. Bob Hart clearly subscribed to the school of thought that since we don't live long enough to make all the mistakes ourselves, we should learn from the mistakes of others. But the educational benefit of those mistakes becomes available only when such matters are 'translated' by analytical minds, such as Bob Hart's. The industry is fortunate that Bob Hart was generous with his professionalism.

Dr. Kenneth W. Fisher
South Orange,NJ
May, 1992

«««««««««««««««««««««««««««««

1. Introduction ••••••

I am the last in a line of people who have stood up here today and very confidently talked to you about the problems of contract management. I don't have that same degree of self-confidence. But the reasons for my lack of complete self-confidence in that area can demonstrate many of the pitfalls that managers for repairs and conversion should avoid.

I started out as a ship operator; the first ten years of my professional life I was in the engineering department, becoming a chief engineer of a submarine. I've been in shipyards for normal overhauls, for conversions and even for emergency repairs when things didn't go quite right. I started working in shipyards about 1956 as an engineering office at Mare Island Naval Shipyard. I was in the repair, conversion and new construction business there.

Later on, after retiring from the Navy, I went to work in private shipyards. I was unlucky. At those shipyards, we had trouble finishing the jobs on time. They said we had no schedule adherence, and the costs that we estimated for the jobs bore little resemblance to the costs we actually incurred. We were plagued with cost overruns. But had a motto. Our motto was this: it may take a good long time to do a job, and we may charge a lot of money, but by golly our quality is poor -- because things didn't work either.

I think that the one thing I realized and I hope you realize is that the ship is terribly complex. It is in fact a city all by itself, and much more complicated than a city because many cities don't have their own power system,

whereas a ship generates all power aboard it from its fuel.

In the housing industry, as houses have become more expensive, people have modified old homes rather than buying a new house. I think you will find the same thing will happen in the shipbuilding industry. As ships are now more expensive, owners are going to look toward modifying their ships to increase capability or achieve improved economy, rather than building a new vessel. For example, Sea-Land has already taken their ships to Japan to have the steam plants replaced by diesel systems. They are doing this because the savings in diesel fuel costs in one year will be $900,000. If we want to get that work in the U.S., we should be prepared to offer the same type of services with intelligent management of the contract.

«««««««««««««««««««»»»»»»»»»»»»»»»»»

2. Equipment Life Cycle Categories

A ship lasts a long time. it will give you twenty years of service easily. Many of them are still running after 40 years. The equipment put on a ship is very reliable. The mean time between failures for major equipment like turbines and boilers can be as high as 600,000 hours. I 'II give you one example. Those of us who were in World War II in the Navy and rode the liberty launch to shore had that miserable hunk of equipment in there called a Gray 671 marine engine. If you are on a Navy ship today and you go ashore, you're riding in a launch that is still powered by the same 671 that was built in World War II, and by every estimate we can make, those engines are going to be around till the year 2000 -- 55 years for the life of a small diesel engine.

Now the life cycle of equipment goes through three phases. The first part is what the shipyards are plagued with, where all the manufacturing and shipyard defects show up -- the infant mortality period. That is where we try to work the bugs out of the equipment. Hopefully, by the time we finish the dock and sea trials, we have worked out those bugs. Then the equipment should come down to a long line of useful life with very few failures. We can prolong that useful life all the way out to the life of the ship if we give it good routine overhauls. Then finally about the time the ship wears out, the equipment wears out, the failure rate goes up again, and the equipment should be replaced.

We can put into three categories those parts that are on the engines and the pumps that we have to replace or overhaul. First, the limited lifetime parts. (Your automobile tires, for example, are limited lifetime parts.) Now those limited lifetime parts can be very critical. One of them that we have on board ship is flex hoses. Just last year one of our California Maritime graduates came back to tell me about a boat he was on that was making a trip from Seattle to Alaska. The flex line that was carrying the fuel oil to the diesels ruptured. The hot oil sprayed into the engine room, started a fire and seriously hurt the engine man on watch. The chief came down to investigate the fire and walked into the spray. He got covered by diesel oil and started burning. So he was out of commission. The captain was ready to give up the ship. He called up the Coast Guard and was ready to abandon it. One of our graduates jumped down in there and isolated the fuel system. He secured the engine, managed to put out the fire and literally saved the ship. But it was a limited lifetime part that was asked to do more than it should that caused it all. So if you are going to have reliability of systems on a ship, the first part of a good overhaul is to replace those limited lifetime parts.

Now other parts of the equipment wear very slowly. There are the parts like the piston rings and the liners which, as they wear, degrade the performance of the equipment. Then you have the parts like bearings, which don't degrade the performance of the equipment, but will fail catastrophically when their useful life has ended.

Finally you have parts of the equipment, such as the pump casing on a feed pump, the block on the engine and the cylinder head, which have for all practical purposes an infinite life period. But we still have a problem with those. If we are going to guarantee that our products will perform satisfactorily, these must be certified as being sound enough for one more overhaul cycle.

The first thing we have to do in overhauls is determine whether or not repairs are necessary to a piece of equipment. In the Navy I never was satisfied with the policy of ripping everything out every three years and overhauling it and putting it back in again. If I go into a hospital as a healthy person and let them do all the operations. on me, particularly opening up my guts to see if everything is ok, I can't be anything but worse when I come out. So I am not in favor of overhauling all pieces of equipment. But I do think that the first problem for maintenance -- and this is a joint problem between

the shipyard and the ship -- is to help the ship determine if repairs are actually necessary. This takes a little more than what a tradesman can do.

