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Monograph No. 4

OPERATIONS PLANNING IN PORTS

by

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INTRODUCTION TO THE SERIES

In the ports of industrialized countries, operating systems and personnel development are based on skills acquired through experience, on emulation of other industries and on the innovation which is easily undertaken in advanced industrial environments. These means are generally lacking in developing countries, and port improvements occur only after much deliberation and often through a process of trial and error. Some means are required by which ports in developing countries can acquire skills that are taken for granted in countries with a long industrial history, or can learn from the experience of others of new developments and how to meet them.

Formal training is one aspect of this, and UNCTAD has devoted considerable effort to developing and conducting port training courses and seminars for senior management and to preparing training materials to enable middle-management courses to be conducted by local instructors. It was felt that an additional contribution would be the availability of clearly written technical papers devoted to common problems in the management and operation of ports. The sort of text that will capture an audience in the ports of developing countries has to be directed at that very audience, and very few such texts exist today.

Following the endorsement of this proposal by the UNCTAD Committee on Shipping in its resolution 35(IX), the UNCTAD secretariat decided to seek the collaboration of the International Association of Ports and Harbors, a non-governmental organization having consultative status with UNCTAD, with a view to producing such technical papers. The present series of UNCTAD Monographs on Port Management represents the results of this collaboration. It is hoped that the dissemination of the materials contained in these monographs will contribute to the development of the management skills on which the efficiency of ports in developing countries largely depends.

Rainer Vogel
Officer-in-Charge
SHIPPING DIVISION
UNCTAD

FOREWORD

When UNCTAD first decided to seek the co-operation of the International Association of Ports and Harbors in producing monographs on port management, the idea was enthusiastically welcomed as a further step forward in the provision of information to managements of ports in developing countries. The preparation of monographs through the IAPH Committee on International Port Development has drawn on the resources of IAPH member ports of industrialized countries and on the willingness of ports in developed countries to record for the benefit of others the experience and lessons learnt in reaching current levels of port technology and management. In addition, valuable assistance has been given by senior management in ports of developing countries in assessing the value of the monographs at the drafting stage.

I am confident that the UNCTAD monograph series will be of value to management of ports in developing countries in providing indicators towards decision-making for improvements, technological advance and optimum use of existing resources.

The International Association of Ports and Harbors looks forward to continued co-operation with UNCTAD in the preparation of many more papers in the monograph series and expresses the hope that the series will fill a gap in the information currently available to port managements.

J.K. Stuart
Chairman
Committee on International
Port Development
IAPH

CONTENTS

PREFACE

This monograph, which discusses a systematic approach to the application of operations planning in seaports, is directed to those middle managers - traffic officers, berth superintendents, etc., - who are responsible for controlling cargo handling operations at a berth or group of berths. It derives from the content of the Improving Port Performance (IPP) Course entitled "Management of General Cargo Operations". The material has been extracted from Unit 7, "Operations Planning", of the Trainee's Workbook and the two associated audio-visual programmes. In its original context, Unit 7 draws together many management concepts and principles from the preceding six units of study: Unit 1 - Introduction to the Course; Unit 2 - Measurement of Port Performance; Unit 3 - The Ship Operation; Unit 4 - The Quay Transfer Operation; Unit 5 - The Storage Operation; Unit 6 - The Receipt/Delivery Operation.

Clearly, in this modified form a great deal of previous knowledge has to be assumed on the part of the reader. It must be realized that the exercises, in-text questions and case material that form an integral part of the instructional strategy of the IPP project have been omitted. This monograph is NOT a learning text; readers who are interested in a more thorough in-depth study of the subject are referred to the full IPP Course.

I. OPERATIONS PLANNING

A. The importance of operations planning

1. Managing a modern general cargo berth, with its complex, varied and continually changing activities, demands a systematic and comprehensive approach to operations planning. Detailed planning is essential to ensure the proper allocation of resources and the effective co-ordination of activities, particularly those involving individuals and organizations outside the port. No matter how well traffic and operations managers undertake their day-to-day control and supervisory functions, it is impossible to achieve the cargo throughput of which the berth is capable unless operations are planned effectively, to produce a smooth, cost-effective and balanced flow of cargo through the berth. Planning is an essential mangement task for all activities on the berth.

B. Responsibility for operations planning

2. The planning responsibilities of seaports are varied; they take place over many time-scales and are performed by different management grades. Many port planning tasks are of a long-term nature and are the responsibility of senior managers; planning investment in new facilities over the next five to ten years, and deciding future manpower requirements are examples of these. Other planning tasks are directed at medium-term time-scales, perhaps involving the devising of policies and decisions on equipment purchase or the improved layout of berths, to cover the next one to five years. Finally, there are the short-term planning tasks, decisions which will affect port performance over the next few days or weeks. These are the decisions that keep day-to-day operations running smoothly.

3. Operations managers employed in middle management grades may be directly or indirectly involved in all three sorts of planning, but their main concern must be with the short-term planning so essential to the efficient management of cargo-handling operations at their berths. This paper concentrates on this short-term operations planning, specifically the detailed planning responsibilities of those middle managers employed in controlling cargo-handling activities at the berth or section level.

4. Operations planning is an essential part of these responsibilities, although this function and the way the different tasks are delegated vary in detail from port to port. In some ports, a central planning department is responsible for gathering information and for planning the major activities for all the berths in the port. Close co-operation between this planning department's staff and those Operations Department staff directly involved in cargo-handling activities at berth level is essential in this sort of arrangement. In other ports, the operations planning function is performed at the berth level.

5. Whatever the organizational arrangements for performing this function in a particular port, operations planning is of vital importance and it is essential for managers to understand the process fully. They may, in fact, be involved directly in this activity, if managers interchange between "line" and "staff" functions. In any case, they will certainly be involved in some planning-related duties, and will have to put planning decisions into effect.

C. The components of operations planning

6. The first task is to distinguish clearly what is meant by operations planning and to define the time-scales under consideration. Short-term or operations planning is itself performed over different time-scales, ranging from a few days or even a week or two, at one extreme, to daily shift planning at the other. It also involves a variety of activities, from allocating ships to berths to controlling the arrival of inland transport in the port.

7. For convenience, we can divide operations planning into three principal groups of activities. The first of these takes place before a vessel arrives in your port and is called pre-arrival planning. It includes such tasks as berth allocation, planning the right labour and equipment and estimating working times. The second activity is work scheduling which takes place when the vessel is alongside a berth and covers all the preparations for the next shift. The final activity is completed when the vessel has left, and is a performance review - a sort of "post-mortem" on the quality of customer service for that vessel call or for the vessels calling at the berth over a longer period, say a month. Although the planning tasks tend to overlap somewhat between these categories this is a very useful framework within which we can look closely at the sequence of steps involved in operations planning.

II. PRE-ARRIVAL PLANNING

A. Introduction

8. Pre-arrival planning is the first, and in many ways the most important, of the steps in operations planning. It is designed to help the planning of the organization of berth operations to achieve the highest possible productivity and the most efficient allocation of berth resources, to reduce to a minimum ship's time in port. It starts well before a vessel arrives at berth, and carrying out this phase of planning effectively is the best guarantee of a smooth and efficient cargo-handling operation. At this stage, a decision has to be made on which berth the vessel will go alongside for discharging and loading. This is berth allocation - making sure the ship goes alongside a berth with the facilities needed to work it. The next question is to work out what labour and equipment will be needed when the hatches are open and cargo-handling operations start. We can call this resource allocation - planning the men and machines needed to turn the ship around as quickly and cost-effectively as possible. At the same time, the duration of each consignment's handling has to be calculated, to forecast when to call forward road vehicles, rail wagons and barges. This planning task we can summarize as estimating operating times. It also allows for calculation of the number of shifts needed to finish, and the estimated time of departure (the ETD) of the vessel, to determine when the berth will be vacant again. These three tasks - berth allocation, resource allocation and estimating operating times - form the core of pre-arrival planning.

