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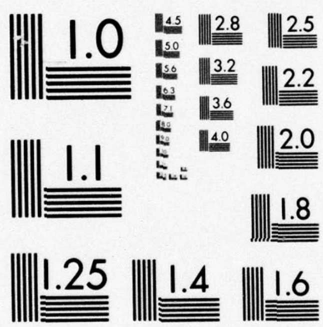
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Program Management Course
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A SCHEDULE MANAGEMENT TECHNIQUE
STUDY REPORT
PMC 73-2

Vincent E. Cooke
CDR US Navy

Fort Belvoir, Virginia 22060

COOKE

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DEFENSE SYSTEMS MANAGEMENT SCHOOL

STUDY TITLE:

A SCHEDULE MANAGEMENT TECHNIQUE

STUDY PROBLEM/QUESTION:

To review the Management of a tight schedule to complete scheduled and programmed repairs on an Aircraft Carrier

STUDY REPORT ABSTRACT:

The purpose of this paper is to describe a scheduling technique which was used in the repair of an aircraft carrier. The paper presents the scheduling technique employed; how it was developed; its simplicity of design; its visibibility, and its utilization. The thrust of the paper is to point out that a scheduling system is necessary to control and complete repairs on such a complex system as an aircraft carrier. Yet, such a scheduling system does not have to be complex. It is illustrated that simplicity of design lends itself to comprehension by all of the users. As the users comprehend the schedule, and its impact on various operations, they begin to accept its necessity and importance, and subsequently keep it updated in order to best utilize it.

KEY WORDS: MATERIEL MAINTENANCE SCHEDULING AIRCRAFT CARRIERS SCHEDULED MAINTENANCE MAINTENANCE MANAGEMENT

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A SCHEDULE MANAGEMENT TECHNIQUE

An Executive Summary
of a
Study Report
by

Vincent E. Cooke
CDR US Navy

November 1973

Defense Systems Management School
Program Management Course
Class 73-2
Fort Belvoir, Virginia 22060

EXECUTIVE SUMMARY

The purpose of this paper is to describe a scheduling technique which was used in the repair of the USS HANCOCK CVA 19 (an aircraft carrier). The paper presents the scheduling technique employed; how it was developed; its simplicity of design; its visibility and its utilization. The thrust of the paper points out that a scheduling system is necessary to control and complete repairs on such a complex system as an aircraft carrier. Yet, such a scheduling system does not have to be complex. It is illustrated that simplicity of design lends itself to comprehension by all of the users. As the users comprehend the schedule and its impact on various operations, they begin to accept its necessity and importance, and subsequently keep it updated in order to best utilize it.

The necessity of a refined schedule control technique became evident when the milestone schedule was received by the ship from the shipyard. This schedule disclosed a compression of key events which had to be met as scheduled in order to complete repairs and leave the shipyard only eight weeks after arrival. All major engineering propulsion and auxiliary machinery, aircraft handling, launch and recovery system, electronics systems and ordnance handling systems were to undergo repairs. The ship would cease to provide her own power requirements during the repair period and power would be received from the pier facilities.

The need for schedule control dictated a control system that would be highly visible, useful to all first-line supervisors, but most of all, would show the interrelationship and interdependence of all jobs whose individual completion controlled completion of the ship on schedule. The system that was devised was

a tier-type schedule. This was a time-phased display showing the key milestone dates to be met along with sub-events within systems. These systems were linearly drawn out and terminated at the key milestone date. The schedule's visibility derived from its ease of readability by those controlling the availability. A red line was moved along the schedule with time and as it approached a key event, status on the probability of meeting that event on time was required. As the red line passed an uncompleted event, the fact of incompletion was obvious because the tag remained on the schedule, as opposed to being deleted when the item was completed.

This schedule control technique, though effective in this case, would not be universally applicable to repair periods of any duration. Longer ones with many more tasks would probably be best controlled mainly using automated data processing equipment, but with some kind of tier system displaying the computer output. Shorter repair periods, where the availability of the ship after the repair period is not in doubt, might be better controlled with a bar-type progress chart, especially if there are very few or no real controlling jobs which will determine whether the ship will be able to leave the repair activity or not.

A SCHEDULE MANAGEMENT TECHNIQUE

STUDY REPORT

Presented to the Faculty

of the

Defense Systems Management School

in Partial Fulfillment of the

Program Management Course

Class 73-2

by

Vincent E. Cooke
CDR US Navy

November 1973

Contents

A SCHEDULE MANAGEMENT TECHNIQUE*

The purpose of this paper is to describe a scheduling technique which was used in the repair of the USS HANCOCK CVA 19 (an aircraft carrier). The paper will present the scheduling technique employed; how it was developed; its simplicity of design; its visibility and its utilization. The thrust of this paper will be to point out that a scheduling system is necessary to control and complete repairs on such a complex system as an aircraft carrier, yet such a scheduling system does not have to be complex. It will be illustrated that simplicity of design lends itself to comprehension by all of the users. As the users comprehend the schedule and its impact on various operations, they begin to accept its necessity and importance, and subsequently keep it updated in order to best utilize it.

