PRODUCTION PLANNING AND MANAGEMENT IN SHIPBUILDING

read before

The Royal Institution of Naval Architects

at

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on

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by

P.G. Newey

GENERAL PRINCIPLES OF PLANNING IN A SHIPYARD

We have always had to plan a job before we do it, but only in recent years has planning been recognised as a separate function in shipbuilding.

It would appear at first sight that the ideal planning set-up is a matter of opinion. But should this be so? Leaving aside the question of the degree of control which a planning office should exercise (which will be discussed later in this paper), two guiding principles must be observed:

1. The planning office should plan every stage in the construction of a ship - design, drawing, procurement, steelwork, outfitting and testing.

2. Planning must be carried out to the optimum detail. In theory, this point is reached when the greatest savings can be made relative to the cost of planning. In practice, the optimum is determined by the planning office's ability to police the job.

In spite of superficial differences, the methods used by planners do not vary much from yard to yard. No matter what high-sounding techniques are applied, or how much computer programmes are bandied about, basically all are concerned with the same things - evaluation of the job, determining the best sequence of operations, setting the result out as programmes of work and reporting progress.

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PRODUCTION PLANNING FOR NEW SHIPBUILDING AT THE STATE DOCKYARD, NEWCASTLE, NEW SOUTH WALES.

The State Dockyard is engaged in shipbuilding, ship repair and general engineering. Shipbuilding capacity, with the existing labour force, is about 5,000 gross steel tons a year. The shipyard has the potential to treble this output, simply by increasing the labour force, if the orders are forthcoming.

On 1st July 1965 a Production Planning Office was set up, comprising, at that time, two planners. The Office now comprises four planners and an apprentice.
We are a purely advisory department, being responsible to the Shipyard Manager, and working through him. It must be clearly understood that we have no authority outside our own office, but in practice, having obtained the Shipyard Manager's approval for our master programmes, we are free to issue detailed programmes direct to heads of departments, to examine any work in progress and to discuss the job with the man in charge. Because we can detach ourselves and see the job as a whole, we can do a lot of the foreman's thinking for him. Whether the foreman observes our programme or not is between him and the Shipyard Manager.

We have, so far, planned two ships, of which one is still in the drawing stage. We are now working on a third ship on which construction will start in January, and a fourth ship which, at the time of writing, has not been ordered.
We feel that our first year of operation has not been particularly effective, as it is necessary to find one's feet and there has been a good deal of trial and error; particularly, we have had difficulty in estimating the output of which the yard is capable.

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Ship 76: 19,600 dwt coastal tanker for B.P. (Australia) Ltd.

The order for this ship, and its sister Ship 77, was received in October 1964 and the first unit was erected on 20th August 1965. It is therefore evident that we missed the opportunity to plan the most vital stages - design, drawing and procurement.

Our first action was to compile and issue an assembly and erection programme designed to meet the then intended launch date, together with an estimate of the number of Boilermakers required. Only 75% of our estimated number was forthcoming over the succeeding months, and this, combined with constant shortage of design information and of bought-in equipment and fittings (particularly valves) has led to frequent revisions of our programmes.
We then compiled, with the help of the outside staff, a P.E.R.T. network to cover all uncompleted work; this was computed in January 1966, and although it ended up far too large for practical use, it proved of tremendous value in analysing the job. Because of its unwieldy size, we have never re-computed this network, but it is still used to derive detail programmes, simply by manual computation of particular parts of the network.
We have issued about 30 detail programmes, covering fabrication, assembly, erection, cargo tanks outfit, deck outfit, cargo pumproom outfit and some engine room outfit; we are now working on accommodation outfit.
Our biggest problem has been to accustom foremen to the use of our programmes. The first and essential step is to give them realistic programmes, after which, by constant progress checks and discussions we can get them into the habit of working with us. We feel we are making good progress in both directions.

Ship 78: 95' lbp Tug for the Public Works Department of N.S.W.