B. Berth allocation

9. The first step in pre-arrival planning is to decide which berth a vessel should go alongside for discharging and/or loading its cargo. Every vessel arriving in the port must be assigned to a berth that it can safely manoeuvre to and occupy throughout all stages of the tide, and that has the appropriate shoreside facilities for the transfer of its particular cargo between the ship, the quayside and inland transport. Since the suitability of the allocation will

utimately have a very significant influence on the berth's performance, we must give berth allocation a great deal of attention, dealing first with the information that is needed before a vessel can be reliably allocated to a berth and then with the actual process of allocating or "stemming" (sometimes called "pinning") a vessel to a berth.

1. The information needed

10. The first thing a port wants to know in any berth allocation exercise is what vessels are due to call in the next few days and weeks, and when they are expected to arrive. As he applies for a berth, the shipowner or his agent tells the port authority of the expected date of his vessel's arrival - its ETA. If the ship is a liner vessel on a regular schedule, or a chartered vessel on a long voyage, the ETA should be known well in advance. At this stage, possibly two or three weeks ahead of arrival, the ship's agent will probably know very little about the cargo carried, but whatever information he has will be recorded on a ship arrival form by a senior traffic officer employed in the central planning department of the port. Nearer to the time of arrival, the ship's agent will know a lot more about the cargo carried and the shipowner's and shippers' requirements. As this information becomes available, the senior traffic officer will add it to his records.

11. So, for each of the vessels arriving at the port over the next 10 to 14 days, he should have information on the type and quantity of cargo to be loaded and discharged, and any special handling requirements. It is this information which is used by the senior traffic officer and the Harbour Master when they come to allocate vessels to particular berths. It is essential that berth allocation is performed jointly by an operations manager and a member of the Harbour Master's staff since vessel manoeuvrability, pilotage problems and similar marine aspects should be considered together with cargo factors in allocating vessels to berths.

12. Every morning the senior traffic officer and the Harbour Master should meet to plan and adjust the berthing sequence for the next 10 days. A good practice for berth allocation is to have, in the planning department, a master planning board drawn up in a form similar to that shown in figure 1, with the days of the month in horizontal rows and the berths in columns. There could also be space for listing anchorage points, berths used in the stream with overside working to barges, and other useful information. Small silhouettes of the vessels (or simply blocks of wood) with their names written on are then slotted into the appropriate square on the board as the vessel is "stemmed" or "pinned" to a particular berth. This simple planning board is extremely helpful in the process of allocation and for providing a status report at a glance on the actual and expected occupation of the port's berths.

13. How do the senior traffic officer and the Harbour Master set about the job of berth allocation? What information will be needed to make sure that the vessel is put alongside a suitable berth? Getting the relevant information about a vessel which is scheduled to visit the port is, in many ways, the most important part of berth allocation. Without the necessary information, any allocation must be largely a matter of guesswork, and cargo-handling performance might not be as good as it could be.

14. First, the dimensions of the vessel have to be known, in particular her length and draught, since the berth chosen must be big enough to take her. Are there any berths in the port that will be ruled out for pilotage reasons - difficulty of manoeuvring a ship of that size and design because of currents and tidal range? Then, what lifting gear has the vessel got? Will she need

Figure 1

BERTHING PLAN

Date	B E R T H S										Remarks
	1	2	3	4	5	6	7	8	9	10	
1		MONSOON			POLNORD			SALAVE			
2									SPERO		SPERO: port side-to
3						CARLOS					
4	ATLANTIC			PAVLOGRAD							
5			KALMIA							EUROPA	
6											
7				TRADER			HERO				
8	ANTHOS				ALPINE			JADRO			ALPINE: port side-to
9									JUDITH		
10		CUMULUS									
11			WINCHESTER			FAIRWATER					
12	GRENADA									GOLFOS	GOLFOS: stbd side-to
13					JANE		ALMADA				
14									CHANTRY		
15			LLANDAFF								
16											
17											
18											
19											
20											

shoreside cranes, or can she handle the discharge herself, with her own cranes and derricks? Or is she likely to unload through side doors? Now, what about the cargo that she is going to discharge? If she is carrying general cargo, she will not need a specialized berth, such as a tanker terminal or dry-bulk berth, but can be accommodated at a conventional berth with facilities for handling break-bulk general cargo.

15. But that is not all the information that is needed. Will the way in which the cargo is distributed among the hatches influence the choice of berth? Are there any heavy lifts, or packages of unusual shapes or sizes? The berth allocation team will have to make sure that the berth can receive the vessel's cargo. If hazardous cargoes are aboard, she may have to be assigned to a berth earmarked for handling such cargoes. How will the cargo move through the port? If most of it is following the indirect route, the selected berth must have adequate storage facilities - with enough space available in them at the appropriate time. If the cargo is going by the direct route, the vessel will need a berth suitable for road, rail or barge traffic, of course. If there is a lot of transshipment cargo aboard, it would be desirable to put the ship at the berth that the cargo is to leave from, or at least at a nearby berth.

16. The Ship's Master or the agent will provide most, if not all, of the information needed to select the most suitable berth for the vessel. If the vessel is a regular caller at the port, her design features will already be very well known and the Harbour Master will have records of her dimensions, but if she is not familiar it will be necessary to look up Lloyd's Register of Shipping, or a similar publication, to find the information needed about design and dimensions.

2. Stemming the vessel

17. During the actual task of steeming a vessel it may be realized that certain berths in the port are unsuitable because of length or draught restrictions. The vessel will have to tie up at one of the remaining berths; the choice will depend on her cargo and, of course, on which of the remaining berths will be vacant when she is due. If the ship's agent has already produced the cargo Stowage Plan and Manifest, that information can be used to work out which of the remaining berths is the most suitable. If not, the Ship's Master must cable a Cargo Disposition, giving a breakdown of the type and quantity of cargo in each hatch, with its stowage position, any heavy lifts or special cargoes, and any special handling requirements. There will still have to be some assumptions, for example on mode of delivery, but from all this information it should not be possible to narrow down the choice of berth. When the most suitable available berth has finally been selected, the vessel is allocated or stemmed by placing her block in the appropriate square for the day of the ETA. But it is also necessary to indicate roughly how many days she will occupy the berth. This is worked out by dividing the total tonnage to be discharged by an average daily ship output figure, in tonnes per ship working day. For example, if a vessel has 2,345 tonnes to discharge, and ship outputs of about 600 tonnes per ship working day can be expected, she will take about four days to discharge. On the basis of this calculation, the master planning board is marked up by blocking in the appropriate squares below the ship's name, to indicate the number of days that the vessel will stay at berth discharging her cargo; this gives an indication of when that berth will be vacant to receive the next vessel.

18. There is a similar procedure for a loading vessel. Early information and stemming are even more important in this case than for a discharger, because of the need to consolidate cargo on the allocated berth before the vessel arrives. Exactly the same information is needed about the ship, but the Shipping List of the cargo to be exported will take the place of the Stowage Plan and Manifest. The senior traffic officer must find out from the ship's agent the expected tonnage to be loaded, port-by-port loading priorities and shippers' names. The agent should provide a copy of the provisional loading plan, if he has one.