Upon completion of each deployment overseas, each aircraft carrier is placed in a restricted availability status at a repair activity for about eight weeks. These repair activities are most often Naval shipyards, but could be private shipyards, as well. The purpose of this restricted availability is to completely shut down the electronics, aircraft handling, electrical ordnance handling and machinery systems in order to accomplish repairs to machinery, the need for which was determined while conducting operations in the deployed

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area. In addition to repairs, a considerable amount of preventive maintenance is conducted as well as the installation of new subsystems in order to update the capability of the onboard systems. Urgency surrounds these periods because the subsequent training of Naval Aviators assigned to fleet squadrons depends on each aircraft carrier completing its repairs in time to undergo refresher training on schedule with all of the ship's equipment restored to a high level of availability and reliability. Refresher training is a period during which the ship's crew is retrained in overcoming all emergency situations, as well as redeveloping navigation, shiphandling, seamanship, operational, command and control, and many other skills. Upon completion of refresher training, the ship is made available for the carrier qualification of pilots in various types of aircraft. Subsequently, the ship's air wing rejoins the ship. Thereafter the air wing and the ship work-up together, preparing for the next overseas deployment. It becomes evident then that if the ship, due to poor maintenance, shoddy repairs, or late completion, is delayed, the training of aviators in various squadrons will not be completed on time; nor will the ship's air wing receive as much training as they should receive prior to deployment.

The extent of the repair effort during the restricted availability is enormous by any standard. During the eight weeks, liquid oxygen manufacturing plants are completely stripped down, pressure tested, and reassembled. All boilers are opened up, on the furnace side as well as the steam side, and refractory and water tubes are renewed as necessary. Main auxiliary machinery associated with the propulsion of the ship is overhauled. Gyrocompasses and radars are removed from the ship for overhaul. Aircraft and ordnance handling elevators and their associated hydraulic and electrical machinery are repaired.

Arresting gear hydraulic engines are repaired where necessary and the steam catapults are opened for overhaul. The flight deck and hull are repaired where necessary. Radio and ECM equipment plus antennae get the kind of maintenance that can be performed only when they are completely shut down. The water distilling plants are torn apart, cleaned, and worn parts are replaced. The preservation (painting) of the ship, inside and out, gets much attention. Aircraft handling equipment (yellow gear) is removed from the ship for repair ashore.

An aircraft carrier is composed of approximately eleven functional departments under the commanding officer. These are shown in Figure 1. The Engineering Department, responsible for the propulsion of the ship, its electrical generating plant, water distillation, liquid oxygen production, and numerous other functions contributing to the hotel and operating functions of the ship, is responsible for generating the largest proportion of repairs necessary during the restricted availability. Next is the Air Department, responsible for launching and recovering the aircraft, storage of the aircraft on board, and for the storage of the jet fuel. Communications, with its extensive radio equipment, operations with radar and ECM, and weapons with numerous bomb elevators make up most of the remainder of the work items.

The Engineering Department plays a dominant role during the restricted availability because the Engineer Officer (Chief Engineer) is assigned the responsibility to see that repairs are accomplished on schedule and in a quality manner. He has a Repair Officer who is specifically tasked with assembling the paper concerned with the project, effecting liaison with repair representatives in the other shipboard departments and with the repair facility, and for monitoring the progress of the repairs. In addition to the Engineering Department's Repair