The order for this ship was received on 1st May 1966 and completion is due for 31st October 1967. For such a small ship 18 months is ample, although it must be remembered that it takes just as long to buy in equipment and fittings whatever the size of the ship. The delivery date and the size of the ship make it an ideal model for a planning system. Because it is to be built at the same time as two other ships twenty times the size, it is essential to plan it in such a way that it never exercises prior claim on resources but can still be completed on time. Our method is simple, we have built-in two months total float on the critical path; other paths have float ranging up to 41 weeks. This has been possible without shortening our time estimates.

The Planning Office started work on the ship in March, by working out, in conjunction with the Drawing Office, the erection break-up, which, having been approved by the Shipyard Manager, together with scantling plans, general arrangement and specification, enabled us to compile a comprehensive master network of 274 activities. This was ready and manually computed two weeks after the order was received. Incidentally, it took one man one day to compute the network by hand; when the network was subsequently put through a computer it ran first time, and the results confirmed our planner's figures as correct. But it took 2 days to prepare the computer input and computer time cost us $75.00

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From the master network we made up a master programme, in bar-chart form, using the earliest dates. Where free float was available this was added to earliest finish dates for the bar-chart. The master programme gives us everything we need for compiling detail programmes, although in some cases it is convenient to draw a sketch network to help us break down a major activity into a number of minor ones. Our detail programmes are issued under the headings of

Ship Drawing Office Work
Engine Drawing Office Work
Purchasing
Loftwork
Fabrication
Assembly
Erection
Main Fairing and Welding
Deck Outfit
Accommodation Outfit
Engine Room Outfit
Sterntube Manufacture
Electrical Outfit.

About a month before work is due to start a head of department receives a folder containing his programme kit - that is, the master programme and the detail programme(s) which affect him. We find that single sheets tend to be lost or put away where they are never looked at. Our folders are, at the oment buff-coloured: next time they are going to be bright red! These programme kits are delivered personally by the planner, who then follows up with frequent visits to the job to check progress. When programmes have to be revised, the planner goes out and makes the alteration himself, and makes sure the head of department knows about it.

The first plates for this ship are planned to be cut on 2nd November; to date, we are three weeks ahead of the programme, and if the Foreman Boilermaker finds it convenient to start before this date, he will have our blessing, but we do not think it necessary to revise the programme for this. We like to tell ourselves that the success so far achieved on this ship has been because all concerned in the design negotiations have been given definite dates by which decisions must be made.
We have had the greatest cooperation and help from the Drawing Offices.

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Ship 77: 19,600 dwt coastal tanker for B.P. (Australia) Ltd.

Although the first unit was erected some months ago, and three further bottom units will follow during the next three months, it is not intended to divert any quantity of labour to this ship until January. We have had time to study progress on the first tanker (Ship 76) and learn from our mistakes. After consulatation with the Shipyard Manager and his staff, including the Drawing Office, the sequence of erection and many of the units have been altered.

The basis of our planning on this ship is a master programme in the form of a bar-chart with 300 activities. As a tanker involves so much repetitive work it was fairly easy to draw this bar-chart, especially for a second ship, but we did make free use of network analysis to assist in working out particular sections of the programme. But simple network analysis is not much help in allocating resources, which, in a major job must always be allowed for, and so we used other methods as well. For instance, although the erection part of the programme was based on an erection and fairing network, we adjusted it to give a consistent rate of erected tonnage.
As in the case of the tug, Ship 78, we shall compile detail programmes from the master.

Future Contracts

It is part of the Planning Office duties to calculate delivery dates for enquiries and to provide a brief outline programme. These are worked out on the basis of current commitments and an analysis of the manpower requirements of the new enquiry. Our most useful yardstick is the boilermakers' manhours estimate. This is not always the primary consideration, as for instance in the case of a dredger; one has to use whatever information can be obtained and applied. The only problem is that we have to make certain assumptions about our future labour force.

We are fortunate in usually having a good idea of what our next order will be. As soon as we scent another order in the wind we get hold of any plans and specifications we can and start to plan the ship. We do not worry too much if the plans are not final; they are not often completely wrong, and if they are we can usually guess where, and anticipate what action to take. The benefits of starting early cannot be over estimated.

We are currently studying a ship for which a tender has been lodged.