19. Of course, although the details on ship arrivals for the next four or five days will be firm, reliable and quite comprehensive, those for later arrivals may well be less so. After all, vessels may be delayed at sea, by bad weather or engine breakdown; they could be held up at previous ports of call, perhaps by bad weather again, or by strikes or low productivity. For any of these reasons, and a whole host of others, a vessel may not arrive when expected, or may even arrive before she is due! The list of vessels due has to be updated continually. Of course, some shipowners may be unable to quote an ETA for their vessels until two or three days before the event. This is particularly likely for vessels engaged in coastal or short-sea trades. So, although a provisional arrival time will be announced when a ship's agent applies for a berth, this can be, and often is, amended nearer to the actual time of arrival.

20. So berth allocation must be flexible - capable of being adapted at short notice. A vessel might have to be reallocated, not just to a different day slot, but even to a different berth. Another complication: a vessel estimated to have finished cargo handling and to have cleared a berth by a particular time could be delayed, so that a vessel due on that berth may have to be reallocated. Clearly, the planning board must be kept up to date at all times for these decisions and adjustments to be made, and so the senior traffic officer must constantly check the estimated time of finishing cargo and of departure for each of the vessels in port. Even if a vessel is sure to leave on a particular day, that does not necessarily mean that it is safe to stem another vessel for that berth immediately afterwards. The senior traffic officer must first check that there is likely to be sufficient storage space available on the berth to receive indirectly routed cargo off the expected vessel. In fact, it is good practice to leave some slack when stemming. A clear day or so should be allowed after estimated departure time for storage areas to be cleared and for the berth to recover ready for the next vessel. Similarly, if a loader is expected to complete in three days, it is safer to allow, say, four days in the initial planning, to cover possible delays. Another restriction facing the allocation team may be the existence of "designated" berths - those appropriated by particular shipping lines or conferences, or set aside for exclusively import or export cargoes. In the event, then, when the senior traffic officer performs the task of berth allocation, his freedom to choose may be more limited than it might at first appear.

3. Berthing Lists and Berthing Plans

21. When all the vessels expected on a particular day have been stemmed to berths in this way, existing allocations revised and updated, times at berth adjusted, and so on, the information on the completed planning board is copied on to the Berthing Plan and Berthing List. A Berthing List (Table 1), shows the names of the vessels due to arrive over the next 10 to 14 days, with their ETAs, agent's names, the quantities and types of cargoes to be loaded or discharged, the numbers of the berths to which they have been stemmed, and all other relevant cargo-handling information. A Berthing Plan is a table showing the vessels already at berth and the berths to which arriving vessels have been allocated. It also shows

Table 1

BERTHING LIST

Date of arrival	Ship's Name	Cargo D/L	Berth No.	Special comments

the number of days the vessels will be at berth together with berthing instructions (e.g. which side-to they must berth). The senior traffic officer prepares the day's Berthing List by revising the previous day's list, crossing out the names of the vessels that have left the port over the previous 24 hours, and adding the names of the newly stemmed ships. He amends the Berthing Plan at the same time. The revised Berthing List and Plan are then typed up and copies distributed to all operations managers. Given this advance warning of the vessels to expect, they can estimate the demand and likely pressures on their berths.

22. That, then, is berth allocation, the first task in pre-arrival planning. It cannot be emphasized too strongly that careful stemming of vessels to the most suitable berth can improve productivity markedly and make much better use of a port's resources. This description may make berth allocation appear rather simple, but problems can and do arise. For example, berthing priorities may not be on a "first-come-first-served" basis; some shipping lines or conferences may have priority, as agreed with the port authority, and port policy may also restrict flexibility in allocating vessels. If there is a disagreement over berthing between the traffic officer and the ship operator (for example, over which berth to stem the vessel to, or when it is to berth), and port policy does not help to resolve it, the overriding consideration must be to stem the vessel to a berth offering the best "match", for the most efficient working, to keep ship's time in port to a minimum.

23. Once a vessel has been firmly allocated to a berth, and detailed information on its cargo is available, the next step in pre-arrival planning can be taken - that of resource allocation.

C. Resource allocation - the initial stages

1. Introduction

24. Before a vessel arrives in port, it is essential to make a provisional plan for the labour, equipment and other resources that will be needed to load or discharge her cargo: provisional estimates of the type of resources needed and the time at which they will be required. This operational or working plan is just as heavily dependent on the availability of information as is berth allocation, particularly details of the type and stowage of cargo. The ultimate aim of resource allocation is to plan the resources needed on the berth in such a way as to handle a vessel's cargo quickly and efficiently, at the lowest cost per tonne of cargo handled. For a discharger, the process of resource allocation - should start three days before the vessel is due to berth, by which time all the cargo information should have been received from the shipowner or his agent. The documents needed are: a copy of the ship's Stowage Plan, a summary of the hatch breakdown if possible, a copy of the Manifest, and a list of "specials" - refrigerated, hazardous, transshipment or overstowed cargo, animals, and so on. For a loading vessel, basically similar information is needed - the expected tonnage to be loaded, the cargo loading sequence, a Loading Plan (as early as possible) and any special working instructions issued by the shipowner or his agent. But in this case the planning process starts earlier, because the resources needed to receive and consolidate the cargo in storage will be allocated perhaps five to seven days before the vessel arrives. Resource allocation for the quay transfer and ship operations will, of course, have to wait until two or three days later, at about the same time as for ship discharge. We can illustrate the sequence of steps in resource allocation by looking at a discharger. Since general cargo operations are so labour intensive we should begin with the allocation and deployment of labour for the ship operation.

2. Allocating shipboard and quayside labour

25. The first task is a preliminary survey of the cargo Stowage Plan, to get a general idea of the type of cargo and its stowage positions. Then comes the job of drawing up Hatch Lists - hatch-by-hatch listings, showing the stowage positions of consignments, the quantity and type of cargo and, as soon as they are known, the delivery instructions and any special handling requirements. Table 2 shows a typical Hatch List for No. 5 hatch of a discharging vessel. From the Stowage Plan are next prepared Hatch Plans, recording deck by deck for each hatch the locations of all the consignments for discharge at the berth. Figure 2 shows a typical Hatch Plan, in this case for the No. 5 hatch cargo referred to in the Hatch List. The Hatch Lists and Hatch Plans are important planning tools and contain the information which forms the basis for subsequent planning. Using the Stowage Plan, Manifest, Hatch Lists and Hatch Plans, it is possible to see how the cargo is distributed between the hatches and to make a rough estimate of the work content in each hatch to determine the labour requirements to work the vessel.

26. Although in particular circumstances there may be alternative aims in view, perhaps determined by operating conditions in the port or shipowners' requirements, the assumption for the present is that the overriding objective is the allocation of labour in such a manner as to load or discharge the cargo as quickly and efficiently as possible so as to cut ship's time at berth to the bare minimum. The first step in determining the labour requirements is to make a rough estimate of the work content of each hatch. This is done by dividing the total tonnage to be loaded and/or discharged from each hatch by the average handling rate for that type of mix of cargo measured in terms of tonnes per gang per shift. For example, if a hatch carries 675 tonnes of cargo for the port, and a gang handles about 100 tonnes of that cargo mix in a shift, then we estimate that it will take about seven gang shifts to clear that hatch. By completing this exercise for all the other hatches it is possible to make a rough estimate of the total work content, and to identify the "heavy" or "commanding" hatch - the hatch with the largest work content and the one most likely to influence the earliest completion time. Once the work content of each hatch has been determined (and it is important not to forget deck cargoes or any consignments stowed in lockers above the weather deck), the number of gangs needed on each shift, throughout the discharging and/or loading operation, can be calculated. It is to the commanding hatch that attention should first be turned when determining labour requirements.