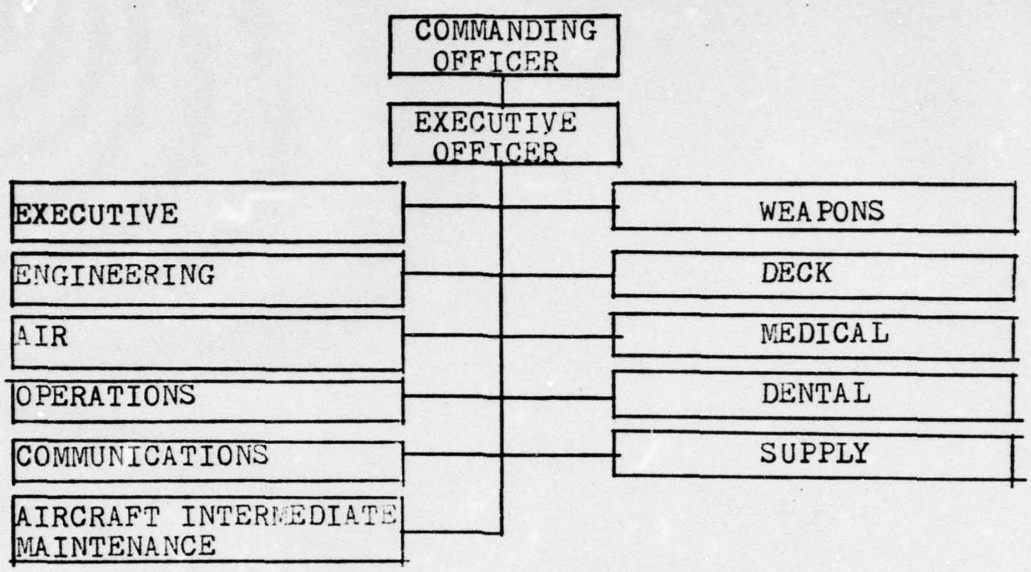

FIGURE ONE

DEPARTMENTAL ORGANIZATION OF AN AIRCRAFT CARRIER

Officer, there is one other key man in the repair planning organization. This is the PMS Officer (Preventive Maintenance System Officer), who is responsible for maintaining the ship's CSMP (Current Ships Maintenance Project). This is a document which records all of the repair items which were found to be necessary to restore equipment to peak and like-new operating condition, but could be deferred while the ship was deployed. It is a type of "tickler" file used as a planning document for organizing repairs during a repair period. When a ship is scheduled for repairs, various departments turn to their copies of the CSMP and extract those work items that need attention at this time and are capable of being repaired during the time alloted to the repair effort. So, though the Repair Officer has primary responsibility under the Chief Engineer for planning the repair effort and coordinating with the Type Commander and the shipyard, he must effect liaison with other departmental repair representatives during the planning phase. As the focal point, however, the Repair Officer issues a call for work requests (requests to be submitted to the shipyard or repair activity via the Type Commander, who provides the money), compares the work requests with the outstanding work items deferred in the CSMP, and prepares them for submission to the Type Commander. Figure 2 shows the flow of work requests until they are transformed into job orders. Though each department assigns personnel keenly familiar with each of the work items, the Repair Officer is expected to become familiar with each item in order to discuss it with outsiders and to defend its priority and the inability of the ship's force to accomplish the repairs within the time allotted. Though many jobs can be accomplished by the ship's force, the ship attempts to get as many accomplished by the repair activity as possible in order to free the men for

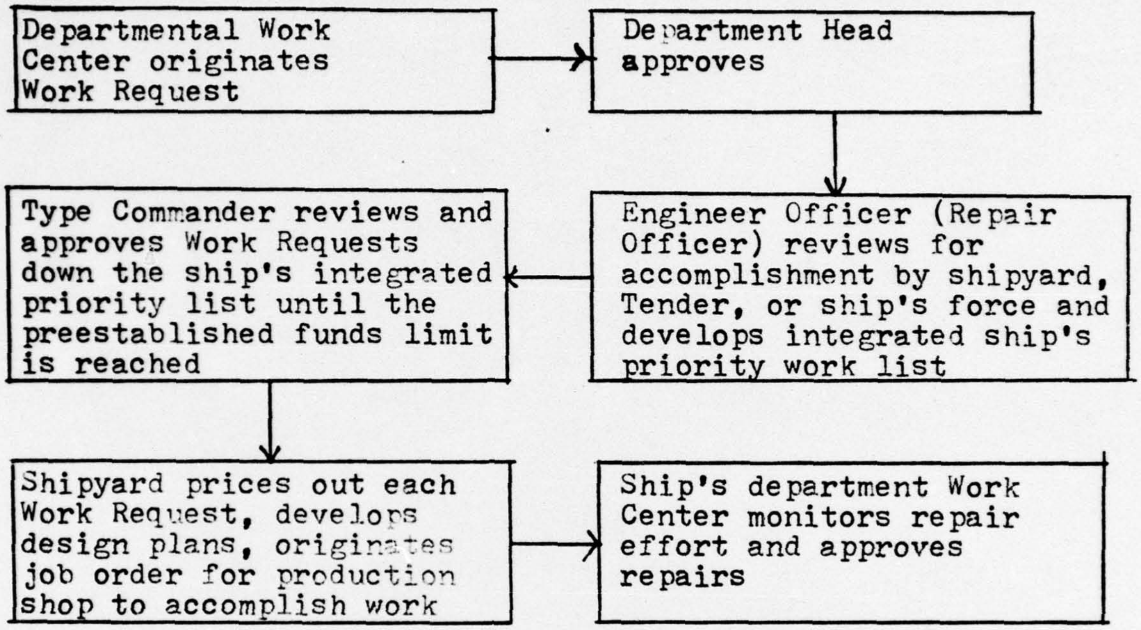

FIGURE TWO

WORK REQUEST FLOW

other items of maintenance or to attend schools.

Planning for the restricted availability begins four to five months before the start date. At this time, all that is known is that the ship will undergo an eight-week restricted availability one month after returning to the States. At this time, the Repair Officer calls for the work requests, and while the various departments, consulting their CSMP, prepare the work requests for consolidation by the Repair Officer, he, with the PMS Officer, examines the CSMP for those deferred work items which are capable of being repaired in the time frame allowed. None of the departmental repair officers works in a vacuum. All of them liaise with the Repair Officer and the PMS Officer in order to develop as complete a work package as possible. Not later than four months before the scheduled start date, all of the work requests which now compose the work package are submitted to the Type Commander for his approval. The term "Type Commander" applies, in this case, to the Commander, Naval Air Forces, in either the Pacific or the Atlantic. There are type commanders for all types of ships; e.g., the destroyer type or force commander, and the submarine type or force commander. These types of commanders report to the Fleet Commander (CINCPACFLT or CINCLANFLT), who administratively reports to CNO and operationally reports to the Unified Commander. Money to accomplish the repairs and to pay the repair activity comes mostly from the Type Commander. Money for ship alterations, approved by the systems commands and authorized for accomplishment during this specific repair period, in most cases comes from the systems command; however, certain kinds of alterations are funded by the Type Commander. Approximately three months before the start of the repair period, the Type Commander's action on the work package is received by both the ship and the repair activity.