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Up-dating and Revision of Programmes

This is a constant source of worry to planners, and our experience may be of value. Work runs ahead, or falls behind; should a new programme be issued? We never revise a programme unless absolutely necessary, and we give careful thought to the matter beforehand. Briefly, there are two circumstances under which we would revise a programme:

1. Where work is running ahead of the original programme and the subsequent work is so "tightly" programmed that it is necessary to pick up any advantage we can.

2. Where work is falling behind the original programme, and there is no chance of catching up within the next month, then we would revise the programme covering the department which was falling behind, and those of any dependent departments. We would not revise the programmes of departments whose work precedes that which was falling behind.

We do not work any fixed routine for updating networks, because we use them only as a tool to work out our programmes rather than as programmes themselves.

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PLANNING AND MANAGEMENT

The main purpose of this paper is briefly to inform readers of the methods in use at the State Dockyard and the results obtained. The remainder will be devoted to some general discussion round the subject of planning, and a few suggestions.

Planning has been dealt with so far purely as an advisory function, working parallel with Management. (In this context, Management means the "line" of production control from Shipyard Manager to Foremen.) There is much merit in the advisory system and in the early stages of planning it is the only practicable system. It is not always realised by heads of departments that the introduction of planning, with written programmes and progress records, affords them complete protection from responsibility for late completion of a ship, providing they have met their part of the programme. The realisation of this fact will give planning considerable influence!

But as planning improves its methods and delves into greater detail, so it becomes more difficult to police the programme and ensure attention to planned detail by Management. Revisions become so frequent that the detail is wasted. The only step which can then be taken is to make planning a part of management - to insert it into the "line". This step can be delayed if personal cooperation between planners and Management is above average. Some shipyards have already reached the point of executive planning and have been led to appoint a Production Manager, with planners as his assistants, who controls the output of the departments by weekly or fortnightly programmes, and is responsible to the Shipyard Manager for the execution of these programmes. Responsibility forces him to keep in touch; foremen must go to him for instructions, and not, as in the case of advisory planning, as an afterthought.
Parallel Management staff will look after matters indirectly affecting production, particularly labour relations.

While planning remains an advisory function, its chief purpose is to take some of the burden of thinking from Management, by virtue of its ability to review all the facts and to offer constructive, consistent advice. As a step towards achieving this object, we are now developing at the State Dockyard, a progress reporting system which is a modification of the "PERT COST" technique. The system is designed to show, at a glance, when progress and costs vary from the planned pattern, and where.

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By assigning estimated costs together with earliest and latest start and finish dates to each activity on our programme, we draw two progressive cost curves. One curve assumes that all activities start and finish on the earliest date, and the other curve the latest date. Such curves are produced for each department.
As costs are expended and reported, so a curve of actual cost is built up alongside the planned curves. The relationship of actual to planned cost curves tells a clear story, but only if the cost estimates are proving correct. Since this is not always the case, it is an essential part of the system that a fourth progressive curve be built up, showing the value of the work done in terms of the original cost estimates for each activity.
Further clarification can be achieved by superimposing a bar chart, showing the planned activities, on the graph, to the same time scale, and keeping it marked up to date.
The relationship of the four curves now tells exactly how costs and work done compare with the programme, and Management have the necessary information on which to base their action.
For instance - as soon as the value curve trends towards the planned latest date curve, action is required to accelerate production; as soon as the actual cost curve trends above the value curve, action is required to save cost; as long as the actual cost curve and the value curve stay together and between the planned curves, no action is required.

At the State Dockyard we are currently only covering labour expenditure, in manhours, with this system; we hope eventually to be able to cover all costs.

Early cost reporting is vital to the success of the system.

Ideally, today's costs should be available tomorrow morning, but how many shipyards are equipped to do this? It can be done, but probably only with the use of automatic data processing machinery. Shipbuilders should be considering the installation of such machinery.

The accelerating advance of technology should be affecting shipbuilding as much as any other industry and yet it is disappointing that so little energy is devoted to research into the practice of shipbuilding. Even tertiary education in naval architecture concentrates almost entirely on design theory. How many Australian shipyards employ anybody on full time research on production techniques? There is a tremendous amount of work to be done in this field, assuming, that is, that we wish to advance in shipbuilding in Australia.
Any number of subjects spring to mind - composition, design and handling of steelwork units for cheapest welding; part identification and marshalling systems; costing systems; automation of clerical work; purchase of new equipment; staging; jigs and tools; materials flow; plant layout. Every reader could name another dozen.