27. The aim is to turn the ship round in the minimum number of shifts and so the first decision must be whether more than one gang can be worked in the heavy hatch. If the ship has narrow hatch openings, it may not be practicable to work more than one hook. Similarly, if the cargo for the port is concentrated in one area of the hold, it may only be accessible by one gang; deploying two gangs may only marginally increase output, because of interference, but will double labour costs. The practice of half-hatching may mean that cargo for discharge at later ports of call, and stowed in the hatch square, prevents the hatch opening up fully. Lifting equipment, either shoreside cranes or shipboard derricks or cranes, must be of the right capacity and outreach if two hooks are to be worked simultaneously on that particular cargo. Finally, it is no good increasing the ship output if the other activities on the berth cannot be organized to keep pace with it.

Table 2

HATCH LIST

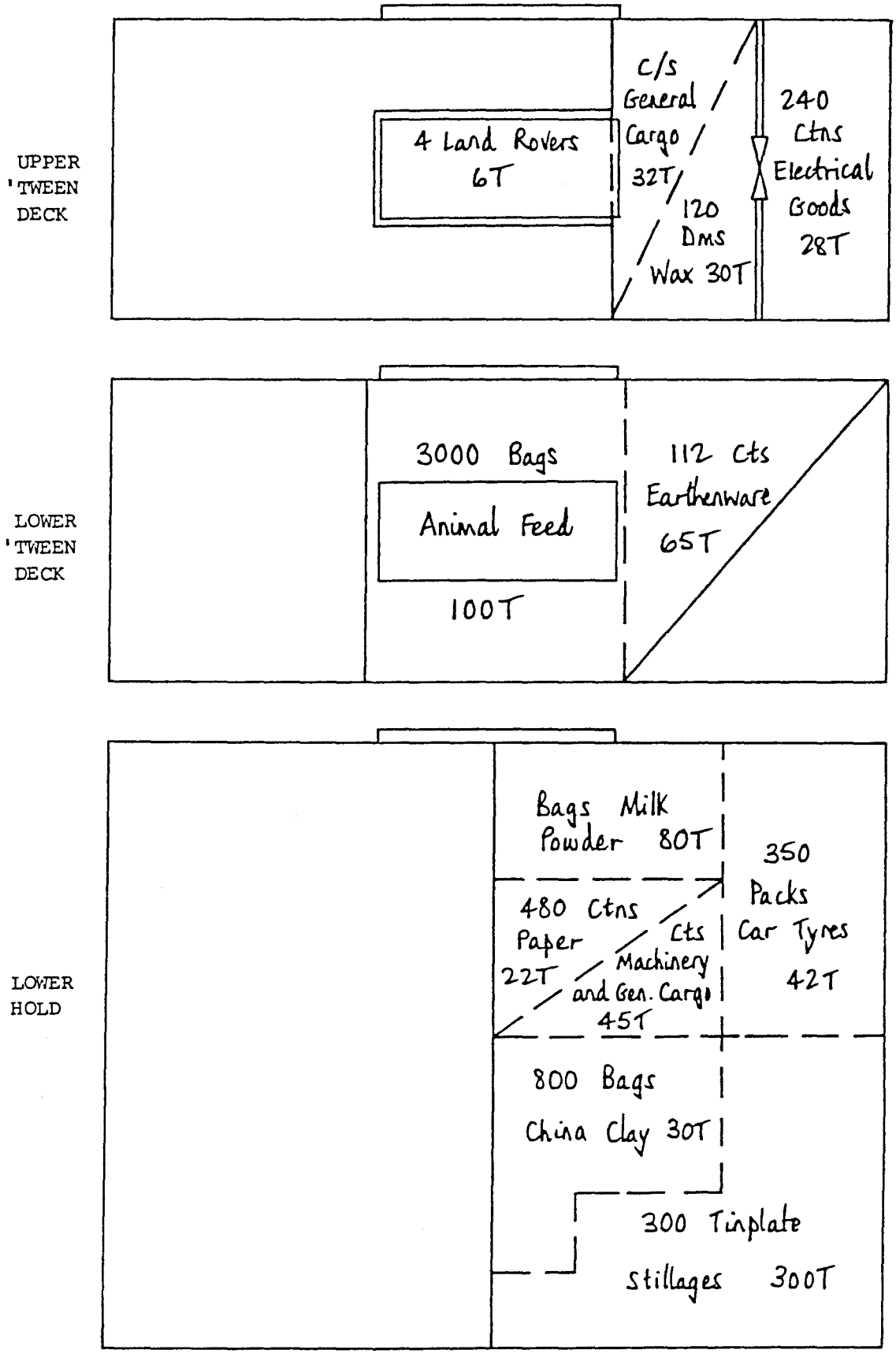
No. 5 Hatch

Stowage Position	Cargo	Delivery Instructions	Special Remarks
UPPER 'TWEEN DECK			
Square	4 Land Rovers 6T		Unlash vehicles Car lifting frame Obtain keys
Forward	c/s General cargo 32T		Pallets required
	120 Drums wax 30T		Drum hooks FLT - (2T)
Locker	240 Ctns electrical Goods 28T		Additional labour Pallets required Locker keys needed
LOWER 'TWEEN DECK			
Square	3000 Bags animal feed 100T		Cargo nets needed
Forward	112 Cts earthenware 65T		Pallets needed FLT (2T)? Hand trucks
LOWER HOLD			
Forward	2000 Bags milk powder 80T		Pallets needed
	480 Ctns paper 22T		Roller conveyors
	Cts machinery & general cargo 45T		Wire slings Crowbar Dunnage
	350 Packs car tyres 42T		Rope nets
	800 Bags china clay 30T		Cargo nets
	300 Tinplate stillages 300T		Rope slings Snotters FLT (2T)

Figure 2

HATCH PLAN

No. 5 HATCH



28. If the Stowage Plan and experience indicates that it is appropriate and, most important, safe to allocate more than one gang to the commanding hatch, it could well be that this is no longer the "heavy" hatch - it may now be possible to complete it before one or more of the other hatches. So the exercise is now repeated for all the vessels' hatches in turn, to decide the minimum number of hours or shifts that each hatch will take to complete. Now the estimated time of departure (ETD) of the vessel can be worked out, the shipowner can be informed, and the berth planning board updated. It is also possible to work out the total labour requirements for working the ship and to allocate the appropriate number of gangs for the first shift.

29. Of course, it is not necessarily desirable to allocate separate gangs to each hatch right from the start. The objective should be to keep the number of gangs or gang-shifts to a minimum. To this end, the labour plan might include moving gangs from a completed hatch to a light one in a later shift, or several other patterns of working. In fact, there may be several objectives, other than maximum Ship Output, when allocating labour to a vessel. For example, it may be better to have only a few gangs working a vessel in the early shifts, to give congested transit sheds time to clear, or because the storage operation cannot keep up with the full rate of the ship operation. Alternatively, it may be desirable to load or discharge cargoes as quickly as possible in the early shifts, whatever the labour cost, or perhaps to allocate labour in such a way as to create a medium but steady flow of cargo across the berth for the whole of the vessel's call.