The repair activity then develops price estimates for each work request and begins planning the work. About two months before the start, representatives from the repair activity visit the ship for the purpose of developing more information on the repairs necessary in order to develop better planning for the accomplishment of the repairs; i.e., to scope out the job and to refine the price estimate. During this same time, the Type Commander's representative visits the ship for what is called the "Pre-arrival Conference". A specific fund limitation is established for each of the ship's repairs. At this conference, attended also by the senior planners and estimators of the repair activity, numerous trade-offs are conducted with the ship's repair personnel in order to get the most important and necessary repairs accomplished by the repair facility, especially those which are truly beyond the capability of the ship's force. A small fund reserve is retained by the Type Commander for repair growth when equipment is opened. All of the outsiders leave the ship and the repair activity begins an intensive planning phase during which a milestone schedule is developed, along with and supported by a precise schedule for the accomplishment of each repair item, time-phased with other work repairs of a similar nature.

The restricted availability for the USS HANCOCK during 1971 was particularly unique in that the availability was not actually scheduled until the night before the ship was due in the shipyard. Five months before the availability was due to begin, it was unknown whether the ship would be overhauled (a nine- to ten-month undertaking, usually occurring once every four years), given a routine restricted availability, be sold to some other country, replace the carrier assigned to train fledgling Naval aviators in the Gulf of Mexico at Pensacola, or be decommissioned. Though the overhaul, sale and training carrier proposals were rejected, the possibility of decommissioning remained viable up until the very last moment. The spectre of such an action usually has the effect on the crew of easing up on maintenance and planning for maintenance. Though a considerable part of the crew felt that decommissioning was all but certain, nevertheless, those of us in charge had to continue to operate as though the ship were going to undergo the repair period as scheduled. Otherwise, there would be no recovery from the letdown. Consequently, in all dealings with the repair facility, which also was infected with the idea that the ship would not be around too much longer, as well as the crew, a positive front had to be maintained. Otherwise, the ship would not be ready to commence the short-fused availability when it was ultimately decided to go ahead with the repairs. The IRPO (human behavior) situation generated by this uncertainty was barely manageable. Some money was turned loose by the Type Commander for preliminary planning and to keep the ship repair project alive in the shipyard. Consequently, the shipyard was able to go on with the development of the paperwork necessary to plan and schedule the repairs. Among the key documents which had to be in the production shops early were the milestone schedule, job orders directing the execution of certain repair tasks, and design plans.

The production of the milestone schedule ties the availability together and is probably the easiest document to develop. It is keyed to the completion date established in the Fleet Commander's schedule. Specifically, the Fleet Commander establishes the start and the completion date of the availability.

Working backward from the completion date, all of the milestone dates are developed. The key milestone dates are:

Boiler light off;

Commence electronics equipment check-out;

Dock trials;

Sea trials;

Completion and depart the shipyard.

Given an eight-week availability, boiler light off must occur somewhere in the fifth week in order to attain the rest of the key milestone schedule.

Boiler light off involves getting one of the ship's main boilers lit off to the extent that it is capable of producing enough steam to drive the auxiliary machinery such as forced draft air blowers, fuel oil pumps and water pumps in order to keep the boiler steaming. It becomes apparent that, in order for this to be accomplished, all of the repairs to that boiler must be completed, as well as all of the repairs to any of the piping in the fireroom in which the boiler is located, and all of the repairs to the auxiliary machinery which will be used to bring air, water, and fuel oil into the boiler. So, in order to get the first boiler lit off requires an intact fireroom with all of the equipment operating. The next milestone event is the commencement of the electronics equipment check-out. When the ship entered the repair activity, its main generators were shut down and electrical power was taken from the dock. Since the ship's electronics equipment will operate off the power developed from the ship's main generators, electronics equipment check-out cannot begin until the ship is capable of again providing its own electrical power. This demands the completion of repairs to additional main auxiliary machinery as well as the turbo-generators which will supply the power. In addition, the ship's water distilling plants ought to be back in commission in order that an adequate supply of boiler feed water is available once the ship is lit off and providing its own power. Dock trials require that all of the engines are turned over alongside the pier. In order to do this, all of the main propulsion machinery must be operable with the possible exception of half of the boilers. The purpose of dock trials is to test all of the quipment required in getting the ship underway. It is primarily aimed at testing the main propulsion and steering machinery. The remaining boilers are completed between dock trials and sea trials. During sea trials, the ship stands out of the harbor with all boilers and main machinery in an operating condition as well as all of the electronics equipment such as ECM, radios and radars. Catapults are test fired at sea (without airplanes) and discrepancies are noted on all of the equipment repaired by the repair activity. This list of discrepancies is turned over to the repair activity and the repair discrepancies are completed on return to port. On completion, the ship leaves the activity and begins its work-up for refresher training.