Let's take an example of the feed pump. If you have studied thermodynamics you know that when the feed pump works on the water, raising the pressure from 30 pounds from the DC heater to 900 pounds for the boiler, there is going to be a temperature rise in the water. A calculated thermodynamic temperature rise would be about 2 or 3 degrees. If the pump actually raises the water about 6 degrees, the resulting excess temperature rise results from inefficiencies in the pump due to the fact that the impeller is not properly propelling the water and the wear rings are leaking. Now as the pump ages, that temperature change across the pump is never going to go down. The pump never gets healthier. The result of all the degradation of the parts inside the pump is to allow that temperature rise to increase. So if you want to determine if a feed pump needs an overhaul, the first thing to look at is the engineering records back when the pump was last overhauled and when it was new. Find out what delta-T was at at that time, compare it with what the records show today. If you have an excessive temperature rise, the pump needs an overhaul.

There are other parts, like bearings, which when they wear out don't affect the performance of the pump except that the pump either works or doesn't work. These deficiencies can also be picked up by vibration testing. Unfortunately, many of our ships do not have vibration test equipment and personnel on many of those that do, do not know how to take the readings right. But we have the same problem with electrical equipment. Megger readings are an excellent tool for testing whether or not a motor or generator needs to be overhauled.

«««««««««««««««««««««««««««««««

3. Equipment Overhauls ••••••

Once you've determined that repairs are necessary, you make the decision to do it in place or to pull it out of the ship. If you are responsible for equipment reliability, your safest bet is to take those parts out of the ship. The environment aboard ship when the ship is in drydock being sand blasted is less than healthy for the parts. The parts will experience considerable damage from the dirt that is going to accumulate in them while you have the equipment ripped open. So I recommend that you take the parts to the shop for the overhaul.

When it gets into the shop, the standard job order reads: "Remove from ship, open and inspect, report results to the planner." But that is not a very good job order. It doesn't really tell the mechanic what he should measure, it doesn't tell him what the limits are on what he should measure, and it doesn't tell him anything at all as to what to do with the pump casing, which usually has nothing done with it at all. There must be a well written job order that tells him exactly what inspections to make on each part. Then those results should go to planning with the mechanics estimate of whether parts should be replaced or repaired.

The head of your planning department should be conscientious enough that when excessive repairs are required on a pump, he goes down and sights it personally. If anybody wanted to do something more to a pump than replace wear rings, I wanted to see the pump myself because there is always the danger that that complete pump was worn out or the planner was padding the job or the shop was looking for work.

The other reason to have the parts inspected very carefully by somebody more than a mechanic is to look for operational difficulties. If the people were operating the equipment with dirty oil, you're going to find scored bearings -- and this should be reported back to the operators. If the lubrication on the cylinder walls is not correct, you are going to find scuff marks -- and that also should be reported back to the operators. The more examples you can find of mal-operation of the equipment, defining it and putting it down in your job orders and in your reports to the customer, the better. It is better because if a subsequent failure occurs, then you can make a decision as to whether or not the operators were qualified to operate their own equipment or if it was in fact due to some defective parts that you replaced.

When the overhaul is completed and the parts are put back aboard ship, there should be another complete check made. You should take your vibration readings. You should take the temperature rise across the feed pump. Even for an air compressor, the length of time it takes to charge its air banks from 60 to 90 PSI is a good indication of the health of the equipment. After it is overhauled it certainly should take far less time for the air compressor to recharge those air banks than it did when the equipment was taken off the ship.

«««««««««««««««««««»»»»»»»»»»»»»»»»»»

4. Liability and Damage Avoidance

Now the customer -- he is our problem. He wants us to fix it cheap, but he wants us to assume all the liability for the part for an indefinite period in the future. He can't have it both ways. The results are incompatible. What your standard job order should define for the important equipment you overhaul is a Class A overhaul. A Class A overhaul should include all the work that you think will be necessary to restore the equipment to its proper working condition. This will replace all the short life items. It will insure that all the moving parts that could possibly wear, and the non-moving parts like the liners that wear, are corrected, and it will insure that the casing and the other infinite lifetime parts which are important to the integrity of the part, have a lifetime guarantee for the next overhaul cycle. If you do that, and if he buys that, then yes you have assumed liability if that part fails.

On the other hand, if he has a leaky valve in an air compressor and all he wants you to do is pull the head and fix the valve, then you should not accept any liability for it, not even for the valve, because the parts interact so much in operation that no one part controls the health of the machine. So define with your customer what your Class A overhauls are, and what your Class B overhauls are, and explain to him your willingness to accept or reject liability based on how much money he is willing to spend to ensure the integrity of his equipment.

Ninety-five percent of the shipyard management can walk through a ship during a major overhaul and not see the obvious mismanagement or poor work that is going on around them. I am talking about people that will walk by a system where you pull the hydraulic component and the hydraulic lines are open. It is very simple to cap a hydraulic line. They make plastic and tin caps that can cap them, and they can be taped on. But an open hydraulic line can't do anything but gather dirt. The dirt that gets in that line won't show up during your shipyard operating period. The oil doesn't flush through a hydraulic component. It goes in and comes out, repeatedly, and it takes quite a while for the dirt to drift into the hydraulic component and ruin the seals.

The same thing is true of main steam lines. I have seen main steam lines where they have been opened up, and the welders have come along to do a two bit welding job. They put their rods in the open pipe-end because they are very conscientious -- they don't want to lay their rods on the deck and get them dirty. They finish the job having one or two rods left. They walk off leaving those rods in the steam line. When the system is restored, those rods will end up either in a valve or they will head for the turbine. If they head for the turbine, you're lucky if the strainer stops them. If it doesn't, you are going to knock the turbine out of operation. This is the kind of thing that should not happen.

Again, as I said, when you go into a hospital you should come out healthier. A ship that comes to us for work should not be damaged while it is in the shipyard. If you let dirt get into the compressed air lines, the dirt goes flying through the lines with almost the speed of sound as you draw compressed air out of the system, sand blast the Teflon seats right off the discs, and the air valves will leak. Again, it is your fault if you're in the shipyard and not the fault of the ship owner.