30. Clearly, the commanding hatch is going to determine the total time the vessel stays in port, and so there may be some flexibility in the way gangs are allocated to the other hatches. The ability to transfer gangs between hatches, and between work areas and tasks on the berth, will obviously increase this flexibility. This will not only influence the provisional shipboard allocation plan but also the way the gangs are deployed during later shifts. Obviously, this plan must be discussed with the shipowner or his representatives to make sure that they are in agreement. If the port is one of those where gangs are requisitioned directly by ships' agents, rather than by berth managers, it is essential to check how many gangs they have asked for. If their estimates of work content and gangs required seem reasonable, then the requisition is approved and passed on to the labour office. However, if calculations show that the ship can be worked more efficiently by a different number or allocation of gangs, then the requisition should be modified. The port must retain over-all control of labour allocation.

31. It is not just a question of the number of gangs, of course, but their size and categories of skills required for the particular cargoes and the way these are stowed aboard the vessel. Most ports have manning level agreements for each class of cargo, but it is a considerable advantage to be able to vary gang size to match the work involved in handling a particular cargo. For example, it is ideal to be able to allocate, say, eight men to a shipboard gang for loose general cargo but to reduce gang size to four when handling a completely palletized cargo. So the cargo in each hatch needs to

be closely examined before deciding how many men to allocate. Then it is a matter of selecting the different categories of skills required for the first and later shifts. An obvious starting-point is to requisition enough skilled crane or winch drivers for the hatches being worked. Drivers of forklift trucks or other equipment may be required in the hold or on the quay, and tally clerks will certainly be needed, preferably in the shed on an in-stack tally. Riggers may be required at the beginning of the shift and possibly at other times, too, and we must not forget to deploy supervisory staff on board, on the quay and in the shed. On the quay, gangs will be allocated one to a hook, while the size of the gang will depend on the cargo characteristics and the route. For example, the two or three men normally needed will have to be reinforced by several more if the cargo is being manhandled direct to road or rail.

32. Although these estimates of labour requirements are still provisional, since the vessel has not arrived and the actual stow has not been seen yet, it is now time to fill in the labour requisition form for the first day's work, to send to the labour office or central labour pool. It will also be possible to give them some idea of the manpower demand for later shifts and of the likelihood of any overtime work. Such advance information could warn the labour office that there might be a shortage of labour, and give them time to arrange for extra casual labour to be brought in. Alternatively, they may be able to warn of an expected labour shortage (for example, because of holidays or sickness) and give time to alter the labour plan, perhaps to introduce overtime or weekend working.

33. That, then, is the first task in resource allocation completed - making a provisional estimate of the shipboard and quayside labour requirements and making sure that all the necessary skills are available when and where they are needed. We can now move on to consider the second stage of resource allocation, the task of allocating storage space.

3. Allocating storage space

34. When the vessel is first stemmed for a berth, the level of demand likely to be made on storage facilities is estimated. At that stage there should be a reasonable idea of the total amount of cargo to be loaded and/or discharged, and the proportion needing storage can be estimated. For a loading vessel, more detailed information will be available, so that the acceptance period can be fixed and storage space allocated for cargo received for consolidation. Then when the Stowage Plan and Manifest are available, the import consignments, too, can be allocated to specific storage locations.

35. The first step is to contact the consignees or their agents, to discuss their handling and delivery requirements, and to find out how much cargo is going into storage. Once it is known which consignments are going into storage, the floor area needed by each consignment, for open and covered storage, can be calculated. It will then be possible to allocate and mark them on the Storage Plans ready for distribution to the storage supervisors. At the same time, the delivery instructions for each consignment and any special requirements can be filled in on the Hatch Lists and Hatch Plans.

36. When the amount of cargo going through storage is known, and the likely pressure imposed by the receipt and delivery of cargo, labour can be allocated to the storage areas, not only for the storage operation itself but also for the receipt/delivery operation. Also required at this time is the requisitioning of equipment for the ship, the quay transfer and other berth operations, but for all these important aspects of resource allocation it is necessary to know fairly accurately when consignments will be handled, and so we have to digress slight to consider how to estimate operating times before continuing with resource allocation.

D. Estimating operating times

1. Introduction

37. A considerable amount of provisional resource allocation can be accomplished in the very early stages of pre-arrival planning (and, indeed, many of the requisitioning tasks for the first shift of a vessel's call have to be done on that basis). However, to be able to plan confidently and organize in detail all the resources required to achieve an efficient berth operation we need to know when each consignment will be loaded into or discharged from a vessel. But this is not an easy task. Clearly, the principal feature of conventional general cargo trades is the wide range of cargoes and consignment sizes carried. This makes resource allocation difficult, as manning levels, equipment needs and demand for berth resources vary from hour to hour and shift to shift. How is it possible to work out when drum hooks will be needed to discharge a large consignment of vegetable oil? When should transport be called up to take delivery of an import consignment going by the direct route? At some stage, a mechanic may have to remove a special attachment from a forklift truck, and replace it with forks so that it can go back to handling general cargo. When? For what time should a floating crane be booked to come alongside, to discharge heavy lifts from the deck? To answer the many questions of this sort, we need to be able to estimate operating times - to determine loading or discharging times for every consignment. A detailed knowledge of the operating times of the ship operation will, in fact, allow us to plan the resources for all berth activities, including the receipt and delivery of cargo to and from storage, and to prepare the work schedules for each shift of the vessel's call. How do we set about doing this?

2. Work values

38. The key to estimating operating times is a reliable set of work values for the major types of cargo regularly handled at a berth. A work value is simply the number of tonnes of a particular type of cargo that can be handled by a gang in a working hour using current operating practices and manning levels.

39. It is obvious that iron and steel in large lots will have very different handling rates (measured in tonnes per gang-hour) from a bagged cargo, and that loading tea on pallets is quite a different job to handling drums of chemicals. The first conclusion we can draw, then, is that work values will vary with the type of cargo and its packaging. At first sight we might imagine that we need to determine work values for every type of cargo and packing passing over our quays. But that would result in an extensive and possibly unmanageable set of figures to work with, as well as being an enormous measuring task. In any case, a 25 kg bag of coffee presents a similar handling problem to a 25 kg bag of sugar; it needs the same equipment, gear and manning levels, and will take about the same time to load or discharge. So what we have to do is to break down the whole range of cargoes handled at a berth into a series of broad classes, based on their handling characteristics.

40. The starting-point for this exercise must be a complete list of all the cargoes handled regularly at the berth, with estimates of the total tonnages handled of each cargo in a year and the average weight per bag, drum or other unit. There are many sources of this information: tally sheets, the Cargo Out-turn, the Hatch Lists, Loading Lists, Storage Records and the Ship's Manifest. This list of cargoes has to be reduced to a more manageable size by grouping the commodities into appropriate classes. For example, we can confidently group together all cargoes packaged in, say, 25-30 kg bags, since they present similar handling problems, will need the same equipment, gear and manning levels, and will take about the same time to load or discharge. Similarly, we can group other cargoes with the same packaging, such as drums, bales, crates and cartons, provided, of course, that we are sure that they are handled in a similar manner and at about the same rate. It is often convenient to separate imports from exports when classifying.