In addition to providing the milestone schedule, the shipyard provides a detailed repair schedule. This schedule provides particulars on when the shipyard intends to start repairs on a piece of equipment, the day that the quipment will be taken off the ship, disassembled in the shop ashore, completion of ship repairs, test (as appropriate) in the shop, repainting, if necessary, return to the ship, installation aboard and hook-up, relagging, if necessary, reinstallation of any interferences removed to get the component in and out of the ship, and light off for test on board. It is necessarily detailed so that the individual shops may plan the repair of each component equipment in a timely manner. Unfortunately, its detail is its great disadvantage because it is extremely difficult if not impossible for any one shop to look at the schedule with the perspective of the entire availability. In other words, each of the production trade shops can look at a specific job and determine when that shop should begin its phase on a work item, but the shop cannot see how its work affects the overall schedule. It is difficult to see the forest for the trees.

About one month prior to the scheduled commencement of the repair period, the milestone schedule was received. Thought was then given to how to progress the availability in order to meet such a tight schedule and insure that repairs were completed in time to meet all of the key dates. The first proposal from the repair organization was a simple bar chart. This would show the progress of each job (repair item) in terms of the amount of work done, aimed towards completion. It would be broken down into perhaps ten segments and responsible crew members would periodically estimate the progress (in ten-percent segments) attained in completing the job. This is the usual approach, and is quite acceptable for short repair periods; perhaps of two to three weeks' duration with not more than about two hundred repair items. The problem with this approach is that it is difficult to see how each job affects the completion of the entire shipwide repair effort on time. It is impossible to see the interface between jobs and the effect of one job on another is not discernible. As an example, the boilers, or at least one of them, must be lit off approximately halfway through the repair period. If at the one-quarter point of the availability the progress of all boiler repair is one-quarter, it is easy to be misled into believing that boiler repair is on schedule. In fact, it may well be behind schedule and result in delaying the completion of the ship. Without tying boiler repair to the other key milestones, it is difficult to get a feel for the required progress of each work item. However, since bar progress charts are easiest to understand, a great deal of resistance was encountered in selling any other kind of schedule. The immediate fear, and obstacle to acceptance, is that too much administrative effort will be necessary to maintain such a schedule. During the return transit from the deployment, and just after the shipyard milestone schedule was received, attempts were made to lay out some kind of schedule which would tie together all of the key steps necessary to accomplish or meet the milestones. A considerable amount of resistance was detected toward developing such a schedule. Mainly, it was felt that without the shipyard input, as to when each job was going to start and finish, it would be impossible to lay out a key event schedule. It was concluded, therefore, that though we could lay out a schedule that would show our desires, it may be an exercise in futility since before we could do anything we had to see what the shipyard was planning. Hopefully, the shipyard schedulers would develop the kind of schedule for each individual job that would neatly dovetail into the master milestone schedule.

On return to CONUS, the extent of the schedule planning was a lot of butcher paper on a bulkhead, time-phased across the top, and with only the milestone dates set on it. However, a great deal of discussion had taken place, and in general the kind of schedule needed was determined. The next step was to get to the shipyard and find out what kind of schedule they were developing and how it could be adapted to the need to easily show how all of the jobs tied together. It was expected that the repair organization would have to develop the whole integrated schedule. This turned out to be erroneous. In fact, quite a large amount of work had already been done insofar as the scheduling of jobs was concerned. The shipyard was informed of our schedule control intentions and this was viewed with halfhearted enthusiasm. Most felt that the ship repair personnel were creating a lot of extra work for themselves, and that the schedules developed by the shipyard ought to suffice. Nevertheless, we received a fair degree of cooperation; but it wasn't until the weekend before the availability began that we were able to get a complete schedule for each job from the shipyard. This was mainly a result of the uncertainty surrounding the availability explained in earlier paragraphs.

Two junior officers were placed in charge of gathering the information and developing the integrated schedule. Two were necessary because each had personal plans on return from the long deployment, and in order to accommodate their plans and the necessity for continuity in developing the schedule, maintaining it, and briefing its status each day, each had to be totally familiar with it. Fortunately, each had some idea of schedule control techniques. They became convinced that schedule control was necessary and, once convinced, set out to do it well. This task was undertaken by each of them on a collateral basis. One was the officer tasked mainly with boiler operation, and the other was the main engines officer. They made their requirements known early to the shipyard scheduler, who cooperated with them throughout the development of the schedule.