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Production planning is the nearest approach that most shipyards have made to this sort of work, but methods research should not be regarded as the next step on from production planning, but as a necessary partner. For practical purposes, the planning office is the best place to start such work from, but it should quickly expand to form a department in its own right.

It is the usual thing to be told, when proposing methods research, that the Staff are expected to improve their methods in the course of their normal duties. But the real progress will only start when it is made someone's first responsibility to devise and introduce improved methods, for as long as it is left to staff who are already immersed in the business of supervising day-to-day production, their ideas will be haphazard, fortuitous and too late.

It is hoped that this paper will have stimulated your thoughts on producion planning and a few of its allied subjects. Perhaps, when you go back to work on Monday and start looking round for your new Methods Research officer, you may think it appropriate to give him, as his first task, the job of studying and improving your planning system.

The writer acknowledges and thanks the Director of the State Dockyard for permission to publish this paper.

DISCUSSION.

PRODUCTION PLANNING AND MANAGEMENT IN SHIPBUILDING.

By P.G. NEWEY.

17th September, 1966.

MR. ELLIS: Newcastle.

I do not intend to ask a question but to try and stimulate a little discussion. The first thing Mr. Newey said was that he was not sure whether what we have now, called "Production Planning", under his control, is better that what we had before. I can tell you quite definitely, yes, it is better. Planning for many years in this shipyard for new ship construction was done by the Assistant Shipyard Manager and myself. Quite a lengthy process was involved in that we issued programmes to the works. They were not always carried out as we would have wished and there are only 24 hours in a day, so while one is producing Production Programmes, cannot be controlling labour. Getting back to the question of whether Production Planning is advisory or in line, I have the strongest views on this, that it should be an advisory department and leave the in line to the normal works management side to carry out the plan. I feel that the planner has done an excellent job in getting out the programme but it is up to the man that knows his ways of doing the job to put it into operation. I am a great believer in what Mr. Newey has put forward about Method Study and in making use of this to achieve the programme dates. The other thing that Mr. Newey has not mentioned in the short time available to him, is that his Department is called upon to do, in fact, a lot of these research problems. It is then up to me either to accept or reject it. Day by day these things are coming forward and I can assure uou they are most helpful, not only as to descriptive matter included but they go into quite a lot of drawing office work and produce plans. They do not leave their presentation at "we think it would be better" but he puts it "by doing it in such and such a way we estimate you can save $1000.00 per job" and I think this is very useful. One of the things we would all like to hear are your views on, is, whether Production Planning should be an advisory department or in line.

CAPT. BELL: G.I.D. R.A.N.

This is a subject very close to my heart, so I take up the challenge that Mr. Ellis just given us. We have at Garden Island, recently applied a great deal of effort to establishing what we think are the proper functions of the Planning Department. The very first thing, of course, is that they should be clear on what has to be done and then the second step is to produce some estimates. I think Mr. Newey glossed over this subject of estimates rather. He asserted at one stage that he and the team in hig planning section were as good as anybody else in producing estimates, they went round and collected information. I have some considerable reservations about this; I think you can get valid estimates by synthesising peoples' knowledge and experience. However, we have come to the conclusion that it is worthwhile putting a great deal of effort into establishing some standard base for estimating, also historical data, based on the foreman's experience, is not a valid starting point and that you really need to get down to some standard based data. This does not mean that every job has to be anylised on a sort of Method Time Measurement system, going right back to fundamentals. It does mean, on the other hand, that you have to have in your planning division, people with sufficient knowledge of jobs, to be able to relate one job to another in terms of the effort involved