41. Some of the classes created may contain cargoes that only pass over the berth in relatively small consignments and quantities each year. It is more sensible to group all such small classes together under a broad general heading, such as "general cargo". On the other hand, it can be useful to divide some of the more important classes, particularly those moving in large quantities each year, into sub-classes with different work values. Instead of just listing "bags", there could be separate entries for "25 kg bags" and "50 kg bags", if these are handled at different rates at the berth. Obviously, the handling rates for shipper-packed palletized loads will be different from those for the same cargo loose, so these should be listed separately if cargo with both types of packaging form a substantial item in your berth throughput.

42. Having grouped the cargoes into broad classes, we are now able to proceed to calculate work values for each class. It is unlikely to be possible to calculate these values from existing performance records - the details almost certainly will not have been recorded - and so we will have to start from scratch. There are four steps in the calculation:

1. Measure the hook cycle times (in minutes) for each cargo class from a large number of observations taken on the quayside, and calculate the mean cycle time for each class.

2. Convert these times into the average number of cycles achieved per hour by simply dividing 60 by the mean hook cycle time.

3. Calculate the average weight of that cargo transferred per cycle from the tally records or from direct observation.

4. Multiply the number of hook cycles per hour by the average tonnes per lift to obtain the work value for each class.

Although a work value in terms of tonnes per gang-hour is ideal for most commodities, it may be better for some individual loads such as cars and heavy lifts to be given work values in terms of the number of minutes it takes to complete one lift.

43. In this way, then, we can build up work values for all the main cargo classes handled at the berth. It does take a considerable effort to make all the observations and measuresments initially, of course, and so it is best to keep the number of categories to a minimum. Also, the fewer work values there are, the more manageable the calculations become.

44. Of course, there are other factors which influence the rate of cargo handling and affect the reliability of single work values: the design of the ship, the way the cargo is stowed, and the route it will follow, the gang size, and the equipment used, and so on. So it is sensible to list not a single work value per class but a range of values, the lower end relating to poor stowage, bad ship design, lack of equipment and so on, and the higher end applying where good handling conditions are expected. A typical range of work values for 11 cargo classes is shown in table 3.

Table 3

TYPICAL WORK VALUES

Cargo class	Range of hook cycles per hour	Average weight lifted per cycle (t)	Work value range (t/gang-hour)
1. 30 kg cartons	12.5 - 20	0.8	10 - 16
2. 50 kg cartons	11 - 17	1.2	13 - 20.5
3. 220-230 kg drums	18 - 27	1.0	18 - 27
4. 2 t reels newsprint	15 - 18	2.0	30 - 36
5. 50 kg bags	10 - 15	1.2	12 - 18
6. 50-100 kg crates	8 - 18	1.5	12 - 27
7. 30 kg sacks	12.5 - 20	0.8	10 - 16
8. 100 kg bales textiles	20 - 30	0.8	16 - 24
9. Palletized cargo	22 - 30	1.0	22 - 30
10. Tinplate	19 - 25	2.0	38 - 50
11. General cargo	15 - 20	1.1	16.5 - 22

3. Estimating starting and finishing times

45. Having developed a set of work values for each of the main cargo classes handled at a berth, how can they be used to estimate starting and finishing times for consignments? The starting-points for the calculations are, as always,

the Hatch Lists and Hatch Plans which have been prepared from the Stowage Plan and Manifest. The process of estimating operating times for a particular consignment of cargo is quite simple. It consists of the following six steps:

1. Extract information on the type, quantity, packaging and other handling characteristics of the consignment from the Hatch List, Hatch Plan or Manifest or from the Loading Plan and Loading List.

2. Determine the appropriate cargo class and extract the range of work values applicable.

3. Study the ship's Stowage Plan and Loading Plan to determine how the consignment is to be worked, in particular the manning level to be adopted, whether mechanical handling equipment can be used and the type of lifting and stevedoring gear to be used.

4. Select an appropriate work value for the conditions the gang is expected to work under and the operating practices adopted.

5. Divide the consignment tonnage by the work value to estimate the total handling time.

6. Estimate the time when the labour will gain access to the consignment and, using the estimated handling time, the time of completion of that job.

46. So, given the tonnages for each consignment to be discharged and loaded, the times of starting each consignment and of completing it can be estimated. This procedure can be used to estimate all operating times and, as we shall see later, has another important function in work scheduling. Of course, when working out the time of access to a consignment, time must be allowed for rigging ship's derricks, opening hatches, releasing cargo lashings, lifting equipment in and out, and other preparatory tasks.

47. Now that we have detailed estimates of the times and work content of the various stages of the ship operation, we can return to resource allocation - finalizing the resources we need to work on the vessel. Remember that we are still talking about a day or two before the vessel arrives.

E. Resource allocation - the final stages

1. Indirectly routed cargo

48. When we digressed from resource allocation, at the end of section C, we had already determined the labour requirements and completed the labour requisitioning for the ship operation. We had also estimated the likely level of demand on storage facilities when the vessel was first stemmed to the berth, and had made a provisional allocation of consignments to specific storage locations (in sub-section 3). We are now in a position to be more precise about cargo following the indirect route, having analysed all the data now available, and can go even further, telling the shed supervisor exactly when to expect each consignment being discharged to storage or, indeed, being loaded from storage. On the basis of this he will be able to plan the development of his labour sensibly and make sure all the resources are in position when a consignment commences transfer. The storage instructions and any other special requirements can also, at this time, be filled in on the Hatch Lists and Hatch Plans. For example, we can now add such notes as "to Bay 4 in D Shed" or "to Section B

of the open yard". The more details available to the supervisors and foremen, the more likelihood there is of the storage operation running smoothly and efficiently. We can also plan all the labour requirements for the storage areas, as we know how much cargo will pass through and what the demand for labour will be, not just for stacking and unstacking but also for the receipt/delivery operation. We shall return to this a little later.

2. Directly routed cargo

49. A similar procedure is adopted for cargo following the direct route. When we know the approximate times of loading or discharging a consignment, we can complete the Vehicle Appointment Forms. This will ensure that the road vehicles, railcars or barges come alongside the vessel at the time consignments are discharged or are to be loaded. For example, we may have estimated that a consignment of 80 drums of tallow, going direct to road, will take about an hour to discharge. If unloading starts at about 0725 hours, it will be completed by about 0800 hours. On the basis of this, we can instruct the consignee to send two of his lorries to the port by 0700 hours and the others by 0730. We can go on to complete the time-tables for as many shifts ahead as we can, for imports and exports, direct and indirect routes, for road, rail and barge.

3. Requisitioning equipment

50. So far, we have organized the shipboard and quayside labour, the storage facilities, and transport for cargo following the direct route. By now, it is probably just the day before the ship arrives, and it is time to begin to select and requisition the mechanical handling equipment for the shipboard, quay and storage activities. If quayside cranes are to be used, the appropriate number will have to be ordered, with their drivers, to be moved into position before the start of the shift. We can instruct the Harbour Master about the time a floating crane is required to handle heavy lifts. What about mobile plant? Are there any times when a heavy duty mobile crane will be needed? The engineers will need to know in plenty of time. What about all the other pieces of mechanical handling equipment that will be needed, in the ship's hold, on the quay transfer operation, and to stack and receive cargoes in storage - plant that is interchangeable between these duties?