The weekend before the ship moved to the shipyard, the shipyard scheduler completed his schedule and provided a copy to the ship. From this extensive booklet, which is just what it was, one officer developed the integrated schedule. It was a type of tier schedule laid out on a bulkhead 12 feet long by 5 feet high. Along the top was time in terms of weeks, but showing each day. The vertical axis was divided into major ship systems such as boilers, machinery, electronics, etc. Figure 3 shows the general layout of these axes with the key milestone dates inserted. Figure 4 shows the boiler portion of the schedule

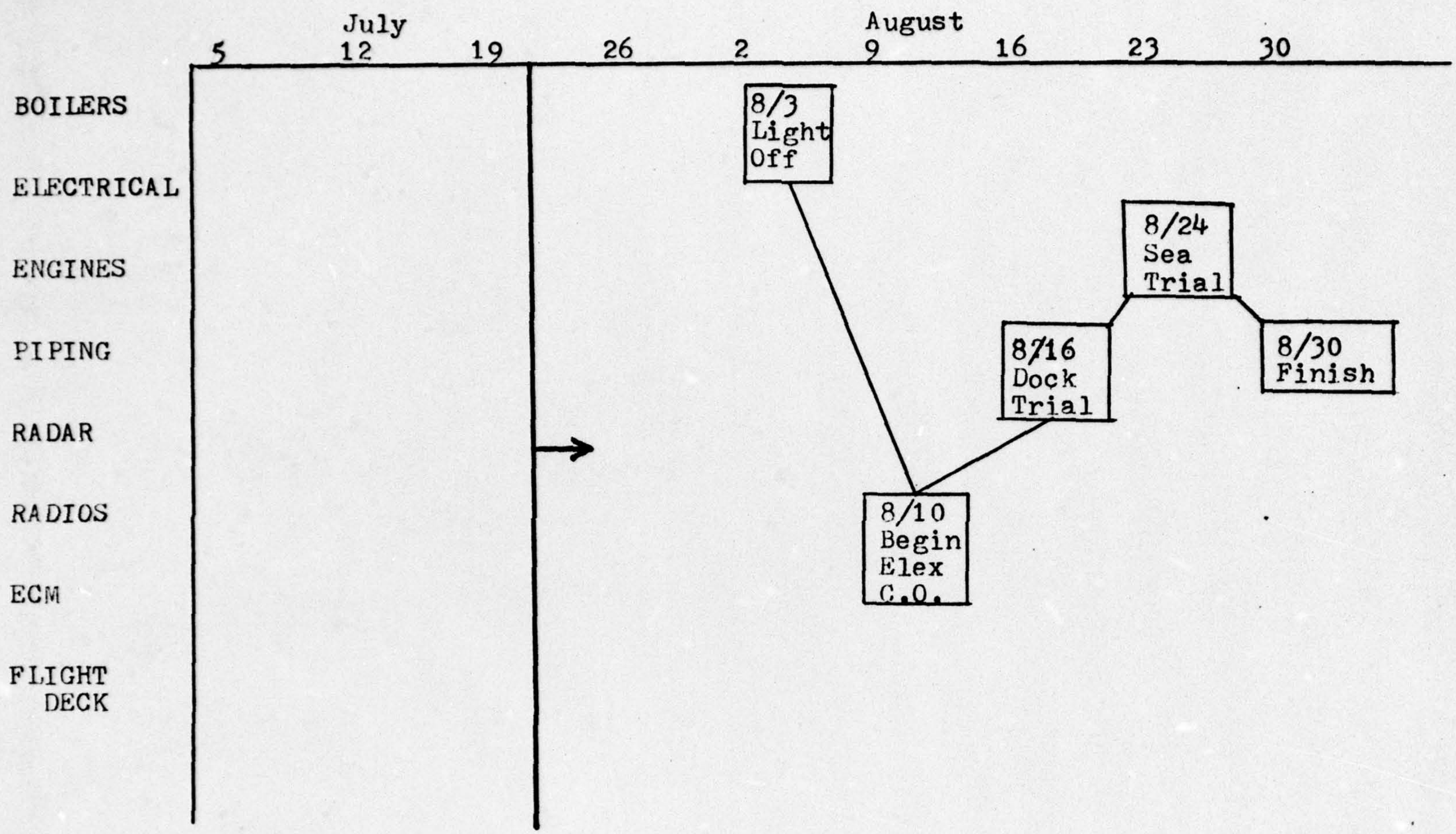

FIGURE THREE

MILESTONE SCHEDULE

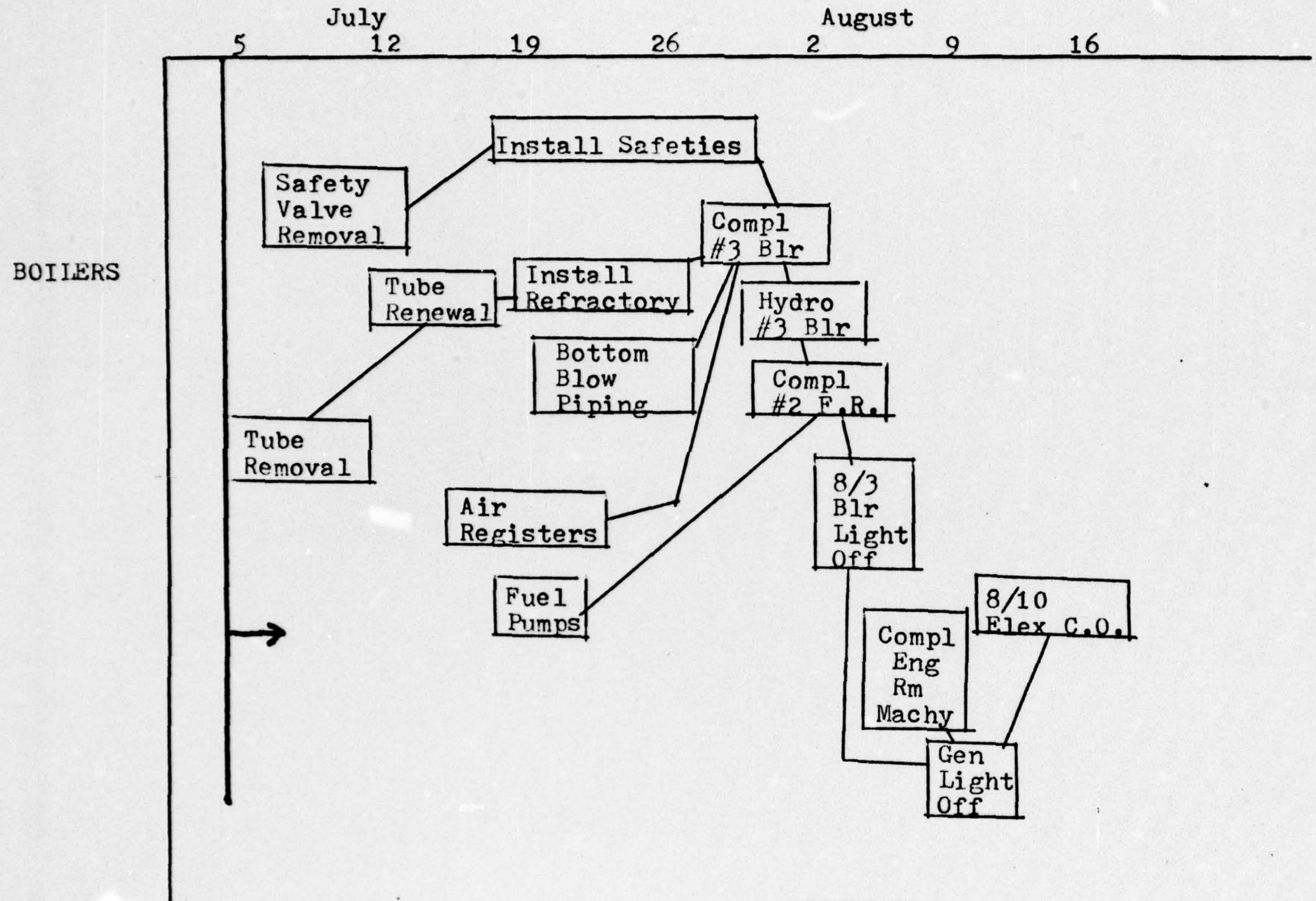

FIGURE FOUR

BOILER PORTION OF SCHEDULE

broken out separately and the various work items which dovetailed into the boiler completion schedule in order to meet the key milestone dates. A red string was dangled from the date of the current day. As an item was started or completed, as appropriate, the tag indicating the fact of that item's status was removed from the butcher paper. All items on the paper were stuck on but were removable once the item was accomplished. As the red string was moved from left to right along the chart with time, any item left on the paper to the left of the string was a missed item. Though missed dates were obviously glaringly pointed up as the string moved and passed an incompleted item, the greatest utility of the schedule was derived from the fact that the urgency in completing items could readily be seen as the string approached the item's time-phased position on the chart. Thus, as the string approached Boiler Safety Valve Installation, the status of their installation became a matter of concern, and an explanation of their repair status was required. Each day a command brief was conducted on this schedule. As the briefer went from the top tier to the bottom, the Commanding Officer could easily tell what the next critical event was and determine whether it would be met on time. If it appeared that the item was in trouble, or wouldn't be complete on time, action could be taken early enough to try to do something about it by bringing it to the attention of the responsible shipyard personnel.

In preparation for this daily briefing, the Repair Officer would gather information from all of the various departmental repair representatives on the status of their key jobs and those not so key. The briefing officer and the Repair Officer would go over each item with an eye toward trying to answer the kind of questions the Commanding Officer would ask. These were usually always of the same kind and involved an explanation of the status of impending trouble areas; i.e., those areas coming due for completion very shortly. As all concerned became more familiar with the mechanics of the schedule, it began to be utilized to a greater degree. It was not very long before the area in which the schedule was displayed became a meeting place first thing in the morning for face-to-face discussion among the various trade leading men as well as with the ship's responsible supervisors. Inputs were made to the schedule in terms of updating status, or in terms of advising the Repair Officer what the problem was in late completion, and what was going to be done to get the job back on schedule, or where the bottleneck was. By the time the Chief Engineer and the CO were briefed each day, everyone knew exactly where he stood and what was being done about each job.

Its greatest utility derived from its acceptance. Once everyone realized that they could get something out of it, and updating it required no paperwork or monumental effort, it began to be a focal point. For the first time since any one could remember at this particular repair facility, a carrier lit off her boilers on time. When that occurred, the schedule received its greatest acceptance, and even the Type Commander took notice.