We had one such incident happen to us on a system that you would not think would need capping. It was an exhaust system on a diesel submarine, a very small exhaust system. If anything is going to be dirty it is going to be a diesel exhaust system. The exhaust system had been opened up. A shipyard worker read his newspaper, and when he finished it, he rolled it up and shoved it in the exhaust pipe. He did not want to throw it on the deck -- that's a fire hazard. We put the ship back together again. We ran that system and almost ruined the engine trying to do a heat run on it. The high back pressure is not good for a diesel engine, to say the least.

It took us a long time to recognize our problem. When we did, we opened up the exhaust system and found the paper. You could read the headlines on it -- in fact you could even read the date on the newspaper. The hot exhaust gases would not burn it out, and that paper would have stayed in there indefinitely and really could have ruined that engine. Again, it was our fault in the shipyard for having an open pipe-end that a person could put something into. This would be the same thing as going into a hospital and having a doctor operate on you while he is smoking a cigar and dropping the ashes into your guts. You know you really would not want that to happen.

When you finish your overhaul, you not only do that vibration testing but you give the equipment a heat run. A heat run means that

the equipment is run for an appreciable period of time -- 4 to 6 hours as a minimum, and under a load. I have seen heat runs like this: the condensate pump gets overhauled, the chief goes down there and he lights the condensate pump off. He doesn't have any load on it. He runs it for 20 minutes, he says, "ok," signs the job order, and he is happy with it.

For the ship owner's protection and for the shipyard's itself, the heat run should be under full load conditions and should be at least a 4 to 6 hour run. Upon completion of a heat run with no defects noticeable, normal temperatures and pressures indicated on the gauges, the job order should be signed by both parties that witnessed it, one for the ship's owner and one for the shipyard. The same is true of motors, generators and other parts.

I can tell you one story about cleanliness that was disastrous because it was the other way -- it was too-clean. We had a man that overhauled a controller panel that actually had an explosion cover on it.. The cover was covered and bolted -- not like the normal panel that opens up. To keep the dirt out of the equipment after he cleaned it, he even put a piece of masking tape over the little drain hole at the bottom. But what he did not do was to let the equipment ventilate -- it had been cleaned with a solvent with explosive fumes. The panel was lit off three months later. When it lit off and exploded, the cover came, across the room and seriously injured the mechanic, an innocent man standing on the other side of the room. It is hard to find an accident that happens to you when you are too clean, but that was one that happened where excessive cleanliness actually hurt us. I almost left that story out except to show you that in the shipyard business it is very difficult to predict what is going to happen to you.

The other source of damage aboard ship is sheet metal and welding. The sheet metal people, if you have been around a ship, have a lot of trouble fitting their ventilation. They have to grind those sheet metal ducts to make them fit. The welders sometimes have to grind their welds between passes. The thing I've found is that when this is done in the vicinity of electronic equipment, it can't give you anything but trouble. We have had beautiful electronics equipment completely ruined before a ship was even built or converted because of the sheet metal grinding dust in the area of the components. This type of work should not even be allowed to be done aboard ship. You should insist the mechanics take it off the ship, or you should set aside an area of the ship where there are non-critical electronic parts, where this metallic dust cannot find its way into the equipment.

It is difficult to tell you how important it is to enforce cleanliness on your ship. The only way you are going to get this is to have a strong supervisor who inspects that ship daily and has the teeth to enforce it, because the trades will dirty it behind your back every time. The sheet metal man, if you're not around, will try to grind that duct in place regardless of where he is. And the mechanics will remove the equipment and leave the pipe-ends uncapped, plaguing you for the rest of your time.

«««««««««««««««««»»»»»»»»»»»»»»»»

5. Planning and Scheduling ••••••••••

One of the things I would like to emphasize is a centralized planning and scheduling department for repair work. The reason is that the job order should be written in far more detail than it is being written today. This can only be done if you have a centralized planning department whose primary task is to write these job orders so that they are complete and guarantee to upper management that the shipyard overhauls are going to be successfully completed.

The planning department should be divided into about four branches: (i) a structural branch covering the hull repairs and sheet metal repairs and welding; (ii) a machinery section covering machinery and piping; (iii) an electrical section for motors, generators, switch boards, and (iv) a section for your service trades, riggers, painting, and sand blasting.

The individual planners should be very capable ex-mechanics who are brought up into the planning department and will have a responsibility for the equipment. They should feel a responsibility for the equipment from the time the ship's owner makes the initial request for an overhaul to the time they see that final test agenda passing their desk saying "this equipment is good." The planners have to work quite closely with the ship's superintendent and the trades to ensure schedule adherence and to ensure that the complete scope of work that is on the job order is done. Weekly conferences are not too often in the repair business for getting this type of coordination. They also have to work very closely with the purchasing agents to locate responsible vendors

and to ensure that the repair parts are brought into the shipyard on time.

In working with these people you will find that you have three responsibilities. You will find the production man who says, "You can't hold me responsible for completing this job in three weeks and hold me for the quality and also hold me for the cost because I might have to put more people on it or I might have to work overtime." You should not let this happen. Nobody should work in this business unless he is willing to accept responsibility for all three parts. He should feel a responsibility to bring these jobs in on the scheduled completion date, within the cost estimate, and at a satisfactory quality level. He cannot shirk any one of the three responsibilities. A ship that comes into your shipyard for a limited availability for repairs and is delayed, cannot meet its operational commitments. For the owner this may cost over $3000 a day. It is a serious business to the owner, and it is a serious business to us.