in doing it and to have reliable data on the standard job. That data may have well had to be developed from quite detailed specific information but I think the success of your planning depends upon the quality of the estimates. The acceptance of planning depends on producing achievable plans for people to work to. If you put out targets which cannot be achieved, or alternatively, and I think there is a slight danger in some of the things you have advocated, allow too much latitude to the Production Division, they are apt to doubt the truth of the plan issued to them. All this is leading on to this question of how planning should fit into the managerial organisation and our conception of it is, the Planning Division should have, firstly, a basic responsibility for authorising work, for establishing what work can be done and in what time intervals for acceptance by the yard. Having done this it has a second responsibility to establish that the work is related to the available resources and particularly the labour resources. There is a second level of planning which needs to be associated with the line management in the Production Division as a direct service to foremen and that it should be fed in at a quite low level as an extension to the individual foreman or lower level management's thinking ability. If you provide this service then they will use it. In fact, we have gone so far as to assume that the people in charge of the units doing estimating at the shop level will themselves retain still the title of foreman although they will not be directly directing men but the product of what they are doing is in fact a work instruction to men. It has to be written in such terms that it can go directly to an individual employee as his work task. I felt that one of the things Mr. Newey said about producing bar charts and dividing up his free float between activities when putting them on the bar chart had considerable danger in it because it gave a great deal of latitude to the shop. You gave an individual foreman a feeling that he had plenty of time and if his estimate didn't line up with the one that went in initially, you suddenly discover that you are running behind on a particular job and it is then apt to become critical.

MR. ELLIS:
Perhaps Mr. Newey would elaborate on this one a little more as there is a definite reason behind this. He did the planning to make sure on this tug that all the drawing office work and the procurement was ready so that we could use this available labour and I think he can elaborate more on this.

MR. NEWEY: Newcastle.
First of all, regarding the question of advisory and executive planning. I am not advocating executive planning; I simply want to define the clear difference between them. We should not confuse the two.
Secondly, regarding time estimates. I take some criticism there. I do feel that one of our weak points is time estimating. We get what are, in my experience, fairly full and comprehensive estimates from our Estimating Department, but these are , of course, only for the purposes of tendering. So we can only get from these how many manhours are estimated for the job, and we have to say that if so many men are used on the job it will take so long. Very often, when a job is not on a critical path, we simply work on the time available.
The core of our time estimating is to estimate most carefully for the main stream of the work, which we regard as the hull construction - the boilermaking and shipwrighting.
We have kept records of tonnage output and have recently startedkeeping records of manhours used on each unit. We have introduced into the Dockyard an elaboration of the existing costing system so that we can now record the cost of 24 different sub-sections of the steelwork. It takes a long time to build up historical cost data, but we are getting some good data on hull construction. We consider that time estimates for the rest of the work are not quite so important. Remember that we do not plan the shop, we plan the job. We say that such-and-such a job should be completed by such-and-such a date; this date is designed to coincide with the date when the ship will be ready to receive the part in question. It requires constant liaison with the foreman to establish that he can, bearing in mind his other commitments, complete our job for when we want it.
It follows from this that correct estimating of resources is far more important than time estimating.

Now the last point - free float and its use. We give heads of department the benefit of free float because if we do not want the job any earlier, why ask for it earlier? We plan the job, so that it is ready for when the ship needs it, we do not plan the shop. We explain this to the head of department where times seem unnecessarily long. He has a lot of other work to do; he is expected to plan his own department, and this gives him the latitude to do it. We do not attempt to plan his department for him, but it is important, of course, not to give him unreasonably short times.

MR. NICHOL: Sydney Technical College.
Firstly, I would like to congratulate Mr. Newey on his paper, from our point of view at the Tech. it is good planning. On Thursday, a sub-committee was formed for the Shipbuilding Course for which I am Convenor, and Mr. Carment is on the committee. This sub-committee is for a revised syllabus in shipbuilding and from this paper today, I think that we could include in our syllabus, some of the general principles of planning in a shipyard. This committee has power to co-opt different people. For this revised syllabus, I wonder if it may be possible not only to have a paper but also to get a chart or two so that we could demonstrate to the students, that good planning is essential, not only in the shipyards but also in small boat construction where most of these boys are engaged.