A reader of this paper may gain the impression that the technique used is too simple and certainly others must use the same thing. They apparently do not, but prefer to use exotic and complex systems which hopefully benefit someone at the top levels of management; but those at the lower working levels charged with getting the tasks done rarely see them, let alone understand them or how they can assist them in meeting their schedules. Perhaps even now the simplicity and utility escape the reader. An example of how this schedule control technique was used may be in order. Assume the ship is approaching boiler light off and the red string is moving closer to the date when all of the boiler safety valves for this particular boiler are to be back and installed. When the boiler trade people are queried as to their expectation of meeting the schedule, they respond that it does not look like the shop will be finished machining them in time. An investigation ensues wherein it is learned that the shop plans to do all of the valves at once, rather than in the order of the boiler light off. Once made aware of which valves are necessary first, there is no great problem, in the shop, shifting from one set of boiler valves to another. A simple matter of communications, and the problem is straightened out. In another case, perhaps, the shop finds it is behind in installing piping. There is no way they can get it done in time, since there are just not enough available man-hours in the shop. The ship's force is shifted onto the job to work alongside the shipyard personnel, and the job gets done on time. The importance of the schedule comes through in projecting ahead, determining in advance where the problems are, and being able to take timely action to get around these obstacles.

The schedule control technique did not control every job. Only those which would affect the completion and departure from the shipyard were controlled. Others, such as the repair of portable tools and test equipment, and even some of the flight deck repair, were left off of the chart because to include them would place so many tasks on the chart that those which truly controlled completion and departure would stand a chance of being overlooked. These smaller tasks which did not impinge directly or even at all on whether or not the ship made its sea trial date, or completion, were still under the positive control of departmental repair officers who watched and monitored the progress of all jobs within their departments. Bar progress charts were still maintained within departments, and, if not, all first-line supervisors had to report daily to their supervisors on the status of repairs. As many of the controlling tasks were completed, attention of the ship's Repair Officer turned with more emphasis on these non-controlling jobs until even they, at the very end, became almost as important as some of the others had been in the early phases of the repair period.

Total engagement of the maximum number of people with this tier type of schedule control technique came at about the fourth to fifth week, especially when the first milestone approached. Those attending the daily Commanding Officer's briefing on a regular basis were: The CO, Chief Engineer, Repair Officer, Electronics Repair area representative, the Briefing Officer, the Ship Superintendent, and the Shipyard Progressman. Both of these latter personnel were from the Shipyard Production Department. Occasional attendees were the ship's Executive Officer, the Air Officer, the Operations Officer (for electronics equipment), the Communications Officer (for radios), the Deck Officer, and occasionally some other shipyard personnel, particularly the production shop leading men, such as those representing the boiler repair trade, outside machinists and shipfitters.

The schedule was received well, used by the shipyard personnel, and enjoyed a high degree of credibility among the shipyard people because it was simple to update, cost the shipyard nothing, was easy to read, and was a very accurate reflection of the most current status. After sea trials had been successfully met on time, the schedule began to phase out. This occurred mostly because there were few key items or events on it which had not been completed and the

CO as well as key department heads began to turn their attention to preparations for the training phase soon to commence. This is not to say that the CO was not kept informed of the progress of the outstanding repairs, because he was. Daily, the Chief Engineer briefed him on the status of critical repairs remaining, but this began to occur at a briefing now held in a different location and addressing more of the operational realm.

On reflection, this system worked because it was simple, easily understood, was credible, and helped the first-line supervisors forestall impending crises. Though this system was totally manually operated, it is easily capable of automation. This same kind of tier scheduling control system is used by Boeing Corporation as attested by Mr. Billy Hughes, an employee of Boeing, and member of the Defense Systems Management School PMC Class 73-2. In that corporation the entire system is automated. This is not to say that the next time such a system is used it ought to be automated. It depends on the extent of the repair effort and the availability of a computer capable of being programmed for this control technique. One of the problems in an automated system which might occur, as opposed to this manual system, is the lack of easy comprehension and visibility this system enjoyed. In this manual system, the whole program was laid out on one bulkhead on butcher paper. Computer output does not have the kind of simplicity, clarity and visibility this system had, but it could certainly be developed.

Keeping it simple paid dividends this time. It assisted managers in managing and provided a viable information system. This kind of system can work again for other similar projects. Whether it ought to automated depends on each situation.

Before accepting and employing this kind of system to control any project, one should keep in mind why it worked and was necessary on this project. The ship had undergone repairs several times before while deployed, but in each case the ship continued to remain lit off, providing her own services and power, and was capable of getting underway on only a few hours' notice. Such was not the case during this post-deployment availability, during which all of the ship's main machinery and electronics were torn down for repair. So, it was extremely necessary to develop some kind of schedule control technique which would enable the managers to control and coordinate those repair functions whose orderly and timely accomplishment would play a decisive role in the completion of the availability on time. During other short-duration repair periods, where the ship is not so completely torn down, simple bar charts to measure the progress may be much more appropriate and useful. Those responsible for the timely completion in a quality manner of the repair effort must decide on the appropriate technique to control the schedule. Failure to do so will result most likely in missed milestone dates and late completion.