«««««««««««««««««««««««««««««««

6. Repair and Overhaul Capabilities

There are components that are going to appear on ships for which you don't have a repair capability. If you have a small yard you might not see a controllable pitch propeller very often. If you have a collision avoidance radar on a ship, it's completely outside of your capability to repair. The pollution control systems vary so widely in design and are made by so many different vendors that it is hard to be knowledgeable on how to overhaul every one of them. For these you should use the service engineers from the original vendor. There are two ways to tackle this job.

If you feel that you have a capability for overhauling the pollution control equipment or the controllable pitch propeller but you need help, then the vendor assists you. In that case the liability rests primarily with the shipyard. But if you are going to bring in a controllable pitch propeller field engineer, and he is going to do the complete job for you, then you are only going to assist him with any incidental things that he needs to have done. In that case your role is really just arranging the contact between the service vendor and the ship's force, and the problem of liability should be a matter for discussion between them without you in the picture at all.

The question comes to be, as these new equipments appear, should you try to gain a shipyard capability or should you be willing to rely on the service engineers? For these very complex electronic systems, such as in the collision avoidance radar and the new combustion control systems, it may be best not to even try to gain a shipyard capability. A man has to be specially trained for a long time in these equipments. He has to work on them at regular intervals or he will lose his training. I know, because the Navy trained me to be a good electronics mechanic on different types of radar and sonars we had. Then I went ashore for three years, and when I came back I could not overhaul it. I had forgotten much of what I had learned.

On the other hand with the pollution control equipment, you may still want to avoid it. I found that these equipments, at least the ones that we have, are so marginal in performance that you don't want to be stuck with the liability for them. It may be wise, until the manufacturers can manufacture equipment that does its job well with a high degree of reliability, that you allow the liability to rest between the manufacturer of the equipment and the ship's owner.

There are also in the repair business usually a lot of specialty shops in your area. There will be if you encourage them. A specialty shop is one that would lay tile for you, make sheet metal lockers, things that you could do yourself, but you really don't want to be bothered with that type of work. There are three advantages I can think of for using them. One is that by using these vendors it is an immediate expansion of your work force to take care of the workload of doing tile work or sheet metal work. Second, since these people do it regularly, the quality of their work should be much higher; whereas we might have a man who works on that part time and at other times does many different types of joiner work. And third, since he works on them so frequently, the specialty shop can probably give you a lower cost than you could get by doing it yourself. However, you can't use these vendors if in fact they are not responsive to your shipyard schedules or if the quality of their work is poor.

The final decision is you have selection of a replacement for a piece of equipment that wears out. The selection is not going to be simple. Because of the age of our ships, the original vendor either probably does not make that equipment any more or he may even be out of business. Let's say you are replacing a forced draft fan that is completely unserviceable. You

could make a terrible mistake here, because engineering departments are not strong in the repair yards. If you pick out a forced draft fan that is undersized, install it and the ship's owner takes the ship out and they put 22 nozzles on the line and they start to black out, they are going to be mighty unhappy with you.

The same thing is true if you put a feed pump in that is undersized. Again, if they go on 22 nozzles, and the feed pump can't deliver water to the boilers and the boilers start running dry, they are going to be mighty unhappy with you. They cannot afford to have the speed of their ships brought down because you put in undersized equipment. In this case, rely on the best engineering judgment you can get, even if you have to hire a consultant, to pick the proper size pump. If anything, err on the side of safety and give the ship's owner a little more capacity than before. Not only will they appreciate the capacity, but they won't have the complaints against you they could have.

«««««««««««««««««««««««««««««

7. Material Control ••••••••••

I want to recommend one other factor which I think is missing in a lot of shipyards -- material control. Material control means that you are putting the proper material into the part. Let me tell you what happened at one particular private shipyard. It was a commercial ship which had a damaged section of steam piping. They wanted the shipyard to replace it. The shipyard looked at the piping -- a 900 pound system -- and they ordered the proper replacement piping for it. They put the system together, welded it in, insulated it and took the ship out. for trials. It had already passed the hydro test. This was fairly easy because the hydro is a cold proof test. As that steam plant came up to temperature, fortunately one of the mechanics noticed that the insulation was splitting. So they paused for a moment, stripped the insulation off the new section of pipe, and lo and behold, the pipe diameter now was almost one inch larger than it was before. At the elevated temperatures that the plant was running under, the pipe had lost its strength and was starting to balloon. If it had continued to go for a few more moments, it probably would have burst and killed everybody in the engine room.

How did this happen? It happened because of a conscientious mechanic. That mechanic had worked on an 8-inch steam line some years before, had some extra pipe form it and rather than throw the pipe away he had put it under his desk. When this job came along, also an 8-inch pipe line, he remembered that old piece of piping he had. He decided to save the shipyard some money and put it in. Unfortunately that pipe was from a 450 pound steam system, and did not have the alloys in it to withstand the higher temperatures and pressures. As a result they almost had a catastrophic failure which would have caused a serious loss.

So again, on those systems where temperature and pressure are very critical, it is important that you have the material control, that special materials to be bought for this purpose, be identified, and the identity be controlled all the way through manufacturing until it gets into the ship. It even gets to the point where sometimes in the Navy on these critical systems we have even taken samples of the weld metals on these high temperature, high pressure systems and subjected them to spectroscopic examination to ensure that the welds were sound. We have had a number of failures in this system in the Navy itself.

«««««««««««««««««««««««««««««

8. Maintenance Supervisors ••••••

A few of the previous speakers have talked about maintenance engineers, and that is what I am talking about -- a good man on the waterfront and a good man in planning, with a wide range of experience over the different components that come into the ship all the way from electrical and structural to the machinery.