51. Again, we go back to the Hatch Lists and Hatch Plans, and to our estimated operating times, to prepare a detailed plan of what types of equipment will be used and where they will be needed. For example, suppose we decided to use a forklift truck to discharge a consignment of crates of piece goods from the upper 'tween deck of a vessel. We estimate that the gang will gain access to these crates at 0645 hours and that it will take about 45 minutes to discharge, so we will need to requisition the truck for the beginning of the shift at 0600 hours, and it will be needed until about 0730. Another vital point for the requisition form: perhaps the crates are stowed on top of a consignment of drums, so the forklift truck will have to arrive fitted with fork extensions. Do not forget that these will de-rate its capacity, and so we will have to order a three tonne forklift truck, to be on the safe side. The truck will also have to have lifting lugs, so that it can be hoisted abroad. In the same way, we will plan the number and type of units, their capacity and the time they are required, for the other consignments in this hatch and for the other hatches on the ship. The best way of doing this is by means of a simple planning chart on which, for each hatch, the type of equipment and the times it is needed during each shift are blocked in.

52. The same process and planning chart can be used for deciding the type and capacity of equipment to use in the quay transfer operation, the shed and open yard, and any other activities on the berth. A plan must be drawn up for the resources for the receipt/delivery operation, too, to determine what equipment is needed there. The number of units ordered to perform these tasks will depend on the rate at which cargo comes into storage from the quayside and/or from inland transport, and its rate of dispatch from all storage areas. The type of equipment requisitioned will depend on the cargo and how it is stacked: tractor/trailers for loose cargo destined for a security locker, heavy-duty mobile cranes for awkward loads in the open yards, and forklift trucks for palletized loads into the shed, and so on. Of course, equipment needs should not be calculated for each of the berth activities independently: equipment will be transferred from one job to another as the work proceeds.

53. The receipt/delivery operation will also have to have labour allocated to it. Gangs might be needed for a whole shift, but on the other hand they might only be required now and again, as vehicles arrive at the sheds or open yards. If that is the case, we can take the opportunity of transferring labour between different working areas, just as we did for equipment. Men could be moved, for example, between a storage bay in a shed, a dispatch point in an open yard, and the quay apron to handle a direct delivery. By sensibly transferring resources in this way, it is possible to reduce to the minimum the demands placed on the port's equipment and labour, as well as keeping these resources working steadily and efficiently.

54. As a general rule, then, equipment and labour needs should never be planned separately for each of the berth activities and areas of work. All parts of the berth operation should be considered together, as a very important aspect of resource allocation is to determine when and how resources can be transferred from one activity to another for maximum economy and efficiency. This may not present a problem as far as equipment is concerned, but the ability to move labour between one activity and znother or between one work place and another may be restricted by local management/union agreements. The benefits of having flexibility in employing labour cannot be over-emphasized. If labour can be transferred between activities, then this should be built in to operations planning when allocating resources. A mobile crane may be transferred from an open storage yard to the quayside, to deal with a particularly heavy lift, and a forklift truck, after discharging crates from a 'tween deck, can be moved to a transit shed. A gang of four men can be transferred from a dispatch bay, when a receipt/delivery operation has been completed, to a storage bay, to manhandle cartons from tractor-trailers into stack, or to the quay apron, to assist in a direct delivery operation.

4. Requisitioning stevedoring gear

55. We have now probably reached the afternoon before the vessel arrives, and are in the last stages of resource allocation. The next step is the requisitioning of stevedoring gear from the storeroom. Again the Hatch Lists and Hatch Plans are used to identify the type and quantity of gear needed to work the cargo safely and efficiently, and when it is needed. Some assumptions will have to be made as to the type of packaging or stow to expect but the Manifest can be used to good effect here. It is often possible to marry the information contained in the ship's Stowage Plan and the Manifest so as to find the actual weight, dimensions and type of packaging of consignments of mixed cargoes. But plans will have to be changed if, at first sight of the stow, it becomes clear that other gear would be more suitable. Then there are the dock

pallets, dunnage, crowbars and all the other odds and ends that are the tools of the trade; it is essential not to overlook the need to requisition these.

5. Preparing a Tally List

56. When all the resource allocation tasks have been completed, there remains one more important step in Pre-arrival Planning - preparing a Tally List of all the consignments to be discharged. From the Manifest, a list is made detailing bill-of-lading number, shippers' marks, quantity and type of cargo and the way it is packaged. A note of the stowage position of each consignment is also useful, if this can be worked out exactly from the Cargo Stowage Plan. Copies of the Tally List must be distributed to all the tally clerks and checkers before the ship arrives, so that they know what to expect.

6. Pre-arrival briefing meeting

57. The final and very important task is to bring the managers and supervisors on the berth together to brief them on the Work Plan, to explain the planned operating procedures, and to discuss the sort of problems that may arise during the working of the ship. Everyone in a position of responsibility or authority must know how the ship is to be worked and what resources have been requisitioned. For this purpose copies need to be made of the Hatch Lists, Hatch Plans, Storage Plans, Vehicle Appointment Forms, and of the rough estimates of operating times, to hand out to all supervisors and managers. The communications exercise does not end there; continuous communication between managers and supervisors is essential for the smooth running of the berth operation. Managers and supervisors will have to be contacted frequently, when problems arise, when there is a change of plan, when there is equipment failure, and so on. It is also advisable, throughout the loading or discharge sequences, to hold regular daily meetings with all managers and supervisors to discuss progress.

58. That, then, is the procedure to follow when completing the very important task of resource allocation at the pre-arrival planning stage, and completes our discussion of pre-arrival planning. We can now proceed to the second stage in operations planning: work scheduling.

III. WORK SCHEDULING

A. Introduction

59. Work scheduling is the name given to the shift-by-shift detailed planning of operations when the vessel is alongside the berth, to achieve the highest possible ship output and the minimum of delays. It is an extension, therefore, of the resource allocation undertaken before the vessel arrives, but now there is the added advantage that the ship and its cargo stowage have been examined. Work scheduling is the task, then, of filling in and adjusting the estimates roughed out in pre-arrival planning.

B. The Work Schedule Form

60. The basic tool of work scheduling is a form, one of which should be completed for each hatch of the vessel for each shift. Figure 3 is a version of such a form completed for the first shift for hatch 3; it gives space for recording the stowage position of each consignment, the work value for that cargo under those conditions, the estimated times of starting and completion, and notes on the handling, equipment, storage and so on. The Work Schedule form is completed by entering each consignment in the sequence in which it will be

Figure 3

WORK SCHEDULE

Berth: 3	Ship: MV UNCTAD	Hatch: 4	Date: 20 March 1982	Shift: 1	No.Gangs: 1

Stowage Position	Cargo	Work Value (Tonnes)	Estimated Time		Remarks
			Start	Finish	
			05.30	06.00	Release lashings. Protective clothing
On Deck	Drums of Insecticide	27	06.00	07.00	Drum hooks. Tractor/trailer FLT in yard with drum clamp
			07.00	07.15	Open hatch
UTD	Reels newsprint	36	07.15	10.15	Leather slings. Schedule road vehicles
	Sacks of Resin	12	10.15	14.00	Pallets. Unit lift needed. 2 FLTs (2T)

handled, as well as all preparatory work - pre-shift rigging, opening hatches, laying dunnage, and so on. Information on the cargo and its stowage position is transferred from the Hatch List, and to this is added the work value selected and, on the basis of that estimate, the times of starting and completing handling. From knowledge of the cargo and its stowage, and previous experience of handling similar cargoes, it is then possible to note the type of gear, equipment and other resources and facilities needed to handle the cargo safely and efficiently. With a little practice, completing such forms becomes a simple, routine matter.