MR. ELLIS:
We are always out to help the Technical College whenever possible. We provide a lot of information, as you know, to various courses and if this is to be of assistance we will certainly provide you with information on planning. I had a talk to Mr. Carment earlier on this very matter, as far as the certificate course is concerned, and it is our view that the work of a naval architect is becoming so varied compared to what it was in theory some years ago, that a specialist lecturer should be called in to give lectures on - say, production planning. Another one may be relationships in labour, subjects like this, and I think that the Colleges could take quite a lot of notice of this because I am quite sure there is no one man proficient in all the various sections. With all due respect to the lecturers at the college, they could not hope to be in touch with every point of the subject matter, although they have a knowledge of parts of it, they could not be specialists in it and I think this would help the college.

MR. NICHOL:
Just adding to that, Mr. Chairman, we have already done that at Sydney Technical College. In fibre glass, for example, we had an expert from one of the fibre glass manufacturing firms one afternoon, lecturing and demonstrating and we have had another one on varnishes.

MR. D.S. CARMENT:
This sub-committee of the trades course is very small; it only consists of Mr. James, Federal Secretary of the Shipwrights, Mr. Nichol and myself and someone from the Education Department. It is really quite a good working committee because it does not have too many people. It is a trades course, don't forget, so we can't go too deeply into these things, but there, we are vastly interested in this tenth scale because I think we must do that and also get all the equipment required. So far as the Certificate Course is concerned, I think the idea of these specialist lecturers is a very excellent one indeed, and I am very sorry that Mr. Ellis cannot be there tomorrow. Thank you for a most interesting and instructive lecture. I think you must have a few headaches and a few heartaches in the process of doing these things, but anyway, you are always moving towards some end. In these things, if you don't achieve all that you try to achieve you at least get some of the way.

MR. BRYANT: Giovenco Bros.
Referring to Mr. Nichol's remarks and suggestions, I support Mr. Carment in that I think the certificate course in itself, particularly if we are to introduce 1/10 scale and other technical developments, will be pretty full. I think such things as Production Planning, and quality engineering, etc., are very interesting and we should do them but as extra curricula subjects, not as part of this certificate course. I think this could be given thought by the Education Committee but I don't think we could put very much more into the certificate course itself.

CAPT. BELL:
Gentlemen, in view of the time we must close the discussion at this time, much as I dislike to. I wonder whether Mr. Robson might like to thank Mr. Newey on behalf of members. For those of you who may not know, he has travelled from Canberra to attend this meeting and I think it would be appropriate that he offers a vote of thanks on our behalf.

MR. ROBSON: Navy, Canberra.
On behalf of all members present, Mr. Newey, I would like to thank you very much for the time which you have spent preparing this Paper. I think everyone has been interested in the subject. I would like all members to carry a vote of thanks by acclaimation.

ACCLAMATION.

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WRITTEN DISCUSSION.

by P. EDMONDS. Cockatoo Docks.

I should like to congratulate Mr. Newey on his paper, also on what lies behind it - the way that he and his colleagues have built up the planning function at the State Dockyard.
The subject matter of this paper is becoming of increasing importance to naval architects and is worthy of forming an increasing part of their training. In fact, Mr. Newey was one of the first to qualify under a degree course that gave emphasis to more general shipbuilding studies rather than some aspects of design theory.
The points that follow, inspired by this paper, are put forward for comments.

On the use of computer programmes for network analysis in the Shipyard, I feel there are two conditions that encourage this:
1. Where a sophisticated technique of analysis is being used, such as resource allocation or P.E.R.T. - type multiple time estimates for activities.
2. Where the production control situation in the yard is such that the computer print-out can be used directly without further transcription, for issue as a working programme.

Otherwise, calculation manually can be a saving in time and cost, particularly when one considers the greater vigour required in defining the activities and their logical relationships required for a computer analysis than required for analysis by a planner, capable of exercising discretion. This assumes that the network containing more than a few hundred activities appears to require the backing of a fairly sophisticated production control system to gain its full potential.
I would like to endorse Mr. Newey's comments on the desirability of introducing teams on full time methods research, particularly as it was my privilege to work in such a team for a period. In practice, a major contribution that such a team can make in the evaluation and presentation of ideas for improvements is the ready access to appropriate data for comparative costs, arising from frequent work in this field. This is in addition to the obvious advantages of time to deal with such matters and expertise in such work.

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