I think the best source for these engineers is the merchant marine. These people are used to operating this equipment and they are used to operating a complete power plant, all the way from refrigeration to steam to electrical generation. You don't find these persons in the shipyards. If you pick your supervisors from engineering, the man has one engineering discipline and he is almost blind to the others. If you pick the supervisors from the trades, it is the same way. He has one specialty and he doesn't have skill or knowledge in the others.

Where we used these people for ship superintendents in the repair business, we found that if we picked a man from electronics who looked good, when he came in to supervise a repair job, he spent all his time up on the bridge and in the radio shack. He never went into the engine rooms. If we picked a good man from the machinery trades, he spent all his time in the engine room and fire room and never went up on the bridge.

You need a person who is not a specialist. The word that I think describes such a person is "nexialist" derived from the word "nexus", meaning alike or connection between different groups. A nexialist is the opposite of a specialist. He is a highly trained man who is competent in several fields. These maintenance engineers can be very good. If I was looking for a real good one, I would look to the staff of one of the maritime academies. These young faculty men not only have their chief engineer's license, but they are also graduates from one of the maritime academies, they have served on ships for many years, and they are also making progress towards a master's degree in some field of engineering that they know. Having taught maintenance for 3 to 5 years as these men have, they would be terrific assets to a shipyard. So if my shipyard lacked a good manager, then I think it would be smart to look around the maritime academy faculties, or the ships that come in and out of the shipyard. Look at the chief engineers in particular as well as these instructors to see if you could find a good person to fit the bill. If I could find one, I would certainly hire him at whatever price it took to get him away from where he was to get him into the shipyard. Some people have talked about the lawyer's role in shipyards. A lawyer has to learn about 41 different things to be a graduate lawyer. All we are talking about is a good knowledge of contracts and torts. It should be far easier to take a good engineer and teach him contracts and torts than it should be to take a good lawyer and teach him all of engineering, which is what he needs.

«««««««««««««««««»»»»»»»»»»»»»»»»

9. Conversion Management Objectives •••••••

The biggest disservice a shipyard can do to a customer is to tell him that a conversion will take, say, nine months, and then take a considerably longer period of time to do it. The worst example, I ever saw of a person giving a yard a ship and then not getting it back was an ammunition ship that arrived at Mare Island Naval Shipyard for a routine three months overhaul. It was incorrectly docked and the main engine foundation became misaligned. No work had been done on the main engines, but when she went out at the end of the overhaul, she could not get through the gate. The bearings failed on the engine, and she came back in. The bearings were repaired, and the ship was sent back out again. It took a long time for the shipyard to recognize the problem -- that they had seriously damaged that engine. Ultimately they had to lift the engine off its foundations and realign it. It took three years from the time she came in until she left. When a customer gives you a ship for three months and you keep it for three years, he can get very, very angry with you.

In ship repairs there's no problem estimating progress and completion dates. New constructions is pretty much the same way -- you call almost walk through a new building and estimate the progress and whether you are going to complete the ship on time. But a conversion is different. With a conversion, you start with a ship that is one hundred percent. Then, as you rip out, modify and replace, you actually push the ship back into time, and then it has to come forward again. It is very difficult to walk aboard a conversion and say this is ten or 15 percent or 20 percent complete. You can get completely lost, as occurred at Mare Island on one conversion. The yard never knew what it was going to cost to complete it. The shipyard went to Washington and asked them for a million dollars and four more months, and they got it. Three months later, the yard went back and asked for another million dollars and four more months. They had no way of telling where that ship's conversion progress was. The shipyard had completely lost control of the ship's conversion job.

I propose that to look at how to manage a conversion contract and to successfully bring it in on both cost and time, there are only two simple questions we need to answer; and if we can answer those questions, we will have everything down pat. The first question is: When am I going to finish it? The second is: How much is it going to cost? If you can get those two answers nailed down, then you won't have any problems satisfying the customer.

«««««««««««««««««»»»»»»»»»»»»»»»»

10. Conversion as a Material Cycle ••••••••••••

You should consider the whole management cycle as not being just manpower, labor and overhead budgets. If we look at the ship conversion cycle as a material cycle, then we see that the design office defines the materials by four different methods. First, there are the working plans that tell you such things as how to land a component on its foundation, how to shape the pipe, how to hook up the cable and where the cable runs from one point to another in the ship. Second, design defines the materi-

als by a technical requirement, say, for a motor or a generator. Third, the design office defines the material by advance bills of materials when they can't get the plans to you on time. Lastly, they define steel by mill sheets. Right now I'll bet everybody who has a college degree and calls himself an engineer is 'turned off' because when I describe this materials system to engineers, they would rather think of designing material than defining it. I am not trying to change their idea of design function, but in terms of a materials cycle, we say it is defining -- not designing -- material.

Purchasing buys the material, or orders it from standard stock in the shipyard. Production shapes the material. They fabricate the hull sections, foundations, install the technical items, hook up the cable, bend the pipe, install the valves, and so forth. Test department 'sells' the material by non-destructive tests, by installation inspections to ensure conformance with the plans, and by operational tests of the equipment.

Each of these steps takes manpower, money and time. Design to define the material may take 25 man-days to produce the plan -- a month and a half, to turn the plan out. Purchasing is going to spend a lot of money buying the material, and it is going to take time to get it from the vendor to the shipyard. Production spends a lot of money as they put the manpower on it and the expenditure of this manpower again requires time. Money, manpower and time are correlative in the material cycle. This doesn't mean that they are secondary to the material, but they are co-joined in the material cycle. If in every step in the planning progress you focus on the material and let the money, manpower and time requirements fall out of the material cycle, then you stand half a chance of bringing your ship conversion in on time.