61. Of course, work scheduling for the very first shift of the vessel's call will have to be completed during resource allocation at the pre-arrival planning stage, but this must be considered as only provisional because neither the ship, the cargo nor the stowage will have been seen at that time. It is essential to do it then, in order to requisition labour, equipment and gear for that first shift. When the hatches are opened, and the first good look at the job is possible, things may not be quite as expected. A consignment may turn out to be overstowed by one for another port, or in a more difficult stowage position than expected; the equipment selected may not be suitable. Many of these factors will influence the work value and so change the estimated times of commencing and completing the consignment. Adjustment of that tentative work schedule must be expected and on-the-spot supervisory decisions taken to get the cargo moving. The resulting amendments to instructions must also be issued to the engineering department, gear foremen, shippers and receivers, etc., without delay. For later shifts, however, there will be plenty of opportunity to see the ship and its stowage and to make a more accurate assessment of work values and resources needed before starting on the Work Schedule for those shifts.

62. When the first shift is under way, planning can begin of the Work Schedule for the second shift; the stow has been seen now, and as the Schedule can be completed more firmly and confidently. The steps to follow are:

1. Check the estimated operating times in the light of progress to that point and where the gangs should be when the present shift ends.

2. On the basis of this, draw up a detailed Work Schedule, listing all the consignments to be handled.

3. Confirm or adjust the over-all plan for the labour needed for the job and requisition manpower for the shift.

4. Requisition the equipment and gear for the shift.

5. Using the Work Schedule, check storage requirements, adjusting the space set aside if necessary, and confirm the times of receipt into stowage with supervisors. For a loader, confirm times of collecting the consignments from storage.

6. Check the road vehicle appointment bookings, the times of rail shunts, and the arrival times of barges or coastal vessels. If adjustments have to be made, cargo owners or their representatives will have to be instructed about the new times.

63. These are, thus, the steps to go through when work scheduling for the next shift. But, of course, things can go wrong even in the few hours before that shift starts. There could be weather delays, non-arrival of transport, equipment failure, a sudden change in shippers' instructions and many other

possible problems. These will obviously upset estimates of operating times and work will not progress as far during that shift as expected. So, the Work Schedules for the next shift will obviously have to be adjusted before it even starts. All the parties, within and outside the port, will have to be informed of these changes and the requisition times of equipment, transport and so on altered.

64. As well as causing changes to Work Schedules, of course, delays and unexpected problems require on-the-spot supervisory action: shifting labour and equipment around, re-routing cargo, calling for extra gear and attachments - all the actions needed to prevent delays snowballing and work falling further behind, and to keep the Berth Operation moving as smoothly as possible.

65. Work scheduling is a continuous planning activity while the vessel is alongside the berth, a process of constant adjustment in relation to progress. It is essential to look ahead constantly and to prepare the Work Schedule for the next shift or work period in good time to allocate the appropriate resources and to plan the delivery of cargo or the arrival of transport in the port. The Work Schedule is, then, a very important form, and needs to be distributed, along with all the other documents, to foremen and supervisors.

66. The vital link and interdependence should now be clear between pre-arrival planning, undertaken a few days before the vessel arrives, work scheduling, carried out a few hours before the shift, and day-to-day supervisory activities. Good planning, over whatever time scale, will certainly create the framework for an efficient operation but must still be supported by on-the-spot and prompt supervisory action whenever things go wrong or when changes of plan are necessary.

IV. PERFORMANCE REVIEW

A. Introduction

67. The final task in operations planning is the performance review, which is undertaken when the vessel has completed the discharge and loading of its cargo and has left the port. It is an exercise in which cargo handling performance and planning, organization and supervision are closely scrutinized. Its great value is that it makes it possible to monitor a berth's performance, to identify problems or weaknesses in planning and operating practices, to establish the causes of poor port performance and to take the necessary action to remove them.

B. Performance indicators

68. The first task is to collect all the available operating data together, to calculate the important performance indicators which form part of the berth's management information system. In this context, we can conveniently identify four broad categories of performance indicators:

1. Indicators of output (relating to the quantity of work performed e.g. berth throughput, ship output and gang output).

2. Indicators of service (measures of the quality of service provided e.g. ship turn-round time).

3. Indicators of utilization (measures of how intensively berth facilities and resources are used e.g. berth occupancy and berth working time).

4. Indicators of productivity (indicators of cost-effectiveness e.g. cost per tonne of cargo handled and labour cost per tonne of cargo handled).

69. The measures of output needed are the total quantity of cargo loaded and discharged during a vessel's call, and the actual operating times. From these can be calculated the various measures of ship output; tonnes per ship hour in port, tonnes per ship hour at berth and tonnes per ship working hour. Also needed are the gang output, in tonnes per gang hour, achieved at each of the hatches and for each of the main cargo classes. These are important measures of performance which can also be compared with the work values established for each cargo class. Periodically, of course, berth throughput needs to be measured, perhaps on a monthly as well as an annual basis.

70. For service indicators, ship turn-round time is a prime measure, as well as its components, waiting time and ship's time at berth, but another good measure of quality of service is ship out-turn. This is a full list of the cargo discharged; by comparing it with the Manifest, a list can be drawn up of the cargo short-landed, any excess-landed, and any damaged or deteriorated cargo. This indicates how well or badly the cargo was handled. All entries on this list should be very thoroughly investigated.

71. For utilization, the relevant indicator is berth working time. It is essential to make sure that the vessel works the greatest number of hours when alongside, and that idle time is kept to a minimum. The major causes of operational delays and idle time should again be thoroughly investigated. At this stage, the amount of non-operational time should also be examined to see whether better utilization of the berth's resources is possible, and whether ship turn-round time could be reduced.

72. Every month or so, a series of other indicators should be calculated: berth occupancy, for example, to indicate the level of general demand; storage utilization, which provides a guide to the pressures on storage space; and, of course, the average in-transit time, to see whether stricter control is needed to enforce the port's storage policies. Then there are equipment availability and utilization measures, which must be calculated as indicators of how well equipment is being operated and maintained.

73. Finally, and most importantly, productivity measures must be calculated. Figures on costs will be needed for these, of course. The port's management accounting system should be able to supply such figures as the berth's labour costs for the period, equipment maintenance and fuel costs, and berth overheads. From the throughput figures, labour cost per tonne and the total cost per tonne of cargo handled can be calculated.

74. When all these data have been collected and the performance indicators calculated, a meeting must be arranged with the managerial and supervisory staff on the berth to have a real inquest on a ship's call or to review the past few weeks' performance. This is the opportunity to identify problems or weaknesses in operating practices, to establish causes and to take the necessary action to remedy them. For example, if ship output is low, is it because of a shortage of road transport, a badly planned vehicle appointment scheme, frequent equipment breakdown, or poor time-keeping by labour? The records and the observations and comments of staff should help to pinpoint the causes, and it is then up to the traffic officer to take the appropriate planning and supervisory action to make sure that these mistakes do not occur again, and to encourage good working practices. This regular performance review, is therefore, a very important element

in the managerial control of the berth operation, as well as the final activity in operations planning. The lessons learnt in the performance review must be applied immediately to the next pre-arrival planning exercise, and to work scheduling, so that cargo handling operations can be managed more efficiently.

V. CONCLUSIONS

75. That concludes this survey of the steps involved in operations planning. Much of what we have discussed has merely been the drawing together of a range of planning and other management skills. It has provided an opportunity for organizing these procedures into a systematic and routine approach to operations planning. By now the importance and value of sound operations planning procedures in berth management should be apparent and the contribution this can make to improving the performance of cargo handling operations in the port. Establishing such a system will quickly be rewarded by improved productivity, better use of the port's resources and improved quality of service to port users.