«««««««««««««««««»»»»»»»»»»»»»»»»

11. Cost Control Systems ••••••••••

The heart of the coordination is the cost control center -- the cost control accounting methods. Yesterday one gentlemen said that, from his stand point, he wanted about 15 jars in which to put the beans to account for where the money was going relative to his budgeted prices. On the other hand, another gentleman said that he wanted the computer to give him cost analysis. He wanted to know how much it cost to install a lube oil system, so that he could use it as a basis for future estimates. These two requirements -- cost accounting and cost analysis -- are not compatible in most of the cost accounting systems used by shipyards today. Cost control systems are keyed to one or the other. They are usually keyed to cost accounting because the cost accountants were the ones who brought the computers into the shipyards. By the time they run all their programs through for warehousing and cost accounting, the number of hours left for production management to use the computer are very small.

We also accept the fact that we run two accounting systems on the shipyard. One for our customer (Navy or MarAd oriented), and one which we use to lodge charges against the individual cost centers. If we must use the Navy or MarAd cost accounting system, we are severely handicapped from the outset. The cost accounting system that Navy foisted on us is the three digit number which I believe was based on the organization of Bureau of Ships. The Bureau of Ships doesn't build any ships; so the cost accounting system they gave us is absolutely worthless.

I propose that you modify that cost accounting system to one similar to that utilized at Mare Island, employing a 15-digit number such as:

<u>022</u> - <u>1041</u> - <u>2547</u> - <u>38</u> - <u>01</u>

022 - cost accounting center
(e.g., purchasing)

10 customer type (e.g., commercial)

41 - customer number

25 system designation (e.g., salt water)

47 - component identifier (e.g, pump)

38 - key shop

01 - sequence number
(one for each job)

This system will obviously be useful to the accountants since it will give all charges for each cost center. The advantage for the planners and estimators is that if the computer is programmed to run off by system, it can show how much it costs to put in a lube oil system or how much it costs to put in a main steam system. If they are interested only in their piping charges, they could run off the charges on every system that ends with 56, and they will then have a complete run down on all piping charges for a ship. With proper computer programming, this cost system can serve two functions -- both

cost accounting for the shipyard and cost analysis for shipyard operations.

For this type of system, you want to use a small planning department. Define jobs that can be done in a relatively short period of time and have a logical package of materials, that are easily gathered together and delivered to the trades.

We first require a plan list from design, much as they have always done. (If design cannot give you a complete list of the plans that they are going to draw for conversion or new construction, we have a rightful accusation that design doesn't understand the problem.) I am not saying that we do away with the master material erection schedule (MMES); the MMES would be there and all of the technical material requirements for the ship would be completely described in it. We don't do away with the material ordering guide (MOG). It is still necessary that the supply of commodity material be properly identified and put into the yard. We still need some basic guidelines for designing the ship, or for controlling our building period; so we would still have a key event schedule, a CPM schedule, or a PERT schedule for the guidance of the planners so that they know what dates to write on the job orders. We would still insist upon a test schedule for the completion of the tests to prove the system.

«««««««««««««««««»»»»»»»»»»»»»»»»

12. Allocation of Funds ••••••••

But I would like to stress one thing. If the planners cannot write a complete list of all the jobs that they are going to describe on the ship, then they are not ready to allocate the funds or to manage the funds on the ship. This is something you haven't been asking for from your planning organization. It is something that your planning organization isn't going to willingly volunteer to give you. But you are going to have to insist on this if you want to manage your conversions properly.

The computer is going to handle the money in three phases: (i) for the key operations as yet unwritten and, for those that are written but not working at this time obligating funds directly against the ship; (ii) for the work that is in progress, the computer should tell you how much money you have remaining in the open key operations that the ship should be working on; and (iii) then as the key operations reach their completion dates, the money should be moved into the completed file. When the computer runs out your cost returns, you know how much money you haven't spent or obligated, and how much you have left to play with. If you have already spent $30 million on a conversion and you are running $5 million in the hole to that point, but you only have a few million left to work with to finish the job, then you are not going to recover that $5 million. But if you are $100,000 in the hole early in the conversion compared to budget, and you still have $20 million to play with, then you have some way of controlling the cost and probably saving your money.

The key operation should not be opened unless the material and plans are available. If the planners can't open the key operations because either the plans or materials are not ready or available, and if production is starved for work, the yard is going to work at a very low efficiency. If a number of key operations are open by the availability of plans and material, but not yet worked, you know production has a healthy workload. Finally, your completed work tells you what your efficiency is to date and how your efficiency is performing. If you spent $100,000 and you were allocated $120,000, you are in very good shape; if you spent $100,000 and were allocated $80,000, then you are in poor shape.

But lets focus on this "efficiency." In these types of systems, where we do measure efficiency of the cost centers, the roof usually falls in on the production workers. That should not be the case. The efficiency on a job may be very high, not because the production worker is particularly effective, but because the planner over-estimated the job. On the other hand, the efficiency on a job can be very low, not because production is particularly ineffective, but because the planner under-scoped the job. The efficiency on the job also can be low if production is starved for materials and design information. If design gets the plans out and draws big circles on them and uses that magic word "reservation", you know they have met their requirements -- they got their plan out -- but it isn't worth a darn to you in production. Then your efficiency is low.

As any intelligent manager would do, you are going to hold some money back from the planners so they don't allocate it all. You don't expect the production department and the shipyard to function at 100 percent efficiency. But your efficiency curve can go only one way, and that is down. It is going to slope down due to change orders cranked into the ship, increasing the scope of the work. Generally you

are not going to re-issue the job order to give them more money -- not only is it not worth the time, but as managers, when you get a few extra bucks, you like to put it in a contingency account and let the trades suffer for the increase in work, putting a little more pressure on them.

The efficiency also is going to fall down because material comes in late -- it is harder to land a component that comes in three months late than it is to land a component on the day it was scheduled to be put into the ship. Installed materials are going to get damaged. For example you put in a cable run. You hook it up -- everything is fine until a welder comes along to put in a pipe fixture and he draws an arc on that cable, wrecks it, and you have to put another cable in the ship. So your efficiency goes down. When the inspection department rejects work, the correction of the deficiencies have to be lodged against the key operation for installation. So again your efficiency comes down.

You should realize that the efficiency curve for your trades is affected by the efficiency of your purchasing department and the efficiency of your design department, as well as by planning. If you divide the amount of work left by the efficiency of a specific department to this point, that will predict cost for completion.

«««««««««««««««««««»»»»»»»»»»»»»»»»»

13. Cost Controls as Management Tools •••••••

We have all seen top management floundering in trying to identify the shipyard's problems so that they can put the full weight and authority of their office to work on them. A shipyard commander once was so interested in doing this that he would walk down the waterfront and talk to us. On one such day he asked me what I was doing, which was replacing a vapor compressor critical to a submarine's sea trials. He knew it was something that could hold up the sea trials, and he felt it was very important. So he went to the production officer to discuss my 'problems'; and the production officer then came down on me like a ton of bricks. Here was the Admiral vitally interested in one of my problems and the production officer did not even know about it. But it wasn't a problem area. It just happened to be what I was doing at that time. I had a lot of problems with which the Admiral could have helped -- for one, the stability of the ship hadn't been determined for sea trials. I needed the data from the inclining experiment for preparing the ship for going to sea. I didn't have it. I would have appreciated his walking up to design and beating on them for that information. But he did not really know what the shipyard problems were.

Now here is how our system keys in the shipyard president. We take this first number (e.g., 022) -- it starts with a zero. If this is a real key job on the ship, if it is on the critical path or if the slack time is very small, we put a one (1) there -- that identifies that the president of the shipyard is interested in it. Now once a week or more often the computer runs off the controlling key ops for the president of the company and puts them on his desk. At 8 o'-clock in the morning he gets the vice presidents in to review that list of all the 'hot' jobs on the ship, especially those that are delinquent. The completed jobs are absent from it, as is the future work. It is only the delinquent jobs and the work in progress. He can discuss with the vice presidents of his major divisions how the work is coming and apply full pressure -- the prestige of his office -- towards getting these jobs on track.

At 8:30 the vice presidents walk out of his office and go back to their own offices. Their listings show not only, the 1XX jobs, but also the OXX jobs. They meet with their branch heads and group superintendents, going over all the work on the ship that might need extra effort or re-allocation of manpower. Then at 9:30 when the branch head and superintendents leave their vice president's offices, they can go to the individual people responsible for those problems. The beautiful thing about a system like this is that everybody in the company can be 'chewed out' before lunch -- and nothing works better than a company where everybody is chewed out before lunch.

We introduced this whole concept at Mare Island at the time we had that submarine for which we had to keep going back and asking for money. We started this series of conversions on a $34 million budget. The first several of the series established the cost at about $33 million. We wanted desperately to finish at least one contract on time and under the target of $34 million. We stayed around $33 million, fluctuating slightly as we went through. For one time in our life, when our ship sailed on time, we had two happy people --- the man who paid the money in Washington and the skipper of the ship who saw his ship leave on time.

«««««««««««««««««««»»»»»»»»»»»»»»»»»

14. Questions and Answers ••••••

Dr. Fisher: You may recall yesterday we heard some not-too-nice comments about the use of computers in the shipyard. We just heard Bob Hart referring to the ability to use the computer to tell the shipyard's president by 8:30 in the morning whom he should chew out before lunch. We also know about 'garbage in equals garbage out'. What, I don't understand is how people who have built ships -- sometimes at a profit, but at least always built ships -- upon deciding that they were going to benefit from the computers, have used people without experience in ship construction to develop PERT or critical path analyses. I fail to understand why shipyard management, who previously relied so much on the judgment and the long-term experience of their personnel, then turned to inexperienced people to develop PERT charts for vessel construction and conversion. How can someone fresh out of graduate school or undergraduate school who knows nothing about shipyard operations or has been in a shipyard for only a year or two develop a PERT chart? Yet managements went ahead and did that. No wonder they got 'turned off' by the computers. It was not a matter of garbage in equals garbage out; it was a matter of the people behind the computer programs. Since I am one of the people who developed computer programs, to hear management people say that computer programs are not worth a dime makes me unhappy. What wasn't worth a dime was the decision as to who was going to develop them.

Seminar Attendee: Mr. Hart was talking about the repair of a ship; and most of his comments appear to apply to new construction as well**.** If there is one word that has caused me problems for the last thirty years, it is 'information', and the lack thereof. How can production produce until they have information that is necessary in the appropriate time frame? How can production, purchasing, planning, scheduling, materials control and all the other divisions get their act together when management doesn't get their act together up front? -- to get engineering information disseminated in time so that the other divisions can use it, and so that production doesn't get boxed in with a delivery date and no time to accomplish it?

Mr. Hart: At Ingalls, as manager of master planning and progressing, from the time we got a ship contract and developed the plan list and the MMES, I held a weekly conference on each contract. We went over the technical requisitions, the plan list and the development of the plans to get ready for production. Production generally started work about one year after a contract was given. As we neared the end of this period and we were getting ready for production, the program manager for the ship came in and sat in on the conferences. From the time that he started outside fabrication, he started chairing the conference (replacing me), and I started dropping back. After that, I would just send a representative. But if I did my job well in that year, with the cooperation of planning and design, then the plan schedule was in good shape and the material was there in the shipyard. It is only by having somebody similarly responsible for the contracts, from the moment they arrive in the shipyard, that the scheduling runs so smoothly. But actually since my office did much of the work for the bid committee in preparing tentative building-way schedules, key event schedules and projections of manpower, we knew that contract pretty well by the day it arrived in the shipyard.

Seminar Attendee: In our yard the term "work around it" is very popular. Work around it if you don't have the information, the material, the proper facility, or the manpower. Work around it. What. happens is that inefficiency sets in -- over-budget sets in. How do we get that information to avoid "working around it?" We have trouble getting information out of vendors, and I'm sure every design sub-contractor has the same problem -- especially during that 'up-front' time period when that information would be tremendously helpful.

Mr. Hart: It does not take as much effort as might be thought. I had only six people working for me. We prepared all the building way schedules, the key events schedules, and coordinated all the plan lists with the purchasing. All of us in my department were production oriented, and we were always watching for the material and the plans to be available when production wanted them. We did very well in those contracts, by working on the contract every day, from the time we got in the shipyard until production was ready to take over. After production took over, I had one man assigned to the contract who went to the conferences. I could not attend that many conferences as we had so many shipbuilding programs in the yard.

Seminar Attendee: You were speaking of job orders, sequences, trades, materials and similar specific information getting into the computer. How does it get there?

Mr. Hart: It gets in from the planners who write the jobs and scope them. We had a centralized job order department in Ingalls, which I think was a wrong way to do it. Ingalls moved all the detail planning from the shops into the centralized planning department. I think it works much better when the centralized department writes job orders and turns the detailed work planning over to the shops, giving them a start date and a completion date, but letting the shops organize the assist trades. If the shops have to plan the job, they are much more likely to try to finish it on time than if you just give them arbitrary figures from a centralized planning department and treat them like idiots. Shop planners are much more effective than centralized planning.

The actual feedback on work completed comes from the leading man's charge sheets at the end of the day -- how many man-hours his people worked and what jobs they were charged to. The charges are the same that go into the computer for pay purposes.

Seminar Attendee: Has anybody made a study of whether or not the end results justify the cost of maintaining a system of this nature? What we are primarily concerned with is the first-line supervisor's time and the control of costs for the book-keeping as well as for the people who work for him. Does the end justify the means?

Mr. Hart: It is going to take a leading man anywhere from 30 minutes to 60 minutes a day to do his paper work; he is going to take more than that amount of time goofing off and away from his trades. I have not been too happy with the performance of the leading men. There were many times when I had a problem aboard ship and I called for my leading men to come and clear it up, and not a single one answered the call. Many time I have gone to the offices at the head of the pier and kicked the leading men out. Part of the problem is not that the leading man doesn't have enough time to do the job; it is trying to get the leading man to use the time he has to do the job right. The paper work associated with the job should be kept to about one half hour to one hour of his time a day. If your system demands more than that from the leading man, then it is too complex. This system didn't. The charge numbers were very easy for him to determine.

Seminar Attendee: That one-half hour or so could be set aside daily, but invariably the leading man is going to be barraged by one particular problem or another. He's under pressure. He's in a position, depending on how many people are reporting to him, of having to record something like 15 digits correctly and on time. Our experience is that if you get any sort of number of digits like that, you get a high error rate in recording. I'm wondering what your experience was in this particular budget where you utilized this control system throughout. When you went back over the results of all the records, did they make sense to you?

Mr. Hart: Not always. But the charges were fairly accurate. Only a few of the digits change daily or weekly for each leading man, so it's not as if he has to remember many different sets of 15 digits each. As long as it is charged to the proper customer, the totals then will add up. What you are looking for is not the cost estimate on the individual job, but the total performance. When your performance goes down, then you have to ask for a more detailed run from the computer and look at the individual jobs that are giving you trouble and put pressure on them. You will find that if the jobs are well planned, the probability of overrunning is less. And if you put pressure on those jobs that are overrunning, you can generally clean up the cost.

Seminar Attendee: The problem is that if you use the computer, people generally start to believe exactly what it is telling them in detail, not just overall. As a practical matter, the probable use of this data as feedback to estimate future jobs is where inaccurate reporting will be felt and mis-used.

Mr. Hart: Well that occurs at the end of the whole program when we have completed the job and the planner wants to know how much it cost to finally put that lube oil system together. He is not interested in that day by day. He is interested in knowing how much it costs to finally put that lube oil system in. As far as the day to day operations were concerned, they only ran on the delinquent jobs and the work in progress. Periodically, about once a month, we had the computer print us out the status on all jobs for the use of the planning and estimating superintendent. Whoever is in charge of the planning is the man who analyzes that computer run and then feeds back the information to top management about what jobs are in trouble.

Seminar Attendee: You used the initials MMES a couple of times. What does that mean?

Mr. Hart: That is the "master material erection schedule" -- a schedule of all the technical material. If you are building a ship, everything for which you have to write a technical requisition should be scheduled. You should know what date you plan to land a component on the ship, and that is the date you want it in the shipyard. You should know your lead time, so that's the date that the technical requisition has to be delivered to purchasing. It coordinates all the technical material on the ship. You might use a different name for that. The MOG, the "material ordering guide" is used for commodity materials which generally have much shorter lead times and is less complex -- small valves, pipe, cable, things like that. We used those systems in the Navy yards, and I was surprised to find them in use at Ingalls. I assume that maybe more private yards use them. But those were our two material schedules.

Seminar Attendee: Did you notice any consistency in the degradation of the efficiency curve?

Mr. Hart: Very consistent. Every trade had that kind of degradation.

Question: Could you detect any pattern or changes in the way the slope degraded or performed? Could that in itself give any indication of the onset of problems?

Mr. Hart: Essentially our efficiency was very low on those contracts that were not properly planned. The materials were late; plan developments were late. But on those where proper planning was done, the downward slope of the curve was much less. The slope of the curve is highly dependent on your planning effort and the cooperation between purchasing and design, which is long before production gets into the pictures.

«««««««««««««««««««»»»»»»»»»»»»»»»»»